Annexure II - Terms of Reference

Consultancy Services for Update of DPR including Environmental and Social Impact Assessment (ESIA) of 770 MW Chamkharchhu I Hydropower Project

1 Introduction

The Detailed Project Report (hereafter referred to as the "DPR 2015") for the Chamkharchhu I Hydropower Project was initially prepared in February 2015 by the National Hydroelectric Power Corporation (NHPC). As nearly a decade has passed since the completion of these studies, Druk Green Power Corporation Limited (DGPC) has initiated plans to update the DPR to ensure the project's alignment with current hydropower development frameworks, engineering advancements, and policy directives. DGPC intends to partner with strategic partner from India to develop this flagship project under PPP model with majority shareholding by DGPC.

Located in Zhemgang Dzongkhag, in the central-southern region of Bhutan, Chamkharchhu I is designed as a run-of-river hydropower scheme, strategically positioned to harness Bhutan's rich hydropower potential while maintaining environmental sustainability.

The proposed dam is situated across Chamkharchhu, approximately 1,515 meters upstream of the suspension bridge along the route to Khomsar village. The underground powerhouse, designed to optimize operational efficiency and minimize environmental impact, is strategically located inside the mountain on the right bank of Chamkharchhu, directly across from Digala village. The site is accessible via a proposed road spanning approximately 29 kilometers from the dam location.

The Head Race Tunnel (HRT), spanning 19.20 kilometers, facilitates water conveyance and is structured with three intermediate construction adits to enhance accessibility during construction. These adits are strategically positioned as follows:

- First Adit: Left bank of Raidigongchhu, near Zangling village
- Second Adit: Right bank of Chamkharchhu, opposite Julambi village
- Third Adit: Left bank of Kirgongchhu

Additionally, the Surge Shaft and Pressure Shaft are located on the right bank of Chamkharchhu within the Duenmang Pam area, directly across from Digala village.

The project location with project components are shown on the map below:

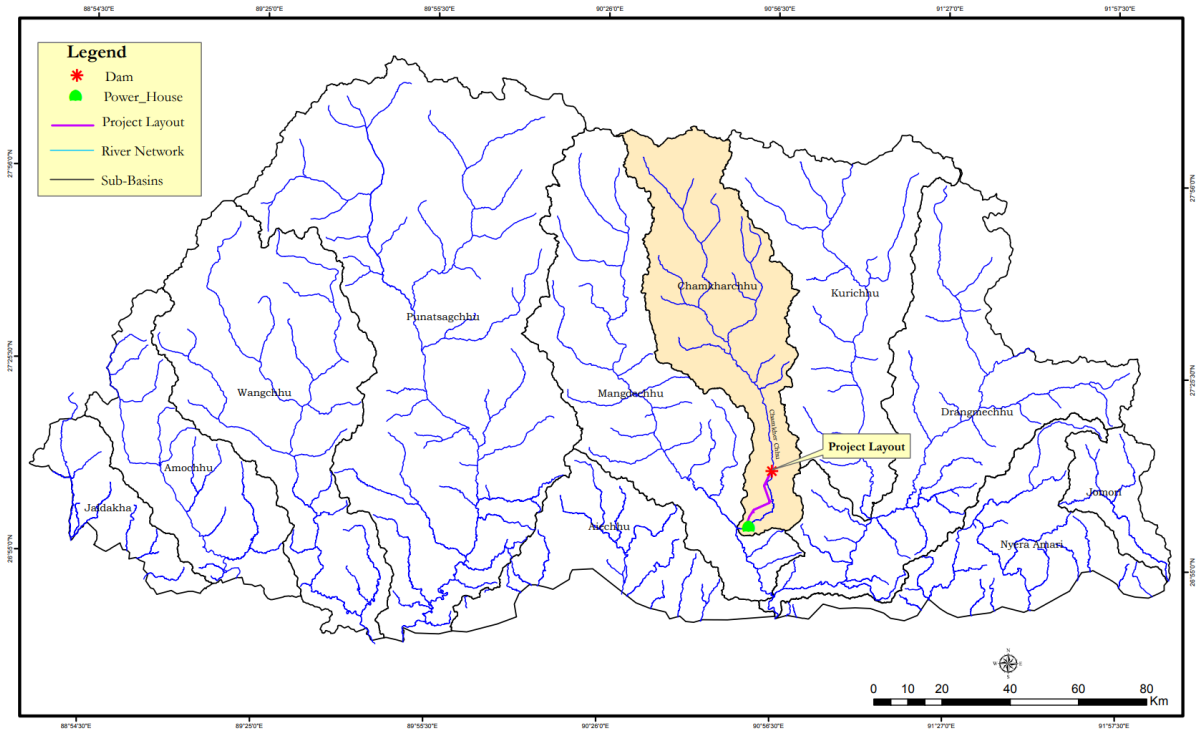

Figure 1: Project location and project component

The project envisages an installed capacity of 770 MW with total energy generation of 3,344.47 GWh annually. The salient features and layout of the project as per the DPR 2015 is as below:

Salient Features of the Project

Catchment area	km^2	2,891
Maximum Water Level (MWL)	masl	857
Full Reservoir Level (FRL)	masl	855
Minimum Operating Level (MOL)	masl	848
Dam type	-	Concrete gravity dam
Crest length of dam	m	149.5
Riverbed level at dam site	masl	777
Maximum height of dam above deepest foundation	m	108
Average Length per penstock (including shaft length)	m	96
Powerhouse (underground)	m	200 x 23.5 x 49.7
Installed capacity	MW	770 (4 x 192.5)
Design discharge	m^3/s	162
Centerline of turbine	masl	279
Rated net head	m	540
Design energy in 90% dependable year	MU	3,344.47
Machine type		Pelton

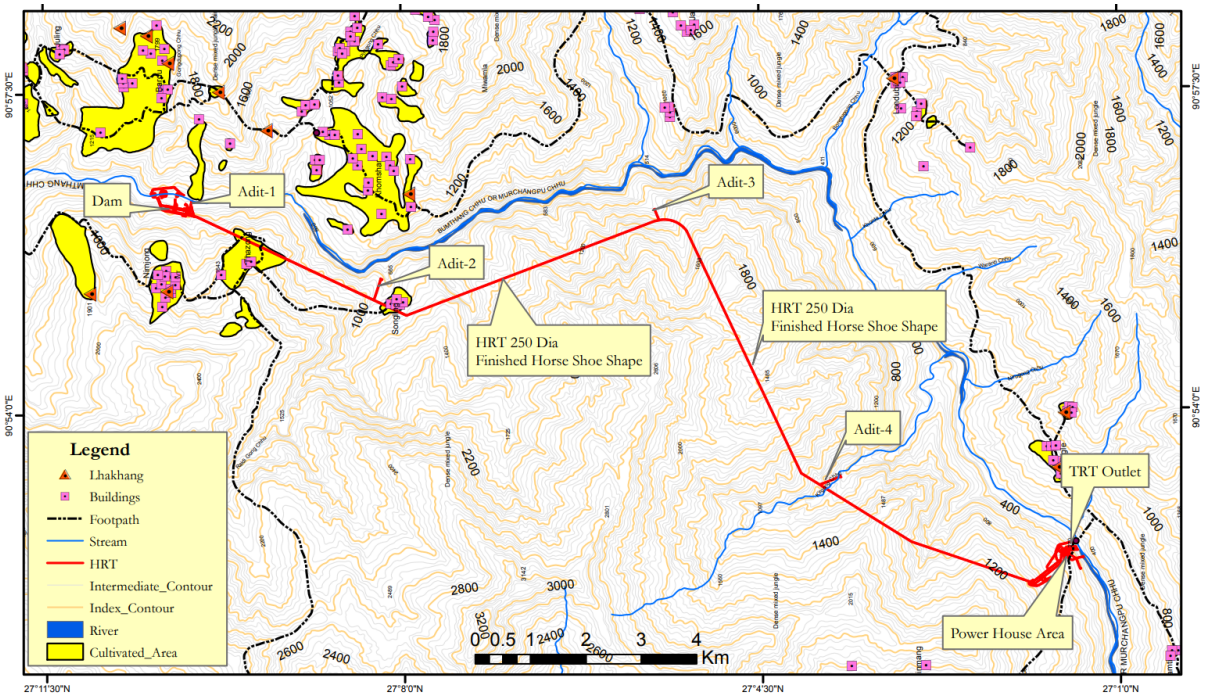

Figure 2: Project layout

As per the Detailed Project Report (DPR 2015), the proposed dam site for the Chamkharchhu I Hydropower Project is located on Chamkharchhu, near Khomsar village (27°10'21" N, 90°56'24" E). The underground powerhouse is positioned on the right bank of Chamkharchhu, opposite Digala village, approximately 29 kilometers from the dam site by road and 57 kilometers from Tingtibi, situated along the Gelephu-Zhemgang-Trongsa highway.

Additionally, the sites for Diversion, Intake, and De-silting basins are positioned about 80 kilometers from the nearest road head at Dakpai, along the Gelephu-Trongsa highway, ensuring logistical connectivity for future project development.

Following NHPC Limited's engagement in the project, a team of experts conducted a detailed reassessment of the dam and powerhouse locations originally proposed by Norconsult. The initial dam site suggested by Norconsult was positioned 500 meters downstream of the suspension bridge; however, geological investigations revealed significant challenges.

- The left bank was characterized by substantial overburden, with exposures of granitic gneiss observed at higher elevations.
- A landslide was identified 250 meters downstream of the suspension bridge, raising concerns regarding slope stability.
- Further analysis indicated creep movement on the left bank, evidenced by the bending of tree trunks, suggesting long-term instability.

Given these geological constraints, the Norconsult-proposed site was deemed unsuitable for dam construction. As the possibility of locating the dam further downstream was not viable, an alternative site was identified 1,515 meters upstream of the suspension bridge. This revised location provided improved geological stability, addressing concerns related to slope movement and foundation integrity.

2 Objective of the Consultancy Services

The primary objective of this DPR update Consultancy Services is to review and update the Detailed Project Report (DPR) for the Chamkharchhu I Hydropower Project, ensuring compliance with international standards and best practices while aligning with the Bhutan Guidelines for the Development of Hydropower Projects 2018 (Revised 2024). The Consultant will play a pivotal role in providing

comprehensive technical guidance and validation throughout the DPR process, ensuring the project's feasibility, sustainability, and strategic alignment with Bhutan's hydropower roadmap.

The Consultant will be fully responsible for executing all major and minor work packages related to the design and engineering of the project. This includes refining technical specifications, optimizing project components, and ensuring seamless integration across hydrological, geological, and structural disciplines. Additionally, the Consultant will foster a collaborative partnership among all involved engineers, promoting interdisciplinary coordination and knowledge exchange. This approach will not only ensure the successful completion of the DPR but also facilitate effective technology transfer and capacity building, strengthening Bhutan's local expertise in hydropower development.

Beyond technical execution, the Consultant will support the project proponent in achieving environmental and social compliance, a critical prerequisite for securing regulatory approvals. This will be accomplished through an update of the Environmental and Social Impact Assessment (ESIA), a key document required to obtain environmental clearance from the Department of Environment and Climate Change, as well as other statutory permits, including social approvals and forestry clearances.

The ESIA will provide a comprehensive evaluation of the project's environmental, economic, and social impacts, identifying potential risks and proposing avoidance, minimization, and mitigation measures for any adverse effects. Moreover, it will outline strategies to enhance environmental sustainability and maximize socio-economic benefits, ensuring that the project contributes to Bhutan's long-term energy security and community development objectives.

By ensuring a comprehensive evaluation of technical, environmental, and social aspects, this DPR update aims to strengthen project viability, optimize design efficiency, and align with Bhutan's hydropower development strategy. The Consultant's expertise will be instrumental in refining the report to facilitate informed decision-making and successful project implementation.

3 Scope of Work

The Consultant will undertake a comprehensive review and update of the Detailed Project Report (DPR) for the Chamkharchhu I Hydropower Project, ensuring that it meets the latest guidelines and aligns with international best practices for project bankability. In addition to revising existing documentation, the Consultant will be responsible for preparing any missing chapters or reports, addressing gaps to enhance the feasibility and financial viability of the project.

The broad scope of the DPR review and update will be structured as follows:

- Technical Design and Engineering:
  - Optimization of hydrological, geological, and structural components
  - Validation of design parameters to meet current regulatory and operational standards
  - Incorporation of advanced engineering methodologies for efficiency and sustainability

- Environmental and Social Impact Assessment (ESIA):
  - Updating the ESIA to meet regulatory requirements, including environmental clearance from the Department of Environment and Climate Change
  - Identifying potential environmental, economic, and social impacts and proposing mitigation strategies
  - Addressing key sustainability concerns and enhancing community engagement strategies

Any additional investigations or information required for the DPR update will be conducted or provided by Druk Green Power Corporation Limited (DGPC) as necessary to support the Consultant's review process.

4 Brief Description of Tasks under Technical and Engineering

The subsequent sections provide a detailed overview of the tasks to be undertaken for the technical and

engineering review as part of the DPR update.

4.1 Field Topographical Survey & Mapping

Detailed topographic surveys of the project area were conducted utilizing in-house capabilities of Project Investigation Division, NHPC. Control points were established in dam and powerhouse area utilizing Differential Global positioning system (DGPS). Reference levels were taken from the two bench marks points established by Survey of Bhutan at Dakphel (El. 1331.3549 m) and Mangdechhu bridge (El. 540.5514 m). The topographic contour plans at a 1:10,000 scale (10m contour interval) using remote sensing data (World View) was developed with limited ground checks. These topographic maps have been utilized for geological mapping and planning/ studying alternative layouts of the project.

The consultant shall review the adequacy and quality of the field topographical survey and mapping that will be used for detailed design and engineering purposes. While reviewing the works, they shall provide expert value additions for completion of tasks as per required standards.

4.2 Field Geological & Geotechnical Investigations and Tests

Detailed geological mapping of the dam and powerhouse area has been carried out on 1:1000 scale with an objective to define various litho-units along with geotechnical characteristics anticipated for major components of the project. Map has been reproduced on 1:2000 scale for incorporation in DPR. During mapping, different rock types and overburden material have been classified. At dam and powerhouse site the rock and overburden boundaries were marked. For geological mapping of reservoir area, beside remote sensing studies, traverses were taken along the reservoir rim to demarcate different type of overburden/rock and to identify potential zones of landslides, if any, to establish overall stability of the reservoir rim.

Geophysical surveys involving seismic refraction profiling for a cumulative length of 700 m has been carried out in the vicinity of alternative dam axes. In all six seismic profiles (P1-P6) were laid. The location of seismic profiles for final dam axis is given in table and is detailed as under:

SN	Seismic Profile	Profile Length	Location
1	Profile P-6	130 m	Final Dam Axis, Left Bank

Subsurface geological conditions were assessed by exploratory drilling for various components of the project. In total 29 exploratory bore holes for a cumulative depth of 2,191 m were completed in dam, HRT & powerhouse area. The dam and its appurtenant structures have been explored with a backup of 15 drill holes for a cumulative depth of 891m. In addition, 4 drill holes of 50 m depth each were also executed for groutability test at dam. The HRT has also been explored by 05 drill holes having cumulative depth of 540 m in low cover reaches. Exploratory Drilling in powerhouse area was carried out by five number of drill holes aggregating to a cumulative length of 560 m. One drill hole PDH-1 of 50 m depth was carried out to establish the overburden thickness above powerhouse cavern. The entire depth of surge shaft has been explored by a 190 m deep drill hole (PDH-2). Similarly, two drill holes PDH-3 and PDH-4 were drilled for a depth of 70 m & 80 m respectively in pressure shaft area. In addition, one drill hole of 170m depth has been completed above the powerhouse cavern.

Summarized log of exploratory drilling is as under:

SN	Hole No	Location	Collar EL (m)	Total Depth (m)	Bedrock Depth(m)/ EL (M)
1	DDH-03	Final Dam Axis, Right Bank (Inclined 60° from Horizontal)	777.3	68	30.5 (El±750.9 m)
2	DDH-04	35m u/s of Final Dam axis, Left Bank	780.01	60	15.5 (El±764.5 M)

SN	Hole No	Location	Collar EL (m)	Total Depth (m)	Bedrock Depth(m)/ EL (M)
3	DDH-05	Left Bank River edge, Final Dam Axis	778.3	60	12m (El±766.3 M)
4	DDH-06	Final Dam axis, Midstream	777.8	90	20.6 (El±757.2 M)
5	DDH-07	U/s coffer dam	781.85	45	21.15 (El±760.7 M)
6	DDH-08	Dam toe, Left bank	774.57	80	16.4 (El±758.17 M)
7	DDH-09	Plunge pool, Right bank	771.54	50	20.4 (El±751.14 M)
8	DDH-10	D/s coffer dam, Right bank (Inclined 60°)	770.75	45	23.5 (El±750.35 M)
9	DDH-11	Desilting Chamber area	941.2	50	13.25 (El±928 M)
10	DDH-12	Right bank debris cone, 220m d/s of dam axis	805.74	51	25.5 (El±780.24 M)
11	DDH-13	Dam axis, Left bank	781.5	50	10.5 (El±771 M)
12	DDH-14	Dam toe, Right bank	774.6	50	18 (El±756.6 M)
13	DDH-15	Diversion Tunnel	864	50	11.50 (El±852.5 M)
14	GH-01	Groutability Holes	782.1	50	9 (El±773.1 M)
15	GH-02		782.2	50	10.5 (El±771.7 M)
16	GH-03		782.3	50	11 (El±771.3 M)
17	GH-04		782.1	50	12 (El±770.1 M)
18	PDH-01	Power House area	486.75	50	18.5 (El±468.25 M)
19	PDH-02	Surge shaft area	957.61	190	32 (El±925.61 M)
20	PDH-03	Pressure shaft	856.44	70	44 (El±812.4M)
21	PDH-04	Pressure shaft	742.68	80	60 (El±682.6 M)
22	PDH-05	Power House	459.52	170m	30 (El±429.52 M)
23	DHRT-01	Raidigongchu	915	120	46.5 (El ±868.5 M)
24	DHRT-02	Menalagongchhu	896.3	120	21.5 (El ±874.8 M)
25	DHRT-03	Adit 3 Area	867.5	100	9.0 (El ±858.5 M)
26	DHRT-04	Kirgongchhu	858.97	80	64.0 (El ±794.97 M)
27	DHRT-05	Rumti	851.9	120	45.5 (El ±806.4 M)

The left and right abutment of proposed dam have been explored by 30 m drift with 10 m cross cut in upstream and downstream direction, to assess the subsurface condition and conducting rock mechanic tests. Moreover, an exploratory drift of 158 m length with 42 m cross cut in upstream direction has been excavated to explore the Desilting chambers. A 260 m long exploratory drift has been excavated in the power house area to delineate the subsurface geological conditions. Further, a 200 m long cross cut along the longer axis of powerhouse cavern is completed. The details of exploratory drifts are tabulated below:

SN	Project Component	Location	Total Length (m)	Invert Elevation
1	Dam	Left abutment	30m + 10m (u/s X-cut) + 10m (d/s X-cut) = 50 m	El±813 m
		Right abutment	30m + 10m (u/s X-cut) + 10m (d/s X-cut) = 50 m	El±809 m
2	Desilting Chamber	Right bank	200 m	El±830 m
3	Powerhouse	Power House main drift	260 m	El±313 m
		Upstream crosscut	140 m	El±317 m
		Downstream crosscut	60 m	El±317 m

The laboratory tests on core samples/lump samples have been conducted to determine the physical and engineering properties of the rock mass.

The Consultant shall review the quality and adequacy of field geological and geotechnical assessments including requisite in-situ and lab tests while updating the DPR. Any new investigations required shall be proposed to DGPC for further action.

4.3 Project Layout and Alternative Studies

The project is a run-of-river hydropower scheme, utilizing a concrete dam, Pelton turbines, and Underground Powerhouse layout. The layout and design were modified based on detailed surveys, geological studies, and feedback from the Royal Government of Bhutan (RGOB), Central Water Commission (CWC), and Central Electricity Authority (CEA). Key changes include relocating the dam axis, changes in the head race tunnel (HRT) alignment and intermediate adits for construction feasibility and modifying shaft arrangements for better construction and operational efficiency. The project involves a 108m high concrete gravity dam, a 19.2 km head race tunnel, surge shafts, and an underground powerhouse. Key components include intake structures, de-silting basins, pressure shafts, and tail race tunnels. Temporary diversion works will include a diversion tunnel and cofferdams. After site visits and detailed investigations, the final dam location was selected 1515m upstream of the suspension bridge.

The consultant should review and validate the detailed project layout and alternative studies including the dam axis relocation, head race tunnel changes, and shaft adjustments, and confirm the dam location 1,515m upstream of the suspension bridge.

4.4 Power Potential and Optimization Studies

The project is a run-of-river scheme with small pondage, utilizing Chamkharchhu's inflows to generate power in an underground powerhouse. It is an installed capacity of 770 MW, features four 192.5 MW Pelton turbines with overall efficiency of generation as 90.6%. The scheme can be operated as a peaking station with a live storage of 2.677 million cumec. Power generation studies were based on 20 years of discharge data from June 1991 to August 2011. Downstream release of 2.655 cumec has been considered for sustenance of aquatic and other environmental needs. The Full Reservoir Level (FRL) is set at EL 855.0 m, with a Minimum Drawdown Level (MDDL) at EL 848 m. The turbine center line is at EL 279.0 m, with a design head of 540 m and head losses considered at 33.5 m.

The optimum installed capacity is 770 MW, chosen from a range of 720 to 810 MW based on power potential studies. Energy generation for the 90% dependable year is 3,396.54 MU, with a design energy output of 3,344.47 MU at 95% machine availability. The project will meet a minimum daily peaking requirement of 3.5 hours, providing full capacity peaking support throughout the year. The Consultant shall review and update the power potential and plant optimization in accordance with the relevant sections of the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024) and considering the Power Market Study.

4.5 Preparation of Geological and Geotechnical Appraisal Reports of the Project including development of geological and geotechnical models as well as all the geological sections, notes and drawings including construction material survey

A 65 m high dam was initially proposed by Norconsult without detailed surveys. Later, NHPC conducted thorough geotechnical investigations and found the right bank geologically sound with exposed granitic gneiss, while the left bank was unstable due to slope wash, creeping movement, and a major landslide 250 m upstream of the proposed dam site. Therefore, it was shifted upstream about 1,515 m from the suspension bridge.

The powerhouse complex is located on the right bank of Chamkharchhu, about 3.5 km upstream of its confluence with the Mangdechhu. Site investigations including geological mapping, drilling, and drifting were conducted to assess subsurface conditions. Key components include a 144.5 m high, 18 m diameter surge shaft, two 957 m long pressure shafts (4.25 m dia) splitting into four 3.0 m dia penstocks each, a powerhouse cavern (23.5 m × 200 m × 49.7 m), a transformer cavern, and four 5.0 m diameter tailrace tunnels.

As part of the geotechnical appraisal, geological mapping and data from the powerhouse exploratory drift were used to interpret rock conditions along the Tail Race Tunnel (TRT). The TRT is expected to pass through moderately jointed, strong blocky quartzite with minor weak phyllite bands. Due to the perpendicular foliation to the tunnel axis and gentler dips, there is a risk of slab failures at the crown and potential wedge failures at joint intersections. The anticipated rock class distribution is 15–20% Class II, 65–70% Class III, and 10–15% Class IV/V, with appropriate support measures recommended. Excavation around steep outlet slopes will require careful execution and timely support to ensure stability.

The Consultant shall review and validate all geological and geotechnical appraisal reports, including geological and geotechnical models, sections, notes, drawings, and construction material surveys, ensuring compliance with relevant standards and codes. Any new investigations required shall be proposed to DGPC for further action.

4.6 Preparation of Geotechnical Baseline Report (GBR)

Based on the geological and geotechnical investigations appraisal report, the Consultant shall prepare a GBR according to "ASCE 2007, Geotechnical Baseline Report for Construction - Suggested Guidelines" and in line with the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024). The GBR shall describe the geological and geotechnical baselines of the site conditions and outline the range of conditions that a future contractor for civil works may expect.

4.7 Hydrological Study Report (Water Availability, Design Floods & Diversion Floods)

A large portion of the Chamkharchhu catchment is located at high altitudes and is fed by snowmelt and glaciers. From May to October, the river carries high discharges due to monsoon precipitation. The minimum flows occur during the winter months of December to March. NHPC has also established a G&D site near proposed dam site (w.e.f. May 2009), near Digala Bridge (w.e.f May 2010) and a gauge site near TRT outlet (w.e.f. Jan 2011). The velocity at these sites is observed by float method and discharge is calculated by area velocity method after observing water levels and measuring cross-section at G&D sites. However, no more measurements were taken after completion of the DPR.

Reservoir elevation area capacity curve has been computed by using river cross-sections available upstream of dam site on Chamkharchhu. The cross sections are available at an interval of around 100 m up to 1000 m u/s of dam axis and at an interval of around 500 m afterwards. A 108 m high concrete gravity dam above river bed is proposed at dam site on Chamkharchhu with gross storage capacity of 13.06 million cumec at FRL i.e., EL 855 m. The criteria of selection of inflow design flood for safety of dam is adopted as per IS:11223-1985. IS:11223-1985 is Indian standard on guidelines for fixing spillway capacity, which was adopted by Indian Standards Institution on 13 February 1985 and reaffirmed in 1995.

The Consultant shall review, validate on the study undertaken on hydrological study report in DPR and update it with the latest data to meet the standards.

4.8 Sedimentation Studies

The Chamkharchhu-I HPP includes a concrete gravity dam with a gross storage capacity of 13.06 million cumec at FRL 855 m and a reservoir length of 2.9 km. As a run-of-the-river scheme, sedimentation studies were conducted to estimate long-term reservoir stability under proper flushing and maintenance. Cross-sections were surveyed at intervals to create the elevation-area-capacity curve. Sediment distribution was analyzed using DHI's MIKE-11 software, along with methods such as the Area-Increment and Empirical Area Reduction Methods for reference.

The long term suspended sediment data is not available in entire Chamkharchhu basin. NHPC has established a suspended sediment observation site near dam site at Thazong with effect from August 2009. The suspended sediment data is also available at the site Bjizam with catchment 1,393 sq.km in adjacent Mangdechhu basin where suspended sediment data is available from Jun 1995 to Dec 2006 with some missing data. The suspended sediment data has only coarse and fine component. The objective to study the sedimentation of the reservoir is to estimate the profile of the reservoir after a certain year of sedimentation when it takes shape of permanent channel and river bed becomes stable and there is no further deposition of sediment into the reservoir, if proper flushing and maintenance of the reservoir is done regularly.

The Consultant shall evaluate and assess the sediment inflow in the river system, model of reservoir sedimentation, a long-term sediment management strategy and plan including the measures to retain and sustain the active storage.

4.9 Hydraulic and Structural Analysis and Design including Plant Optimization of the Project using Numerical Modeling as well as Project Instrumentation

The Consultant shall carry out all review hydraulic and structural analysis and design including plant optimization of all civil components of the project and update it using agreed numerical modeling in conformance with standard norms, codes and practice. The project instrumentation shall be reviewed and updated by the Consultant in accordance with the latest codal provisions and relevant guidelines.

4.10 Site Specific Seismic Hazard and Design Parameter Studies

The seismicity of project area was determined by the Indian Institute of Technology, Roorkee, India, by preparing a seismic hazard map of Bhutan. According to the map, Thimphu, Paro, Punakha, Bumthang and Trongsa valleys fall in low to moderate hazard areas, while Haa, Chukha, Trashigang, Mongar, Lhuentse and Trashiyangtse and the eastern part of Bhutan are located in high to very high-risk areas. According to the map, the Chamkharchhu-I project lies in low to moderate hazard zone.

The project site lies within the Bhutan Himalayas, an area influenced by active tectonic features such as the Main Central Thrust (MCT), Main Boundary Fault (MBF), and Main Frontal Thrust (MFT). Seismic hazard assessments were based on detailed literature, historical earthquake data, and regional seismotectonic mapping. Notable seismic events in the region include the 2009 Mongar earthquake (M6.1), which caused significant damage, and historical high-magnitude earthquakes in neighboring areas (e.g., Shillong 1897, M8.7 and Assam 1950, M8.5). Geological studies indicate the project spans the Higher Himalayan

Crystalline and Shumar Formation, with the MCT crossing the HRT alignment. In-situ shear wave velocity was assessed using MASW techniques, yielding an average Vs (30) of 834 m/s.

Site-specific seismic studies by CWPRS, Pune, determined the following design parameters:

- Peak Ground Acceleration (PGA): 0.362g (horizontal), 0.230g (vertical) for Maximum Credible Earthquake (MCE)
- Design Basis Earthquake (DBE): 0.210g (horizontal), 0.108g (vertical)
- Horizontal Seismic Coefficient (αh): 0.224g
- Vertical Seismic Coefficient (αv): 0.149g

The consultant shall review and finalize all seismic design parameters for the dam and associated structures in accordance with the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024) and ICOLD guideline for large dam. They will determine the relevant seismic coefficient for design of main project components, dam and appurtenant structures.

4.11 2D and 3D Linear and Non-linear Dynamic FEM Analysis and Design of Dams using Acceleration Time Histories

The Consultant shall carry out 2D and 3D linear and non-linear dynamic FEM analysis of the final configuration of the dam structure, using the agreed software, to confirm the stability (sliding displacement) and cracking of the dam under seismic conditions. The analysis shall be made for the full MCE using acceleration time histories and shall include the rock mass of the foundation. Post- earthquake static stability analysis assuming a fully cracked section shall also be performed by the Consultant.

4.12 Transient Analysis of the Project

A hydraulic transient study was conducted for the Chamkharchhu-I HPP to analyze flow and pressure variations (transients) during turbine operations, as per Indian Standards. The analysis used the WHAMO 3.0 software developed by the US Army Corps of Engineers, which simulates dynamic behavior in fluid systems including turbines, valves, surge tanks, and pipelines. WHAMO applies an implicit finite difference method to calculate time-varying flows and heads.

Hydraulic transient analysis for the upstream waterway proposes a restricted orifice-type surge tank with an 18 m diameter and 18.98 sq.m orifice area. The maximum upsurge and down surge levels are EL 924 m and EL 786 m, respectively. The detailed studies are documented in Hydrology Volume III, Part-I of the DPR, which can be made available by DGPC if required. The transient analysis for the project shall be reviewed and updated by the Consultant in accordance with the relevant standards and codes using agreed software tools.

4.13 Reservoir Rim Stability Assessment and Remedial Measures

The accessibility to reservoir is poor due to challenging terrain. The right bank is accessible only via a narrow footpath at higher elevations, traversing dense forest and steep cliffs. A steel suspension bridge is located downstream of the reservoir tail for river crossing. The area is heavily forested, with human settlements situated well above the reservoir rim - Nimsong village on the right bank (around EL 1600 m), and Bardo and Juling villages on the left bank (around EL 1800 m). The Chamkharchhu-I reservoir lies in a narrow gorge with steep escarpments on both banks, where the river flows north to south. Major tributaries include Gandugong Chhu and Juling from the left bank, and Thendigong Chhu from the right bank near the reservoir tail. Therefore, remote sensing studies of the reservoir area were conducted with limited field geological mapping was carried out on a 1:10,000 scale, along with field checks.

Geological mapping of the reservoir area reveals several types of overburden/unconsolidated sediments, including, River-borne material, River terraces and Slope wash material under dense vegetation. The riverbed is covered with medium to large boulders and pebbles, primarily consisting of granite gneiss, augen gneiss, quartzites, and riverine sand. Small shoals and river terraces are found along both banks. Slope wash

material, found at higher elevations, includes rock fragments of gneiss and schist mixed with silty soil. While there is no cultivated land within the reservoir area, the higher slopes above the reservoir rim are used for maize and paddy cultivation.

The reservoir's bedrock is part of the Sure Formation, a lower unit of the Higher Himalayan Crystalline. It consists of medium-strong, slightly weathered garnetiferous quartz mica schist and granitic gneiss. The main discontinuity is foliation planes dipping upstream, with steep rock faces influenced by S-3 joints. A southwest-trending lineament, parallel to the S-3 joint, was identified from satellite imagery. The slopes near the FRL are stable, with no signs of landslides or instability. Both banks are made of strong schistose/gneissic rocks, with no fractured zones. The narrow valley results in minimal submergence, and no impact on settlements. No mineralization or mining activity was observed, and no economically important minerals will be submerged. The reservoir formed by the Chamkharchhu-I Project is small and situated in a narrow valley. Field investigations show no significant fractured zones along the riverbanks. The river occupies the lowest elevation, and there are no major depressions in the surrounding areas, so leakage from the reservoir banks is not anticipated.

The consultant shall review and validate the potential failure of slopes along both the banks of the reservoir in accordance with the standard norms, codes and practice using appropriate software.

4.14 Glacial Lake Outburst Flood (GLOF) studies

A review of past studies and basic data on glacial lakes and GLOFs was conducted, focusing on their potential impact on the Chamkharchhu project. A GLOF discharge of 5,112 cumec was estimated at the proposed dam site. This estimate was submitted to the FE&SA Directorate of CWC and was approved as per their letter dated 27.11.2012. The detailed glaciology studies, along with annexures and figures, are included in Hydrology Volume-III, Part-II of the DPR. The Consultant shall review and update the inventories of the glacial lakes in the catchment and shall be endorsed by DGPC. Selection of the potentially most dangerous lake/lakes for the project will have to be carried out by the Consultant which needs to be approved by DGPC to take forward the analysis. The GLOF analysis and routing considering the approved glacial lake/lakes shall be carried out by the Consultant. The studies shall be based on Digital Terrain Model (DTM) data and satellite imageries using appropriate software tools and image resolution.

4.15 Dam Break Analysis including Preparation of Hazard Zonation and Classification Assessment

The dam break analysis for the Chamkharchhu Project involved a detailed hydrological modeling and glacial lake assessment to evaluate flood risks from potential Glacial Lake Outburst Floods (GLOFs).
Snow cover and streamflow Modelling:

Remote sensing data was used to estimate snow cover, with a permanent snowline set at 5000 m elevation. A hydrological model was calibrated using streamflow data from 2004–2006 and validated for 2006–2008, showing high model efficiency (R^2 between 0.87–0.91). The model successfully simulated daily streamflow, and runoff components—rainfall, snowmelt, and base flow—were calculated separately. Rainfall was found to be the primary contributor, accounting for nearly half of the total runoff.
Glacial Lake Inventory:

Using GIS and satellite imagery, an inventory of glacial lakes in the 2904 km^2 project area was created. Between 2006 and 2008, the number of lakes increased from 372 to 433. Most lakes are located above 3500 m, with Chubda Lake identified as the largest and most hazardous due to its increasing size and elevation above 5000 m.

GLOF and Dam Break Simulation:

The MIKE 11 hydrodynamic model was used to simulate a breach scenario with a breach width of 112 m. The GLOF peak discharge was estimated at 11,030 cumec, which attenuated to 5,112 cumec at the project site when combined with a 100-year return period flood (1500 cumec), and to 4430 cumec with an average

flood of 641 cumec. The travel time of the flood peak from the lake to the dam site ranged between 3 hours 10 minutes and 3 hours 30 minutes, depending on the flood scenario.

The detailed Dam break analysis is included in Hydrology Volume-III, Part-II of the DPR, which can be made available if required by DGPC. The Consultant shall review and validate the Dam break analysis performed conforms to the relevant international standard such as FEMA, USACE, USBR and Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024).

4.16 Design of Electro-Mechanical Equipment

The Consultant shall review and update the plan and design the electro-mechanical equipment of the project including updating of drawings.

1. Turbine - Considering the available head and discharge, a vertical axis 6-jet Pelton turbine with a synchronous speed of 250 rpm is deemed the most efficient choice. The turbine will have a rated output of 195.43 MW, based on a generator efficiency of 98.5%, and will operate under a design head of 540 meters, with a provision for 10% overloading. To endure silt abrasion, the Pelton runner and injector nozzles will be made from high-quality stainless steel.
2. Penstock Valve - Two butterfly type valves of 4.25 m diameter each will be provided between the surge shaft and the penstock inlet to shut off water to permit the dewatering of penstock in reduced time.
3. Generators - Each synchronous generator would be of vertical shaft, salient pole type, 3ϕ, 50Hz directly coupled to the turbine. It would be rated for a continuous output of 192.5 MW at a power factor of 0.90 and a rated voltage of 13.8 kV with a 10% continuous overloading capacity. The generator bearing arrangement shall be of suspended type.
4. Excitation System - The excitation system of the generator would be of the static type and shall include digital type voltage regulator, field suppression equipment and the associated accessories. The power for the excitation system would be obtained from a dry type excitation transformer, connected directly to the generator voltage bus.
5. 13.8 kV Bus Duct - Each generator would be connected to its step-up transformer by means of air insulated isolated phase bus ducts.

4.17 Design of Hydro-Mechanical Equipment

The design of hydro-mechanical equipment of project and its specifications are listed below:

1. Diversion Tunnel Gates and Rope Drum Hoists
    - One horseshoe-shaped diversion tunnel (9.5m diameter) on the left bank.
    - Two fixed wheel gates (5.0m x 9.5m) for tunnel closure at EL 782.00 m.
    - Electrically operated rope drum hoists (115T capacity) at deck level EL 815.00 m.
    - Designed for heads up to EL 855.00 m.
2. Spillway Radial Gates, Hydraulic Hoists, Stop Logs, and Gantry Crane
    - Five radial gates (10.5m x 13.0m) with crest at EL 810.00 m.
    - Operated by hydraulic hoists (2x230T cylinders) under unbalanced head up to EL 857.00 m.
    - Teflon-coated rubber seals, stop logs (10.5m x 16.5m) operated with 65T gantry crane.
5. Power Tunnel Intake Gates, Hoists, Bulkhead Gate, Trash Rack & Cleaner
    - Two intake gates (5.3m x 6.0m) with 75T hoists.
    - Bulkhead gate (5.3m x 6.0m) in 3 units, lifted using a 45T EOT crane.
    - Trash racks (6.3m x 15m) cleaned using a 1T rail-mounted machine.
7. Silt Flushing Gates & Hydraulic Hoists
    - Slide type gates (2.0m x 2.0m) operated under unbalanced head using 180T hydraulic hoists.
    - Emergency gates also provided for maintenance with similar specs.
8. Surge Shaft Gates and Rope Drum Hoists
    - Two slide gates (4.25m x 6.0m) at EL 773.745 m with 50T rope drum hoists.
    - Designed for head up to surge level EL 894.0m.
9. Tail Race Tunnel Gates and Rope Drum Hoists
    - Four wheeled gates (5.0m x 5.0m) for isolating generating units.

- Operated with 35T rope drum hoists under head up to EL 293.30 m.

The Consultant shall review and update the plan and design of the hydro-mechanical equipment of the project including updating of drawings.

4.18 Construction Methodology, Equipment Planning and Project Scheduling

Construction methodology and selection of equipment has been planned with the aim to commission the project in a total period of 108 months (including infrastructure works). Major construction works shall start from 25th month after necessary initial mobilization, & the project shall be commissioned in 108th month. Available working season in a year in the project area shall be 12 months for all underground works & 8 months for surface works.

Construction of 1 number horse shoe shaped diversion tunnel of 9.5 m finished dia and 600 m long will commence from 27th month and will be completed in 6 months. 99800 cum & 12700 cum material have been proposed for construction of U/s & D/s Coffer dams respectively. The 17 m high upstream & 8 m high downstream Coffer dams will be constructed in a period of 4 months from 37th month to 40th month and 3 months from 38th month to 40th month of the construction schedule. It is proposed to utilize the useful excavated material from the excavation of diversion tunnel and abutments for the construction of coffer dam.

For construction of Concrete Dam, river bed excavation will start after completion of coffer dams. 213000 Cum excavated quantity will be handled with 2 numbers of 2.5 cum, Hydraulic Excavator, 20T Rear Dumper, Air Tracks, Rock Breaker etc. in 3 months starting from 40th month. The concreting of the Dam up to River bed level EL 777 m will be started from 43rd month and will be completed in 4.5 months. 1no. Batching & Mixing plant (of capacity 180 cum/hr.), Aggregate Processing Plants (of capacity 400 TPH), Chilling plant, Ice plant etc. will be used for production of aggregates and concrete placement will be carried out by 3 nos. Tower cranes of capacity 6T @ 45 m radius. The quantity of excavation for Intake Structure is approx. 31050 cum. The excavation will commence from the 25th month & will continue up to mid of 26.5th months. Two number underground Desilting basins of 330 m length have been proposed for desilting purpose. Excavation of both the Desilting chambers would be carried out in 38 months. The excavation will be starts from 31st month and completed in 88.5th month. The equipment to be utilized for excavation purpose are Drill Jumbos wagon drills, air compressors, loader, excavators, dumpers, scoop tram etc. The entire construction time for Desilting basin would be 26 months.

The construction of approximately 19.20 km long head race tunnel of 7.25 m dia. horse shoe shape is to be taken up by full face excavation method using Drilling & Blasting method. The excavation & concreting along with cleaning and grouting of Head Race Tunnel will commence from 29th month and completed in 99th month, after the construction of 5 nos. adits having length of 195 to 450 m. The equipment used for excavation are 2 boom Drill Jumbos, 20T Rear Dumpers, Side Dump Loaders etc. The excavation of powerhouse cavern would be carried out after constructing ventilation tunnel/ construction adit of size 7.0 m diameter. This ventilation tunnel would be extended up to the full length of powerhouse in a period of 2 months. The detailed Construction methodology, equipment planning and project scheduling of each hydraulic structures shall be reviewed and updated with the current technologies and methodologies to optimize the construction period. The duration for pre-construction activities shall be review and accordingly optimized with the current state of development in the locality.

The construction schedule shall indicate the critical path for construction and take into account the meteorological and hydrological conditions. The Consultant shall also prepare an implementation schedule showing all major stages of implementation of the project, including required studies and design, tendering, financing, preparatory works and construction and commissioning. The details of the year-wise construction program for each of the major components of the project, including the preparatory works shall be prepared by using Primavera or Microsoft Project. PERT chart shall be prepared for each major component showing the duration and sequence of construction activities. Critical deadlines and activities shall be identified as well as potential interfaces with other activities showing the critical path network. All schedules must be sufficiently detailed to show an accurate estimate of the project cost.

The Consultant shall also identify and adequately provision for induction and engagement of locals for providing goods and services including outsourcing construction of project colonies in partnership with locals. The Consultant shall also prepare a Construction Supervision and Quality Assurance Plan (CSQAP). The plan shall set out details of the organization, staffing levels, procedures, equipment, and qualifications for supervision of the construction of the project. The plan shall also take into account the usual long construction period, covering the supervision requirements as the dam grows in height—with any accompanying changes in construction materials or the characteristics of the impounded material— over a period of years.

In addition, the Consultant shall prepare a preliminary Operation and Maintenance Plan (O&MP). The plan shall outline the organizational structure, staffing, technical expertise, equipment and facilities needed to operate and maintain the project including long-term maintenance and safety inspections.

4.19 Preparation of Engineering Drawings of the Project at the level of Tender Stage including Design Notes/Memos

All civil, hydro-mechanical and electro-mechanical drawings prepared by the Consultant shall conform to the prevailing and relevant international codes, standards and best practices. Such codes and standards shall be indicated against various designs. All engineering drawings shall be prepared and detailed at the level of tender stage. In addition, the design notes/memos for each of the project components shall be prepared by the Consultant.

4.20 Power Evacuation Study

The transmission study to select (i) the optimal routing, based on analysis of alternative routes, to the connection points within Bhutan to the intended off-taker(s) based on the existing national transmission system master plan, (ii) voltage level, and (iii) number and type of circuits, at a level required to adequately estimate the associated costs of the transmission system (including substations) within Bhutan in agreement with Bhutan Power Corporation (BPC) and the existing National Transmission Grid Master Plan (NTGMP).

The Consultant shall, however, prepare an estimate of the potential wheeling charges and total transmission losses, based on experiences from other projects, to be included in the economic and financial evaluation.

4.21 Power Market Study

The power market study to assess the power market(s) of the off-taker(s) of the generated energy from the project to determine, for example, the role of the project in the power system, and hence the operation strategy (base load, intermediate load, peak load, etc.), and the benefits from energy generation to be used in the optimization studies (Task II. 2 Power potential and optimization studies) and the financial evaluation including potential tariffs for sale of energy (Task II. 22 Financial and economic Analysis).

Good understanding of the electricity market and policies in the region is necessary that have a bearing on regional hydropower development and should be in a position to augment any updates to the data that may become available and form realistic market development scenarios.

4.22 Infrastructural and Construction Facilities.

As per DPR 2015, for external road communication, the Gelephu-Tingtibi stretch of the Gelephu-Trongsa highway is proposed as the primary route for transporting materials and personnel. Existing bridges and culverts may need to be upgraded or replaced to handle heavy equipment and machinery. It was envisaged to improve existing 36 km road from Dakpai to Buli and construct a new road from near Nimshong to the Dam Site that totals to road length about 94 km. A new bridge of about 45m span was planned to be constructed over Raidigongchhu on Buli-Nimshong Road. The total road from Tingtibi to the Power House site was around 57 km, including a 2 km internal road from the proposed bridge. Road and bridge

improvements were included in the Project cost. All internal roads were planned to have an 8m formation width, 5m carriageway, 1m shoulders on both sides, and a 1m drain on the hill side. Detailed planning was done to connect the dam, power house, HRT adits, and colony locations.

Two project colonies were planned be established: one at Khomsar near the Dam site and the other at Babrangbe, near Digala and Langdrubi, for the Power House. The headquarters were planned to be at the Power House colony. The Dam colony is 8 km from the Dam, and the Power House colony is 8 km from the Power House. A 1.7 km road was to connect the Power House colony to the main road. Project headquarter has been planned to be kept in the Power House project colony area keeping in view the concentration of the activities in power house area during construction as well as O&M stage. Due to non-availability of any Hotel/ Resort in Project area, Transit camp (500 Sqm) at Buli for Dam area and at Tingtibi (500 Sqm) for Power House Area have been proposed.

Muck disposal yards were proposed at various project locations for disposing the muck generated in an environment friendly manner. The agencies awarded major contracts will need land for offices, employee colonies, labor camps, site offices, storage for cement, spare parts, and miscellaneous items, workshops, equipment parking, and fabrication yards. Civil contractors will also need to establish crushing and aggregate processing plants, sand plants, batching and mixing plants, and compressors.

While the infrastructural and construction facilities were planned based on the connectivity status then and the other upcoming development at time of the DPR preparation stage, many changes has occurred over the period. The road till Khomsar is already available and the left bank villages from Khomsar (Village near Dam site) to all the way till Digala (village near the PH) is connected by the unpaved farm road which further connects to Tingtibi-Nganglam Highway passing downstream of Mangdechhu-Chamkharchhu confluence. The Consultant shall review and update the changes in the infrastructure available and requirement for the project including the construction facilities.

4.23 Project Cost Estimate

The cost of construction of the project has been estimated at January 2014 price level with a completion period of 9 years including 2 years for infrastructure development. The estimated Cost of the project was Nu. 64,714.02 million without transmission cost including IDC of Nu. 19,539.41 million and Financing charges of Nu. 453 million at January 2014 Price level. The total tentative cost of Associated Transmission System of Chamkharchhu-I HPP after apportionment is Nu. 6,165.90 million, without cost of Land, IDC and Financing Charges. Majority of materials and equipment shall be sourced from India and Bhutan. In the estimate currency conversion rate of 1 INR = 1 Nu and 1 US$ = 62.07 INR was considered.

The cost estimate of the project shall be reviewed and updated by the Consultant based on the final design, drawings, technical specifications, work methodology and also considering other parameters such as project location, material sources, taxes/duties, etc. and based on prevailing market conditions and international competitive bidding. The bill of quantities adequate at the level of tender stage shall be prepared and shall include the following costs:

- Costs for engineering services during implementation of the project, including tender design and documents, construction design, supervision and additional surveys and investigations.
- Costs for RGoB/DGPC prior to commercial operation, including administration, legal costs and land acquisition.
- Costs for infrastructure and preparatory works required for the construction of all project components, including access and temporary roads, construction camps, etc.
- Costs for civil works of the project. The unit rates for civil works shall be derived specifically for the project considering construction methodology and costs for construction equipment, labor costs, and materials.
- Costs for hydromechanical, electromechanical and other equipment for the project. For the electromechanical equipment, prices shall be based on information/budget prices from potential suppliers.
- Costs for the transmission system within Bhutan required to connect the project to the off taker(s),

including required substations.
- Environmental and social mitigation costs.
- Physical contingencies, to reflect uncertainties to determine the quantities of work considering the level of knowledge of e.g., the geological conditions, and miscellaneous costs.
- Cost for financing, price contingencies, interest during construction, and all other project related financial costs such as taxes and duties.

A disbursement schedule over the construction period shall be established, and the yearly operation and maintenance costs shall be estimated.

4.24 Financial and Economic Analysis

The Consultant shall perform comprehensive economic and financial analyses of the Chamkharchhu I Hydropower Project, in accordance with the Bhutan Sustainable Hydropower Development Policy, the Bhutanese Guidelines for the Development of Hydropower Projects (June 2018; Revised 2024), and the latest CERC (Central Electricity Regulatory Commission, India) guidelines.

Prior to the commencement of analysis, the Consultant shall engage with DGPC to agree upon the methodologies, underlying assumptions, and analytical frameworks to be applied. Given the regional relevance of the project, the analyses must be structured to incorporate perspectives from all key stakeholders, including DGPC, RGoB, and potential regional off-takers.

The scope of the economic and financial analyses shall include:
- Comparison of the "with-project" and "without-project" scenarios to determine net project benefits.
- Establishment of a base case using estimated implementation costs and projected energy output.
- Revenue projections under differentiated tariff scenarios (domestic and export).
- Calculation of key indicators such as Internal Rate of Return (IRR), Net Present Value (NPV), and Benefit-Cost Ratio (BCR).
- Analysis of the project's financial viability and funding requirements.

The Consultant shall also conduct rigorous sensitivity analyses on the following variables, at a minimum:
- Increase in construction costs.
- Extension of construction period.
- Reduction in energy generation due to lower-than-expected inflows, accounting for climate variability and sequences of dry years.
- Variations in electricity tariffs.
- Changes in financing structures, interest rates, and loan terms.
- Disruption or failure of power offtake arrangements.

The outcomes of these analyses will inform final investment decisions and provide a risk-informed basis for structuring financial agreements and stakeholder engagement strategies. All assumptions and sources must be clearly documented and justified.

4.25 Contract Strategy

The Consultant shall develop a comprehensive contract strategy for the implementation of the Chamkharchhu I Hydropower Project in close coordination with DGPC. The strategy shall be aligned with international best practices in procurement and contract management, while also accounting for Bhutanese legal, institutional, and operational contexts.

The contract strategy shall include, but not be limited to:
- Recommended form(s) of contract to be used (e.g., EPC, Design-Build, Item Rate, Turnkey, or Hybrid models), providing justification for each.
- Division of project works into logical, manageable contract packages based on technical interfaces, construction sequencing, and market capabilities.

- Identification of critical contract interfaces and dependencies between civil, electro-mechanical, hydro-mechanical, transmission, and auxiliary works.
- Preliminary procurement timeline and contract award sequence aligned with the project schedule.
- Risk-sharing mechanisms and allocation of responsibilities across parties.
- Preliminary recommendations on prequalification criteria, bid evaluation methodology, and contract performance management.

The Consultant shall also highlight the implications of contract packaging on cost, schedule, construction logistics, and quality control. Lessons learned from similar regional or international hydropower projects should be reflected to ensure the proposed strategy is pragmatic and risk-responsive.

This strategy will serve as a foundation for DGPC to initiate procurement planning, draft tender documentation, and prepare internal approvals required prior to launching the procurement process.

4.26 Risk Analysis including Integrated Geo-Hazard Assessment

The Consultant shall develop a comprehensive risk analysis framework for the Chamkharchhu I Hydropower Project, in alignment with the Bhutan Guidelines for the Development of Hydropower Projects 2018 (Revised 2024). The risk assessment shall identify and evaluate all project-related risks including but not limited to commercial, technical, environmental, social, and geo-hazard risks.

Key responsibilities include:

- Preparation of a Risk Register, cataloguing identified risks, categorizing them (e.g., financial, contractual, geotechnical, environmental), and assessing their likelihood and potential impact.
- Formulation of mitigation measures, including prevention, minimization, response actions, and contingency plans.
- Quantification of risks where applicable and evaluation of their effect on project schedule, cost, and performance.
- Incorporation of geo-hazard risks, including landslides, slope failures, fault zones, seismic activity, glacial lake outburst floods (GLOFs), and reservoir rim instability.
- Alignment of the risk analysis with geological and geotechnical models prepared under Task II.3 and site-specific seismic and hydrological studies.
- Integration of findings from the Environmental and Social Impact Assessment (ESIA) to address environmental and social (E&S) risks.
- Documentation of an E&S Risk and Impact Assessment chapter, including evaluation of alternatives considered through the ESIA process, in the final Feasibility Study Report.

The Consultant shall ensure the risk management framework is robust, forward-looking, and supports informed decision-making by DGPC, lenders, and government stakeholders.

5 Environment and Social Impact Assessment

The Consultant shall be responsible for updating and preparing a comprehensive Environmental and Social Impact Assessment (ESIA) report that ensures the project's compliance with all applicable national regulations and international standards. The ESIA must demonstrate conformity with the World Bank's Environmental and Social Framework (ESF), the Asian Development Bank's Safeguard Policy Statement (SPS), and the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024).

Scope of Work:

i) **Baseline Studies**: The Consultant shall conduct field investigations and secondary data review to establish detailed baseline environmental and socio-economic conditions. This includes land use, biodiversity, water quality, air and noise levels, cultural heritage, livelihoods, and demographic profiles of affected communities.

ii) **Impact Assessment**: The ESIA shall comprehensively assess both direct and indirect impacts of all project phases (pre-construction, construction, operation, and decommissioning). The Consultant must identify significant risks to biodiversity, water resources, ecosystem services, physical and economic displacement, and community health and safety.

iii) **Mitigation and Enhancement Measures**: For each identified adverse impact, the Consultant shall recommend specific mitigation, minimization, or offset measures. Positive impacts should also be enhanced wherever possible. The measures must be detailed in a tabulated format along with implementation responsibilities, monitoring indicators, and timelines.

iv) **Environmental and Social Management Plans (ESMP)**: The Consultant shall develop a comprehensive ESMP that includes site-specific management sub-plans (e.g., Biodiversity Action Plan, Livelihood Restoration Plan, Community Health and Safety Plan, Waste Management Plan, etc.). These should be aligned with institutional capacity and reflect realistic timelines and budget estimates.

v) **Resettlement Action Plan (RAP):** The consultant shall prepare Resettlement Action Plan in line with international good practices and guidelines which sets out strategies to mitigate adverse effects induced by the project. The consultant shall examine impacts of proposed project on private land and property and shall establish the parameters for the entitlements package for affected people (APs), the institutional framework, mechanisms for consultation and grievance resolution, the time frame, and cost estimates.

vi) **Stakeholder Engagement and Consultation**: The Consultant shall design and implement a stakeholder engagement strategy in line with international good practices. This includes public consultations, community disclosure meetings, and grievance redress mechanisms. Records of meetings, feedback, and responses must be documented.

vii) **Cumulative Impact Assessment (CIA)**: If applicable, the Consultant shall analyze cumulative environmental and social impacts from existing or planned hydropower and infrastructure projects in the same basin or region.

viii) **Permitting Support**: The Consultant shall assist DGPC in securing all required permits, including Environmental Clearance from the Department of Environment and Climate Change, Forestry Clearance, and any other statutory approvals.

ix) **Alignment with International Standards**: The Consultant must ensure the ESIA is fully aligned with the safeguard policies of multilateral development banks such as the World Bank and ADB. References to Appendix I and II must be integrated to ensure that the report meets the legal and institutional requirements of Bhutan.

x) **Disclosure and Submission**: The final ESIA report, including all annexes and non-technical summaries, shall be prepared in a format suitable for public disclosure and submission to regulatory agencies.

The ESIA must reflect a thorough understanding of the project's potential environmental and social footprint and propose clear, actionable strategies to manage risks and enhance benefits throughout the project lifecycle. The detailed scope of works and the report formatting requirements to be followed by the Consultant are provided under **Annexure - III**.

6 Meetings and Site Visits

The Detailed Project Report (DPR) for the project was completed in February 2015 and will be shared with the Consultant for review and updating. To facilitate an in-depth assessment, a team of experts from both the Consultant and Druk Green Power Corporation (DGPC) will conduct periodic site visits throughout the DPR review and update process. These visits will serve as key opportunities for technical discussions, ensuring the finalization of project layout, evaluation of alternatives, refinement of design parameters, and validation of project features.

A total of four site visits are envisaged during this process:

- The first visit will be organized immediately after the signing of the Contract Agreement, allowing the Consultant to initiate on-site assessments and project familiarization.
- The subsequent visits will be scheduled by the Consultant in consultation with DGPC, ensuring alignment with project milestones and technical requirements.

Throughout the DPR review and update, the Consultant will lead the required assessments, while DGPC will provide necessary assistance to support seamless execution and decision-making. This structured approach will ensure a comprehensive evaluation and optimization of the project's technical and engineering components, contributing to its long-term feasibility and success.

7 Data and Facilities to be Provided by DGPC

DGPC will provide the following data and facilities free of charge to the Consultant for the duration of the assignment:

- Digital copy (PDF) of the DPR 2015, the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024), and all other information and data relevant for the assignment as available with DGPC.
- All permission and authorization necessary for the implementation of the assignment, including support for obtaining visas and work permits. Office facilities, including access to internet, printer and copy machine, while visiting DGPC office.

8 Staffing

It is envisaged that the Consultant's team will consist of a multidisciplinary group of highly qualified experts, each possessing substantial experience in their respective domains and fluent in both spoken and written English. The staffing structure should ensure coverage across all technical, environmental, and managerial aspects of the assignment.

Each expert shall demonstrate a strong track record of previous work on similar hydropower projects, and the Consultant shall assign staff with qualifications that align with the scope and complexity of the Chamkharchhu I Hydropower Project.

The Consultant's core team is expected to include, but not be limited to, the following professionals:

Key Experts	Required Experience	Main Tasks
Hydropower Expert/Project Manager	University degree in Civil Engineering with minimum 15 years of experience of design of hydropower projects of which minimum 5 years as project manager for international hydropower projects (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	• Overall responsible for the assignment, including on-the-job training and capacity building for the DGPC team, and reporting including Design Memorandum and Monthly Progress Reports • Review of all works performed by DGPC. • Carry out the design & optimization studies of the project. • Prepare construction schedule. • Establish a risk register for the project in coordination with other experts. • Provide experts guidance during the investigation stage • Review and coordinate all the activities under Task II. • Develop contract strategy.

Key Experts	Required Experience	Main Tasks
Hydrology & Sediment Expert	University Degree in Hydrology & Sediment or related field. At least 10 years of experience in hydrology & sediment management studies. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Review the data collected by the DGPC. ● Review hydrological analysis performed by DGPC. ● Carry out sedimentation studies using appropriate numerical models ● Carry out the dam break and GLOF studies and preparation of EPP in coordination with other experts.
Seismic Expert	University Degree in Geology, Engineering Geology or related field. At least 10 years of experience in the assessment of seismic hazard risks, including for the Himalayas.	● Seismic hazard assessment ● Establish a risk register for the project identifying all risks, including geo-hazard risk, their potential impact, probability of occurrence, and response and strategy for contingency plans in coordination with other experts.
Dam Expert	University degree in Civil Engineering with minimum 10 years of experience in design of dams including dynamic FEM analysis. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Carry out final dam type selection, layout planning including appurtenant structures. ● Pseudo-static stability analysis. ● Carry out 2D and 3D linear and non-linear dynamic FEM analysis of the final configuration of the dam structure, using the agreed software.
Hydraulic Expert	University degree in Civil Engineering with minimum 10 years of experience in hydraulic design of hydropower projects including modelling for surge and water hammer analysis. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Carry out all hydraulic analysis and design including plant optimization of all civil components of the project using agreed numerical modeling in conformance with standard norms, codes and practice.
Structural Engineer	University degree in Civil Engineering with minimum 10 years of experience in design of dams including structural analysis. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Carry out the structural analysis and design including plant optimization of all civil components of the project using agreed numerical modeling in conformance with standard norms, codes and practice.

Key Experts	Required Experience	Main Tasks
Engineering Geologist	University degree in Geological Engineering with minimum 15 years of experience in interpretation of geological and geotechnical information, engineering geological assessments, preparation of GDR, GIR and GBR for hydropower projects, and and underground works for hydropower projects. International experiences are required, including experience in Himalayan terrains.	● Prepare the geological and geotechnical appraisal reports of the projects including development of geological and geotechnical models as well as all the geological sections including construction material survey, in accordance with relevant standards and codes. ● Review and validate the geotechnical investigation work carried out by DGPC. ● Prepare a geological model of the dam complex, HRT and powerhouse complex to determine the robust support system required for the long- term stability. ● Prepare a GBR according to "ASCE 2007, Geotechnical Baseline Report for Construction- Suggested Guidelines" and in line with the Bhutan Guidelines for Development of Hydropower Projects 2018 (Revised 2024). ● Conduct geo-hazard assessment and reservoir rim stability assessment.
Hydro-mechanical Expert	University degree in Mechanical Engineering with minimum 10 years of experience in studies of electromechanical and hydromechanical equipment for hydropower projects. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Shall plan and design, including preparation of drawings of the hydro- mechanical equipment of the project.
Electro-mechanical Expert	University degree in Electrical or Mechanical Engineering with minimum 10 years of experience in studies of electromechanical and hydromechanical equipment for hydropower projects. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Shall plan and design, including preparation of drawings of the electro-mechanical equipment of the project.
Construction Method, Equipment Planning and Scheduling Expert	University degree in Civil Engineering or related field with minimum 10 years of experience in Construction Method, Equipment Planning and Scheduling of	● Provide a construction schedule considering construction rates for the various project items based on rates for similar projects and construction methodologies.

Key Experts	Required Experience	Main Tasks
	international hydropower projects (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Prepare an implementation schedule showing all major stages of the implementation of the Project, including required studies and design, tendering, financing, preparatory works and construction and commissioning. ● Identify and adequately provision for induction and engagement of locals for providing goods and services including outsourcing construction of project colonies in partnership with locals ● Prepare a Construction Supervision and Quality Assurance Plan (CSQAP).
Cost Estimator	University degree in Civil Engineering or related field with minimum 10 years of experience in cost estimation of international hydropower projects (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size).	● Prepare unit rates for civil, H&M and E&M, bill of quantities, and total cost estimate of the project.
Power Market Expert	University degree in Electrical Engineering with minimum 10 years of experience. International experiences are required (outside the country of nationality of the key expert) with minimum of one no. of completed similar assignments (nature and size) in the region. Good understanding of the electricity market and policies in the region is necessary that have a bearing on regional hydropower development and should be in a position to augment any updates to the data that may become available and form realistic market development scenarios.	● Shall carry out the power market study to assess the power market(s) of the off-taker(s) of the generated energy from the project. ● Shall determine the benefits from energy generation to be used in the optimization studies (Power potential and optimization studies) and the financial evaluation including potential tariffs for sale of energy (Financial and economic Analysis).
Economic and Financial Analyst	University Degree in Finance, Business Administration or Economics. At least 10 years of international experience (outside the country of nationality of the key expert) in financial analysis of power generation investment projects, including hydropower projects with minimum of one no. of completed similar assignments (nature and size).	● Carry out economic and financial analyses of the project in accordance with the provisions of Bhutan Sustainable Hydropower Development Policy, Guidelines for the Development of Hydropower Projects, Bhutan 2018 (Revised 2024) and the latest CERC guidelines of India.

Key Experts	Required Experience	Main Tasks
Environmental Specialist (Team Leader)	University Degree in environmental sciences, environmental or civil engineering, or a related field and at least 15 (fifteen) years' experiences including extensive international experience (outside the country of nationality of the expert), in leading and/or conducting an ESIA with minimum of one no. of completed similar assignments (nature and size).	● Shall be in charge of coordinating the ESIA, EMP and RP and other plans integrating the inputs of each specialist, putting together the ESIA, and managing the consultation processes
Social Development Specialist	A university degree in social sciences such as anthropology, sociology, economics, development or other related fields and a minimum of 15 (fifteen) years of relevant professional experience is required with minimum of one no. of completed similar assignments (nature and size). The social specialist should have broad operational experiences, including extensive international experience (outside the country of nationality of the expert), in social development aspects such as gender and GBV/SEA/SH, solid knowledge and application experiences applying safeguard policies, particularly involuntary resettlement and indigenous people. This specialist is expected to have experiences in leading teams. He/She should also have an understanding of and experience in applying international standards on social development aspects (for instance World Bank and/or IFC and those of ADB's).	● shall be in charge of the social aspects of this consultancy, including consultations for and social impact. He/she shall conduct additional social surveys to gather data on local communities and assess potential impacts of the projects. Shall monitor and evaluate the social outcomes of projects to ensure they meet the expected standards and objectives. Shall prepare detailed reports on social aspects
Environmental Flow Specialist	University graduate degree in civil engineering, hydrology/ecohydrology, environmental sciences or a related field and minimum of 10 (ten) years of experience in aquatic ecology, water quality and environmental flow assessments in hydropower projects with minimum of one no. of completed similar assignments (nature and size).	● Shall have a deep understanding in environmental decision processes, and utilizing multi-criteria approaches to holistic (environmental and social) decision making in hydropower projects, including ecohydraulic modelling and impact assessment of flow regimes on aquatic ecosystems. Shall also have deep understanding of and experience in applying international

Key Experts	Required Experience	Main Tasks
	He/She should also have an understanding of and experience in applying international standards on e-flow assessment (for instance World Bank and/or IFC and those of ADB's).	standards on environmental and social standards. He should be able to determine the E-flow based on the Guideline to Determine Minimum Environmental Flow - Regulations for Dewatered Reaches of Hydropower Projects in Bhutan, 2019 using appropriate tool, software and equipment.
Aquatic and Riparian Biodiversity Specialist	University Degree in aquatic biology, freshwater ecology, environmental studies or a related field and a minimum of 10 (ten) years' experience in conducting aquatic and riparian ecosystems assessments in hydropower projects with minimum of one no. of completed similar assignments (nature and size). He/She should also have an understanding of and experience in applying international standards on aquatic and riparian ecosystem assessments (for instance World Bank and/or IFC and those of ADB's).	• Shall have deep understanding of macroinvertebrates and experience in applying international standards.
Terrestrial Biodiversity Specialist	University degree in terrestrial biology, zoology, ecology, wildlife management or a related field and a minimum of 10 (ten) years' experience in conducting terrestrial biodiversity impact assessments including in hydropower projects with minimum of one no. of completed similar assignments (nature and size). He/She should also have an understanding of and experience in applying international standards on natural and critical habitat assessments (for instance World Bank ESS6 and/or IFC PS6 and those of ADB's).	• Provide all biological inputs to the ESIA to ensure that the report meets all TOR requirements in terms of content, time and quality as well as documenting project conformance with World Bank standards and ADB and government requirements. To include biodiversity baseline studies, alternatives analysis, and impact assessment, and the development of appropriate biodiversity management plans, covering both upstream and downstream areas, and a Biodiversity Action Plan if needed. Pay special attention to terrestrial and aquatic biodiversity, and the Project's conformance with natural and critical habitat requirements.
Climate Change Expert	University Degree in Engineering, Environmental Science or related discipline with technical skills such as Climate modeling and simulation, Statistical analysis and data interpretation, Programming languages relevant to climate science and a minimum of 10 (ten) years' experience in conducting climate change related studies	• The expert will do the following tasks, but not limited to: o Calculate the GHG emissions and savings from the project in accordance with World Bank and ADB guidelines (including reservoir emissions) and calculate the climate mitigation financing o Determine the climate change trends that will affect the study

Key Experts	Required Experience	Main Tasks
	minimum of one no. of completed similar assignments (nature and size). He/She should also have an understanding of and experience in applying international standards on GHG emission assessments (for instance World Bank and/or IFC and those of ADB's).	area over the project's life cycle and need to be taken on board in the project design to ensure climate resilience e.g., rainfall, temperature etc. o In conjunction with the technical team assess climate change risks to the project/project vulnerability to climate change (e.g., flash floods and glacial lake outburst floods) and how the project design can be adapted to ensure climate resilience. o Recommend and design measures to adapt to climate change (e.g., riverbank protection, spillway design and early warning systems) and improve safety measures (e.g., dam safety) and calculate the climate adaptation finance contribution
Environmental Specialist (National Expert and Country focal point)	University degree in environmental sciences, environmental or civil engineering, or a related field and a minimum of 10 (ten) years of experience in conducting an ESIA with minimum of one no. of completed similar assignments (nature and size).	● Shall work with the environmental specialist (Team leader, international) to design and conduct fieldwork for ESIA and other plans, putting together the ESIA, and conduct the consultation processes. As the national focal point, he/she is also expected to work closely with the Environmental Specialist (Team Leader) and Social Development Specialist (Co-Team Leader) to coordinate environmental and social aspects of the project.
Biodiversity Expert (National)	University degree in terrestrial biology, zoology, ecology, wildlife management or a related field and a minimum of 10 (ten) years' experience in conducting terrestrial biodiversity impact assessments including in hydropower projects with minimum of one no. of completed similar assignments (nature and size). He /She should also have an understanding of and experience in applying international standards on natural and critical habitat assessments (for instance World Bank ESS6 and/or IFC PS6 and those of ADB's).	● Provide all biological inputs to the ESIA to ensure that the report meets all TOR requirements in terms of content, time and quality as well as documenting project conformance with World Bank and ADB guidelines and government requirements. To include biodiversity baseline studies, alternatives analysis, and impact assessment, and the development of appropriate biodiversity management plans, covering both upstream and downstream areas, and a Biodiversity Action Plan if needed. Pay special attention to terrestrial and aquatic biodiversity, and the Project's conformance with natural and critical habitat requirements.

Key Experts	Required Experience	Main Tasks
Social Expert (National)	University degree in social science or similar and experience of large hydropower. They should possess a minimum of 10 (ten) years' experience with minimum of one no. of completed similar assignments (nature and size) in relevant field or the design, implementation and monitoring of social development schemes and safeguards interventions for internationally financed projects, including those related to Indigenous Peoples, resettlement, gender equality and social inclusion, and safeguards administration. He /She should be experienced with, and fit to undertake, participatory rapid/rural appraisal, transect walk surveys, and other field-based tools for social data collection and impact analysis. Preference will be given to those with knowledge of statistical sampling. They will generally support the international social expert with all their tasks especially field-based activities deputizing for them when needed.	• Shall undertake socioeconomic/use of ecosystem services/physical cultural resources surveys and baseline studies, alternatives analysis, and impact assessment. Shall be responsible for developing a social baseline study plan and protocol, overseeing proper execution of the baseline study, evaluating the data, preparing the baseline and impact assessment sections of the ESIA, identifying appropriate mitigation measures, and developing appropriate management plans, in consultation with the international social expert. Specifically responsible for assessment of the project impacts on affected land and non-land assets and livelihoods, local communities, labor, and women, minority, vulnerable, disadvantaged, and indigenous people. Shall identify permanent and temporary socioeconomic impacts arising from land acquisition, changes in land use, and involuntary restrictions on land use or on access to legally designated parks and protected areas, due to changes of river flow and project facilities. Include measures to minimize and mitigate the involuntary resettlement (physical and/or economic displacement) and other impacts on affected land users within the river catchments including upstream and downstream areas Develop appropriate social management plans to mitigate identified project impacts. Guide and oversee the development of a resettlement plan, if required.

9 Time Schedule for DPR Update

The time schedule for preparation of DPR including ESIA shall be 12 months from the date of signing of the Contract Agreement.

SN	Activities	Timeline (Months)
1	Signing of Contract Agreement.	T
2	Project Layout & Alternative Study and ESIA inception report.	T+2
3	Preliminary engineering and design & outcome of at least two-season field survey for ESIA.	T+5
4	Geological & Geotechnical Investigation Appraisal/	T+7

SN	Activities	Timeline (Months)
	Geotechnical Baseline Report.	
5	Construction methodology, equipment planning and project schedule.	T+8
6	Detailed engineering and design & outcomes of all four-season field survey for ESIA.	T+10
7	Submission of draft FSR including ESIA report	T+11
8	Submission of final FSR including ESIA report	T+12

10 Reporting and Deliverables

Throughout the review and update of the DPR, an interdisciplinary team of experts from both the Consultant and DGPC will conduct site visits at regular intervals. These visits will serve as key opportunities for technical discussions, ensuring the finalization of project layout, evaluation of alternatives, refinement of design parameters, and validation of project features.

At the outset of the assignment, the Consultant will present the Inception Report to DGPC and other relevant agencies within the Royal Government of Bhutan (RGoB), outlining the project scope, methodology, and initial findings.

As part of the reporting and documentation process, the Consultant will submit the following reports to DGPC:

- Inception Report (2 copies, both hard and soft formats)
- Quarterly Progress Reports (2 copies)
- Interim/Mid-Term Progress Reports (2 copies)
- Draft Report of the Feasibility Study Report (2 copies)

All soft copy reports will be provided in both PDF and editable formats, ensuring accessibility and usability. These files will also include design memos, calculation sheets, and executable models, drawings, enabling DGPC to conduct necessary technical assessments.

Following the review process, the draft Final DPR will be presented to DGPC and relevant RGoB agencies for comprehensive evaluation. DGPC will provide comments, views, and suggestions within two weeks from the date of the presentation. The Consultant will then incorporate the necessary revisions to ensure the report's completeness and alignment with project objectives.

Once the final clearance is granted, the Consultant will submit two hard copies of the Final DPR, along with an editable soft copy, to DGPC. This finalized documentation will serve as the foundational reference for the project's implementation, ensuring clarity in design, feasibility, and regulatory compliance.

The following table shows the deliverables of the Consultant. Refer Annexure III for key deliverables of ESIA.

SN	Description	Duration	Remarks
1	Milestone 1: Inception Report	T + 2 months	Among others, review and comment on the scope of field survey and investigation works, project layout and alternative study, review of Hydrological studies, including findings from the site visits and review of past studies and ESIA.
2	Milestone 2	T +5 months	Among others, finalize the project alternative studies, Power Potential studies and optimization, review of geological studies and submit the preliminary design and engineering of the project.

			Submit report documenting the outcomes of at least two-seasons field survey for ESIA.
3	Milestone 3	T + 10 months	Among others, submit the geological & geotechnical investigation appraisal/ geotechnical baseline report, construction methodology, equipment planning and project schedule and detailed engineering and design report. Submit report documenting the outcomes of all four-seasons field survey for ESIA.
4	Milestone 4	T+ 11months	Submission of draft DPR including ESIA report.
5	Milestone 5	T+ 12 months	Submission of final DPR including ESIA report.

11 Responsibilities of the Consultant

The Consultant shall be fully responsible for the effective execution of the assignment, ensuring all tasks are completed in accordance with the scope, timeline, and quality standards outlined in the agreement. In addition to technical and reporting obligations, the Consultant shall be responsible for arranging and bearing the costs of all logistical and operational needs of its staff during the assignment. This includes:

- Air transportation to and from Bhutan
- Local transportation within Bhutan
- Accommodation and per diem allowances
- Travel insurance and medical coverage
- Visa fees, work permits, and other legal clearances for expatriate staff
- Communication tools, laptops, and necessary software licenses
- Field equipment required for surveys, inspections, or investigations not otherwise provided by DGPC

All associated costs shall be included in the Consultant's financial proposal. The Consultant shall ensure that deployed personnel are adequately supported and equipped to fulfil their roles efficiently throughout the project duration.

Annexure III - Detailed Scope of ESIA and Deliverables

1 Applicable Standards

The ESIA and associated management plans shall be prepared in accordance with the international best practices like World Bank standards or ADB Safeguard Policy Statement (2009), as well as climate change and gender requirements. The ESIA shall also document conformance with applicable government laws, regulations, and international and regional conventions. The ESIA team of the consultant, in conjunction with their engineering team, is also expected to apply the mitigation hierarchy in order to avoid, minimize, and restore/offset/compensate impacts to the extent possible.

2 Project Components to be included in the ESIA

The ESIA scope of work shall include all of the following components:

- Hydropower facilities (e.g., dam, reservoir, powerhouse);
- Ancillary facilities (e.g., spoil disposal areas, worker camps, maintenance yards, fabrication shops, fuel depots, explosive magazine, power plant, water plant, quarries and borrow areas, batch plant and crushers);
- Permanent access road to dam and powerhouse, as well as other permanent or temporary construction roads as well as road upgrading works to accommodate construction vehicles; and
- Transmission line (e.g., powerhouse switchyard to substation connecting project to the electrical grid, including any necessary improvements at existing substations or switchyards.

The ESIA shall also include any offsite areas required for reforestation, livelihood restoration, or other environmental and social mitigation etc.

3 Monthly Progress Reports

The Consultant shall submit electronically to DGPC monthly progress reports by the sixth working day of the month for the previous month. The progress report shall include the following:

- Describe key work from the prior month and work plan for the coming month;
- Identify any issues/problems encountered and any important new information obtained, especially that might influence the ability of the Project to meet fin;
- Estimate percent complete for each task; and
- Indicate project status relative to approved schedule and explain any delays and strategy to recover schedule.

Deliverables – monthly progress reports.

4 Initial Site Visit

The Consultant will coordinate with DGPC to plan the dates and logistics for the initial site visit. DGPC will accompany the Consultant on the site visit. The Consultant shall arrange an Initial Site Visit Debrief call with the DGPC for the week following the site visit to share key observations and identify any issues/concerns.

Deliverable – PowerPoint slide deck or similar format for debrief call.

5 Project Description and Area of Influence

The ESIA team of the consultant shall coordinate with their engineering team to develop a comprehensive Project Description and associated mapping sufficient to conduct the impact assessment. This Project Description should include all project components, ancillary facilities, any associated facilities. The Project

Description should describe how the infrastructure needs of the worker camps (e.g., potable water, wastewater treatment, solid waste management, power, worker housing, health clinics) will be provided. Based on the Initial Site Visit and the above referenced coordination with their engineering team, the ESIA team of the consultant will define the proposed Area of Influence (AoI), which will be the subject of the baseline studies and impact assessment. The AoI shall take into consideration the project footprint/area of disturbance, including the hydropower facility, all ancillary project facilities, the access road, and the transmission line corridor, as well as direct or indirect impacts that may extend beyond the project footprint/area of disturbance including upstream and downstream impacts, and take into account social impacts (e.g., changes in livelihood) due to changes in environmental media as well as environmental impacts.

Deliverable – brief memo describing and justifying the proposed AoI as well as the Project Description chapter of the ESIA.

6 ESIA Report

The ESIA report should have:

6.1 Title Page

The title page should contain the following:

- The name and location of the project.
- Name and address (mailing address, telephone number, fax, and email address) of the proponent.
- Name, qualification and address of the ESIA consulting firm

6.2 Table of Contents:

- The title and page number of all sections, abbreviations/ acronyms, maps, plans, tables, figures, and annexure of the environmental assessment reports.

6.3 Executive Summary:

A brief description of the proposed project in clear and non-technical language including:

- The objective and need for the project. Explain whether the proposed project has been identified in the Hydropower Master Plan or not, if yes, what rank the project holds in the plan.
- Summary of project area to be acquired for various appurtenant works and the land use pattern within 5 km from the main project components (i.e., dam structure, midpoint of dam and power house) and catchment area.
- Summary of key findings and recommendations of the assessment, including the details of the main environmental impacts, social issues, project footprint of the main project and ancillary/associated facilities, economic benefits, and impacts covering cumulative impacts and proposed mitigation measures.
- A brief on how the public was consulted and stating the issues raised, resolved and pending.
- A brief description on an assessment of alternatives to the project, its main components and ancillary components with respect to the location, technical design and other environmental and social components.
- A brief description on the climate change impact, vulnerability & adaptation assessment.
- Project financial statement including project cost, funding source and the project activity schedule.
- Name of the organization/consulting firm preparing the ESIA report, and qualifications and experience of experts involved in the ESIA/EMP preparation.
- Project benefits: The local, regional and national benefits of the project should be explained.
- A declaration stating that the information disclosed in the ESIA report is correct.

6.4 Maps and Figures

All the maps should be colored and provided in A3 size.

- A map (1:50,000) specifying the location of the project.
- A study area map (1:50,000) indicating features such as a) total catchment area, b) directly draining catchment area, c) submergence area, & d) project area to be acquired for various project components. The map should also include area of influence including direct impact area, indirect impact area and cumulative impact area.
- A map (1:10,000) showing the land use pattern of the a) directly draining catchment area, b) submergence area, & c) project area to be acquired for various appurtenant works area within 5 km from the main project components (i.e. dam axis, reservoir boundary, power house, HRT, etc.).
- A map (1:10,000) showing locations of human settlements and major constructions including roads and major industries/mines.
- To examine the cascading effect (if applicable), a clear map (1:50,000) showing the approved/under construction/completed hydropower projects on both upstream and downstream of the proposed project.
- A drainage map (1:50,000) of the directly draining catchment up to the project site showing the submergence area.
- Soil map (1:50,000) of the study area showing different regions and soil characteristics.
- Geological map (1:250,000) and siesmo-tectonic map (1:1,000,000) of the study area.
- A map (1:10,000) specifying the forest cover in the upstream and downstream area, and marking the presence of migratory corridors, occurrence of any endangered/threatened flora and fauna species and/or plants and animals of economic/ecological importance.
- A map (1:50,000 clearly showing the location of various monitoring stations (for ambient air, water, noise and soil).
- A map (1:25000) specifying the areas vulnerable to floods.
- Demarcation of snow fed and rain fed areas (1:10,000) for a realistic estimate of the water availability.
- A map (1:10,000) showing the number of villages (with population) getting affected due to the project.
- A map/layout showing the project components.
- A map with appropriate scale showing the proposed transmission and distribution line project together with alternative options, the location of towers, sub-stations and existing infrastructure along the length of new route/alignment.
- Map showing the dewatered reach where E-flow assessment was undertaken.
- Map of reach affected by hydro-peaking and flow-regime alteration of reservoir or dam toe type HPP.

6.5 Policy and Legal Framework

- Provide descriptions on the review of existing legislations and policies governing the implementation of the proposed activity and environmental assessment requirements.

6.6 Details of the Project Site and Proponent:

a) Location
b) Gewog
c) Dzongkhag
d) Name of proponent
e) Geographical coordinates for the location of dam
f) Geographical coordinates for the location of powerhouse
g) Geographical coordinates for the location of TRT outlet point
h) Present mailing address including telephone number, fax and email (if any)
i) Name and contact address of the environmental focal person

6.7 Catchment area characteristics:

a) Name of the river and major tributaries
b) Overall description of the catchment area
c) Total catchment area in km2 including the catchment area at the dam
d) Rivers mean annual flow at the project site in Mm3 (MCM)

e) Maximum mean monthly flow at the project site in Mm3 (MCM)
f) Minimum mean monthly flow at the project site in Mm3 (MCM)
g) Probable maximum flood in Mm3 (MCM)
h) Headworks/spillway design flood in Mm3 (MCM)
i) Minimum flow of river in m3/sec
j) Number of tributaries in the dewatered reach
k) Minimum dry season flow from side streams/rivers in the de-watered stretch

6.8 Type of project:

a) Simple run-off-river
b) Reservoir run-off-river (e.g., with daily or hourly storage)
c) Seasonal storage
d) Pumped storage
e) With or without an inter-basin diversion
f) Location of the powerhouse in relation to dam
g) Installed capacity in megawatts
h) Energy generation

6.9 Engineering Characteristics

6.9.1 For hydropower plant:

a) Type of dam
b) Dam height in meters (Below and above the river bed)
c) Dam length in meters
d) Power house type
e) Type of turbine(s)
f) Flow through turbine(s)
g) Tunnel length in Kms
h) Tunnel diameter in meters
i) Total length of access roads in Kms
j) Surge shaft top and its location
k) Gross head
l) Provision for E-flow release
m) Fish migration – upstream and downstream

6.9.2 Provide brief information on the construction power:

a) Voltage level (in kV)
b) Tapping point
c) Termination point
d) Length of line
e) Right of Way (RoW)
f) Conductor (Number of lines and circuits, composition and diameter, minimum height over ground level for overhead lines, depth and trench and fill specifications for underground lines).
g) Number, type and composition of towers

Note: Detailed information should be provided in line with the Initial Environmental Examination form for transmission and distribution projects - 2017. In addition, please note that the ESIA should be undertaken for power evacuation in line with the endorsed ToR.

6.10 Reservoir Characteristics

a) Reservoir area in hectares
b) Reservoir length in km
c) Reservoir volume in Mm3 (MCM)
d) Reservoir live storage in Mm3 (MCM)
e) Reservoir dead storage in Mm3 (MCM)

f) Dead storage available for sediments above intake in Mm3 (MCM)
g) Storage available for flood retention Mm3 (MCM)
h) Reservoir draw-down height
i) Full reservoir water level elevation (meters)

6.11 Permanent Structure for Power Generation

a) Main dam
b) Bottom outlet
c) Secondary dam and dykes (if applicable)
d) Intake
e) Spillway
f) De-sander, De-siltation tanks
g) Tunnel
h) Surge tank (if applicable)
i) Valve house (if applicable)
j) Penstock (if applicable)
k) Powerhouse
l) Switchyard
m) Tailrace and headrace tunnel(s)
n) Re-regulation weir(s) (if applicable)
o) Permanent access roads
p) Offices, residential areas and colonies
q) Reservoir
r) Adit (s)

6.12 Construction Phase

a) The location, area and accommodation details of the camp and office areas.
b) Temporary access roads.
c) Size, number, location and capacity of the burrow pits and quarry site to be used for construction purposes.
d) Muck disposal/spoil areas (in hectares).
e) The resource requirement (cement, aggregates, steel, etc.,) in appropriate units including its source, storage areas, mode of transportation and construction schedule should be presented in the ESIA report

6.13 Operational Phase

a) Reservoir filling.
b) Reservoir operation.
c) Downstream hydrology and water quality below intake point.
d) Downstream hydrology and water quality below tailrace.
e) Downstream hydrology and water quality below re-regulation weir.

6.14 Alternatives to the projects

Together with their engineering team, the ESIA team of the consultant shall ensure that all alternatives are identified and adequately considered, including for avoiding and/or minimizing as possible any adverse environmental and social impacts, not just technical and economic considerations, and are taken into account in finalizing the project's design. The Consultant shall conduct a robust alternatives analysis applying the mitigation hierarchy's first principle of avoidance of impacts to the extent practicable. It is anticipated that the alternatives analysis will include a description and analysis of all feasible alternatives for all ancillary and associated facilities to the project covering the following:

- The alternative of not undertaking the project (i.e., no-build alternative) in absence of any alternative/ No Project Alternative;
- Description of the project alternatives.
- Analysis of its potential environmental impacts and mitigation measures.

- Principle differences among the feasible alternatives under considerations, particularly regarding potential environmental impacts.
- Reasons for considering the present project over the other alternatives.
- Description of the cleaner technology and environmental management taken into consideration while selecting the equipment and technology.
- Integrated development of Hydropower projects with multipurpose use of water for drinking, irrigation, flood control and recreational purposes.
- The alternative analysis should also cover alternatives for project/facility locations, routing, alignment for transmission line, technologies, and construction methods among others.
- System Alternatives considered by government, including generation of the same energy by alternative sources of power including fossil fuel and other renewables in Bhutan, taking into consideration energy security;
- Dam and Powerhouse Location Alternatives – need to coordinate with the engineering team of the consultant to jointly recommend locations and design in terms of dam height and the full elevation level;
- Sediment Management Alternatives – need to coordinate with the engineering team of the consultant to jointly recommend a sediment management strategy and associated design;
- Ancillary Facilities Location Alternatives (see Section 3.4 for typical ancillary facilities) – need to coordinate with the engineering team of the consultant to jointly recommend ancillary facility locations and designs;
- Access Road Route Alternatives - need to coordinate with the engineering team of the consultant to jointly recommend an access road route and design;
- Transmission Line Alignment Alternatives - need to coordinate with the engineering team of the consultant to jointly recommend a transmission line alignment and design, taking into consideration efforts to avoid legally protected areas and international areas of biodiversity importance, avoiding and/or minimizing physical and economic displacement through design; and
- Project Operation Alternatives - need to coordinate with the engineering team of the consultant to jointly recommend a proposed project operating mode and how operations of the Chamkharchhu I HPP will be integrated with the two existing hydropower projects in Lhuentse.
- Mitigation Alternatives (e.g., E-Flow) - need to coordinate with the Project Engineer to jointly recommend appropriate mitigation options considering technical, economic, environmental and social criteria.

For each alternative, the Consultant's engineering team and social and environmental experts shall coordinate to evaluate feasible alternatives, identify the preferred alternative with minimal adverse impact as possible, and indicate whether the preferred alternative was adopted into the Project design, and if not, provide an explanation to support the design discussing technical, economic, environmental and social cost-benefit.

The project will impact natural habitat, which requires demonstration that there is "no alternative" that would avoid impacts to natural habitat and that benefits outweigh the costs including the environmental cost.

Deliverable – alternatives chapter for inclusion in the ESIA

6.15 Description of Existing Environment of the Project Area (Baseline Data)

The ESIA report must present recent and relevant four seasons' baseline information pertaining to the geo-physical, biological, socio-economic and cultural situation of the area under study, including any changes anticipated prior to project implementation. Baseline information should be provided within the 5 km radius from the dam structure, midpoint of dam and powerhouse, and the powerhouse. The study area should be defined as the area of influence, including direct impact area, indirect impact area and cumulative impact area.

This section should provide detailed description and analysis of the type of baseline data and information collected, methodology used for data collection and explain how they were used, and the time and frequency of data collection. Based on the data collected, describe the existing baseline environmental and socio-economic conditions in quantitative and qualitative terms including comparison/analysis of the previous baseline data with the recent data.

Predictive, quantitative models and standards should be used for baseline data collection wherever possible to avoid vague and subjective predictions. Some of the models, but not limited to, are available in the 'Environmental Assessment Guideline for Hydropower Projects, 2012'. In addition, the public and relevant stakeholder agencies should be involved during socio-economic data collection.

The Consultant shall execute the baseline studies to characterize the existing physical, biological, and social conditions within the AoI. In addition to the baseline write up the raw data linked to GIS will be shared with the DGPC. The baseline studies scope should meet the following requirements, or the GoB requirements, whichever are more stringent.

6.15.1 Physical Environment

The Consultant shall conduct baseline surveys to characterize existing ambient physical environment conditions described below:

Land Environment: Provide details of land use pattern, land cover (forested, agricultural, degraded, built up, non-built-up areas, etc.) by area, topography, soil characteristics, slope stability in the 5 km study area.

Geological and Geospatial Aspects: The consultant shall cover geography and physiography of the site. The consultant shall also cover regional geology. The consultant shall conduct critical review of the geological features around the project area. The consultant shall identify the current and potential landslide prone areas in and around the project area. The past records of landslides occurrence in the region should be scrutinized and information such as past events of landslides, area affected, frequency of occurrence per decade, geomorphologic conditions and degree of susceptibility to mass movement should be provided. The consultant shall also justify location and execution of the project in relation to structural components

Seismic-tectonics: The consultant shall provide site-specific information on earthquake parameters and study on Design Earthquake parameters. The consultant shall prepare detailed description of seismic character of the study area should be included.

Protected Area: The consultant shall determine the presence of the protected area and the biotic pressure on it at project site. DGPC to provide required files on protected areas of Bhutan. The consultant shall prepare a management plan for protected area (if any) and list of threatened/endangered flora and fauna including their habitat and associations as per FNCA 2023 and IUCN red list.

Air quality: The Consultant shall determine ambient air quality conditions by collecting air quality samples for standard parameters (e.g., NOx, SOx, Particulate Matter (PM) 10, PM2.5) over a period of at least 24 hours following nationally stipulated methods near the proposed dam and powerhouse sites, quarry sites, muck disposal sites, off-site access routes as well as the nearby villages at least during the dry, pre -monsoon, monsoon and post monsoon season.

Hydrology and hydrogeology: The Consultant shall gather available flow data for the Chamkharchhu I River from existing river gauging stations and measurements at the downstream of Chamkharchhu I. The Consultant shall also investigate the hydrogeology in the direct impact area by collecting flow and water quality samples at springs and untreated water from nearby wells. If the Project proposes to use groundwater as a potable water source for the worker camp, then the ESIA team of the consultant is expected to coordinate with their engineering team to conduct pump tests to determine potential effects on groundwater levels in the Project area. The consultant shall present monthly flow rates and the average annual flow rates of the river.

The consultant shall take following points into consideration:

- Hydrology of the basin
- Hydro-meteorology, drainage system
- Rainfall-runoff data
- Hydrology and length of the dewatered area
- Source and possibility of a Glacial Lake Outburst Flood (GLOF) must be documented.
- Flood and its recurrence interval including data related to the frequency of floods, its location and maximum flood levels should be collected and presented in the ESIA report.
- Catastrophic events like cloudburst and flash floods, if any, should be documented.
- Water availability for the project and the aquatic fauna. The flow measurements shall be planned and executed in such a way that average, maximum, mean maximum, mean minimum and absolute lean flows should be modeled or measured.
- Sedimentation rate

Water quality: The Consultant shall collect water quality samples from different sampling stations including upstream of the dam, downstream of the power house and other major components to characterize project water quality at least during the dry, pre-monsoon, monsoon, and post-monsoon periods following nationally stipulated methods. The Consultant shall propose location of wastewater discharges and the locations should include those used for aquatic ecology surveys. The sampling parameters shall at least include total suspended sediment, turbidity, pH, nutrients, applicable metals, dissolved oxygen, temperature, and coliforms. For proposed potable water sources, a full suite of GoB drinking water standards will be tested. The consultant shall study and provide information on current downstream water use in keeping with the principles of National Water Resources Management Plan, 2016.
Soils: The Consultant shall collect soil samples in any areas where there is evidence to suggest potential soil contamination and test them for parameters applicable to the suspected contamination risk and soil fertility following nationally stipulated methods.

Noise: The Consultant shall conduct noise monitoring at least at the proposed dam and powerhouse work areas, quarry sites, muck disposal sites, construction work camp locations, and off-site access routes as well as the nearby villages to characterize ambient noise levels at nearby noise sensitive receptors (e.g., residences, schools, health clinics) taking measurements of one-hour LAeq over a 48-hour period following nationally stipulated methods.

6.15.2 Biological Environment

The Consultant shall conduct biological surveys to characterize the terrestrial and aquatic biodiversity of the AoI. These studies shall include at least the following terrestrial and aquatic field surveys. Biological surveys will be seasonal, to be timed to pick up periods when the most sensitive species could be present.

Terrestrial habitat surveys: The Consultant shall conduct four seasonal terrestrial surveys that at a minimum include the following:

- Map vegetative communities within the AoI using a combination of field surveys and aerial imagery interpretation sufficient to distinguish natural and modified habitats. Particular attention shall be given to riparian habitats and potential future submerged areas;
- Identify and characterize types of forest land within the project area of disturbance including protected and reserve forest as well as undesignated forest, tree enumeration and survey of forest quality sufficient to inform no net loss calculations;
- Provide information on the floral biodiversity resources of the river basin and project area
- Total forest cover, type of forests, change in forest cover and threats and degradation of forests
- Vegetation profile and number of species in the project area
- Predominant flora and introduced exotic flora
- Species Diversity Index of the biodiversity and Importance Value Index of the predominant species
- Documentation of economically important plants, medicinal as well as timber, fuel wood, non-wood timber products, etc.

- Endemic, endangered and threatened species and their geographical distribution as per Forest and Nature Conservation Act 2023 and IUCN red list
- Location of any protected areas, biological corridors, conservation hotspots and other ecological sensitive areas in the project area.
- The carbon capturing potential of the forest land to be diverted or submerged
- Surveys of mammals, birds, amphibians, reptiles, invertebrates, and plants supported by impacted habitats; specifically include biodiversity surveys targeted for any critically endangered, endangered, or vulnerable species (as identified by IUCN red lists) or other critical habitat triggers potentially present in the AoI, so as to document their presence or absence and population estimates in the AoI to help refine screening of critical habitat triggers and the critical habitat assessment. If the rarity of the species potentially triggering Critical Habitat will make direct observation unlikely, alternative methods (e.g. e-DNA, habitat suitability studies) should be used.
- Present status of wildlife as per Forest and Nature Conservation Act 2023 and IUCN Red list including their habitat condition (separately for aquatic habitat, terrestrial habitat and arboreal habitat.
- Calculate Species Diversity Index of the biodiversity and importance Value Index (IVI) of the predominant species.

Aquatic surveys: The study/sampling should be carried out in following locations at appropriate locations such as in the reservoir, upstream and downstream of the Dam. The consultant shall conduct four seasonal aquatic surveys that at a minimum and should comprise the following:

- Inventory of existing aquatic fauna like micro-invertebrates, zooplankton, benthos, etc.
- Study the fish population and fish diversity in the influence area of the project.
- Identification of spawning habitats in the main river and its tributaries, and migratory pattern.
- Specifically include biodiversity surveys targeted for any critically endangered, endangered or vulnerable aquatic species as identified by the IUCN or the Bhutan Schedule I, II and III.
- Assess the fluvial geomorphology of the river downstream of the powerhouse to understand the risk of geomorphic impacts from the proposed Project peaking operations (riverbed and bank erosions)
- Conduct a critical habitat screening and assessment on aquatic and riparian ecosystem in line with ADB/WB requirements and relevant government regulations, including no net loss and/or net gain, where applicable/relevant
- Assess the fluvial geomorphology of the river downstream of the powerhouse to understand the risk of geomorphic impacts from the proposed Project peaking operations (e.g., riverbank or riverbed erosion, channel armouring etc.); and

General requirement: The consultant shall also consult with appropriate international, national and/or regional species experts in making decisions regarding potential Critical Habitat species that may be affected by the project and documenting these consultations.

Ecosystem Services: The Consultant shall conduct an ecosystem services survey. It is expected that this survey should focus on provisioning services (e.g., food, fuel, and timber benefits, and specifically quantifying seasonal fish catch, the number of households whose livelihoods are dependent on these provisioning services) and cultural services (e.g., spiritual, recreational, and aesthetic benefits). These data will primarily be captured through the various social science methods. This survey should fully document the affected communities' use of the Chamkharchhu I and other affected terrestrial habitats. It shall document the extent of community use and reliance on these services, whether there is any seasonality to their use, and evaluate potential alternatives for the use or replacement of these services.

6.15.3 Cultural Environment

The consultant shall conduct inventory of Cultural heritage (both tangible and intangible) that may be affected directly or indirectly by the proposed project including from its ancillary facilities in consultation with the Department of Culture and Local government.

6.15.4 Minimum E-flow Assessment

The consultant shall conduct assessment of minimum E-flow should be undertaken in line with the "Guideline to Determine Minimum Environmental Flow Regulations for Dewatered Reaches of Hydropower Projects in Bhutan, 2019". The consultant shall determine the approach and methodology to be applied for E-flow assessment can be undertaken as per the Decision-Making Tree under the E-flow guideline. The consultant shall also be responsible for site selection for dewatered reach for E-flow assessment, reach affected by hydro-peaking and flow-regime alteration. The consultant shall use the decision tree in the Environmental Flows for Hydropower Project Good Practice Handbook (IFC, 2018) to determine the appropriate resolution of the EFlow study (i.e., High, Medium, or Low resolution). This E-Flow study shall consider biological, social, cultural, transportation, recreation, irrigation, and any other downstream water users/uses. Include an estimation of the uncertainty of the model and a monitoring plan with provisions for an adaptive management of the flow based on specific parameters (e.g., fish or other critical biodiversity features impacts). The e-flow recommendations should also include the provision of "freshes" (e.g., high-flow periods necessary to trigger biological responses) and/or "morphogenic flows" to address the downstream sediment starvation impacts.

6.15.5 Socio-economic Data

The consultant shall conduct a social baseline survey, which is expected to include the following social science methods:

- Project affected household socio-economic surveys (sample size of average 20- 25% of total affected households, subject to total number of affected households to be identified) to generally characterize the socioeconomics and demographics of the affected households in the AoI. Consultant should conduct also a 100% census of all physically or economically displaced households (whether permanently or temporarily displaced), total area of private and non-private land to be affected by the project, inventory of other affected non-land assets and livelihoods, and costs for compensation and mitigations of such impacts for preparation of the Resettlement Plan, and a statistically valid survey of other households within the AoI for each project including those downstream potentially affected by the peaking power operation;
- Focus group discussions (FGD) with key groups such as women, fisherfolks, and other river-based livelihoods, farmers, users of ecosystem services (e.g., non- timber forest products), and other vulnerable groups; and
- Key Informant Interviews (KII) with local officials, health workers, national park managers, and other key informants identified by the Consultant.

Based on this information, the Consultant shall document the socio-economic conditions of the project affected households within the AoI, including the following:

- Administrative, governance, and political context;
- Demographic and ethnicity of the population in the vicinity
- Presence of Indigenous People;
- Religion, Family Life, and Social Organization;
- Education Attainment;
- Language and Literacy
- Economic structure
- Land Ownership and details (agricultural or forest land required for the project)
- Employment and livelihoods
- Household Income and Expenditures
- Dietary Habits and Food Sources
- Study on the structural integrity of the existing private and public structures
- Living Conditions (e.g, house condition, potable water source, wastewater disposal, electricity supply)
- Community Health and Wellbeing including access to community facilities (e.g., health facilities) and communication (e.g., phone, internet access) and identify key organizations (e.g., non-governmental organizations, civil society groups) active in the area

- Transport and access
- Traffic Density in the project area
- Waste Management Facilities (solid and hazardous waste)
- Cultural Heritage (tangible and non-tangibke, including Physical Cultural Resources)
- Existing public infrastructure (permanent, semi-permanent, temporary structures) and social services available to the affected population including education, road, health, water and sanitation, communication, network facilities, etc.
- River and Other Water Source Use (e.g. navigation, fishing, bathing, washing, and drinking).

Deliverable – Baseline chapter for inclusion in the ESIA with supporting GIS maps.

6.16 Public Consultation

Public consultation needs to be carried out as per Article 16 of the Environment Assessment (EA) Act 2000, and Section 41 of the Regulation for Environmental Clearance of Projects (RECOP) 2016. The proponent must explain the expected impacts (both positive and negative) of the proposed project to the public and stakeholder agencies, listen to the concerns raised, provide clarifications and maintain record as follows:

- Description of issues raised and resolved during the consultation. List out pending issues and the proponent's views on the pending issues and how it will be addressed by the project.
- Provide evidence of public meeting and participation duly authenticated by the Local Government and Dzongkhag.
- Provide records of public consultation signed by the member(s) of the concerned local authority present during the public consultation.

6.17 Assessment of Environmental Impacts

The consultant shall conduct impact assessments and shall include all project direct and indirect environmental and social impacts and risks from all project components for each project in an integrated and holistic manner. The Consultant will conduct the necessary assessment of potential impacts and risks of the construction and operation of hydropower and its allied activities and alternatives so as to determine their pre-mitigation significance, propose Good International Industry Practice (GIIP) measures to mitigate these impacts, and determine the significance of the project's residual (post-mitigation) impacts. Impacts will be quantified where appropriate. The Consultant shall distinguish direct and indirect construction (including site preparation and establishment) and operation phase impacts as well as cumulative and induced impacts.

Predictions of impacts should be accompanied by commonly used quantitative and qualitative methods and models available, but not limited to, in the 'Environmental Assessment Guideline for Hydropower Projects, 2012'.

The ESIA Report should contain a list of both adverse and beneficial impacts anticipated as consequences of the proposed Project activities at different stages of project cycle and the following ancillary activities but not limited to:

- Submerged area
- Dewatered area and regime change
- Permanent colony, labour camps and offices, stores and other temporary structures
- Proposed roads
- Batching and mixing plants
- Construction material extraction (Quarry)
- Stacking Yards, workshop and job facilities
- Muck disposal sites
- Preconstruction power

- All other ancillary facilities

The impacts to be predicted and quantified, as far as possible in context of their magnitudes, location and duration. Matrices, networks, checklists and questionnaires used in the process of identifying impacts should be appended in the annexes. Any environmental quality standards or socio-economic measures applied in the assessment should be stated. The impacts should be grouped into following categories.

Physical Impacts

The Consultant will assess Project effects on:

Physical Environment

- Changes in land use/land cover and drainage pattern
- Changes in land quality including effects of waste disposal
- Riverbank and their stability
- Impact due to submergence and diversion of the river course
- Impact of workforce on the local resources
- Impact due to induced infrastructure development (if applicable)
- Soils from clearing and grading activities resulting in erosion and sedimentation as well as pollution risks – the volumes of soil moved and muck generated and disposal areas quantified and identified;

Water Environment

- Changes in surface and ground water quality due to construction activities and induced development.
- Impact due to reduced flow in the dewatered stretch.
- Changes in the hydraulic regime and downstream flow.
- Sedimentation of reservoir
- Downstream siltation during construction
- Impact on current water use
- Impact on the ground water flow and recharge due to tunneling works and impact on surface water bodies, etc.
- Impact of pollution load i.e., sewage disposal, sanitation, etc.
- Impact of muck disposal on water bodies
- Hydrology has to be described pre- and post-Project for the affected sections of the river. The baseline flows and post-project flows should be presented clearly sh owing changes in river flow from the effect of the project. This discussion should clearly indicate the flow data and estimation methods applied, and describe the catchment size and land cover; seasonality of river flows; and elevation, grade and accessibility (for river use) of the river sections where flow is reduced.
- Water quantity and quality from water abstraction, wastewater discharges, erosion and sedimentation, pollution risks e.g. potential spills, poor solid and hazardous waste management, risks of groundwater flow interruption
- Flow as a result of project construction and proposed operations – to be informed by the results of the E-Flow assessment;
- Sediment as a result of project construction and proposed operations – to be informed by the E-Flow assessment. Catchment and sediment management plans will need to be part of the ESMP

Air and Noise Environment

- Changes in ambient and ground level concentrations due to total emissions from point and non-point (fugitive) sources.
- Changes in ambient levels due to noise generated from equipment, blasting operations and movement of vehicles.
- Impacts on health of human and wildlife due to changes in air and noise quality.
- Air quality as a result of project-related emissions from stationary and mobile sources;

- Noise sensitive receptors from construction equipment and activities and project operations – these effects must be modeled/quantified and compared to Good International Industry Practice (GIIP, e.g., WB ESH guidelines or national standards);
- Vibration from heavy truck traffic and use of explosives, including potential for property damage – the effects must be quantified and compared to GIIP standards/guidelines with an explosives management plan in the ESMP; and
- GHG emissions including from the reservoir – the effects must be quantified.

Biological Impacts

The Consultant will quantify habitat and species lost to the extent possible, document how the requirements and no net loss or net gain of natural habitat will be achieved, and, if applicable, how no net loss or a net gain in biodiversity will be achieved in relation to any identified Critical Habitat species. Biodiversity Management Plans will need to be included in the ESMP and, if necessary, a Biodiversity Offset Plan (BOP) will also be needed if any residual impacts will be identified. The BOP shall clearly demonstrate that the offset is feasible by identifying appropriate offset areas, identifying implementation arrangements, consulting with the potential affected communities and other stakeholders, and establishing a long-term financial mechanism that will need to remain in place for the duration of the project, potentially in perpetuity. Offsets must only be used if the government is able to commit to their protection in the long-term. The consultant shall also study:

- Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare threatened and endangered species, medicinal plants, etc.
- Pressure on existing natural resources
- Changes in aquatic ecosystem
- Impact on breeding and nesting grounds of animals and fish, if any.
- Impact on fish migration and habitat degradation and/or loss due to decreased flow of water.
- Impact on animal distribution, migration routes (if any), habitat fragmentation and destruction.

Important Areas

a) Legally protected areas
b) Areas of biodiversity importance, such as Important Bird Areas and Key Biodiversity Areas (KBA)

Terrestrial Biodiversity

a) Terrestrial habitat and species, taking into account habitat loss and fragmentation including tree cutting and forest clearing
b) Terrestrial Natural habitats
c) Terrestrial Critical habitats/species

Aquatic Biodiversity

a) Aquatic Habitat and species, taking into consideration the recommended EFlow and consideration of ramping rates and the sediment flushing regime
b) Aquatic Natural Habitat
c) Aquatic Critical Habitat/species
d) River Connectivity (including lateral and vertical connectivity)

Social Impacts

The Consultant will assess how the project impacts on socio-economic status of affected population including:

- Impact of land acquisition including a list of all affected families including names of family members, age, educational qualification, source of income, land holdings, house/land to be acquired and house/land left after acquisition, details of any other property in possession and getting affected, animal possession, type of house, etc., number of houses, huts and other infrastructure that will be lost as a result of construction of various project components.

- Impact on local economy including demographic changes
- Impact due to immigration of labour population
- Impact on human health, hygiene and communicable disease risks
- Impact due to increase in traffic
- Impact and risks on gender and vulnerable groups
- Impact on cultural heritage (both tangible and intangible) such as archaeological, paleontological, historical, religious, pilgrims' properties, sacred sites, and traditions and customs among others. Any cultural heritage present in the project area and study area should be verified by the Department of Culture and Dzongkha Development, MoHA and Local Government. Further, views of DoCDD, MoHA must be sought and submitted to DECC.
- Indigenous Peoples
- Labor and Working Conditions, including a Labor Management Plan in the ESMP, and Occupational Health and Safety (risk assessment approach)
- Community Health and Safety, including disclosure of the results of the Engineers' Dam Break Analysis and including an Emergency Preparedness and Response Plan for dam break and other emergency circumstances in the ESMP
- Gender, including sexual exploitation, abuse, and harassment
- Influx of workers and possibly their families, including pressure on community infrastructure and resources and social unrest

Minimum E-flow Impacts

Impacts of different E-flow scenarios on conservation, energy generation, socio-economic and cultural aspects, and hydrological regime.

Climate Change Impacts

Detailed description of climate change study (using appropriate methodology) should be provided. A hydrological assessment of its watershed and the likely hydrological and allied risks associated under different climate change scenarios should be presented. And the change in project design, and implementation and management plan as per projections and scenarios under changing climate should also be included. The assessment should encompass the following:

- Impacts of temperature and precipitation due to changing climate
- Impacts of climate change in the hydrological regime
- Impacts of climate change during the operational life of the project
- Vulnerability of a hydropower project to climate change, considering its geographic, regulatory, technical and socio-environmental characteristics.
- Identification and assessment of climate risks
- The risks and opportunities for the hydropower projects
- Hydrological and other associated risks
- Assessment of likely Greenhouse Gas (GHG) emission from the project (Reservoir) and its implication on Carbon Neutral Policy of the country.

Cross-cutting Impacts

- Climate Change and Disaster Risk – including natural hazards such as earthquake, seismic, glacial lake outburst floods, and landslide risk)
- Ecosystem Services – especially impacts on river uses and livelihoods.

Deliverable – Impact chapters for inclusion in the ESIA.

Cumulative Impact Assessment

The Consultant shall prepare a Cumulative Impact Assessment (CIA). The CIA shall generally follow the guidance of the International Finance Corporation's Good Practice Handbook on Cumulative Impact Assessment (2013). The Consultant shall propose the spatial and temporal boundaries for the impact assessment.

The Consultant should take into consideration other proposed hydropower, transmission line, road, and other planned future activities that could interact with the proposed project and result in cumulative impacts. Based on the consultations conducted as part of the scoping process and the local community FGD and KII, the Consultant will recommend the important Valued Environmental and Social Components (VECs) to be evaluated in the CIA.

Deliverable – Cumulative Impact Assessment for inclusion as an appendix to the ESIA.

6.18 Stakeholder Engagement

The Consultant will prepare a Stakeholder Engagement Plan (SEP), which will describe how the Project will engage with Project Affected Persons (PAPs) and other stakeholders throughout the duration of the ESIA process and the project implementation and establish the framework for a tiered project level grievance redress mechanism.

The objectives of the SEP are:

- To identify the stakeholders and establish a systematic approach to stakeholder engagement that will help the borrower build and maintain a constructive relationship with each potentially Project affected persons (PAP) and community in the AoI and other stakeholders with an interest in the project;
- To provide means for effective and inclusive engagement with Project- affected parties and other interested parties throughout the project life cycle on issues that could potentially affect them. This should include specific efforts to include vulnerable groups and women through separate Focus Group Discussions or other means;
- To assess the level of stakeholder interest and support for the project;
- To enable stakeholders' views to be taken into account in the project design and to improve the environmental and social sustainability of the Project;
- To ensure that appropriate Project information on environmental, resettlement and social impacts and risks is disclosed to stakeholders in a timely, understandable, meaningful, accessible, and appropriate manner and format (i.e., all local communication materials shall be prepared in English for review, but translated to Dzongkha and all community meetings shall be conducted in Dzongkha); and
- To provide PAP with accessible and inclusive means to raise issues and grievances and allow the borrower to respond to and manage such grievances.

This SEP shall identify the key stakeholders, and describe the strategy, frequency, focus, and responsible party for the engagement with each stakeholder or stakeholder group. For the duration of the ESIA process, the responsible party for most engagements will be the Consultant. The SEP should also describe the grievance mechanism and include the grievance mechanism as an appendix, and the relationship of the SEP with the resettlement process.

Deliverables – draft and final SEP, with a proposed grievance mechanism as an appendix.

6.19 Resettlement Action Plan (RAP)

The proposed project will require private land to be acquired for construction of project infrastructure. Land acquisition from submergence area is expected to be substantial. Such land acquisition may induce involuntary resettlement, disturb indigenous communities/ethnic minorities, and impact on cultural properties of significance. Therefore, a detailed resettlement plan will have to be prepared. The consultant

shall acquire cadastral data and socio-economic data to prepare a detailed resettlement action plan based on following task:

- Record any measures taken to reduce land acquisition and resettlement impacts through changes in the design of the project.
- Mobilize and train enumerators. Lead and provide overall guidance and supervision to enumerators in data collection. Ensure data quality control. Check and review the outputs submitted by enumerators to ensure accuracy, completeness and consistency of responses, conduct validation checks of a sample of accomplished questionnaires to ensure data reliability and consistency. Data analysis and reporting.
- Conduct participatory rapid appraisal (PRA) in the project area. Identify key stakeholders and conduct meaningful consultations with them about the project and resettlement effects.
- Identify any vulnerable groups who might require special assistance and consult with them.
- Conduct a census of all the people potentially affected, to determine the scope and magnitude of likely resettlement effects, and to record likely losses. Suggest a cut-off date for entitlements.
- Conduct a socioeconomic survey of a sample of 30-50 percent of the people affected. Establish a baseline of incomes and expenditures, occupational and livelihood patterns, use of resources, use of common property (water sources, irrigation channels, wetlands, etc.), social organization, leadership patterns, local community organizations, and cultural parameters.
- Consult with the agencies (central as well as dzongkhag-level) responsible for land acquisition, land replacement, valuation of assets, and compensation rates.
- Review laws, regulations and directives of the RGOB that apply to land acquisition, resettlement, and compensation. In this review consider the method for valuing assets, the timing and method of paying compensation, the legal and administrative procedures applicable, land titling, and registration procedures.
- Prepare an entitlement matrix listing all likely effects of permanent as well as temporary land acquisition. Establish criteria for the eligibility of resettlement assistance and benefits of affected households. Prepare standards for compensation and restoration of the social and economic base of the people affected to replace all types of losses.
- If APs are displaced and need to be relocated, prepare options for relocation and for income restoration which build upon the existing social, economic and cultural parameters both of the people affected and of any host populations. Provide for relocation costs, lost income, and income support during transition.
- Prepare a framework for participation of APs. All APs should be meaningfully consulted when designing entitlements and the implementation of land acquisition and resettlement. Prepare special measures for consultation with any vulnerable groups. Specify mechanisms for the resolution of grievances and an appeals procedure.
- Prepare an institutional framework that designates responsibilities to provide compensation, undertake relocation work, take responsibility for income restoration, supervise, manage, and monitor the implementation of land acquisition, land replacement and resettlement activities.
- Prepare a monitoring and evaluation plan, identifying the responsibilities, time frame, and key indicators. Specify the time frame for monitoring and reporting.
- Prepare a time-bound implementation schedule for land acquisition and resettlement in conjunction with the agreed implementation schedule for project components, showing how APs will be compensated before actual acquisition of the affected land, or before demolition of any affected structures.
- Prepare an indicative budget. Prepare indicative land acquisition and resettlement costs. Prepare budgetary allocation and timing. Specify sources of funding and approval process. Prepare an annual budget estimate for resettlement by major category of expenditures

Deliverable – Resettlement Action Plan (RAP) for inclusion as an appendix to the ESIA.

6.20 Environmental and Social Management Plan

The Consultant shall prepare an Environmental and Social Management Plan (ESMP) as an appendix to the ESIA. This ESMP shall identify the minimum requirements that the Project Construction Contractor and DGPC need to implement to manage the environmental and social risks and impacts identified in the ESIA. The consultant shall prepare ESMP outlining how the monitoring plan of Project construction and operation will be elaborated. The consultant shall prepare a report that clearly specify the nature of the monitoring required, stipulating who should undertake these activities, the cost and any other necessary inputs. The time schedule for monitoring should also be specified. The report should provide a comprehensive plan covering the environmental and social variables to be monitored, and provide the location and timing of sampling and measurement of the variables. The report should include baseline, compliance and impact monitoring and indicators to be measured for each of them. The name the institutions responsible for monitoring the different variables and how the management plan is expected to influence the operation of the project should be included. The consultant shall provide sufficient guidance and prepare a 'training needs assessment on sampling protocol and analytical standards to ensure the generation of reliable data.
The Construction Contractor is expected to develop a detailed construction ESMP including site- or activity specific sub-plans, such as health and safety risk assessments and plans for approval by the borrower reflecting at least the minimum requirements identified in the ESMP whilst the borrower is similarly expected to develop an operational environmental and social management system (ESMS) for the operational stage.

Each Management Plan is expected to include the following information:

- Purpose of the Management Plan
- Key Project Risks and Impacts to address
- Institutional arrangements
- Contractor Responsibilities and Minimum Requirements
- DGPC Responsibilities and Minimum Requirements (including PMC if being proposed)
- Mitigation Requirements – including tabular mitigation plan
- Monitoring and Reporting Requirements – including tabular quantitative monitoring plan
- Implementation Schedule
- Training Requirements
- Budget and funding source
- Mechanism to self-monitoring for compliance with environmental regulations.
- Monitoring of quality of water, air, noise, vibration and occupational health status of project personnel and surrounding habitations and vulnerable population.
- Description of the administrative aspects and planned monitoring program to evaluate the effectiveness of various/specific aspects of technological/mitigation measures.
- Environmental audit of various activities including budgeting and financial management with reference to environmental management.
- Hydro geological monitoring for the entire life of the project.
- Analysis of data, its interpretation and evaluation of any additional studies to be carried out if required.
- Closure/Decommissioning Plan for the project activities along with the fund requirement for implementation of the activities.
- Monitoring of maintenance of minimum E-flow
- In case of hydropeaking; monitoring of flow fluctuations & upramping/downramping periods in relevant time steps (e.g. 10 minutes)
- Access to tributaries, especially if they are spawning areas, must be monitored (it could be that measures need to be taken after every flood season to restore access).
- Monitoring, evaluation and reporting of climate change impacts and risks.
- Cost and budget outlay for all the plans: Cost for implementing all the EMP including the cost for implementing Environmental Monitoring Programme, aforesaid compensation, mitigation and management measures (Clearly outline a summary of cost estimate for implementing all the EMPs

including the cost for implementation of environmental monitoring programme and operation of Environment Management Cell).

Deliverable – an ESMP for inclusion as an appendix to the ESIA (should be able to be a stand-alone document).

6.21 Additional Studies

This section contains a description of other major studies that may be undertaken in support of the preparation of the ESIA. If formal studies on environmental valuation and environmental risk assessment have been undertaken as part of the ESIA, these need to be included.

6.21.1 Environmental Valuation

Environmental Valuation provides means of assessing the benefits of environmental conservation and its contribution to the national economy. Based on such study, the benefits of the proposed Project and environmental conservation can be compared and decisions could be made accordingly. Therefore, this part of the study should assess the economic value of the conservation and protection of the environment in the proposed Project area and comparison of benefits with the proposed Project should be presented.

6.21.2 Environmental Risk Assessment

An environmental risk assessment may be a necessary part of the ESIA if there is considerable uncertainty about the likelihood or the magnitude of environmental impacts. The data collected during the basic ESIA studies provides much of the information needed for explicitly dealing with the uncertainties relating to environment impacts. There are two major categories of risk: 1) those to human health, and 2) those to ecosystem integrity. The primary goal of environmental risk assessment is to evaluate risks, their monetary costs, the costs of emergency response and/or avoidance of risk.

Environmental risk assessment studies require a high degree of scientific and mathematical rigor and may be costly if not properly planned.

6.21.3 Greenhouse Gas Emissions

The management may present emission savings from the generation of renewable energy as this is one of the major project benefits. Accordingly, the volume of CO2 emissions that will be avoided per annum by the generation of renewable energy from the Project as opposed to the volume of CO2 that would be emitted by the generation of an equivalent amount of power from the current mix of generation supplying the National Grid should be estimated.

6.21.4 Climate Resilience Study

Climate Resilience Study assesses the vulnerability of the Chamkharchhu I Project to climate change and identifies measures to enhance its resilience. The consultant shall assess the risk and vulnerability of climate change impacts and submit a comprehensive report on climate risks and resilience strategies for the project. The consultant shall provide recommendations for integrating climate resilience into project design and operations.

- Analyze historical climate data and future climate projections for the project area, including temperature, precipitation, and extreme weather events. Use climate data sources and projections relevant to Bhutan.
- Identify potential climate-related risks to the Chamkharchhu I HPP, such as increased flooding, droughts, glacial lake outburst floods (GLOFs), and changes in river flow patterns
- Assess the potential impacts of these risks on project infrastructure, operations, and surrounding communities.
- Evaluate the vulnerability of key project components (dam, reservoir, powerhouse, transmission lines, etc.) to identify climate risks.

- Assess the vulnerability of local communities and ecosystems that depend on the river and surrounding resources.
- Consider the potential for cascading impacts, where climate change exacerbates existing environmental and social vulnerabilities.
- Identify and evaluate a range of adaptation measures to enhance the climate resilience of the Chamkharchhu I HPP.

6.21.5 Labor Management Plan

Continuing from and based on the identification of different project workers and risk analysis carried out under the ESIA, the consultant will develop a Labor Management Procedure (LMP) that will set out the way in which project workers will be managed, in accordance with the requirements of national law and international requirements (such as WB's ESS2). Key elements of the LMP should include:

- Description of the types of project workers to be employed under the project.
- Description of the anticipated risks, including Occupational Health and Safety, and its analysis.
- Review of the relevant national laws, regulations and policies related to labor management, including child labor, forced labor, etc.
- Laying out the policies and principles to be followed under the project, including terms and conditions of employment.
- A general code of conduct for project workers and gender-based violence management plan to minimize/mitigate such risks.
- Implementation arrangements, including delineation of responsibilities among PMU, contractors, sub-contractors, as well as management procedures and staffing plan.
- Contractor management.
- A grievance redress mechanism, to be established specifically for project workers.

At the same time, the project will also need to come up with actions to manage issues related to the other influx of in-migrants, including workers' family members, and the "camp-followers" who come in for business opportunities. This is probably beyond the contractors' obligation and would need close involvement of local administrations and the project office in their planning and implementation.

6.21.6 Gender & Vulnerability Assessment

The Consultant shall develop gender and vulnerability action plan by carrying an analysis on gender and vulnerability in the project area as part of the ESIA, including risks of gender-based-violence, to inform gender action planning and interventions related to vulnerable groups.

One particular risk is related to gender-based-violence (GBV)/Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH) particularly with the estimated influx of population. This risk needs to be assessed and required mitigation measures need to be planned. All the above should be documented in the ESIA. Based on this analysis, the consultant will develop an action plan on gender and for the vulnerable population, including specific actions against GBV. This plan could be included in the EMP.

7 GIS and Mapping

The Consultant shall develop GIS maps to document existing conditions (e.g., land covers, natural and modified habitats, sampling locations, village locations, community facilities such as water sources and health clinics, cultural sites), the location of project facilities (e.g., dam, powerhouse, worker camps, spoil disposal areas, other ancillary facilities, transportation corridors, access roads, transmission line), as well as key impacts (e.g., Project area of disturbance, location of physically displaced households). The GIS database should also include cadastral maps including all land acquisition and be made available to DGPC and funding bodies.

8 Inputs to Bidding and Contract Documents

The Consultant will also provide input to the DGPC in terms of the construction contractor's bid and contract documents. This shall include contractor staffing requirements, BoQ cost items, and language in the main contract clauses requiring the contractor to implement the ESMP in the bid/contract documents, as well as penalties for non-compliance, a short section highlighting key contractor responsibilities (e.g., Worker Code of Conduct, Worker Grievance Mechanism, provision of appropriate PPE, provision of worker accommodations in conformance with ILO and IFC/EBRD good practice guidance, identifying any key mitigation requirements involving design and construction (e.g., EFlow release facilities), identifying the need to update the ESIA in relation to design changes including for ancillary facilities, and including the ESMP as an appendix to the bid/contract documents. The Consultant will also provide the draft TOR for the environment and social experts of any Project Management Consultant required by DGPC.

9 ESIA Documents and ESIA Disclosure Process

The Consultant will prepare an ESIA for the Chamkharchhu I HPP that meets RGoB, World Bank, IFC and ADB requirements. Appendix A provides an illustrative Table of Contents for the ESIA, which also reflects the Bhutan Department of the Environment requirements. The Consultant will prepare the following versions of the ESIA document including all management plans:

i) Preliminary Draft ESIA and management plans – for internal review by the DGPC and funding body
ii) Draft ESIA and management plans – addressing the comments from the DGPC and funding body. This document will be disclosed to the stakeholders and a disclosure meeting held with the Project-affected communities.
iii) Preliminary Final ESIA and management plans – addressing any comments received during the Draft ESIA disclosure period, for internal review by the DGPC and funding body.
iv) Final ESIA and management plans – addressing any final comments from the DGPC and funding body

The ESMP, CIA, various stakeholder consultation materials, and the ESIA disclosure materials, among other items, should be included as an appendix to the ESIA.

The Consultant shall plan and facilitate in-person disclosure meetings with the project affected communities. These disclosure meetings should be conducted in Dzongkha and have handouts describing the project, key project impacts, and proposed mitigation measures in simple layman's language.

Deliverables – a preliminary draft, draft, preliminary final, and final ESIA, including any appendices.

10 Key Deliverables

The Consultant shall submit the identified deliverables for review, comment, and approval by the DGPC and funding body (if needed). These documents will be prepared in English, unless otherwise noted below. The Consultant shall provide electronic copies for all draft and final documents. The Consultant shall provide the final approved documents listed below in both pdf and native (e.g., Word, Excel, PPT) formats, as well as one hard copy for the DGPC.

i) Stakeholder Engagement Plan – draft and final versions in English with the Executive Summary translated into Dzongkha;
ii) Community and Worker Grievance Mechanism for receipt of environmental and social grievances – draft and final versions in English and Dzongkha;
iii) Environmental and Social Impact Assessment, including the ESMP and CIA – preliminary draft, draft, preliminary final, and final versions in English with the Executive Summary of the Draft and Final translated into Dzongkha;
iv) Resettlement Plan (including livelihood restoration) – draft and final versions in English and Dzongkha, this should include among others, a census of all affected households, their socio-economic survey and asset survey of affected private land and other non-land assets and livelihoods;
v) Meaningful consultations with PAPs, Communication and Public Disclosure documents and presentation materials – draft and final in English, with the Final translated into Dzongkha;
vi) Gender Assessment and Action Plan – draft and final version in English; and

vii) Climate and Disaster Risk Assessment.

11 Environmental Clearance of the Project

Environmental Clearance of the Project shall be pursued by DGPC. However, the Consultant shall update and incorporate into the report if there are comments from the stakeholders including Department of Environment & Climate Change (DECC). The Consultant should have adequately consulted DECC and other relevant stakeholders for comments and recommendations before finalizing the report.

12 Conclusions and Recommendations

Based on the findings of the ESIA study, conclusions should be drawn and recommendations should be made regarding project implementation.

13 Checklist for No Objection Certificate

In order to obtain an Environmental Clearance for the project, NOCs must be obtained from all relevant parties. A checklist of agencies from whom NOCs may be required should be presented.

14 Support from DGPC

DGPC will provide the Consultant with support in the form of:

- Providing necessary documentation such as background information, relevant data, engineering design reports, laboratory tests where applicable and other design documents related to the Project.
- Assisting the consultant in arrangements for meetings and field visits including obtaining permission and authorization necessary for the implementation of the consultancy.