Environmental Impact Assessment (Draft)

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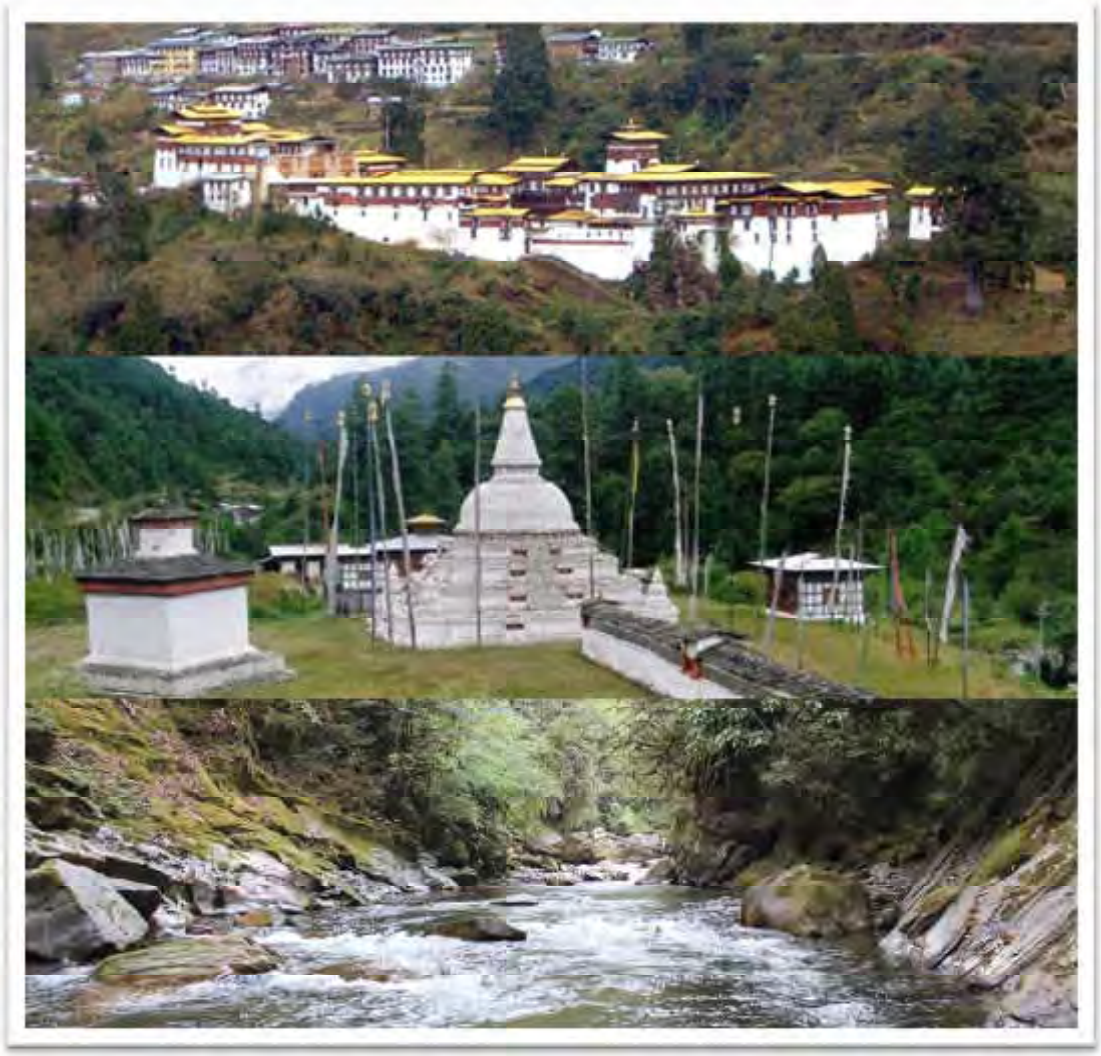
BHU: Second Green Power Development Project

(Part B: Transmission Component)

Prepared by Druk Green Power Corporation Limited and Tangsibji Hydro Energy Limited for the Asian Development Bank



NIKACHHU HYDROPOWER PROJECT, BHUTAN (118 MW)

ENVIRONMENTAL IMPACT ASSESSMENT FOR 132 kV TRANSMISSION LINE FROM NIKACHHU POTHEAD YARD TO MANGDECHHU POTHEAD YARD- 2014

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ABBREVIATIONS

ADB	Asian Development Bank
ADB-SPS	ADB Safeguards& Policy Statements (2009)
BAP	Biodiversity Action Plan
BC	Biological Corridor
BDL	Below Detection Level
BHU	Basic Health Unit
BHUCORE	Bhutan Consultants & Research
BPC	Bhutan Power Corporation
CA	Competent Authority
CA	Concession Agreement
CDM	Clean Development Mechanism
CITIES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNR	College of Natural Resources
Db	decibel
DGM	Department of Geology and Mines
DGPCL	Druk Green Power Corporation Limited
DHPP	Dagachhu Hydropower Project
DLAAC	Dzongkhag Land Acquisition and Allotment Committee
DoFPS	Department of Forest and Parks Services
DoR	Department of Roads
EA	Environmental Assessment
EC	Environmental Clearance
EFP	Environmental Focal Person
EMP	Environment Management Plan
ESIA	Environmental and Social Impact Assessment
FNCA	Forest and Nature Conservation Act
FNCR	Forest and Nature Conservation Rule
GDP	Gross Domestic Product
GLOF	Glacial Lake Outburst Flooding
GNHC	Gross National Happiness Commission
GRC	Grievance Redressal Committee
GRFL	Government Reserved Forest Land
HH	Households
IEE	Initial Environmental Examination
IPCC	Inter-Governmental Panel on Climate Change
JE	Junior Engineer
JSWNP	Jigme Singye Wangchuck National Park
LPG	Liquid Petroleum Gas
LRO	Land Record Officer

M&E	Monitoring & Evaluation
MHEP	Mangdechhu Hydro-Electric Project
MoAF	Ministry of Agriculture & Forest
MT	Metric Tons
MW	Mega Watt
NBC	National Biodiversity Centre
NEC	National Environment Commission
NECS	National Environment Commission Secretariat
NHPP	Nikachhu Hydropower Project
NOC	No Objection Certificate
NLCS	National Land Commission Secretariat
OHS	Occupational Health and Safety
O&M	Operation and Maintenance
ORC	Outreach Clinic
PA	Protected Area
PAVA	Property Valuation & Assessment Agency
PFS	Pre-Feasibility Study
PHCB	Population and Housing Census of Bhutan
PM	Particulate Matter
PM	Project Manager
PSMP	Power System Master Plan
PWC	PriceWaterhouseCoopers
RGoB	Royal Government of Bhutan
RNR	Renewable Natural Resources
RoW	Right of Way
RP	Resettlement Plan
RS	Resettlement Plan
SFD	Social Forestry Division
SIA	Social Impact Assessment
SPS	Safeguard Policy Statement
STD	Sexually Transmitted Disease
TA	Technical Assistance
TCD	Transmission and Construction Division
TGC	Thimphu Gneissic Complex
TL	Transmission Line
ToR	Terms of Reference
TW	Transmission Wing
UNCCD	United Nations Convention to Combat Desertification
WCD	Wildlife Conservation Division
WHO	World Health Organization
UWICE	Ugen Wangchuck Institute for Conservation and Environment

Executive Summary

1.0 Background

Bhutan's technically feasible hydropower generation potential is estimated to be 23,760 MW.[1] At present, only about 5% (or 1,488 MW) of this generation potential has been harnessed. Export of hydropower is the largest revenue source for the Royal Government of Bhutan (RRGoB) accounting for over 17.3% of its national revenues. A total of 10 projects (about 10,000 MW) have been selected jointly by RRGoB and the Government of India (GoI) for hydropower development by 2020. These 10 projects have different implementation modalities such as bilateral development by RRGoB and GoI, and by joint ventures between government corporations of the two countries. Hydropower development in Bhutan is considered to be a source of 'clean power' due to its minimal contribution to greenhouse gas (GHG) emissions compared to conventional energy sources.

Recognizing the need to develop the hydropower potential, the Asian Development Bank (ADB) provided in October 2011 a technical assistance to prepare the 118 MW Nikachhu Hydropower Project (NHPP). NHPP is a medium-sized run-of-river (ROR) hydropower type which will have lesser degree of environmental and social impacts compared to reservoir types. The power generated by NHPP will be evacuated by a 18.6 km 132 kV D/C transmission line running to Yurmo, where it will be integrated into the Pothead yard of MHEP. Farther power transmission to India shall be through the MHEP power transmission system. The associated transmission line has an estimated cost amount of Nu. 233.836 million.

NHPP will be located in Trongsa District and will draw water from the Nikachhu River and will discharge its tailrace water above the dam of the Mangdechhu Hydroelectricr Project (MHEP). The NHPP will be constructed over a 5-year period and expected to be operational by 2019. The power generated by NHPP will be evacuated through a 18.6 km 132 kV D/C transmission line running to Yurmo, where it will be integrated into the Pothead yard of MHEP. Farther power transmission to India shall be through the MHEP power transmission system.

Druk Green Power Corporation Limited (DGPCL), established in 2008 and mandated to accelerate hydropower development projects, will implement the NHPP. DGPCL currently operates five power plants with an installed capacity of 1,480 MW.

According to ADB's Safeguard Policy Statement 2009 (SPS 2009), NHPP is Category A on environment requiring the preparation of an Environmental Impact Assessment (EIA).[2] As specified by Bhutan National Environment Commission (NEC) regulations and the SPS 2009,

[1] Bhutan Power System Master Plan-April 2004
[2] Asian Development Bank Safeguard Policy Statement (SPS 2009), http://www.adb.org/documents/safeguard-policy-statement. (Accessed 25 July 2013)

an EIA was conducted for the hydropower project along with the preliminary assessment for the associated transmission line.

The EIA was prepared based on the Terms of Reference (ToR) approved by NEC as required by the Environmental Assessment Act 2000 and its Regulation 2002. The original EIA was prepared by Bhutan Consultants & Research (BHUCORE) in 2012. Based on additional field data and consultations undertaken in 2013, the updated EIA, Environmental Management Plan, and the Resettlement Plan were submitted by Pricewaterhouse Coopers (PWC India) Consultants to NEC in December 2013. The EIA was later revised in May 2014 to incorporate stakeholder presentations and comments from NEC. The EIA of the NHPP consists of two parts: Part 1 - 118 MW Nikachhu hydropower project and Part 2 - 18.6 km 132 kV D/C transmission line. This report covers Part 2.

2.0 Need for the project

This project forms a vital part of NHPP as it entails the construction of 18.6 km 132 kV D/C transmission line from Nikachhu Pot Head Yard - to Yurmoo under Trongsa Dzongkhag which will evacuate the power generated from NHPP. At Yurmo, it will be integrated into the Pothead yard of MHEP from where it will be evacuated to India through the MHEP transmission line system. The project is entirely for the purpose of power evacuation from NHPP and shall not entail construction of any access road or establishment of sub-stations.

3.0 Expected Impacts and Proposed Mitigation Measures

Protected area. The Environmental Assessment reveals that the Transmission line does not fall within any Protected Area, National Park, Wildlife Sanctuary, Strict Nature Reserve or Biological corridor. The line stretches from Nikachhu Pothead in Tangsibji gewog to the Mangdechu Pothead in Langthel gewog at a distance of 18.6 km.

Forest clearance. Along the transmission line (TL) route, a right-of-way (RoW) of 27 m needs to be cleared to prevent shorting and disturbance. The total amount of forest to be cleared is 100 acres or 0.5 km^2 (27 km x 15 km) within the project area. Field surveys of the TL confirms that 15 km of the line passes through broadleaf and mixed conifer forest while 3.6 km passes through scrub forest comprising of a few trees shrubs, degraded vegetation, community forest and private land. The biggest impact of any TL is usually the loss of forest cover (or vegetation) and the loss of habitat for wildlife. In the case of this TL however, the magnitude of this impact is lessened due to the following reasons:

(i) The proposed 132 kV line is aligned almost parallel to the existing 66 kV line running from Trongsa to Yurmo and crosses the upcoming 400 kV D/C Mangdechu-Goling-Jigmeling transmission line as well. Thus, much of the alignment falls on an already semi-cleared forest land;
(ii) The actual forest area requiring clearance is <0.03% of the total forest land in the Dzongkhag and largely insignificant considering the total forest cover in the district. Also, field investigations revealed that the selected route runs through forest which forms the

buffer between the high forest on the hill tops and the villages and agricultural lands on the lower elevations. Due to its proximity to the villages, much of the forest is highly disturbed and it is not expected that it is the habitat of wildlife species;.

(iii) The forest area is already cleared so not much trees need to be felled along most of the alignment from TL27-TL50.

The main mitigation measure proposed to offset the reduction in forest cover is to undertake Compensatory Afforestation wherein twice the area of the forest (in this case 100 acres) should be replanted with local species of trees and shrubs.

Impacts on biodiversity. The removal of trees and other vegetation may have ecological impacts as it will destroy forest habitat and displace wildlife, birds, herpetofauna and insects. The forest being continuous especially above the highway provides good habitat for a variety of wildlife species but within the TL area, the most common wildlife species signs recorded were those of Wild Pigs, Barking deer and Sambar. These species are considered more as pests due to crop damage caused by these on neighboring agricultural fields. Other rarer species like Tigers, Leopards and Bears are expected in the denser, less disturbed forests on the higher slopes. Since the project does not lie within any protected area or biological corridor, it is not expected to hinder any migratory routes of such species, and the motility of most animals means that they are very likely to move away in response to the disturbance caused by the felling activity, thus avoiding accidental damage or death.

There is also a high diversity of birds in the project area. While there are Vulnerable species, the biggest constraint is the lack of information on the distribution, range and population of these bird species in Bhutan to adequately determine their population trends. Bird surveys revealed species such as Rufous-necked Hornbill (*Aceros nipalensis)*, listed in the list of totally protected species in Schedule-I of the Forest and Nature Conservation Act, 1995 and categorized as *Vulnerable* (population trend decreasing) in IUCN. Other significant bird species include the Satyr Tragopan (*Tragopan satyra*) and the Yellow-rumped Honeyguide (*Indicator xanthonotus*) both listed as 'Near Threatened' (population trend decreasing) by the IUCN Red List (IUCN, 2014). The presence of many birds in these areas indicates that local disturbance is not significant. However, with increasing intrusion of workers, the risk of poaching is quite real, especially.

Mitigation measures proposed are aimed at:

(i) Minimize forest clearance along the RoW by reducing the width of the RoW where conductors are strung from one slope to another across a valley, ensuring that clearance does not go beyond the approved width and only marked trees are felled;

(ii) Leaving low trees, shrubs and ground vegetation to grow back to at least 2 meters height, which will provide cover for most wildlife that need to move through the right-of-way;

(iii) Counter the loss of trees through habitat enhancement and planting suitable fruit trees at the edge of the RoW ;

(iv) Provide funds to the Department of Forest to conduct surveys in the forest areas to determine the distribution and population of rare and endangered bird species (to be prioritized by Forestry Office), and to conduct ecological studies to determine the precise habitat requirements, feeding, breeding and impacts on species distribution from habitat fragmentation;
(v) All wildlife encounters must also be logged by the supervisor, wherever land clearing may result in encounters with wildlife and birds;
(vi) Since this project forms a component of the NHPP rather than duplicating conservation efforts of the NHPP and MHEP, this project must tie up its conservation activities with the two projects and become part of their conservation programs which include; a) Establishing the Biodiversity Management Committee to prioritize conservation areas and programs; b) Rescue and Release Program c) Wildlife conservation program for capturing, treating/rehabilitating, and releasing wild animals found in pain or distress; d)Biodiversity Conservation and Management programs aimed at conserving and preserving natural ecosystems around the proposed project, and developing the information database on biodiversity at the project site.
(vii) Measures to reduce poaching include a) awareness-raising of the existing laws, rules and penalties against poaching and prohibiting workers from indulging in such lawless activities; b) strengthen patrolling by forestry staff and involvement of locals in vigilance activities.

Land acquisition

There will be two kinds of land acquisition, permanent and temporary land requirement.

Permanent land requirement is only 0.6 acres, for the construction of 6 towers, which falls on privately owned dry land. In total this will affect 6 households that will lose 10 decimal of land each towards the footing of the transmission towers. All other towers will be located on Government Reserve Forest Land for which not land acquisition is required.

Temporary land requirement for Project work sites, worker campsites, storage of materials and machinery. These however are not expected to be much and impacts are transient in nature and land taken for these purposes will be handed over back to the Dzongkhag or Department of Forest on completion of the Construction work.

Mitigation. The direct impact of project land acquisition will be mitigated through Compensation which is guided by the “Land Compensation Rates (2009)” and the Land Act of Bhutan (2007). This will prevent any additional vulnerability for the affected households. If affected households are not satisfied with the proposed compensation, the grievance redress mechanism, based on the existing governance structure involving the Gewog Yargay Tshogchung and the Dzongkhag Yargay Tshogde can be activated.

To minimize the clearance of forest for temporary land use, Contractors must be encouraged to lease private land from land owners close to the project site. Where this is not possible,

especially for the worker camps in the forest, the Project, Forestry staff and Dzongkhag can collectively select areas that are already quite degraded and where not much forest clearance is required.

Once project construction phase is completed, contractor must follow Closure Plan before handing over the land back to the Dzongkhag.

Mobilization of vehicles, construction equipment and materials

The major materials to be mobilized are construction materials for tower excavation and footing and erection. Other materials are the insulators and conductors that are required for the evacuation of power. Since there are only 61 towers, the quantity of material required is low and all these can be easily dropped to the site by the Pre-construction phase.

The main impacts of mobilization of vehicles, construction equipment and materials is the risk of accidents, congestion on the Trongsa-Zhemgang highway, air pollution and potential "wear-and-tear" on the highway (damage) due to heavy truck traffic. Such impact shall not be significant due to the TL construction alone, since the number of vehicles required for the TL construction is significantly less.

The net impacts are deemed acceptable as these impacts will be temporary and can be mitigated through proper planning and sequencing of tasks to reduce these impacts.

Mitigation measures involve (i) (ii) use flag persons and signs to reduce congestion and warn travelers; (iii) encourage Contractors to plan and stage drop off of materials to avoid congestion; and to (iv) provision budget for making repairs to the National Highway and Access roads damaged by the project

Air Quality. With the current ongoing construction works of the Mangdechhu Hydropower Project, it is expected that air quality will be impacted due to cumulative impacts of additional machines and vehicles from the new Nikachhu project. The other sources of air contaminants will be from the additional worker camps where wood and kerosene may be the main fuel for cooking and heating, especially since these camps will be located away from access roads and LPG or electricity will not be readily available.

The net impact of the Project on Air Quality is small and transient, because air pollution will be generated at the sporadically spread worker camps and along the highway, and will be limited to the pre-construction and construction period.

A number of mitigation measures are recommended that include;

(i) Ensuring that all vehicles and machinery meet Bhutanese regulations and standards for noise and vehicle emissions;
(ii) Requiring trucks to be covered to avoid spillage; compacting;

(iii) Providing the use of personal protective equipment including respiratory protection devices;
(iv) Spraying water regularly on the access roads to reduce dust;
(v) Prohibit burning waste vegetation;
(vi) Establishing an ambient air monitoring program.

Noise, dust and access issues during vegetation clearing

Much of the noise generated will be during the felling of trees in the RoW and from the operation of construction equipment and movement of vehicles. Noise emanating from such activities may have some adverse impact on the ambient noise levels in the area. The clearance of forest for the RoW is expected to sometimes impede access for workers or wildlife. The impact from this however is small as it is localized and limited to the area along the RoW. For the most part, while these are unavoidable risks, they are not considered significant because the quantity of materials required are limited to basic tower structure materials like steel lattice, insulators, conductors and accessories.

Mitigation measures

(i) Work times near villages must be limited to daylight hours (8am-6pm);
(ii) Cordon off work sites and leave enough space for locals to move around these;
(iii) All workers must also be required to wear PPE at appropriate times and locations;
(iv) Contractors must not stock material also foot trails or access roads where access may be impeded.

Increase in demand for water resources

It is estimated that about 246 workers (14 management staff and 230 labourers) will be deployed at various locations along the Transmission line during the peak pre construction and construction period. Assuming usage of 50 litres of water per day for each worker (as communal kitchens and pit latrines are expected to be used), the total water requirement during peak construction period is 12,500 liters per day.

Water will also be required for sprinkling on roads to suppress dust and for foundation works at each tower location. The net impacts of the project activities on water resources small and transient, and drinking water can easily be sourced from streams crossing the TL.

Excavation of soil and impacts on surface water

With a total of 61 towers, the total amount of land required for tower footings is 12,810 m^3 generating a total of 11,346 m^3 of muck. The net impacts of the excavation and muck generation is small and transient, because not all tower sites are located on steep slopes or near streams, so excavation is not expected to cause large quantities of silt/soil to be washed into the river or streams during rain. Also, tower sites are dispersed and spaced at least 300m away from each other and will generate only 186 m^3 of muck per site. Thus, there will be no large stockpiles of soil that could create a major point-source of silt pollution.

Mitigation measures

(i) Locate all towers at a safe distance of 30m from water sources so that excavation work does not cause large quantities of soil to be washed into the streams;
(ii) Stockpile all excavated muck at a safe distance from the foundation site, to minimize the risk of soil falling back into the pits, or blocking access to the pit;
(iii) Dump and compact unused remaining muck nearby and revegetate through the Compensatory Afforestation Program;
(iv) Contamination of water. Linkages between the project and groundwater are difficult to predict, but are expected to be minimal. The major source of contamination of water sources is from the workers camps since there will be no requirement for fuel storage and risks of fuel spills. Thus the impacts on aquatic habitats are minimal as most streams are fast flowing and any sediment or pollution will be quickly flushed out;
(v) Any intrusion or contamination of sediments is avoided by locating towers 30-50m away from water sources so no impacts on aquatic habitats or fish are anticipated. Also all water required will be properly sourced through pipes and storage tanks. No washing of clothes, dishes or cars in the streams will be permitted, and pit latrines will be located far away from water sources.
(vi) Water quality monitoring will be conducted at key streams along the alignment at least twice a year.

Risk of slope instability

The concern for slope stability only arises where excavation work is carried out at localized tower sites. Since the economic and technical consequences of slope instability are significant for the Project, this risk will be adequately addressed during the design and planning phase through detailed investigation of the geotechnical hazards and soil of each tower footing site to ensure that there are no risks associated with stability of tower foundations. The site reconnaissance survey report indicates that there are no geological disturbances on any segment of the TL alignment.

Mitigation Measures

Detailed investigation of the geotechnical hazards and soil of each tower footing site to ensure that there are no risks associated with stability of tower foundations. Tower footings will be located at stable locations.

Blasting. Blasting is not anticipated but may be required at Tower sites where foundations need to be dug in difficult geology. If this is so, the impacts of blasting will be localized at such sites, which are away from local communities. Disturbance from blasting will thus be localized and transient during pre-construction and construction. Construction activities such as excavation, concreting, tower erection, backfilling, use of pumps (for pumping excess water) and compressors, etc.; might result in noise levels in the surrounding area.

Social Impacts.

Impacts from influx of workers. Only about 246 workers, at the maximum, shall be deployed during the peak construction phase of the project when most of the works such as tower erection, foundation laying and sagging are carried out simultaneously. Since, for transportation of material no access road shall be constructed, all the equipments and materials shall be transported by manual head loading for which most of the laborers shall be required.

The main concerns with an influx of workers include:

(i) Possible social instability;
(ii) Increased pressure on housing, infrastructure, and services;
(iii) Risk of communicable diseases spreading in the local community;
(iv) Waste and sewage entering the local environment;
(v) Health concerns in the camps (communicable diseases, poor air quality), and
(vi) Safety issues at the work sites.

Mitigation measures against the risk of communicable diseases spreading in the local community include (i) Screening and regular unannounced checking of workers, and (ii) conducting sudden, unannounced checks on workers to look for diseases such as HIV, STDs, and hepatitis.

To reduce the pressure on housing, infrastructure, and services, the Contractor must provide proper sitting and design of the temporary worker camps that takes into account drinking water storage tanks; communal kitchens; pit latrines and soak-aways (as far away from watercourses as possible), proper site drainage; a solid waste storage area (for onward transfer to the local landfill). Other important requirement are LPG gas, kerosene, or fuel wood for cooking.

The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy. Other measures include addressing the hazards and risks at the workplace; nominating focal health personnel; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency plans for the workplace or workplaces; providing Personal Protective Equipment for workers and ensuring awareness on safety at the work place.

Workers must also be briefed on code of conduct and behavior towards the host community as well as penalties for illegal activities such as hunting.

When the project construction is completed, worker numbers will decrease significantly, just leaving permanent project staff, so all positive and negative impacts associated with an influx of workers will be transient. Campsites should also be cleared at the end of their occupation, all temporary structures demolished, pit latrines covered up, all materials removed and the area revegetated and allowed to grow back to its natural state.

Impacts on Cultural and Religious Sites

There are a few religious and cultural sites within the project area but it is expected that there will be no impact on Cultural and Religious sites because during design stage extra care was

taken to ensure that religious structures/ public property were avoided. No Transmission towers are located adjacent to such sites and the Transmission line will not in any way or manner hinder any religious or cultural practices.

Mitigation Measures include consulting all affected communities and custodians of monasteries, lhakhangs, and nunneries in advance to inform them of the purpose, nature, duration, extent and timing of all work in and around their village, and explain to them the purpose of the Project and its activities along with the work plan and schedule of activities.

All work must be planned to avoid sensitive times (such as key dates in the religious calendar, festivals etc).

Visual impacts

The main negative impact on visual aesthetics in the project area will occur during construction, as a result of clearing, site work, and heavy equipment and vehicles on the road. Specifically to this Transmission Line (TL), the visual impacts are not expected to be significant because the TL is aligned parallel along the already existing 66 kV line from Trongsa to Yurmo. Only TL 27 to TL 31 shall be visible from the national highway. While the forest itself could provide a good natural screen to hide the TL from the highway, this is difficult as the hilly terrain makes the TL line quite visible.

Mitigation measure

Developing a greenbelt along the highway will allow for enhancing forest habitat as well as providing a good natural screen while also achieving slope stability, reducing soil erosion and reducing air pollution. These areas will be demarcated and handed over to be replanted under the Compensatory forestry program.

Economic Impacts. The project is expected to have a positive impact as far as opportunities for income generation for project-displaced households is concerned because it is expected that the influx of workers for both the Hydropower Component and the TL component will substantially increase the demand for locally grown vegetables, crops and dairy products as well as provide employment opportunities within the project for implementation of various components such as construction work, forest clearance, slope stabilization, afforestation which require little or no education.

Potential economic impacts that are associated with the mobilization of construction equipment and vehicles include potential “wear-and-tear” on the highway (damage) due to heavy equipment and truck traffic for the main project compinent. This will result in increase in maintenance and repair costs both to the project as well as the Ministry of Works and Human Settlement.

Impacts during Operation Phase

Economic Impacts: Decrease in Income opportunities

The routine maintenance of the RoW will not have any negative economic impacts as it will not affect agricultural areas or farm roads used by locals for transporting produce. If a line failure requires the repositioning of Towers, it should not be necessary to purchase land for the new foundations, as the new foundations maybe dug close to the old ones, involving the same land owners so exchange of land can be possible and the previously used area can be returned.

At the local level though, once the major construction works are completed, and as contractors and migrant workers leave, there will be a huge decrease in demand for agricultural products such as vegetables, dairy products etc.

At the national level, the evacuation of power from the Mangdechhu will have significant positive economic impacts for the country in terms of increasing its income generation from the sale of power to India.

Mitigation measures include ensuring (i) prior briefing by Project on project duration and scheduling at the outset of the project, (ii) assisting farmers to increase productivity on newly compensated land; and (iii) revenue sharing arrangements

Reduced pressure for local resources.

With the removal of workers from site, no negative social impacts are anticipated. Instead, the local district authorities will benefit positively due to reduced pressure on health, water, resources such as LPG, kerosene, diesel and fuel wood, as well as reduced incidences of poaching, and anti-social activities.

Risk of electrocution and accidents during maintenance works.

The main hazard to people from the operation and maintenance of the completed TL system is the risk of electrocution. All workers are exposed during the performance of their duties such as repairing towers, transmission lines and its associated components. Locals can also be at risk especially as they are unaware of the risks and potential hazards which make them vulnerable to the danger of electrocution.

Mitigation measures include following the Operation and Maintenance procedures and Occupational Health and Safety Guidelines issued by BPC for the O& M of all Transmission lines in the country. This must also include securing the workplace, wherein all lines are shut down prior to maintenance work, use of PPE and procedures for emergencies and compensation procedures in case of accidents.

Electromagnetic Field (EMF)

The impacts of EMF are considered during the design stage and mitigation options for Transmission lines. This includes increasing the distance of local communities, populated areas, other occupied buildings and wildlife and vegetation from the EMF source.

There is no specific regulation on EMF for high voltage transmission line in Bhutan. According to Safety Code 2008 issued by Bhutan Electricity Authority, the clearance of 132 kV line should be 2.1 m horizontal and 5.5 m vertical distance from any buildings. Since the entire stretch of 132 kV transmission lines of NHPP will not traverse settlements, it does not violate any such safety requirements.

Mitigation measures include following the minimum distance requirements for a RoW; minimum clearance of 6.1 m from the ground vegetation or moving workers and wildlife; minimum distance has to be maintained for line crossings at different voltage levels (66 kV, 132 kV and 400 kV). Other options include phase cancellation, conductor separation, vertical double circuiting, selection of conductor and OPGW and spacing and clearance from live metal to earthed metal

Risk and hazard associated with TL

The transmission line runs parallel to the existing 66 kV line that has been in operation for over 7 years. Thus far, there has been no record of incidents related to landslides or earthquakes damaging the existing 66 kV line. The TL will be designed following the national and international (as applicable) standards required by incorporating a margin of safety to withstand natural disasters such as earthquake.

Mitigation measures include a) selection of stable tower foundation areas during design and survey stage; b) regularly cut overhanging trees that could fall on the Transmission line during during an earthquake or landslide; c) enforce appropriate building codes and infrastructure design; d) raise public awareness about disasters, their risks and ways to cope; e) develop emergency protocols; and, f) conduct regular check and maintenance.

Environmental impacts of RoW maintenance

Maintaining the RoW through regular clearing and repairing faults along the line will have no new major ecological impacts because there are no additional physical impacts. Maintenance work will be very small in scale and infrequent, and involves few changes to the existing situation.

Mitigation measures include (i) scheduling of work to avoid disturbing wildlife and birds during such maintenance works; (ii) public education on the risks of tampering with the towers and TL lines and (iii) provide prior notice to locals about Operation and Maintenance work being carried out in their areas, they may be more amenable to disturbance.

Electrocution of raptors and other large birds

While there has been no documented evidence in Bhutan that existing transmission lines have caused electrocution of large birds, this risk needs to be considered. The impact of electrocution of birds depends on the electro- technical design of the pylon and the natural features surround it.

Mitigation measures to minimize the risk of electrocution include (i) construction of cage box on conductors to prevent birds from sitting or making nest on the towers; (ii) Placing colorful/fluorescent tape on the towers to make them conspicuous; (iii) aligning the TL close to the 66 kv line which reduced the need for birds to duck two power lines at the same time; (iv) ensuring sufficient phase-to-phase and phase-to ground wire spacing; (v) using silhouettes of predators (falcon/hawk) as scaring devices for repelling bird; and (vi) working closely with the Department of Forest to collect information on any reports of bird collisions/accidents due to the TL.

4.0 Analysis of alternatives

The preliminary assessment of the project includes an analysis of various project alternatives, addressing the optimal match between required technical specifications and site conditions, especially geological stability, as well as addressing any concerns for environmental, social, and economic features in each location.

1st Option: The proposed 132 kV transmission line with 18.6 km and 19.2 km respectively is aligned mostly in the Government Reserved land/forest with only 6 towers within private land and community forest. The preferred route, 18.6 km was diverted via Raphey top crossing the existing 66 kV line at T7 and T8.

2nd Option: The second option after crossing 66 kV line at T7 and T8 runs parallel to 66 kV line and crossing upcoming 400 kV D/C Mangdechu-Goling-Jigmeling transmission line and finally enters the Mangdechu Pothead yard.

The "Do Nothing" Alternative

The "do nothing" alternative is not viable as it is absolutely necessary to have a transmission line to evacuate the power generated in NHPP. Without this associated transmission line, the NHPP is incomplete.

The first option was chosen due to the following reasons:

(i) Environmental impacts of the length of the transmission line: 2nd option is 19.2 km which is 0.6 km longer than the 1st option entailing an additional 5 acres to be cleared for the RoW.
(ii) Social impacts on private land: In the 2nd option, an additional 4 towers fall within a wetland at Yurmoo village whereas the 1st option will have 6 towers in dryland. Thus, the number of affected parties is much lower in the 1st option compared to the 2nd option.
(iii) Technical reasons: The terrain along the route of the 1st option was found to be comparatively moderate than the 2nd option.

5.0 Conclusions

The environmental assessment of the TL indicates that there are no significant adverse economic, environmental, and socioeconomic impacts associated with the 18.6 km transmission line route due to the following reasons:

(i) The TL alignment does not fall within any environmentally-sensitive, protected area, or biological corridor of the country.
(ii) Although the length of the TL is 18.6 km, most part of the alignment falls within forest areas located close to the local community, is heavily disturbed, and is not relatively dense. Trees that have to be cut will be replaced in a larger re-vegetated area, and land that is required for the project will be compensated.
(iii) One of the major criteria for selection of the TL alignment is to minimize, as far as possible, the need for forest clearance and the acquisition of private land. Almost 90% of the alignment runs parallel to the existing 66 kV line from Trongsa to Yurmo, where the forest is already cleared.
(iv) Most of the construction work is small in scale (involving the excavation of small pits for the tower foundations and erection of towers and stringing of conductors) and will be conducted by small teams of workers without the use of heavy vehicles and machinery. Construction work is relatively straightforward and can be completed in a fairly short time (17 months).
(v) Most of the impacts are temporary and occur only during the pre-construction and construction phase. These impacts are social and environmental impacts arising from construction works and operation of worker camps, impacts on health and safety, waste generation, increase in demand for resources (fuel, water, space) and services, impacts on air quality and noise from increase in traffic, and impacts on water quality from excavation works. These impacts will be temporary and will be over once the Construction period is complete.
(vi) Only 6 households are affected due to the location of 6 towers requiring 10 decimal of dryland. No relocation is required and no other infrastructure will be affected.

The Bhutan Power Corporation has gained significant experience with similar projects in other parts of the country and is well equipped to cope with the risks that may arise during operation and maintenance works. The project will bring significant power service reliability to Bhutan and local and national economic benefits, as well as significant greenhouse gas emission reductions.

The overall conclusion of this process is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impacts as a result of location, design, construction or operation of the subproject. There should in fact be some small benefits from recommended mitigation and enhancement measures, and major positive economic impacts for the country once the scheme is in operation.

The total estimated environmental management cost of the Project is Nu. 143 million. An additional budget of Nu. 7. 8 million is earmarked for environmental mitigation and monitoring for the transmission line.

The EIA was prepared based on the ToR approved by the NEC and in accordance with SPS 2009. The environmental assessment was based on findings from field investigations and

ocular inspection, secondary data from sources such as feasibility studies and design of NHPP and MHEP, and from public consultations.

1 Introduction

1.1 Background

1. Bhutan's technically feasible hydropower generation potential is estimated to be 23,760 MW. At present, only about 5% (or 1,488 MW) of this generation potential has been harnessed. Export of hydropower is the largest revenue source for the Government of Bhutan (RGoB) accounting for over 45% of its national revenues. A total of 10 projects (about 10,000 MW) have been selected jointly by RGoB and the Government of India (GoI) for hydropower development by 2020. These 10 projects have different implementation modalities such as bilateral development by RGoB and GoI, and by joint ventures between government corporations of the two countries. Hydropower development in Bhutan is considered to be a source of 'clean power' due to its minimal contribution to greenhouse gas (GHG) emissions compared to conventional energy sources.

2. Recognizing the need to develop the hydropower potential, the Asian Development Bank (ADB) provided in October 2011 a technical assistance to prepare the 118 MW Nikachhu Hydropower Project (NHPP). NHPP is a medium-sized run-of-river (ROR) hydropower type which will have lesser degree of environmental and social impacts compared to reservoir types. The power generated by NHPP will be evacuated by a 18.6 km 132 kV D/C transmission line running to Yurmo, where it will be integrated into the pot head yard of MHEP. Farther power transmission to India shall be through the MHEP power transmission system. The associated transmission line, with an estimated amount of Nu. 233.836 million.

3. NHPP will be located in Trongsa District and will draw water from the Nikachhu River and will discharge its tailrace water above the dam of the Mangdechhu Hydropwer Project (MHEP). The NHPP will be constructed over a 5-year period and expected to be operational by 2019.

4. Druk Green Power Corporation Limited (DGPCL), established in 2008 and mandated to accelerate hydropower development projects, will implement the NHPP. DGPCL currently operates five power plants with an installed capacity of 1,480 MW.

1.2 Purpose of the report

5. The EIA has been prepared based on the Terms of Reference (ToR) endorsed by the National Environment Commission as required by the Environmental Assessment Act 2000 and in accordance with the Safeguard Policy Statement 2009 (SPS 2009) of ADB.

1.3 Extent and scope of the study

6. Bhutanese law and SPS 2009 require that the environmental impacts of development projects are identified and assessed as part of the planning and design process, and that action is taken to reduce the impacts to acceptable levels. This is done through the environmental

assessment process which has become an integral part of lending operations and project development and implementation worldwide.

7. This report discusses the existing environment within the project's area of influence, environmental impacts and mitigation measures relating to the location, design, construction and operation of all physical works that will be covered by the associated transmission line for NHPP.

8. As required by the Environmental Assessment Act 2000 and its Regulation 2002, a ToR providing the scope and framework for conducting the EIA of the 18.6 km 132 kV D/C transmission line (TL) for NHPP was submitted to the NEC and was subsequently approved. The TL will start from Nikachhu Pothead Yard to Mangdechhu Pothead Yard and is under Trongsa Dzongkhag.

9. Based on the approved ToR from the NEC, the EIA was prepared. The level of detail and analysis in the report reflects the potential environmental, economical and social impacts of the proposed project and recommends mitigation and management plans for the likely adverse environmental impacts. Along with the EIA, other documentation and clearances required that are under process include the following:

(i) Forest Clearance from the Department of Forest and National Park Services for vegetation clearing along the 27 m right-of-way (RoW);
(ii) A report on the public consultations held to discuss issues and concerns related to the NHPP including the TL;
(iii) Reports on separate consultations held with affected people along with their signatures of 'No Objection' for the TL; and,
(iv) Clearance from the Local District Authorities, Trongsa Dzongkhag for executing the project.

1.4 Structure of the Report

10. Following the SPS 2009, the Report is structured as follows:

Executive Summary

Chapter 1 *Introduction* provides the background on the project, environmental clearance applicant details, and the scope of work.

Chapter 2 *Policy, Legal, and Administrative Framework* presents a review of relevant national laws and policies, international environmental obligations, and ADB's environmental requirements.

Chapter 3 *Description of the Project* provides a brief description of the Project, the location, size and need, description of project components, implementation schedule and staffing requirements.

Chapter 4 *Analysis of Alternatives* presents the two alternatives considered during the feasibility study in order to arrive at the best option.

Chapter 5 *Description of the Environment* includes details on the baseline data for environmental conditions in the project area (current features and conditions, pre-project) including the methodology used to obtain the baseline data.

Chapter 6 *Anticipated Project Impacts* identifies the potential environmental, economic and social impacts from pre-construction, construction, and operation phase.

Chapter 7 *Environmental Mitigation and Management Plan*

Chapter 8 *Environmental Monitoring Program and Institutional Responsibilities* outlines the environmental monitoring program, institutional responsibilities including the cost of implementing the EMP

Chapter 9 *Grievance Redress Mechanism* describes the process of addressing complaints

Chapter 10 *Information Disclosure, Consultation, and Participation* discusses the issues raised during the consultations, proposed actions to address them, and the information needed to disclose to the public.

Chapter 11 *References*

Annexes

2 Policy, Legal, and Administrative Framework

2.1 National Laws and Regulations

11. Sustainable development is enshrined in the policy of RGoB through the *Middle Path* approach of its National Environment Strategy for Bhutan (1998) which aims to maintain a balance between environment and development. One of the key implementing mechanisms is the Environmental Assessment Act (2000) which establishes procedures for assessing the potential impacts of plans, policies, programs and projects. It also establishes that Environmental Clearance (EC) must be obtained from the National Environment Commission (NEC) or other Competent Authority for any project or activity that may have adverse environmental impacts.

12. A number of Acts and Regulations are pertinent for this Project. A brief summary of these is as follows:

1. Forest and Nature Conservation Act 1995

13. The Bhutan Forest Act 1969 was repealed in 1995, with the enactment of the Forest and Nature Conservation Act (FNCA) 1995, in keeping with evolving conservation needs and to allow for community stewardship of forests. The objective of the FNCA is to "provide for the protection and sustainable use of forests, wildlife and related natural resources of Bhutan for the benefit of present and future generations". The act covers forest management, prohibitions and concessions in government reserved forests, forestry leases, social and community forestry, transport and trade of forestry produce, protected areas, wildlife conservation, soil and water conservation, forest fire prevention, and enforcement and penalties.

14. Protected areas are regulated under this act in Bhutan. A protected area is an area that has been declared to be a national park, conservation area, wildlife sanctuary, wildlife reserve, nature reserve, strict nature reserve, reserve forest, or critical watershed. Other protected areas include areas for the preservation of natural beauty of national importance, protection of biological diversity, management of wildlife, conservation of soil and water and related purposes. A Protected Area includes various management zones classified as: core zone, buffer zone, administrative zone, seasonal grazing zone, enclave zone, and multiple use zones. Schedule I of the Act provides a list of wild animals and plant species that needs full protection in Bhutan.

15. Among others, the Forest and Nature Conservation Rules (FNCR) 2000, allows for: declaration of protected areas (PA), administration of PAs, and prohibitions in PAs; and for protection of wildlife and use of certain wild species.

2. The Forest and Nature Conservation Rules of Bhutan, 2006

16. This came into force with effect on September 1, 2006 and supersedes all relevant rules and regulations, notifications, circulars and instructions existing as of August 31, 2006. Chapter III describes regulations related to Government Reserved Forests. For any developmental activity in a Government Reserve Forest, the proponent is required to seek Forestry Clearance from the Respective Divisional Forest Office in the District (there are 12 Forest Divisions and 9 Protected Areas). The proposal after being reviewed in the field by the District Forest Officer (now known as Chief Forestry Officer) is forwarded to the Department of Forest and Park Services where the final Clearance is granted based on the field review.

17. Once clearance is granted and the Project is ready to commence, the trees to be cut are marked by the field staff. Marking or felling of trees within 100 feet of the bank or edge of any river, stream, and watercourse or water source; Marking or felling of trees within 600 feet uphill and 300 feet downhill of any motor road or Felling from any place where the slope is greater than 45º is restricted. By law, no trees may be felled it if has not been marked by a designated Forestry staff.

3. The Environment Assessment Act (2000)

18. This act requires the government to ensure that environmental concerns are considered when formulating, renewing, modifying and implementing any policy, plan or programme. Issuance of an environmental clearance is to be a prerequisite to the issuance of any development permit.

4. Regulation for the Environmental Clearance of Projects 2002

19. The EC procedure is described in the Regulation for the Environmental Clearance of Projects (2002), and specific guidance is given in a series of sectoral guidelines, prepared in 1999 and revised with ADB assistance in 2006. For any developmental activity, the proponent is required to submit an EC Application, containing information on the applicant, the project, funding agency, the affected environment, potential impacts, mitigation, monitoring and public consultation. The NEC considers the application and issues or denies EC, or decides that a full EIA is necessary.

20. For all transmission lines above 33 kV, NEC requires an EIA to be conducted irrespective of whether the projects falls in a protected area buffer zones or biological corridors. The proponent, the DGPCL in the case of this project submits a proposed Terms of Reference (ToR) to NEC, and then conducts the EIA study and prepares the report according to the approved ToR. NEC will then review the completed EIA report and decide whether Environmental Clearance is granted or denied based on an EIA presentation conducted by the proponent and the field visits conducted by the NEC review team. EC may include certain conditions with which the proponent must comply, which would include some or all of the mitigation proposed in the EIA or EC Application, plus other measures if necessary.

21. The NECS or CA may issue EC based on the following: (a) the effects of the project on the environment are foreseeable and acceptable; (b) the applicant is capable of carrying out the

terms of EC; (c) the project, alone or in connection with other programs/ activities, contributes to the sustainable development of the Kingdom and the conservation of its natural and cultural heritage;(d) adequate attention has been paid to the interests of the concerned people; and, (e) the project is consistent with the environmental commitments of the Kingdom.

22. As per Article 16 of the act, public consultation is mandatory. EC for a project shall be reviewed and may be revised and renewed at least every five years, unless a shorter period is stated. The NECS or CA may review and modify the terms whenever there are: (a) unacceptable risks to the environment resulting from the project which were not known at the time the clearance was issued; (b) availability of improved and cleaner technology; and, (c) a need to bring the project into compliance with changes to the laws of the country.

23. Non-compliance with environmental terms specified in the issuance of environmental clearance makes the offender liable to penalties that may include compensation for environmental damage, fines, sanctions, and suspension or revocation of environmental clearance in part or full. The applicable time limit that will be required to obtain environmental clearance is provided in **Table 2.1**.

Table 2.1: Applicable time limits to obtain environmental clearance

Works	Time limits
Response by National Environment Commission Secretariat on the receipt of application. This is simply an acknowledgement of the receipt of the application.	Within 15 days
Review by the Secretariat to assess the adequacy of the application as per government rules and guidelines.	30 – 90 days
Decision/Response on the environmental clearance, based on the findings of the Environmental Assessment report.	30 – 90 days
Public notification on decision by the Secretariat/Competent Authority.	Within 15 days
Appeal on decision by public.	Within 30 days
On approval of the clearance, a legal undertaking with the proponent of new projects to comply with the EA Act, 2000.	10 – 30 days
Maximum time required to get EC	**270 days**

5. The Biodiversity Act (2000)

24. Among the many objectives of this Act, the relevant ones are to ensure the conservation and sustainable use of the biological and genetic resources; to promote the equitable sharing of benefits derived from the use of genetic resources, to recognize and protect traditional knowledge, innovation and practices of local communities associated with biodiversity and to promote technology transfer and capacity building relevant to the conservation and sustainable use of biological diversity;

6. National Environment Protection Act 2007

25. The National Environment Protection Act (2007) outlines principles and a legal framework that have implications for forest governance and management. It requires that a person taking natural resources from the environment, or deriving economic benefits from it, should ensure sustainable use and management of the resources and ecosystems

7. Mines and Minerals Management Act, 1995

26. The relevance of this Act for a hydropower project is when the project requires quarries for sand or stone; this law is enforced to get the site clearance. However, since this TL project does not require any quarries, it is not necessary to seek clearance from the Department of Geology and Mines, the Competent Authority over all Mines and Minerals in the Country.

8. The Road Act, 2004

27. The Act establishes a framework to ensure balanced socio-economic development, promote social equity, and define and establish an efficient system of road networks. According to the Act, the construction of access roads for a hydropower project falls directly under the jurisdiction of Ministry of Economic Affairs, and termed as a power road. If there is a need to construct access roads that take off from the National Highway, a Clearance is required from the Ministry of Works and Human Settlement. In this project, there are no new access roads to be constructed so No clearance is required.

9. Bhutan Electricity Act, 2003

28. This act provides a framework for licensing and regulating the operations of power companies. Under this act, the Bhutan Electricity Authority has been established as an autonomous body and the custodian for enforcing this act. The Electricity Act provides power to acquire land and water for generation and supply of electricity.

10. Waste Prevention and Management Act 2009 and Waste Prevention and Management Rules, 2012

29. This Act clearly states that: all developmental activities that generate waste shall be planned and executed in harmony with the carrying capacity of the country's fragile ecological settings and geographical terrains, in line with the concept of 3 Rs (Reduce, Reuse and Recycle). Any person polluting the environment or causing ecological harm shall be responsible for the costs of avoidance, containment, abatement, medical compensation, mitigation, remediation and restoration. Implementing agencies shall ensure that the minimization, storage, treatment and disposal of hazardous waste are addressed in an environmentally sound manner.

11. The Local Government Act of Bhutan, 2009

30. This Act repeals the Local Government Act 2007; Thromde Act 2007; Dzongkhag Yargay Tshogdu Chathrim, 2002; Gewog Yargay Tshogchung Chathrim, 2002. According to this Act, local Governments shall comprise the following categories:

31. The Dzongkhag (District) Tshogdu shall be the highest decision making body in the Dzongkhag. It shall comprise the Gup and Mangmi as the two elected representatives from each Gewog, one elected representative to represent the Dzongkhag Thromde and one elected representative to represent the Yenla Throm.

32. The Gewog (block) Tshogde (Committee) shall be the highest decision making body in the Geog. It shall comprise the Gup, Mangmi and Tshogpas.

33. Under this Act, the Dzongkhag and Gewog Tsogde must ensure the provision of such social and economic services for the general wellbeing of the residents of the communities in a sustainable and equitable manner; Local Governments shall be supported by the Government to promote holistic and integrated area-based development planning.

12. Bhutan Sustainable Hydropower Development Policy 2008

34. The key objectives of the policy are to:

(i) Mobilize funds and attract investments for accelerated hydropower development.
(ii) Enhance the revenue contribution to the Royal Government.
(iii) Contribute to socio-economic development.
(iv) Ensure domestic electricity supply security and reliability.
(v) Ensure that the hydropower development is in accordance with the sustainable development policy of the Royal Government, keeping in view the fragile mountain ecosystem of the country.
(vi) Contribute towards development of clean energy to mitigate problems related to global warming and climate change.

35. Listed under the Institutional Arrangements of the Hydropower Sector in this policy document, DGPCL is responsible for managing all hydropower plants fully owned by the Royal Government. It will also develop projects on its own, through joint ventures on behalf of the Royal Government as may be directed. The policy document stipulates that projects funded through bilateral assistance shall continue to be managed and supervised by the MoEA through formation of project authorities. Such fully Government-owned generating plants shall be handed over to DGPCL when the Project Authority is dissolved.

13. The Water Act of Bhutan, 2011

36. This Act applies to all issues related to water resources with the objective to ensure water is protected, conserved and/or sustainably managed through Prioritization of water use, Protection of Water Catchments, Development of National Integrated Water Resources Management Plans for the conservation, development and management of water resources, river basins, ensuring Minimum Environmental Flow requirement of Rivers, Prohibition to

abstract or use water without Environmental Clearance (except for exemptions) and ensuring Prevention and Control of Water Pollution.

14. Rules and Regulations on Occupational Health and Safety 2006

37. The purpose of the OHS Rules and Regulations is to assure safe and healthful working conditions for workingmen and women, as well as other persons present at workplaces, and protect them from work-related risks to their health, safety, and well-being. The rules apply to all employers and workers (both Bhutanese and non-Bhutanese) of licensed manufacturing, mining and service enterprise, construction companies, bodies corporate incorporated under the Companies Act 2000 of the Kingdom of Bhutan, and any other agency employing large numbers of workers at the work site.

Table 2.2: List of applicable acts and regulations for the Project

No.	Acts/ Regulations	Pre-Construction phase	Construction Phase	Operation Phase
1	The National Environment Protection Act 2007	Y	Y	Y
2	Forest and Nature Conservation Act 1995	Y	Y	Y
3	Forest and Nature Conservation Rules 2006	Y	Y	Y
4	Environmental Assessment Act 2000	Y	Y	Y
5	Regulation for the Environmental Clearance of Projects 2002	Y	Y	Y
6	National Environment Protection Act 2007	Y	Y	Y
7	Land Act (2007) Cash Crop Compensation Rates (1996) and PAVA Rates (2009).	Y	Y	N
8	Mines and Minerals Management Act, 1995	N	N	N
9	The Road Act, 2004	N	N	N
10	Bhutan Electricity Act, 2003	Y	Y	Y
11	Waste Prevention and Management Act, 2009	Y	Y	Y
12	Waste Prevention and Management Rules, 2012	Y	Y	Y
13	The Local Governance Act of Bhutan, 2009	Y	Y	Y
14	Bhutan Sustainable Hydropower Development Policy 2008	Y	Y	Y
15	Biodiversity Act, 2003	Y	Y	Y
16	The Water Act of Bhutan, 2011	Y	Y	Y
17	Rules and Regulations on Occupational Health and Safety, 2006	Y	Y	Y

2.2 Applicable Guidelines and Standards

38. A number of guidelines and standards have been notified or issued by line ministries and departments in Bhutan in order to ensure compliance. The guidelines and standards relevant to the current project are noted below.

1. Environmental Discharge Standard 2010

39. National ambient air quality standards establish upper limits on the concentration of air pollutants in outdoor air, for the protection of human health, agriculture, natural vegetation and ecosystems, and the environment in general.

Table 2.3: Ambient air quality standards (maximum permissible limits in µg/m^3) NECS Bhutan (2010)

Parameter	Industrial Area	Mixed Area*	Sensitive Area**
Total Suspended Particulate Matter			
24 Hour Average	500	200	100
Yearly Average	360	140	70
Respirable Particulate Matter (PM 10)			
24 Hour Average	200	100	75
Yearly Average	(World Bank/WHO = 150)	60	50
	(World Bank/WHO = 70)		
Sulfur Dioxide			
24 Hour Average	120***	80	30
Yearly Average	80	60	15
Nitrogen Oxides			
24 Hour Average	120	80	30
Yearly Average	80	60	15
	(World Bank/WHO = 40)		
Carbon Monoxide			
8 Hour Average	5,000	2,000	1,000
1 hour Average	10,000	4,000	2,000

* Mixed Area means an area where residential, commercial, or both activities take place.
*Sensitive Area means an area where sensitive targets are in place, like hospitals, schools, sensitive ecosystems.
*Exceeds (better than) WHO/World Bank guidelines.

Table 2.4: Motor vehicle emission standards

Fuel Type	Vehicle registered prior to Jan 1, 2005	Vehicle registered after Jan 1, 2005	Type Approval
Petrol (%CO)	4.5	4	
Diesel (%HSC)	75	70	Euro-II

Table 2.5: Environmental standards for noise

Land Use Category	Maximum Level	
	Day	Night
Industrial Area	75 dB	65 dB
Mixed Area	65 dB	55 dB
Sensitive Area	55 dB	45 dB

40. Noise standard as per land use Category 2. World Bank noise guidelines are 70 dB day and night for industrial areas, and the same as Bhutan guidelines for sensitive areas.

Table 2.5: Checklist of compliances required for the Project

No.	Agency/Concerned Person	Why/When	Sought?
1	Trongsa Dzongkhag	Administrative Approval from Dzongkhag	Yes
2	Department of Forest and Park Services	Should the project damage or acquire Tsamdo	Yes
3	Department of Culture	Should the project be located within 50 m of a cultural or religious site	Not required
4	Private Owners	Should the project need to acquire private property	Yes
5	Public Consultation	Project is impacting their gewog	Yes
6	Department of Health	Within 50 m of a hospital	Not required
7	Department of Education	Within 50m of a school	Not required
8	Department of Roads	Should the project require access from highways and feeder roads	Not required

2.3 International Agreements and Conventions

41. RGoB is well represented in the international and regional environmental arena as part of its commitment to environmental conservation and protection. The National Environment Commission Secretariat, as a key environmental policy making body/nodal agency of the country, participates in various international meetings relating to conventions and agreements that Bhutan has signed or ratified. Bhutan is party to Multilateral Environmental Agreements as given in Table 2.6.

Table 2.6: International Commitments and Dates of Ratification

No.	International Commitments	Instrument of Ratification
1	UN Framework Convention on Climate Change	1995
2	UN Convention on Biological Diversity	1995
3	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	2004
4	Kyoto Protocol to the United Nations Framework Convention on Climate	2005

No.	International Commitments	Instrument of Ratification
	Change	
5	Cartagena Protocol on Biosafety (the Convention on Biological Diversity)	
6	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal Bhutan became a party in 2004.	2002
7	UNESCO World Heritage Convention	2001
8	International Plant Protection Convention (Adherence)	1994
9	The Final Act and the Law of Sea Convention	1982
10	Statute of the Centre for Science and Technology of the Movement of Non-Aligned Countries and other Developing Countries	1985
11	Statutes of the International Centre for Genetic Engineering and Biotechnology	1985
12	Vienna Convention for the Protection of the Ozone Layer;	2004
13	United Nations Convention to Combat Desertification (UNCCD)	2004

2.4 Environmental Requirements of ADB

42. The SPS 2009 of ADB provides guidance on the environment category of projects based on the degree of anticipated environmental impacts. The initial process of categorization involves filling out a sectoral Rapid Environmental Assessment (REA) checklist. A project is classified as one of the four environmental categories (A, B, C, or FI) based on the most environmentally sensitive component. Categories are as follows:

Category A: Project that is likely to have significant adverse environmental impacts which are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA), including an environmental management plan (EMP), is required.

Category B: Project with potential adverse environmental impacts that are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination (IEE), including an EMP, is required.

Category C: Project that is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications need to be reviewed.

Category FI: Project is classified as category FI if it involves the investment of ADB funds to, or through, a financial intermediary.

43. The SPS 2009 also provides the content and format of environmental assessments (see Annex to Appendix 1, p. 41). Impacts and risks are required to be analysed according to the project's area of influence which encompasses the primary project site(s) and related facilities that the Borrower (including its contractors) develops or controls such as power transmission corridors, construction camps, etc., and associated facilities that are not funded as part of the project but whose viability and existence depend exclusively on the project and whose goods and services are essential for the successful operation of the project. An EIA is required for public disclosure to ADB website 120 days prior to its Board consideration of the project.

3 Description of the Project

3.1 Introduction

44. The 18.6 km 132 kV D/C transmission line will evacuate the power generated from the 118 MW run-of-river Nikachhu Hydropower Project (NHPP) located in Trongsa District, with a proposed installed capacity of 118 MW.[3] This transmission line will start from Nikachhu Pothead yard and terminating at the Mangdechhu Pothead yard at Yurmo. Construction activities for NHPP is expected to begin by 2014.

45. The 132 kV transmission line is within Trongsa Dzongkhag and will traverse three gewogs: Tangsibji, Drakteng, and Langthel.

46. The construction of transmission line and power evacuation system for NHPP shall be awarded to Bhutan Power Corporation (BPC) on a deposit work basis. Tentatively, detailed survey and engineering and design of the transmission lines shall be implemented between 2015 and 2018, and shall be completed before the commissioning of NHPP.

47. **Map 1** presents the location of Trongsa District, **Map 2** shows Trongsa District and its gewogs while **Map 3** shows the alignment of the transmission line.

[3] The 18.6 km 132 kV D/C transmission line is an essential component of the 118 MW Nikachhu Hydropower Project to evacuate power it generates into the national grid but will not be financed by ADB and thus, considered an associated facility according to ADB's Safeguard Policy Statement 2009 (SPS 2009). The SPS 2009 provides that, "Impacts and risks will be analyzed in the context of the project's area of influence. This area of influence encompasses…(ii) associated facilities that are not funded as part of the project (funding may be provided separately by the borrower/client or by third parties), and whose viability and existence depend exclusively on the project and whose goods or service are essential for successful operation of the project…(Appendix 1, para. 6, p.31)."

Map 2: Trongsa District and its Gewogs

Map 1: Location of Trongsa District

Map 3: Alignment of the Transmission Line

3.2 Description of the Transmission Line

48. The associated transmission line of NHPP consists of the following:

(i) Voltage level: 1**32 kV**
(ii) Tapping point: **Nikachhu Pot Head Yard**
(iii) Termination point: **Mangdechhu Pot Head Yard**
(iv) Length of line: **18.6 km** (Maximum)
(v) Right of Way (RoW) width: **27 m**

49. As shown in **Map 3**, the transmission line route stretches from Nikachhu Pot Head Yard - Mangdechhu River Crossing - parallel to Mangdechhu Dam Axis road - TL1 – Alternative - TL56, Taktse-Tashidenkha-Euse-Bubja-Kuengarabten-Samchholing-Lhakhang Jab-Raphey-Khompey-Yurmoo at Yurmo, it will be integrated into the Pothead yard of the Mangdechhu Hydropower Project (MHEP). **Table 3.1** presents the details of the transmission line route while **Table 3.2** provides the description of the components.

Table 3.1: Transmission Line Route Details

From	To	GIS Dist (Crow Fly)	Actual in km (approx.)	Place under Trongsa Dzongkhag
TL1	T6	2.07	2.48	Tashidingkha, Eusa
TL7	TL14	2.02	2.42	Tashidingkha, Eusa, Taktse
TL15	TL26	3.15	3.78	Taktse, Eusa, Bubja, Kuengarabten
TL27	TL42	5.32	6.38	Kuengarabten, Samcholing, Lhakhang Jab
TL43	TL50	1.7	1.57	Lhakhang Jab, Raphey Top
TL51	TL56 at Yurmo	1.31	1.57	Raphey, Khompey and Yurmo
Total Distance (km)		15.57	**18.68**	

Table 3.2: Description of Project Components

Component	Function	Description
Towers comprising of body, cage, cross arms and peak	To support the conductors	Total of 61 towers Design (height of 41m, width of 8m) Material- Stainless steel Purpose. To provide support to the overhead conductors
Insulators 6 string (each with 10-11 discs)	To prevent unwanted flow of electric current from conductor to the earth	Pre-manufactured electrical component made of Porcelain For each tower 12 insulators (tension string) are required
Conductors (Double	To evacuate electricity	Type used: Panther /EW ; OPGW (Optical fiber

Component	Function	Description
circuit) 18.6 km length	from Yurmo to MHEP pothead	composite overhead ground wire)

Infrastructure requirement

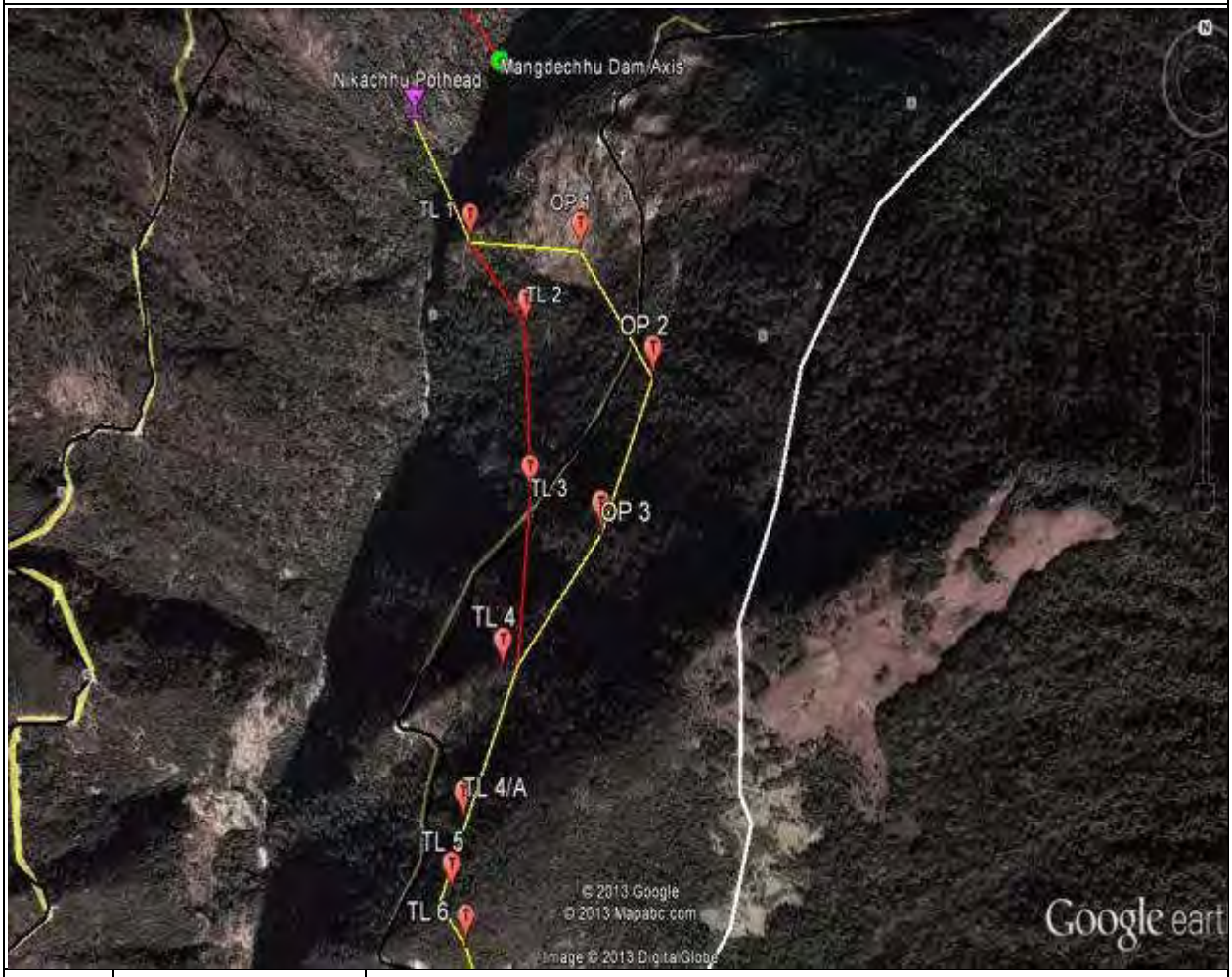
50. The associated transmission line (TL) for NHPP will not require any access roads to be constructed because the take off point is right next to the Mangdechhu dam site, and then the transmission line mostly runs either below or above the National highway from Trongsa to Zhemgang. At regular intervals, the TL crosses other access roads such as the Mangdechhu dam axis road, access to dam colony, Taktse College, cremation ground, Samcholing MSS School, Kuengarabten Nunnery Centre and to the Mangdechhu Surge shaft area.

Construction of towers

51. The TL will require the erection of 61 towers, each of which will be spaced at a distance of 250-350 m (depending on the terrain and stability of the soil) along the 18.6 km stretch. **Figure 3.1** shows the location of the towers while **Table 3.3** presents the description of each segment of the TL..

Figure 3.1: TL alignment showing the location of the towers

Table 3.3: Description of each segment of the transmission line

Section 1: Port head yard (TL1) to dam colony opposite (T6).		
		
1.1	Type of soil	Hard soil type, black alluvial/soft & hard rock, gentle slope.
1.2	Accessibility	Access road of Mangdechu Dam axis, Trongsa-Zhemgang highway, and old footpath
1.3	Details of crossing	Crossing existing 66 kV at T59 & T60, Highway crossing, long valley crossing
1.4	Places along the TL line	Tashidingka, Eusa, Taktse.
1.5	Vegetation	Thin bushes and cool broad leaved forest
1.6	Geological stability	No sign of geological disturbances, but marshy area spotted at TL 9
1.7	Land use	Under Zhemgang District Forest
1.8	Gewogs	Tangsibji, Nubi

Section 2: Tashidingka (TL7) to Taktse top (TL14)

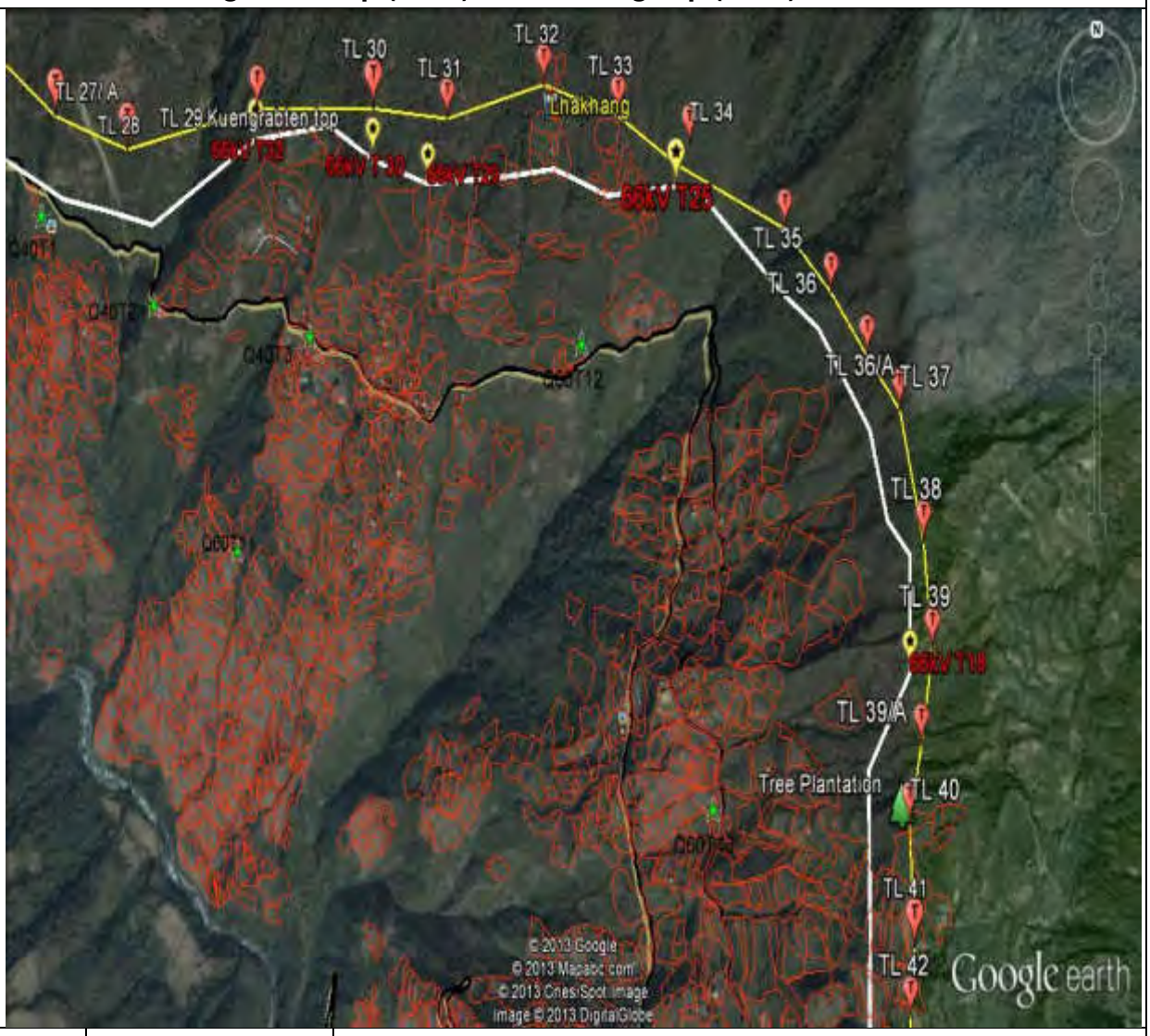
2.1	Type of soil	Hard and dry soil type/soft rock, marshy area
2.2	Accessibility	Trongsa-Zhemgang highway, access road of dam colony & taktse road, old foot path
2.3	Details of crossing	Mangdechu river crossing, highway crossing
2.4	Places along the TL line	Tashidingka, Eusa
2.5	Vegetation	Cool broad leaved forest with dominance of oak species
2.6	Geological stability	No geological disturbance
2.7	Land use	under Zhemgang District Forest & Taktse Community Forest
2.8	Gewogs	Drakteng

Section 3: Bubja top (TL15) to Kuengarabten (TL26)

3.1	Type of soil	Hard and dry soil type with thin vegetation, steep terrain at TL 25 & TL26
3.2	Accessibility	Road to cremation ground, approach road to Taktse College, old footpath used for 66 kV line
3.3	Details of crossing	Small stream, Bubja top crossing
3.4	Places along the TL line	Taktse, Eusa, Bubja,Kuengarabten.
3.5	Vegetation	Cool broad leaved forest with thin bushes and with oak species
3.6	Geological stability	Stable with no sign of geographical disturbance.
3.7	Land use	Under Zhemgang District Forest

3.8	Gewogs	Drakteng

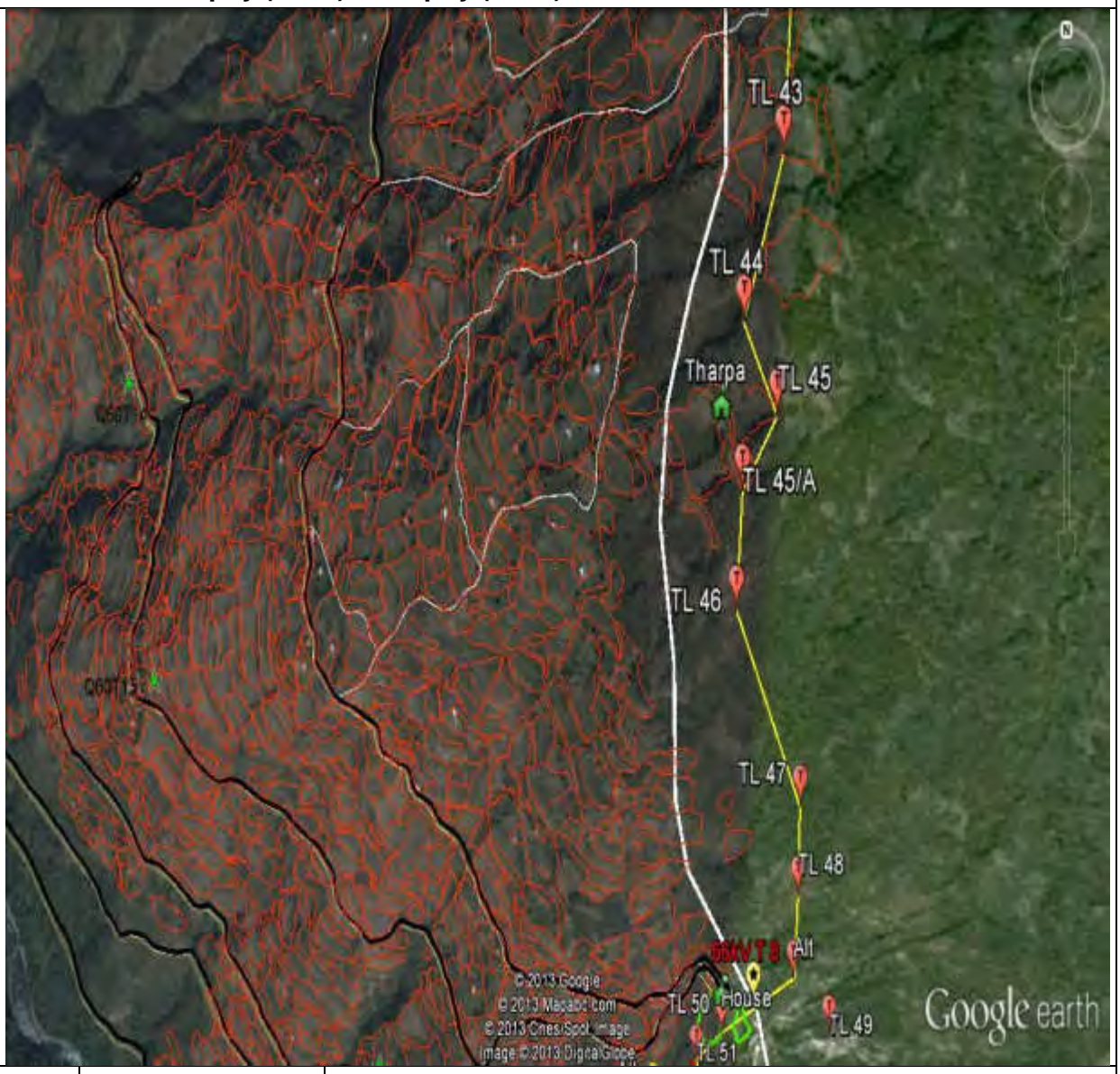
Section 4: Kuengrabten top (TL27) to Lhakhang Jap (TL42)



4.1	Type of soil	Hard and dry soil type, steep terrain at TL27
4.2	Accessibility	Old footpath, access road to Samchholing middle school and Kuengrabten Nunnery centre
4.3	Details of crossing	Small stream, and tree plantation, valley crossing at TL 28 & TL 29.
4.4	Places along the TL line	Kuengarabten, Shomchholing, Lhakhang Jap. TL 40 & TL 41 falls under private land
4.5	Vegetation	Cool broad leaved forest, oak species, mixed forest and barren land
4.6	Geological stability	Stable with barren land and no geographical disturbance.
4.7	Land use	Forest territory and TL40 & TL 41 public land

4.8	Gewogs	Drakteng

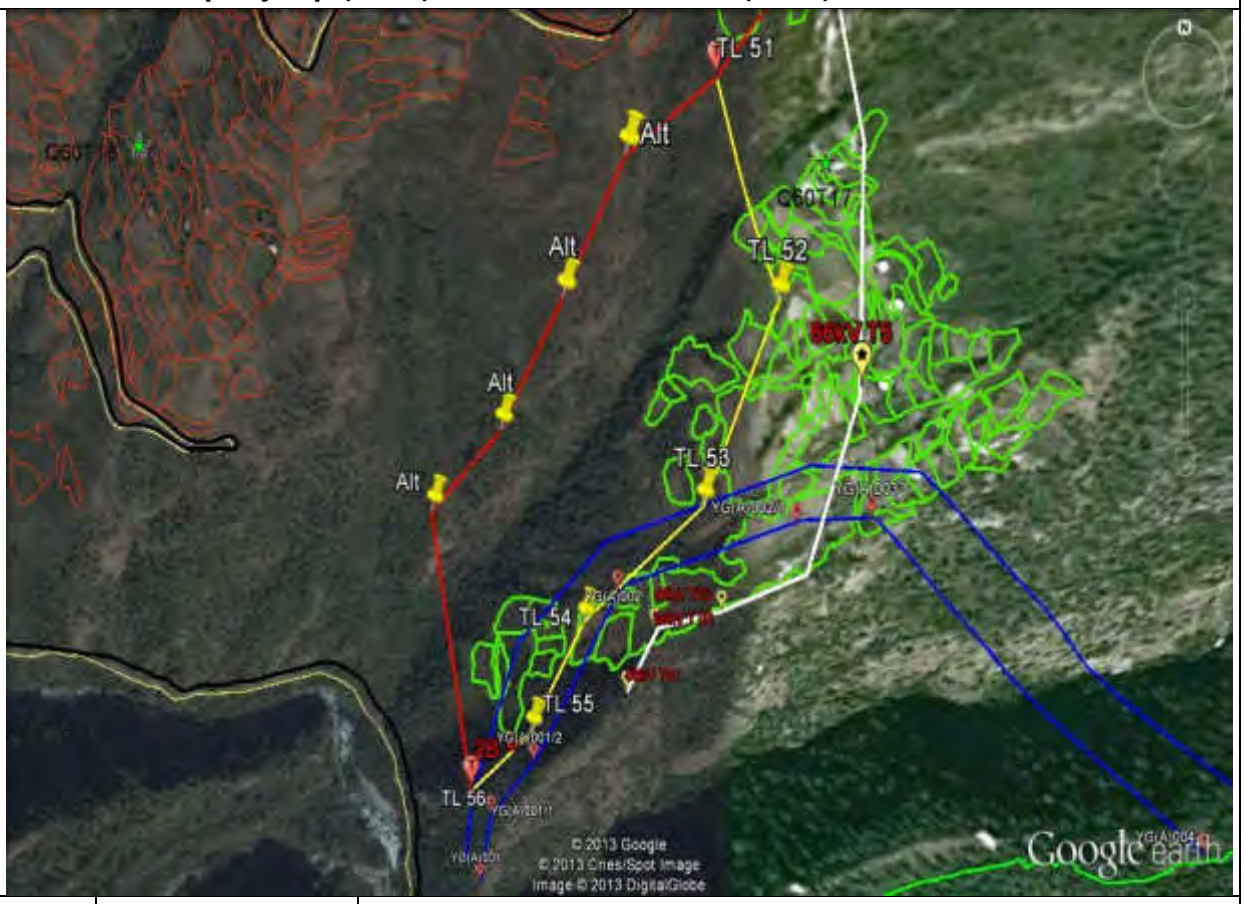
Section 5: Kompey (TL43) to Raphy (TL50)



5.1	Type of soil	Hard and dry soil type, barren land with gentle slope
5.2	Accessibility	Old footpath, approach road to surge shaft
5.3	Details of crossing	No major crossing, only small streams, TL 43 falls in the private land, 66 kV line crossing at T7 & T8.
5.4	Places along the TL line	Lhakhang Jap, Raphey top
5.5	Vegetation	Warm tropical thin alpine forest, mixed thin bushes and barren land
5.6	Geological stability	Stable with gentle slope, barren land and no geographical disturbance

5.7	Land use	Forest territory and Community Forest, TL 43.

Section 6: Raphey top (TL51) – Alternative-Yurmo (TL56)



6.1	Type of soil	Hard and dry soil type, barren land, gentle slope with hard rocks in some area.
6.2	Accessibility	Highway, Trongsa-Zhemgang new bypass, approach road of power house, old foot path.
6.3	Details of crossing	New Bypass crossing, 66kV line crossing, 11 kV line crossing, T-off for alternative route
6.4	Places along the TL line	Raphey, Kompey, Yurmoo area
6.5	Vegetation	Warm tropical thin alpine forest, mixed thin bushes and wet land
6.6	Geological stability	No geological disturbances
6.7	Land use	Under Zhemgang District Forest
6.8	Gewogs	Trongsa, Langthel, Mangdechu Porthead Yard

3.2.1 Project Ancillaries

52. The project will not require any access roads, sub-stations or construction of buildings, or other large infrastructure.

3.2.1.1 Project office site

53. It is expected that staff will be required only during the Project Pre-Construction and Construction Period. It is planned that the transmission line component of NHPP will be placed under the responsibility of the Superintendent Engineer and his staff who are currently overseeing the on-going 400 kV Mangdechhu Project Transmission Line Project. Therefore, there is no need for a separate project office.

3.2.1.2 Contractors facilities and worker camps

54. The private contractors will require space to build their temporary labour camps at various sites, stores/warehouse and parking yards for machines/equipment and material stock piling yards, etc. Local building shall be hired for site office and residence for regular technical employees, there is no need for its construction. Adequate space has been earmarked for the construction of facilities as given in Table 3.4.

Table 3.4: Area requirement for contractors' facilities

No.	Description	Area (in acres)	Remarks
1	Site Office	0.2	1 site
2	Labor Camps	0.8	5 sites
3	Godown/Store	1.8	1 common go-down and one store at each site
4	Material stocking yard/machine parking	0.8	
	Total area	3.6	

3.2.1.3 Muck disposal

55. An estimated amount of about 12,810 m^3 shall be generated from excavation works of 61 towers along the 18.6 km stretch. Considering 50% reuse in backfilling the pits of 2mx2mx3m, the amount of balance muck will be about 11,346 m^3. The muck generated will be mainly due to benching which requires clearing and excavation to about 2 m below the ground. At each tower only about 168 m^3 of muck shall be generated. Considering the relatively small amount of excess material, the muck shall be disposed off at appropriate area near the towers which shall be used for levelling the burrow.

3.2.2 Land Required for the Project

56. Along the TL, a right-of-way (RoW) of 27 m needs to be cleared to prevent shorting and disturbance. About 15 km of the line passes through broadleaf and mixed conifer forest while 3.6 km passes through scrub forest comprising of a few trees and mostly shrubs, degraded vegetation, community forest, and private land.

57. Of the 61 transmission towers to be constructed, 55 fall on government land and 6 towers fall on private land. 60 decimal of land will have to be acquired from 6 displaced households that will lose 10 decimal of land each towards the footprint of the 132 kV transmission towers. All the tower feet falls in dry land and no wetland shall be affected by the TL. **Table 3.5** gives the details of private land requirement while **Table 3.6** provides the land use along the ROW.

Table 3.5: Details of private land required in acre

No.	Name of owner	Village	Thram No.	Land required	Land type	Dryland	Wetland	Total Land	% of total land
1	Phurpamo	Yurmo	284	0.1	dryland	3.4	2.462	5.862	1.7
2	Lemo	Yurmo	274	0.1	dryland	3	0	3	3.33
3	Tshering Mo	Refe	361	0.1	dryland	2	1.642	3.641	2.75
4	Tshering Dema	Refe	52	0.1	dryland	3	3	6	1.67
5	Sangay Wangdi	Refe	357	0.1	dryland	3.65	1.95	5.6	1.78
6	Tashi Wangmo	Kinga Rabten	372	0.1	dryland	2.13	2	4.13	2.42

Table 3.6: Land use along transmission line right-of-way

Component	Dryland	Wetland	Orchard	BL and Conifer	Conifer forest	Scrub forest	Community forest	Exposed/Rocky area	Total	Acres
Transmission line	0	0	0	15	0	3.3	0.3	0	0	
Corridor required	0	0	0	0.027		0.027	0.027	0	0	
total area required	0	0	0	0.405		0.0891	0.0081	0	0.5 km^2	123

3.2.3 Construction Power Requirements

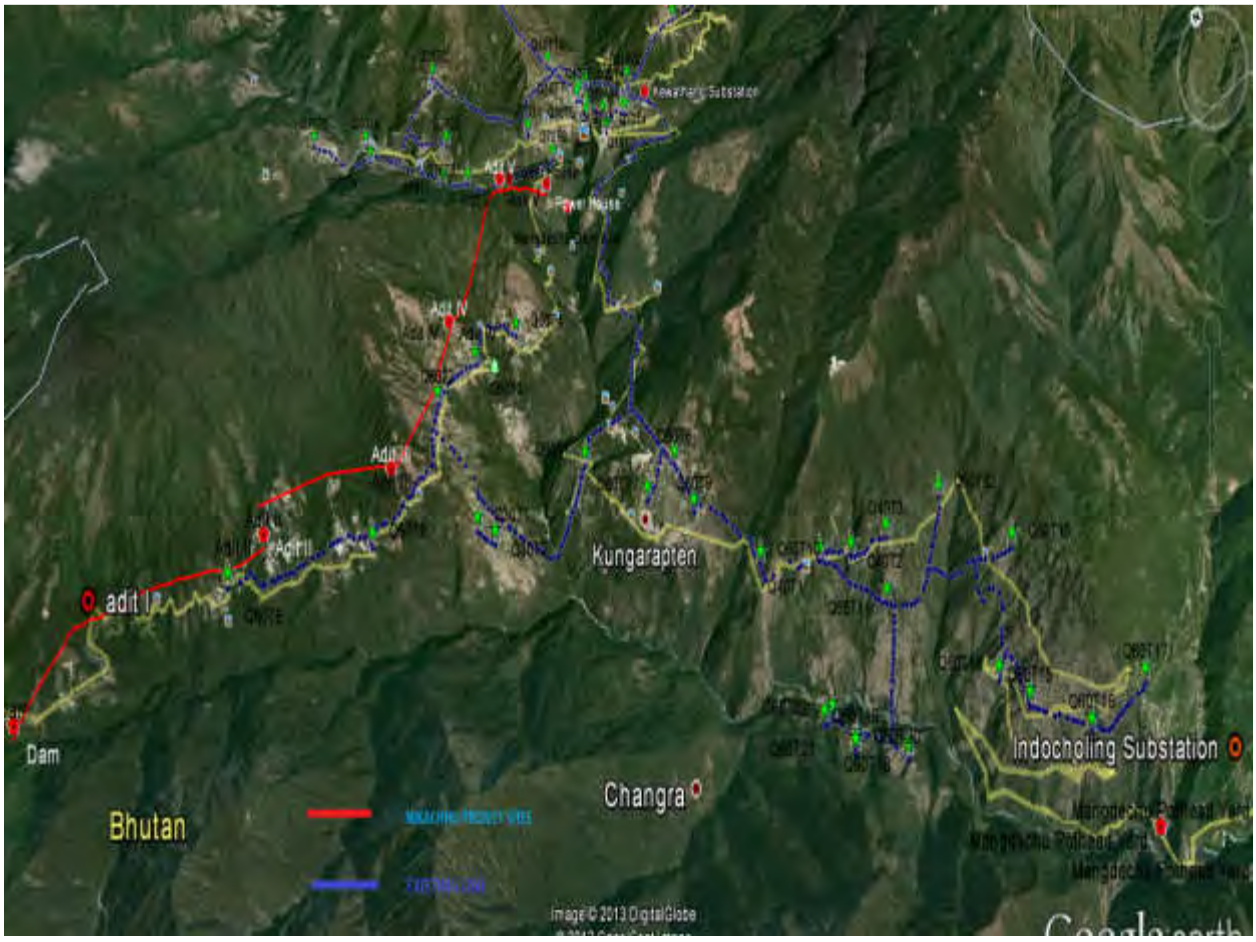
58. There will be no requirement for electricity for the construction of this Project. However, light may be required for lighting of labour camps. About 5 kW of power has been estimated to be required for lighting and heating purposes.

59. The 132/33 kV, 2 x 15 MVA , Endocholing Sub-Station which is currently under construction will be the main source of supply for Trongsa Region. There is also existing 33/11 kV, 2x 2.5 MVA Sub-Station at Kewathang which at present supplies power to Bumthang and some parts of Trongsa region. The present power supply in Drakteng Gewog, Taktse Gewogs are met through the 33 kV Nubi Feeder.

60. As seen above, the power supply for the labour camps in all the project areas shall be drawn at the 33 kV system which is more than adequate to meet the power requirements. The capacity of the 33/0.415 kV Sub-Stations shall be developed through which electricity shall be drawn to the camps.

61. Low voltage Ariel Bundled Cables shall be used for distribution of electricity in the camps which shall not require clearing of vegetation in the ROW. Map 4 shows the existing 33 kV system within the project area.

Map 4: Existing 33 kV system in project area (indicated by blue colour)



3.2.4 Water Supply Requirement

62. With a total of 14 project staff and 230 Contractors' staff and workers, the daily water requirement is estimated at 12,500 liters per day.

63. For construction work, water shall be used only for concreting. The volume of concrete used shall be about 952.897 m^3 which shall consume about 300 litres/day. However, concreting shall be done only for laying foundation for the tower and the duration shall be at the most 60 days. Table 3.7 gives the daily water requirements.

Table 3.7: Daily water requirements for drinking and other purposes

No.	Purpose	No of staff/workers	Water Requirement (liters per day)	Total water required (in liters per day)
1	Project staff requirement	14	50	700
2	Contractor facility and workers	230	50	11500
3	Construction works		300	300
	Total water required			**12,500**

64. The major requirement of water is in the labour camps for domestic purposes. All the 230 labourers shall not be camped in the same area but shall set up camps in 5 groups along 61 tower locations. Each camp shall have about 50 labourers and the camp area shall be identified in proximity to streams.

3.2.5 Requirements for Raw Materials/Construction Materials

65. The construction of NHPP will require large quantities of materials. These materials include cement, coarse aggregates, sand, rough sawn timber, ballies and steel. The details are provided in Table 3.8.

Table 3.8: Requirement of Construction Materials

Purpose	Concrete Volume (m^3)	Cement (m^3)	Sand (m^3)	Gravel/ Aggregate (m^3)	Boulders (m^3)	Ballies (m)	Rough sawn timber (m^3)	TMT Bars (kg)
Soling for tower foundation					146.40			
Plane Cement Concrete for foundation	48.80	8.30	24.40	47.01				

Purpose	Concrete Volume (m^3)	Cement (m^3)	Sand (m^3)	Gravel/ Aggregate (m^3)	Boulders (m^3)	Ballies (m)	Rough sawn timber (m^3)	TMT Bars (kg)
Reinforced Cement Concrete for foundation and pillars	815.27	261.94	383.17	766.35				856.03
Shuttering works						1,586.75	19.42	
Plastering works	2.2	25.38	67.47					
Total	866.27	295.62	475.04	813.36	146.40	1586.75	19.42	856.03
Contingencies (10%)	86.627	29.562	47.504	81.336	14.64	158.675	1.942	85.603
Grand Total	**952.897**	**325.182**	**522.544**	**894.696**	**161.04**	**1745.425**	**21.362**	**941.633**

**** The quantity requirement has been worked based on LMC 2012*

3.3 Construction Activities and Schedule

66. **Pre-construction Activities:** All administrative, financial and legal formalities for the execution of the project will be completed before the start-up of construction activities. Activities such as site preparation, setting up project offices, contractors' offices and worker camps will be completed prior to the beginning of the formal construction works.

Deputation of Project Staff

67. **Land Acquisition:** The permanent land acquisition process will be completed before construction work. There will be temporary use of some land for the work areas of the contractors, their camps, and other facilities. These will be identified by the Project Management, the Dzongkhag Authorities and allocated according to (i) proximity to the project site, (ii) minimal forest clearance required, and (iii) accessibility to the roads as well as drinking water and electricity.

68. **Tenders and Contracts:** The contracts for the various packages will be finalized during the pre-construction phase.

69. Establishment of contractors' camps, arrangement of electricity, drinking water, cooking gas and fuelwood will also be completed during this phase.

70. **Implementation of construction works**: The construction works will be carried out in the following sequence:

(i) Delineation of TL corridor. The selected route which has already been identified and approved will be finalized by the project staff in consultation with the affected landowners, the district authorities, local custodians of religious sites and Forestry staff. This includes resurveying the entire alignment and securing forestry marking on trees.

(ii) Vegetation clearance along RoW, wherever required.
(iii) Excavation of foundation areas, casting, and construction of foundation.
(iv) Assembly and erection of towers.
(v) Stringing of conductors.
(vi) Rehabilitation of disturbed areas and protection of erosion/slope sensitive areas.
(vii) Testing and commissioning.
(viii) Operation and Maintenance works.

3.4 Work Implementation and Staffing Requirement

71. The project construction will be outsourced to the Transmission Construction Department of BPCL under the Transmission Wing (TW). This Department is responsible for the construction of all 66 kV and above transmission lines, substations and any associated infrastructures. It is mainly responsible for the award of work, monitoring of progress, supervision, and quality control during construction. The construction works are usually executed by engaging both local and international (mostly from India) contractors. The organogram of the BPCL and the Development, Construction Department and the Project Management Unit is depicted (see **Figure 3.2** and **Figure 3.3**).

Figure 3.2: Organogram of the Bhutan Power Corporation

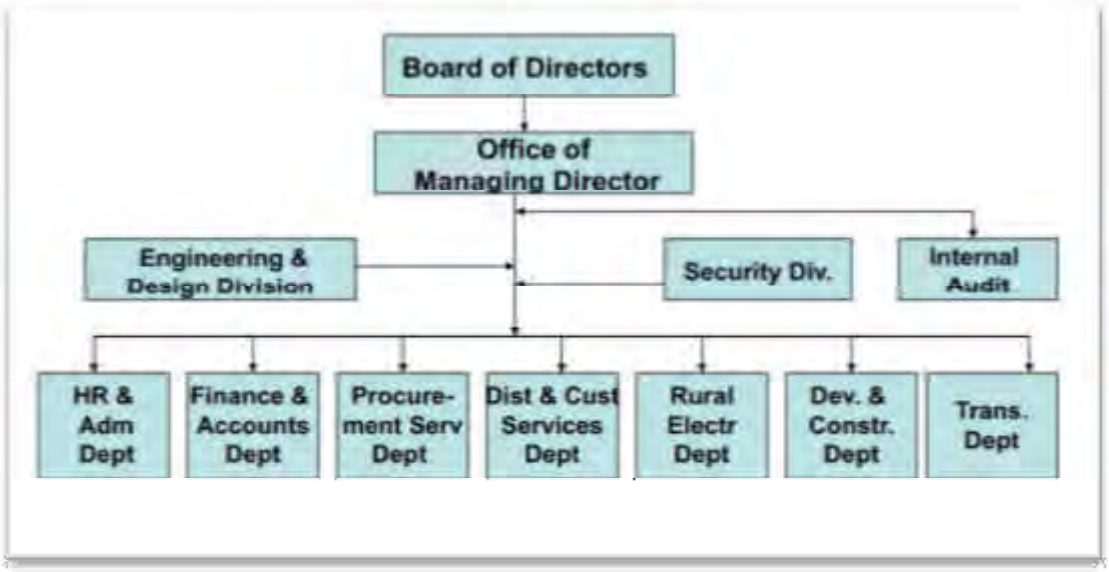
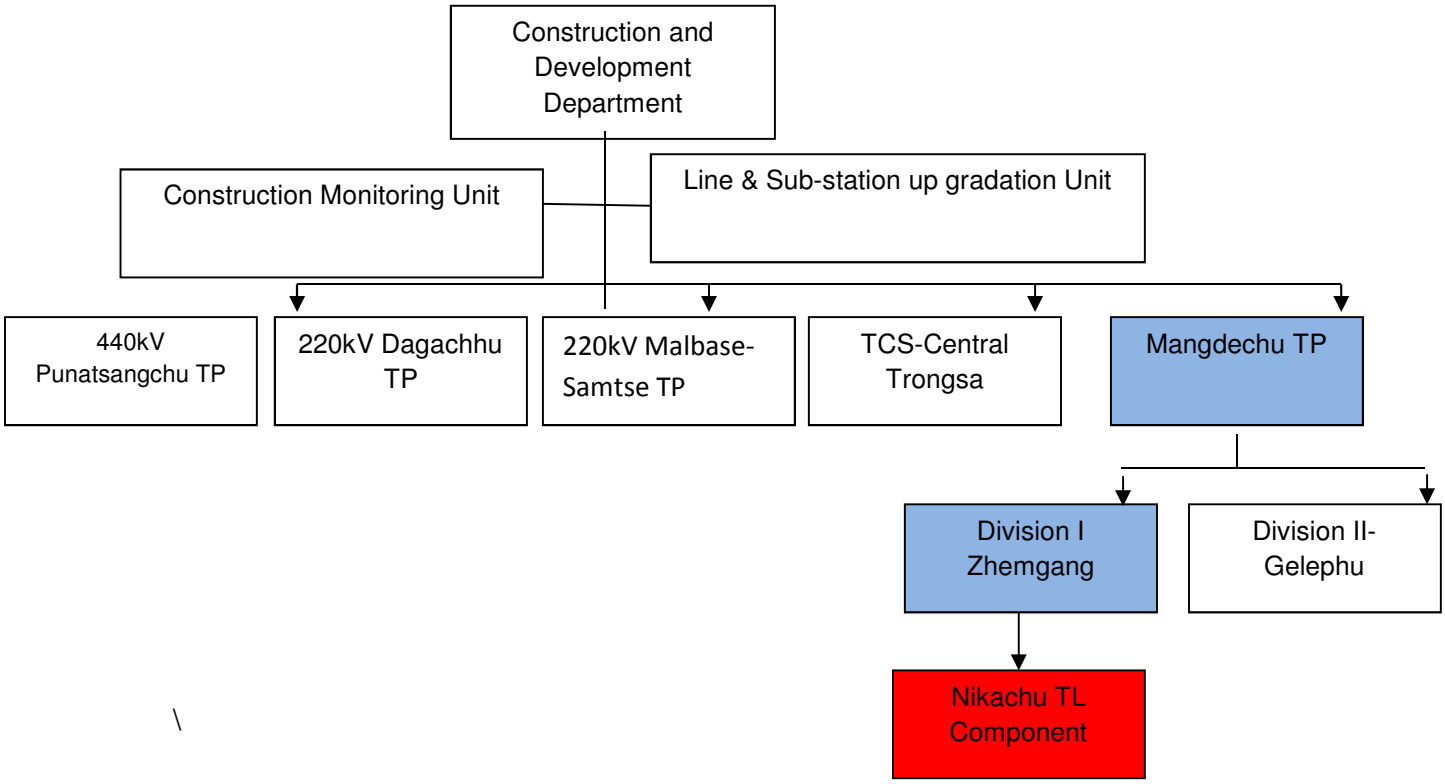


Figure 3.3: Organogram of the Development and Construction Department



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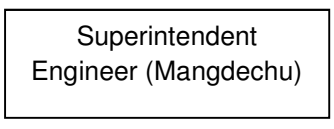
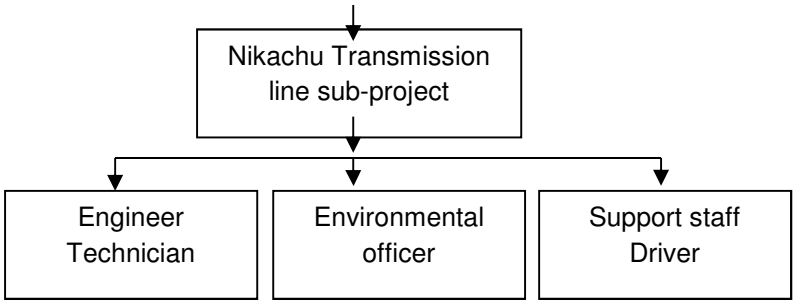
72. **Construction Phase.** It is estimated that 14 staff will be hired/deputed during the pre-construction and construction stage excluding security. This does not include contractors and their regular staff plus migrant workers (see **Figure 3.4**).

Figure 3.4: Organogram of the Project Management Unit





OPERATION AND MAINTENANCE

73. After completion of the construction, the TL will be included under the Transmission Department (TD) of BPCL, that is responsible for the operation and maintenance (O&M) of high voltage (66 kV and above) transmission system in Bhutan. It is mandated to ensure reliable transmission network for transmitting electric power from hydropower plants to load centers within Bhutan for local consumption and export to India. This Department has 598 staff posted under three Regional Superintendent Engineers overseeing eight Divisions.

4 Analysis of Alternatives

74. The preliminary assessment of the project included an analysis of alternatives, addressing the optimal match between required technical specifications and site conditions, as well as addressing any concerns for environmental, social, and economic features in each location.

75. , A walk on survey of the 132 kV line was carried out from Nikachhu Pot Head yard to Mangdechhu Pot Head yard by BPCL technical staff, from 24th September to 14th October, 2013. Two options were considered and described briefly below:

76. There are two TL routes with 18.6 km and 19.2 km which are aligned mostly in the Government reserved land/forest with few numbers of towers falling under private land and community forest. **Figure 4.1** shows the two TL routes.

77. **1st Option**: The first and the preferred route with 18.6 km is diverted via Raphey top crossing the existing 66 kV line at Tower No.7 and T8.

78. **2nd Option**: The 19.2 km option is after crossing 66 kV line at T7 and T8 runs parallel to 66 kV line and crossing the newly constructed 400 kV D/C Mangdechu-Goling-Jigmeling transmission line then finally enters the Mangdechu Pothead yard.

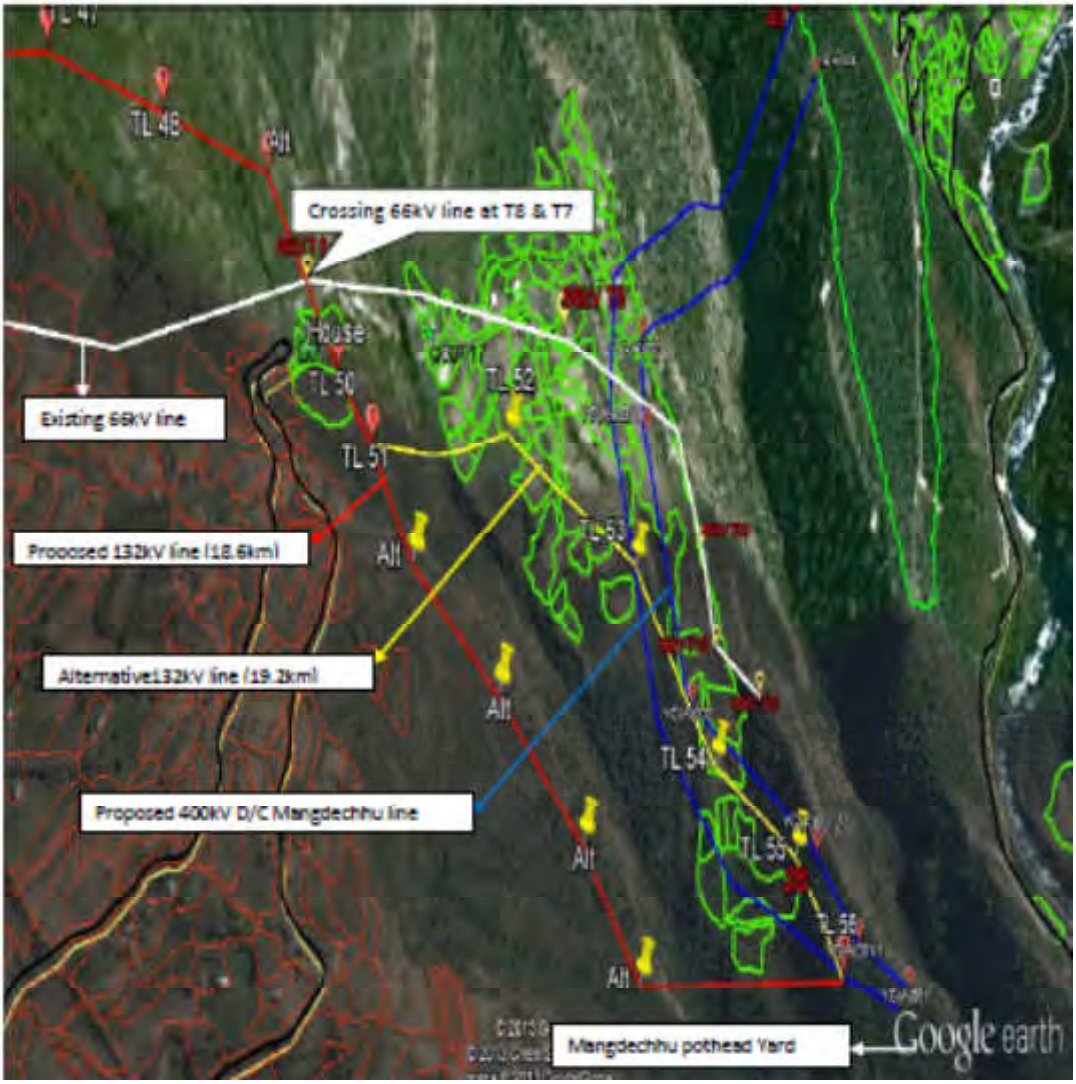
79. The 1st option was chosen due to the following reasons:

(i) Environmental impacts of the length of the TL: The 2nd option is 19.2 km which is 0.6 km longer than the 1st option entailing an additional 5 acres to be cleared for the ROW.
(ii) Social Impacts on private land: In the 2nd option, an additional 4 towers fall in the wetlands at Yurmoo village compared to the 1st option where the 6 towers are within drylands resulting to lesser number of affected parties.
(iii) Technical reasons: The terrain along the 1st option was found to be comparatively moderate compared to the 2nd option.

The "Do Nothing" Alternative

80. The "do nothing" or "without the project" option is not viable as the associated transmission line is an essential component of power evacuation from NHPP to the national grid.

Figure 4.1: The two TL routes considered



5 Description of the Environment

5.1 Physical Resources

5.1.1 Location

81. The Nikachhu Hydropower Project is located in Trongsa Dzongkhag, which is located in Central Bhutan at latitude 27.5° North and longitude 90.5° East, with Bumthang Dzongkhag to the northeast, Wangdue Phodrang Dzongkhag to the west, and Sarpang and Zhemgang Dzongkhags to the south.

82. Trongsa District covers an area of about 1,807.29 sq. km. (km^2) and is subdivided into five gewogs. The 18.6 km 132 kV D/C transmission line will cross through three of these five gewogs (Drakteng, Langthel, and Tangsibji). The dzongkhag is further divided in two Constituencies – Nubi-Tangsibji and Drakteng-Langthel for electoral purposes. The main administrative centre is Trongsa town, which is approximately 150 km east of the national capital, Thimphu (see Maps 1-3). **Table 5.1** gives the list of blocks and sub-blocks at Trongsa District.

Table 5.1: List of Blocks and Sub-Blocks in Trongsa District

No.	Gewogs/Block	Chiwogs (basic electoral precinct/sub-block)
1	Drakten	Kuenga Rabten, Samlingkha Maed, Samlingkha Toed, Tagtse Tashidingkha, Uesar
2	Korphu	Korphoog Maed, Korphoog Toed, Nabi, Nyimzhong Maed, Myimzhong Toed
3	Langthel	Baling, Dangdoong, Jangbi, Langthil, Yuendroonchhoeling
4	Nubi	Bagochen Boolingpang Ueling, Bemji Chela, Bji Saengbi, Darbab Sinphoog, Gagar karzphong
5	Tangsibji	Chendebji, Kyela, Nyala Drangla, Tangsibji, Tshangkha

a. Drakten Gewog

83. Drakten Gewog is located about 25 km South-East of Trongsa Dzong. Although the smallest of the 5 gewogs in Trongsa covering just 84 km^2, it is the most populous consisting of 37 villages with a total population of 2,697 people and 445 households. It has a population density of 31.9 persons per km^2. Forest cover is 67 percent of its total land area.[4]

Drakten gewog has 1 RNR Centre, 1 BHU, 3 Out Reach Clinics, 3 farmers cooperatives, 8 irrigation schemes, 1 Higher Secondary School, 1 Middle Secondary School, 3 Community

[4] 11th Five year Plan Document

primary Schools, and 4 non-formal education centers. The gewog has 20 lhakangs (temples/monasteries).[5]

84. Paddy, maize, wheat, and vegetables are the major crops cultivated. Most households rear livestock which is an important source of income. Although all the 37 villages are electrified, not all the households are electrified. Out of 445 households, 420 households receive electricity while 25 households do not receive electricity.[6] **Photo 5.1** shows the villages near the proposed alignment that will traverse the Drakten gewog.

Photo 5.1: Villages located near the proposed alignment

b. Langthel gewog

85. Langthel gewog is located about 52 km South-East of Trongsa and covers an area of 508 km^2. The gewog has a population of 2,637 people living in 424 households spread across

[5] 11th Five Year Plan Document
[6] 11th Five Year Plan Document

20 villages. The population density is 5.2 persons per km^2. 78 percent of the gewog is under forest cover[7].

86. Langthel gewog has 1 RNR centre, 2 BHUs, 6 outreach clinics, 23 irrigation schemes covering 91 kms, 1 Lower Secondary School, 4 Community primary Schools, and 15 Non-formal education centers. The gewog is home to 8 lhakangs (temples/monasteries)[8].

87. Paddy, maize, mandarin, and vegetables are the major crops and fruits grown. Livestock rearing is a major source of income with most households owning and rearing livestock.

88. 17 of the 20 villages under the gewog are electrified and 387 of the 424 households are electrified.[9]

c. Tangsibji gewog

89. NHPP falls mostly in this gewog since all the project components and infrastructures (apart from the transmission line component) are located in this gewog.

90. Tangsibji gewog is located about an hour's drive away from Trongsa along the east-west highway that runs through the Gewog. The Gewog consists of seven villages, 270 households and a population of 1,848 persons according to the 11th Five Year Plan (FYP). The population density of Tangsibji gewog is 5.0 persons per km^2. It covers an area of 372 km² with Wangdue Phodrang Dzongkhag to the west, Langthel Gewog to the south and Drakteng Gewog to the east.

91. The gewog has 4 farm roads and 11 irrigation schemes that cover 40 kms. It also has 1 RNR centre, 3 farmer's cooperatives, 1 BHU, 6 outreach clinics, 1 Higher Secondary School, 5 Community Primary Schools, and 10 Non-formal education centers.

92. Paddy, wheat, chili, potato, and cabbage are the major crops grown. Livestock is owned and reared by most households accounting for a large portion of household incomes.

93. It is inhabited by people known as Mandeps who speak Mangdehka, a dialect spoken in Tangsibji gewog and a few villages under Drakten gewog such as Taktse, Yuesa and Tashidingkha.

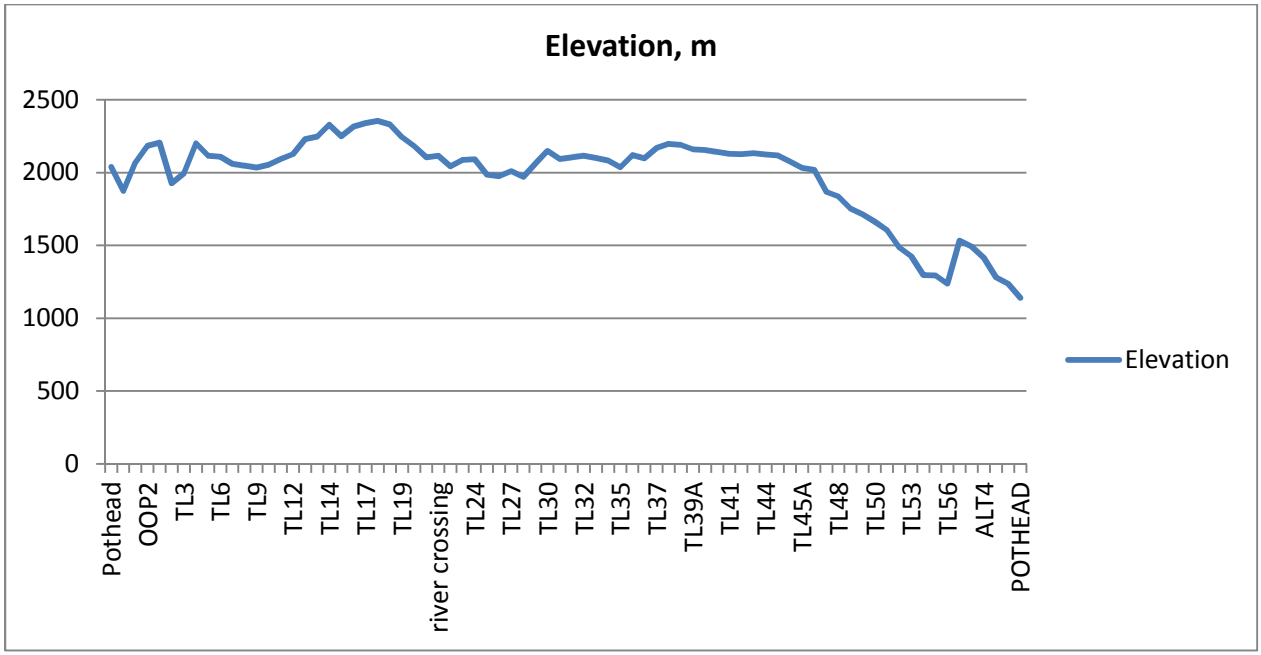
94. There are two micro hydels in the Gewog at Chendebji and Tangsibji, respectively. The micro hydel at Tangsibji village was established in 1987 with a generating capacity of 0.03 MW benefiting 53 households. The micro hydel at Chendebji was established in 2005 with a generating capacity of 70 KW benefiting 31 households. All villages now have electricity supply. Besides the Trongsa Dzong, the most popular and sacred monument, Chendebji chorten is located within this Gewog. There are 14 lhakhangs (temples) in the gewog.

[7] 11th Five year Plan Document
[8] 11th Five Year Plan Document
[9] 11th Five Year Plan Document

5.1.2 Topography, Geology and Soils

95. The topography of the project area is rugged with deeply cut valleys with steep side slopes and narrow V-shaped valley floors, caused by swift-flowing rivers like the Mangdechhu, and the Nikachhu. The elevation of the Dzongkhag ranges from 1,200 m to 4,800 m above sea level (masl), but most settlements are situated closer to the valley floors and at mid-level altitudes of up to 3,000 m (Atlas of Bhutan, 1997). The project area is located in mid elevations from 1,140 m to 2,355 m (see **Graph 5.1**).

Graph 5.1: Changes in elevation along the TL



96. The intense tectonic activity that resulted from the collision of the Indian and Eurasian continental plates, the closure of the intervening Tethys Ocean, and the uplift of the Himalayas are responsible for the topography and geology of Bhutan. The project area falls in the zone of predominant north-south valleys and ranges, with smaller east-west river system cuts, where the bedrock comprises mostly gneiss, schist, quartzite, and limestone, with intrusions (Norbhu *et al*., 2003).

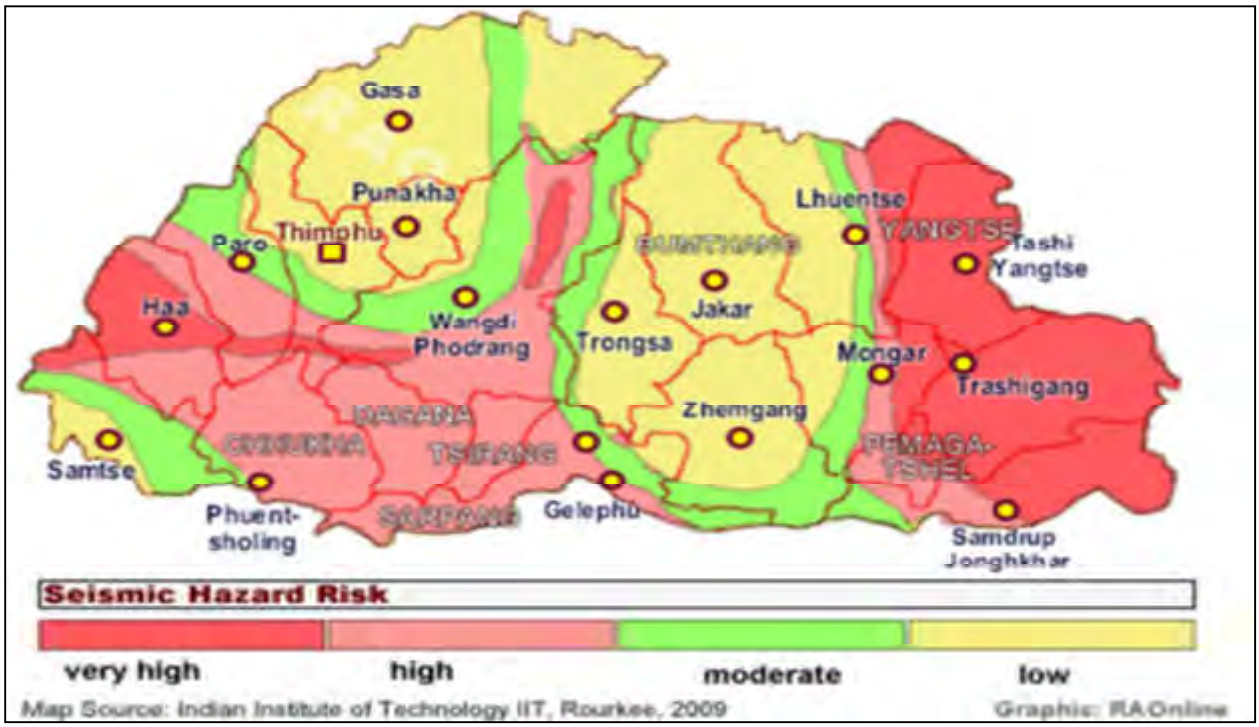
97. The recorded seismic activity in the project area dates back to June 12, 1897, when the epicenter of an earthquake was 80 km south of Bhutan (in Rangjoli, Assam, India). In Bhutan, the earthquake destroyed Punakha and Lingzhi Dzongs, and damaged Wangdi, Trongsa, Jakar and Utse of Tashicho Dzong. **Figure 5.1** shows the seismic hazard map of Bhutan prepared by the Indian Institute of Technology in Roorkee, India. The seismic hazard map shows that the Trongsa area lies in a low hazard zone (rated in a 4-point scale of low to very high).

98. The Nikachhu project area lies in a central crystalline belt surrounded by the lithology of the Thimphu Gneissic complex (TGC) and the meta-sediments of the Chekha Formation. The

riverbed geological investigation revealed that below 2 m under the riverbed, the granite bedrock was found to be highly stable.

99. The site of the Mangdechhu Hydropower Project encompasses a linear area between Trongsa and Yurmu village. The southerly flowing Mangdechhu River, in its upper reaches, flows almost along the contract plane between the rocks of the Sure Formation on its left flank and the rocks of the Chekha Formation on its right flank. After taking an easterly turn, the river cuts across the leuco-granite suite of rocks. Further, it continues through the rocks of Chekha Formation (MHEP, 2010)

Figure 5.1: Seismic hazard risk of Bhutan



100. In Bhutan, the soils produced by local base materials remain largely unmapped. In the valleys, surface layers consist mainly of alluvium brought in by the rivers, which deposit large quantities of sand and silt on the banks each year. The rivers and forested catchments produce soils that are high in organic material, and are mainly temperate stagnogleys and podzols (Norbhu *et al*., 2003). Soils are generally sandy loam and clay loam, with good permeability and moderate moisture retention (DOFPS website). Forest soils are generally shallow. The topsoil in agricultural areas has a pH value between 5 and 6, with loamy clay making up 10-30% content, and silt comprising 20-50% (MPFD, 1991). The rugged terrain in the project area suggests that maintenance of vegetative cover and careful use of soils is necessary to check erosion and landslides.

101. Soil samples were collected from seven sites from the Mangdechu Hydropower Project. Soils in rural areas are largely uncontaminated from chemical fertilizers as farmers mostly use leaf litter and manure from farm animals for their fields. Soils in the project site are largely sandy clay with pH value between 5.4 and 6.2. **Table 5.2** gives the results of the analysis of the soil samples.

Table 5.2: Results of soil samples analysis of the study area

Parameters	Soil Samples						
	S-1	S-2	S-3	S-4	S-5	S-6	S-7
pH	6.19	5.96	5.59	5.84	6.1	5.91	5.44
E.C m.mho/ cm	0.3	0.35	0.32	0.39	0.36	0.42	0.36
Organic carbon (%)	0.4	1.71	0.87	1.28	0.23	1.77	0.53
Organic matter (%)	0.695	2.954	0.821	2.733	0.391	2.972	0.732
Moisture content (%)	7.84	73	47	75	21.36	80	58
Total Kjeldahl N %	0.055	0.109	0.076	0.031	0.236	0.279	0.053
Potash as K_2O in ppm	72.38	69.72	71.3	64.48	92.12	90.23	70.74
Phosphorus as P_2O_5 in ppm	14.56	14.31	17.28	13.06	25.03	25.41	15.46
Sulphur (as SO_4^{2-}) in ppm	22.58	29.47	31.22	34.56	32.82	33.65	31.32
Texture	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay
Sand (%)	62	63	63	60	58	56	62
Silt (%)	2	3	2	4	6	7	3
Clay (%)	36	34	35	38	34	37	35

Source: MHEP, 2010

102. About 11,346 m^3 of spoils shall be generated from the excavation works of the 61 towers along the 18.6 km stretch. The volume of excavated material will be at various locations along the TL route and is considered low with some to be reused as backfill for the foundation of tower footing to stabilize it. **Table 5.3** gives the soil type and terrain along the TL route.

Table 5.3: Soil Type and Terrain along the TL

Section of TL	Soil Type and Terrain
Section 1: Port head Yard (TL1) to Dam colony opposite (T6).	Hard soil type, black alluvial/Soft & hard rock, gentle slope.
Section 2: Tashidingka(TL7) to Taktse top(TL14)	Hard and dry soil type/soft rock, marshy area
Section 3: Bubja top (TL15) to kuengarabten(TL26)	Hard and dry soil type with thin vegetation, steep terrain at TL 25 & TL26
Section 4: Kuengrabten top (TL27) to Lhakhang Jap (TL42)	Hard and dry soil type, steep terrain at TL27
Section 5: Kompey (TL43) to Raphy (TL50)	Hard and dry soil type, barren land with gentle slope
Section 6: Raphey top (TL51) – Alternative-Yurmo (TL56)	Stable with barren land and no geographical disturbance.

5.1.3 Climate

103. Most of the central portion of the country experiences a cool, temperate climate year-round. In the south, a hot, humid climate helps to maintain a fairly even temperature range between 15° C and 30° C year-round, although temperatures sometimes reach 40° C in the valleys during the summer.

104. Spring starts in early March and lasts until mid-April. Summer weather commences in mid-April with occasional showers and continues through the pre-monsoon rains till June. The monsoon lasts from June to September with heavy rains of the southwest. The monsoon brings heavy rains, high humidity, flash floods and landslides, and numerous misty, overcast days. Autumn, which starts from late September to late November, follows the rainy season. It is characterized by bright, sunny days and some early snowfalls at higher elevations. From late November until March, winter sets in and with frost throughout the country. Snowfall is common above elevations of 3,000 masl.

5.1.3.1 Temperature and Relative Humidity

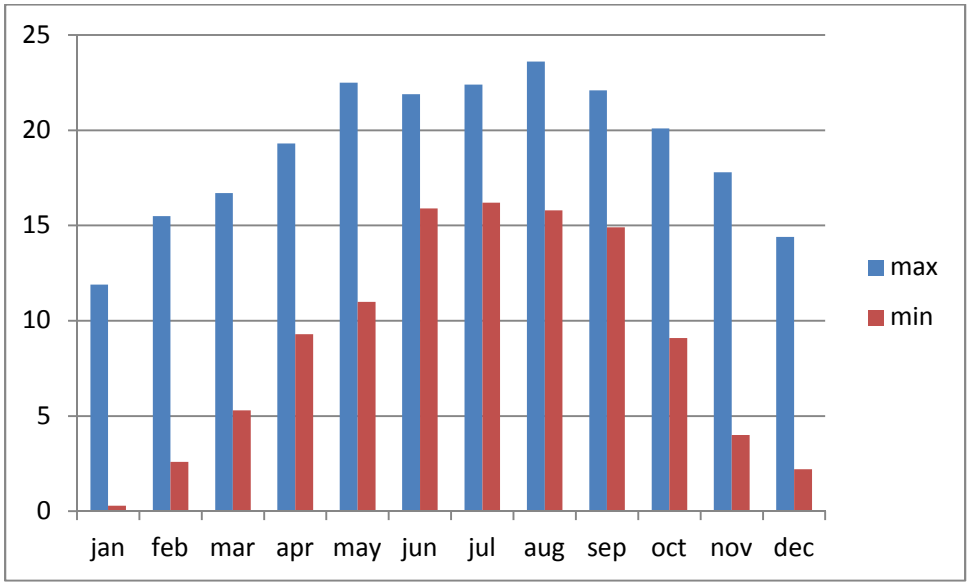
105. The climate data exist for each day of each month over a period of 16 years. The location of various climatological stations closest to Trongsa is given in **Table 5.4** while **Graph 5.2** presents the monthly variations in temperature.

Table 5.4: Location of Climatological stations closest to Trongsa

Name of station	Latitude (N)	Longitude (E)	Altitude (m)
Bjizam	27^0 31' 11"	90^0 27' 23"	1840
Chendebji	27^0 30' 29"	90^0 16' 35"	2660
Kuengarabten	27^0 24' 23"	90^0 31' 05"	1780
Nobding	270 32' 52"	900 09' 10"	2600
Trongsa	270 30' 07"	900 30' 18"	2120

106. During winter, temperatures can drop to below 1 degree in January, but ranges from 6.1°C to 11°C while the highest temperature during July to August goes up to 23.6°C (average ranges between 17-20°C).

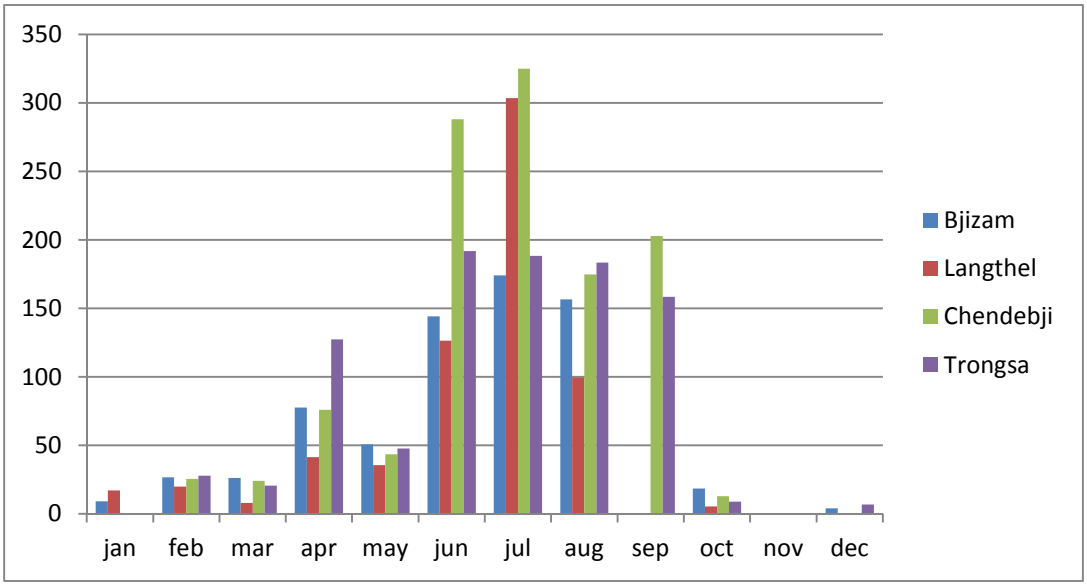
Graph 5.2: Monthly variation in temperature



5.1.3.2 Rainfall

107. The rainy season commences from late May and continues until the end of September and is characterized by heavy rains, high humidity, misty overcast days, and the risk of flash floods and landslides. Autumn weather is characterized by bright sunny weather running to late November. Winter, from end-November to March, is characterized by lowest temperatures and generally dry weather. The maximum rainfall recorded in 2012 was 1,173 mm (NSB, 2013). **Graph 5.3** shows the monthly rainfall variations within the project area.

Graph 5.3: Monthly rainfall variations (mm)



5.1.4 Air Quality

108. Trongsa being a largely rural area with 87% forest cover, low population density and little traffic, has good air quality especially as there are no industrial activities in the project area. Generally, the air is clean and does not show any deviations from the standards set internationally or by the National Environment Commission for assessing the quality of air. The ongoing construction activities by the Mangdechhu Hydroelectric Project (MHEP) are the only source of dust and air emissions that are expected to be completed in the next three –four years.

109. Air quality measurements were taken during preliminary environmental assessment for the MHEP and NHPP. Ambient air quality standards of the government and the WHO/Woldbank are given in **Table 5.5** while **Table 5.6** presents the results of ambient air quality measurements within the project area.

Table 5.5: Ambient air quality standards

Standards	Particulate Matter (PM10)	SOx	NOx
Bhutan standards for sensitive areas	75 µg/m^3	30 µg/m^3	30 µg/m^3
WHO/World Bank guidelines	150 µg/m^3	125 µg/m^3 - 24 hour average	40 µg/m^3 yearly average

Table 5.6: Results of ambient air quality measurements in the project area

No.	Location	Oxides of Nitrogen (NOx) in µg/Nm^3	Respirable particulate matter in µg/Nm^3 (size less than 10µ)	Information Source
1	Lorim	BDL	20.293 µg/m^3	NHPP
2	Trongsa View Hotel	BDL	24.607 µg/m^3	NHPP
3	BOC Petrol Pump	BDL	10	MHEP
4	Yankeel Resort, Trongsa	BDL	6	MHEP
5	Hospital, Trongsa	BDL	8	MHEP
6	High School, Trongsa	BDL	10	MHEP
7	NHPPC Office, Sherubling, Trongsa	BDL	8	MHEP
8	Hotel Chokhorling,Trongsa	BDL	7	MHEP
9	NHPPC Camp,Kuengarabten	BDL	8	MHEP
10	Community Centre, Kuengarabten	BDL	6	MHEP
11	Sonam Wangmo,Kuengarabten	BDL	8	MHEP
12	Near D.G. Set,Yurmong	11	10	MHEP
13	Near Powerhouse,Yurmong	BDL	8	MHEP
14	Rice Mill, Refee	BDL	9	MHEP

No.	Location	Oxides of Nitrogen (NOx) in µg/Nm^3	Respirable particulate matter in µg/Nm^3 (size less than 10µ)	Information Source
15	Tendril General Cum Bar	BDL	8	MHEP
16	Dzong,Trongsa (Police duty House)	BDL	9	MHEP
17	Dzong,Trongsa(Car parking)	BDL	11	MHEP
18	Saw Mill,Bagoshin	BDL	10	MHEP
19	On Road side NH Bumthang(Near PWD Colony)	BDL	10	MHEP
20	In front of PWD Guest House	BDL	8	MHEP
21	Kuengarabten-I	BDL	10	MHEP
22	Kuengarabten-II	BDL	8	MHEP

BDL: below detection limit.

110. Sulphur oxides (SO_x) and nitrogen oxides (NO_x) were not detected while analyzing (reflecting the low population density, absence of heavy industry, and low traffic levels). These results were substantiated by the air sampling results from 19 sites out of the 20 sites at MHEP. Particulate matter (PM_{10}) in NHPP area was quite consistent at 20.3 - 24.6 µg/m^3, only about one-third of the standard for Bhutan. The only real sources of air contaminants are the small amount of traffic and a number of rural households where wood and kerosene are the main fuel for cooking and heating. The latter may result in localized increases in levels of smoke and soot (contributing to PM_{10}), and carbon dioxide, when fuel usage is highest (in the evening and during winter). **Table 5.7** gives the results of suspended particulate matter (SPM) measurements at various sites within the project area, **Table 5.8** shows the results of ambient SO_x, **Table 5.9** presents the ambient NO_x and **Table 5.10** provides the results of PM_{10}.

Table 5.7: Levels of Suspended Particulate Matter within project area (µg/Nm^3)

No.	Location	Winter	Post monsoon	Summer	Monsoon	Total	Average
1	BOC Petrol Pump	38	42	41	31	152	38
2	Yankeel Resort, Trongsa	18	25	21	19	83	21
3	Hospital, Trongsa	22	28	24	17	91	23
4	High School, Trongsa	14	15	18	13	60	15
5	NHPPC Office, Sherubling, Trongsa	22	19	25	14	80	20
6	Hotel Chokhorling,Trongsa	34	37	38	22	131	33
7	NHPPC Camp,Kuengarabten	22	22	26	19	89	22
8	Community Centre, Kuengarabten	12	14	20	12	58	15
9	Sonam Wangmo,Kuengarabten	23	21	27	16	87	22
10	Near D.G. Set,Yurmong	18	21	22	17	78	20
11	Near Powerhouse,Yurmong	19	20	26	15	80	20
12	Rice Mill, Refee	12	23	19	17	71	18
13	Tendril General Cum Bar	22	22	27	16	87	22

No.	Location	Winter	Post monsoon	Summer	Monsoon	Total	Average
14	Dzong,Trongsa (Police duty House)	18	18	21	13	70	18
15	Dzong,Trongsa(Car parking)	18	20	21	20	79	20
16	Saw Mill,Bagoshin	21	19	23	19	82	21
17	On Road side NH Bumthang(Near PWD Colony)	20	21	24	21	86	22
18	In front of PWD Guest House	17	17	22	11	67	17
19	Kuengarabten-I	18	18	21	12	69	17
20	Kuengarabten-II	17	18	21	13	69	17

Table 5.8: Results of SO_x measurements at various sites in the Project district (µg/Nm^3)

No.	Location	Winter	Post monsoon	Summer	Monsoon
1	BOC Petrol Pump	7	BDL	6	BDL
2	Yankeel Resort, Trongsa	BDL	BDL	BDL	BDL
3	Hospital, Trongsa	BDL	BDL	BDL	BDL
4	High School, Trongsa	BDL	BDL	BDL	BDL
5	NHPPC Office, Sherubling, Trongsa	6	BDL	6	BDL
6	Hotel Chokhorling,Trongsa	BDL	BDL	BDL	BDL
7	NHPPC Camp,Kuengarabten	BDL	BDL	BDL	BDL
8	Community Centre, Kuengarabten	BDL	BDL	BDL	BDL
9	Sonam Wangmo,Kuengarabten	BDL	BDL	BDL	BDL
10	Near D.G. Set,Yurmong	8	BDL	7	BDL
11	Near Powerhouse,Yurmong	BDL	BDL	BDL	BDL
12	Rice Mill, Refee	BDL	BDL	BDL	BDL
13	Tendril General Cum Bar	BDL	BDL	BDL	BDL
14	Dzong,Trongsa (Police duty House)	BDL	BDL	BDL	BDL
15	Dzong,Trongsa(Car parking)	BDL	BDL	BDL	BDL
16	Saw Mill,Bagoshin	BDL	BDL	BDL	BDL
17	On Road side NH Bumthang (Near PWD Colony)	BDL	BDL	BDL	BDL
18	In front of PWD Guest House	BDL	BDL	BDL	BDL
19	Kuengarabten-I	BDL	BDL	BDL	BDL
20	Kuengarabten-II	BDL	BDL	BDL	BDL

Table 5.9: Results of NO_x measurements at various sites in the Project district (µg/Nm^3)

No.	Location	Winter	Post monsoon	Summer	Monsoon
1	BOC Petrol Pump	BDL	BDL	BDL	BDL
2	Yankeel Resort, Trongsa	BDL	BDL	BDL	BDL
3	Hospital, Trongsa	BDL	BDL	BDL	BDL
4	High School, Trongsa	BDL	BDL	BDL	BDL

No.	Location	Winter	Post monsoon	Summer	Monsoon
5	NHPPC Office, Sherubling, Trongsa	BDL	BDL	BDL	BDL
6	Hotel Chokhorling,Trongsa	BDL	BDL	BDL	BDL
7	NHPPC Camp,Kuengarabten	BDL	BDL	BDL	BDL
8	Community Centre, Kuengarabten	BDL	BDL	BDL	BDL
9	Sonam Wangmo,Kuengarabten	BDL	BDL	BDL	BDL
10	Near D.G. Set,Yurmong	11	10	11	9
11	Near Powerhouse,Yurmong	BDL	BDL	BDL	BDL
12	Rice Mill, Refee	BDL	BDL	BDL	BDL
13	Tendril General Cum Bar	BDL	BDL	BDL	BDL
14	Dzong,Trongsa (Police duty House)	BDL	BDL	BDL	BDL
15	Dzong,Trongsa(Car parking)	BDL	BDL	BDL	BDL
16	Saw Mill,Bagoshin	BDL	BDL	BDL	BDL
17	On Road side NH Bumthang(Near PWD Colony)	BDL	BDL	BDL	BDL
18	In front of PWD Guest House	BDL	BDL	BDL	BDL
19	Kuengarabten-I	BDL	BDL	BDL	BDL

Table 5.10: Results of PM_{10} measurements at various sites in the Project district ($\mu g/Nm^3$)

No.	Location	Winter	Post monsoon	Summer	Monsoon		Average
1	BOC Petrol Pump	10	8	10	5	33	8
2	Yankeel Resort, Trongsa	6	5	9	3	23	6
3	Hospital, Trongsa	8	7	7	4	26	7
4	High School, Trongsa	10	9	11	4	34	9
5	NHPPC Office, Sherubling, Trongsa	8	7	9	5	29	7
6	Hotel Chokhorling,Trongsa	7	4	8	3	22	6
7	NHPPC Camp,Kuengarabten	8	6	8	4	26	7
8	Community Centre, Kuengarabten	6	5	7	3	21	5
9	Sonam Wangmo,Kuengarabten	8	6	9	4	27	7
10	Near D.G. Set,Yurmong	10	11	10	6	37	9
11	Near Powerhouse,Yurmong	8	9	9	4	30	8
12	Rice Mill, Refee	9	7	10	4	30	8
13	Tendril General Cum Bar	8	5	7	3	23	6
14	Dzong,Trongsa (Police duty House)	9	7	8	3	27	7
15	Dzong,Trongsa(Car parking)	11	10	10	5	36	9
16	Saw Mill,Bagoshin	10	8	11	6	35	9
17	On Road side NH Bumthang(Near PWD Colony)	10	8	11	4	33	8
18	In front of PWD Guest House	8	7	8	4	27	7

No.	Location	Winter	Post monsoon	Summer	Monsoon		Average
19	Kuengarabten-I	10	9	9	5	33	8
20	Kuengarabten-II	8	7	9	3	27	7

111. Air quality data was collected by MHEP in June 2013 assisted by the National Environment Commission. Respirable Dust Sampler was used for PM_{10} sampling for 8 hrs and 24 hrs (see **Table 5.11**). Level of PM_{10} for 8-hour average was also measured at the workplace (see **Table 5.12**).

Table 5.11 Results of PM_{10} measurements (24 hrs)

Sl. No	Location	PM_{10} (μ/m^3)	National Standard (μ/m^3)
1	Trongsa Town	30.28	100
2	Dangdung Colony	78.32	100

Table 5.12 Work Place Emission for average 8hrs

Sl. No	Location	PM_{10} (μ/m^3)	National Standard (μ/m^3)
1	Kuenga Rabten (Gup Office)	0.072	5
2	Khamey	0.083	5

5.1.5 Noise

112. The Project area is remotely located with sparse population, devoid of any industry and thickly buffered by vegetation. While the town lies along the Trongsa – Gelephu highway, the frequency of long distance travelers and vehicles is quite low.

113. Ambient noise levels were measured by MHEP at 10 locations in different seasons (see **Table 5.13**) and two sites for NHPP (see **Table 5.14**).

Table 5.13: Noise levels at various sites in MHEP

Sl. No.	Mangdechu Project sites	Noise level, dB		
		Monsoon	Post-monsoon	Winter
1	Trongsa market (11 a.m.)	47	48	41
2	Chunjupang Road side	41	38	37
3	Mid-way to Dam site	33	33	31
4	Dam site	48	47	43
5	Bubja Road side	40	49	37
6	Power House area	31	31	30
7	Langthel	36	39	33
8	Yurmu quarry site	34	35	34
9	Kurjey quarry site	33	33	33
10	Kuengarabten Adit 4 area	32	33	32

Table 5.14: Noise levels at NHPP (July 2012)

Sl.No.	Nikachhu project sites	Noise level, dB(A)		National Standards	
		Day	Night	Day	Night
1	Trongsa view hotel	48.11	42.84	55 dB(A)	45 dB(A)
2	Dam site at Lorim	40.7	35.49		

114. The data indicate that noise levels are currently below the national standards for noise, day and night. With MHEP currently being implemented, noise is by generated from the operation of construction equipment, movement of vehicles, and blasting operations. However, many of the access roads have been completed and not much construction work remains as the construction phase is nearing completion.

5.1.6 Surface Water

115. There are four major rivers in Bhutan. Drangme Chhu is the largest river system which flows south-westerly from India's state of Arunachal Pradesh. It has three major tributaries: the Drangme Chhu, Mangdechhu, and Bumthang Chhu. These three tributaries form the Drangme Chhu River basin which spreads over most of eastern Bhutan and drains the Trongsa and Bumthang valleys. In the southern plains, where eight tributaries join it, the Drangme Chhu is called the Manas Chhu. The Puna Tsang Chhu rises in northwestern Bhutan as the Mo Chhu and Pho Chhu are both fed by the snow-covered Himalayas. These two rivers join to form the Puna Tsang Chhu in Punakha and flow southerly into West Bengal, India. The smallest river system, the Torsa Chhu or Amo Chhu, flows out of Tibet into the Chumbi Valley and swiftly through western Bhutan before broadening near Phuntsholing and then flowing into India.

116. The Mangdechu River flows through the heart of the dzongkhag dividing it into two. The Mangdechhu, rises in northern Bhutan near Kula Kangri Peak. At Trongsa Dzong, the bed of the river is about 1, 666 masl and its flow is very swift.

117. The Nikachhu River is a tributary of Mangdechhu River with the catchment north and south of the road running from Pele La to Tangsibji. The topography in the area is characterised by steep slopes, deep gorges with approximately one third of the catchment area lying above 4,000 m elevation. A number of smaller tributaries flow into the Nikachhu River.

118. The different sites of the project are located in an area of about 40 km in length between Trongsa to Langthel. **Table 5.15** shows the various streams where the transmission line has crossings.

Table 5.15: River and stream crossing along the TL alignment

Section of TL	River and stream crossing
Section 1: Port head Yard (TL1) to Dam colony opposite (T6).	Mangdechu river
Section 2: Tashidingka(TL7) to Taktse top(TL14)	Dzongkhalumpa
Section 3: Bubja top (TL15) to kuengarabten(TL26)	Yuesagangchhu
Section 4: Kuengrabten top (TL27) to Lhakhang Jap (TL42)	Bubja fall and Nikhachhu
Section 5: Kompey (TL43) to Raphy (TL50)	None
Section 6: Raphey top (TL51) – Alternative-Yurmo (TL56)	None

119. Water samples for analysis were collected in 2012 from ten sites in and around Trongsa in Central Bhutan in relation to MHEP and four sites for NHPP (see **Table 5.16** and **Table 5.17**).

Table 5.16: Water quality at the project site and downstream (sampled July 24-29, 2012)

Parameter	Unit	Category	Locations		
			Upstream of Nikachhu Dam Site	Downstream of Nikachhu Dam Site	Downstream of Nikachhu and Mangdechhu Confluence
Turbidity	TU	Physical	17	18	22
pH		Physical	7.52	7.4	7.6
Temperature	centigrade	Physical	13.4	16.5	16.2
Conductivity	S/m	Physical	62.8	58.5	51.1
Dissolved Oxygen	mg/L	Physical	7.91	8.49	9.3
Coliform	cfu/ml	Microbiological	25	29	70
Chlorine	mg/L	Chemical	< 0.05	< 0.05	< 0.05
Arsenic 50 ml	Ppb	Chemical	0	0	0
Arsenic 9.6 ml	Ppb	Chemical	0	0	0

Parameter	Unit	Category	Locations		
			Upstream of Nikachhu Dam Site	Downstream of Nikachhu Dam Site	Downstream of Nikachhu and Mangdechhu Confluence
Iron	mg/L	Chemical	0.082	0.065	0.82
Ammonia	mg/L	Chemical	0.025	0.025	0.016
Total Hardness	mg/L	Chemical	80	81	86
Calcium	mg/L	Chemical	59	45	19
Magnesium	mg/L	Chemical	21	27	67

Table 5.17: Water quality at the project site and downstream (sampled December 2012)

Parameters	Sites					
	Near dam site	Downstream from Dam Site	Confluence with Mangdechhu	Downstream from Confluence	Downstream Mangdechhu	Downstream Mangdechhu
Conductivity (S/m)	82	82	117	90	105	110
TDS (ppm)	41	41	57	44	52	56
Water Temp. (^{o}C)	7	7	9	9	10.5	12

120. In general, the analytical data for the Nikachhu reflect a very healthy river system, with no evidence of contamination from human sources. In addition, despite water sampling at the beginning of the monsoon, turbidity is actually very low, reflecting very little sediment mobilization (from erosion) in the upper watershed of the Nikachhu (which in turn reflects very high vegetative cover).

121. On the other hand, there is some evidence of higher levels of some water quality parameters in the Mangdechhu below the confluence. Given the much higher discharge of the Mangdechhu and the fact that it flows near Trongsa town, it is not surprising that there are higher levels of coliform. The surficial geology of the Mangdechhu Basin may also account for the higher levels of iron and magnesium, and lower levels of calcium. Like the Nikachhu, the Mangdechhu shows little evidence of contamination from human activity, and all parameters, such as turbidity, ammonia, and coliform are low by any standard. Water quality at Tsheringma Drupchhu (a small tributary of the Nikachhu, on the north side, about 2 km upstream of the confluence of the Nikachhu and Mangdechhu) is also very good, although coliform levels are similar to those in the Mangdechhu (possibly reflecting more human habitation and pastureland in this area, compared to further upstream on the Nikachhu).

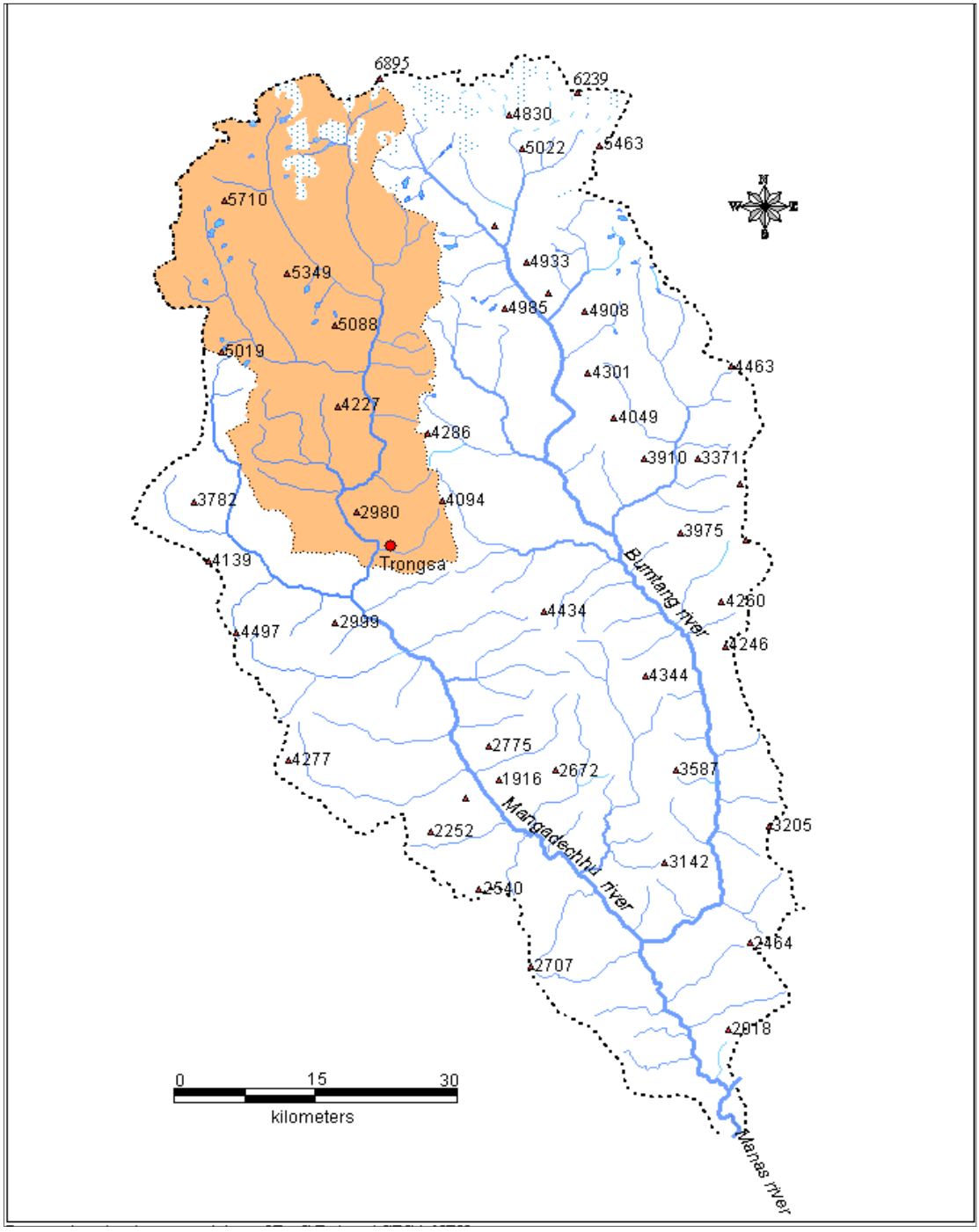
122. The water quality analysis in December 2012 reflected lower water temperatures, but showed the trend of increasing water temperatures from the Nikachhu to the Mangdechhu (the latter at lower altitudes). As with the July 2012 data, the Mangdechhu showed higher levels of total dissolved solids and conductivity, compared to the Nikachhu.

123. The river Mangdechhu, a tributary of river Manas, rises from Northern Bhutan near Kula Kangri Peak. The river system exhibits a dendritic pattern with tree like branches of smaller rivers meeting to form a larger river. The entire project area is located in a highly mountainous and difficult terrain of Bhutan. In the upper course the river flows between high rocky Himalayan Mountains confining the channel in a narrow valley.

124. The profile of Mangdechhu from source to proposed dam site is relatively steep. The overall river length is 80 km. The average slope of the river is around 40 m/km. There are two glaciers on the northern most part of the catchments, with total area of 5,079 ha (see **Map 5.2**). In addition, there are around 108 glacier lakes/water bodies in the northern and middle portion of the river basin, having a combined area of 1,177.53 ha. All the lakes are situated above elevation 4,271 m and around 50% of the lakes are situated above 500 m altitude.

125. The river Mangdechhu in general flows in southerly direction; however, in the vicinity of project area it follows a meandering course. In the dam area, it flows in northeast to southwest direction and after making a big loop, it follows a northwest to southeast course near power house site. The entire terrain is dissected by many streams, which drain into river Mangdechhu. Prominent left bank tributaries of Mangdechhu are Tarkha and its tributaries Tergang and Kharma; Trespang chhu; Gormang chhu and Bungzam chhu; whereas right bank tributaries are Khangkham chhu, Branji; Chuu, Dangi bang chhu, Duigang chhu and Thampe Chhu. Some of these nallas follow a sub-parallel drainage pattern indicating structural control, however the second order and third order streams are more or less dendritic. Peak flows occur during the monsoon months of June to September and lean flows during December to March.

Map 5.2: Mangdechu River system



5.1.7 Ground Water

126. Little is known of Bhutan's groundwater reserves, although there are many springs in both low and high altitudes, some of which are used for irrigation and/or domestic purposes. There has been no significant study on the location, extent and potential yield of aquifers, or on

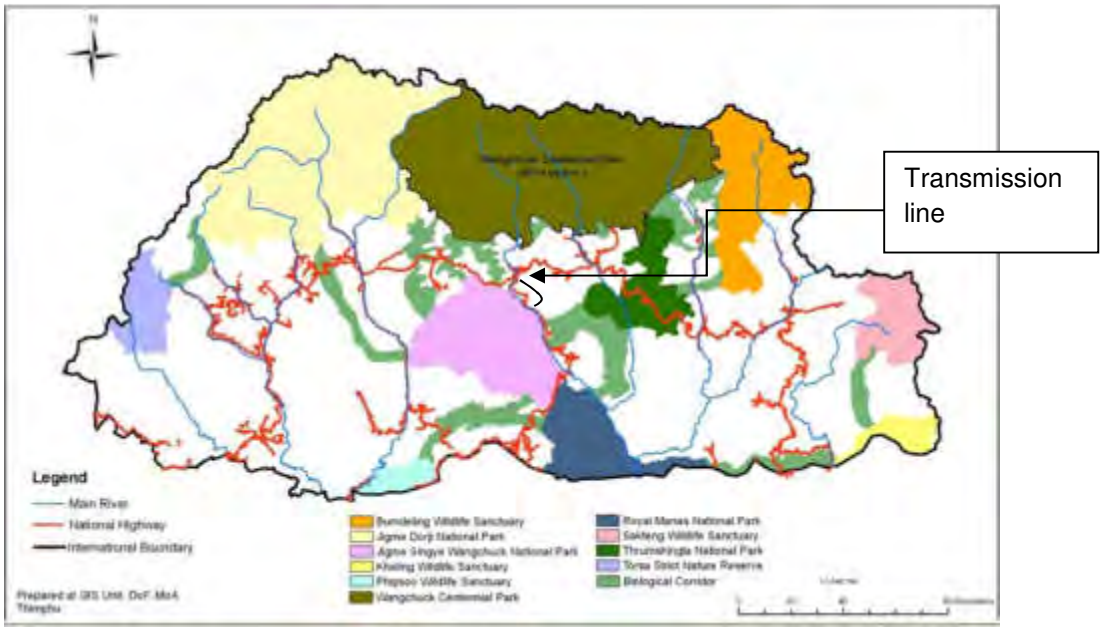
the quality of the water they contain. Arsenic levels are, however, known to be low, and water quality should be good, given the limited population, lack of polluting industries, and relatively low use of chemical fertilizers in agriculture in the project area. It is known that no local communities use wells for any water supply.

5.2 Ecological Resources

5.2.1 Protected Areas

127. Bhutan has the highest proportion of forest cover and protected areas compared to all other countries in Asia[10]. With a total land area of 38,394 km^2, protected areas cover 51.32% (19,676.57 km^2). This comprises 16,396.43 km^2 in ten protected areas and 3,307.14 km^2 of Biological Corridors (Circular of NCD, Nov 30, 2009; NEC/Adm (02)/2009/1595). These are shown in the Map below.

Map 5.3: National parks and biological corridors in Bhutan (the project area is marked)

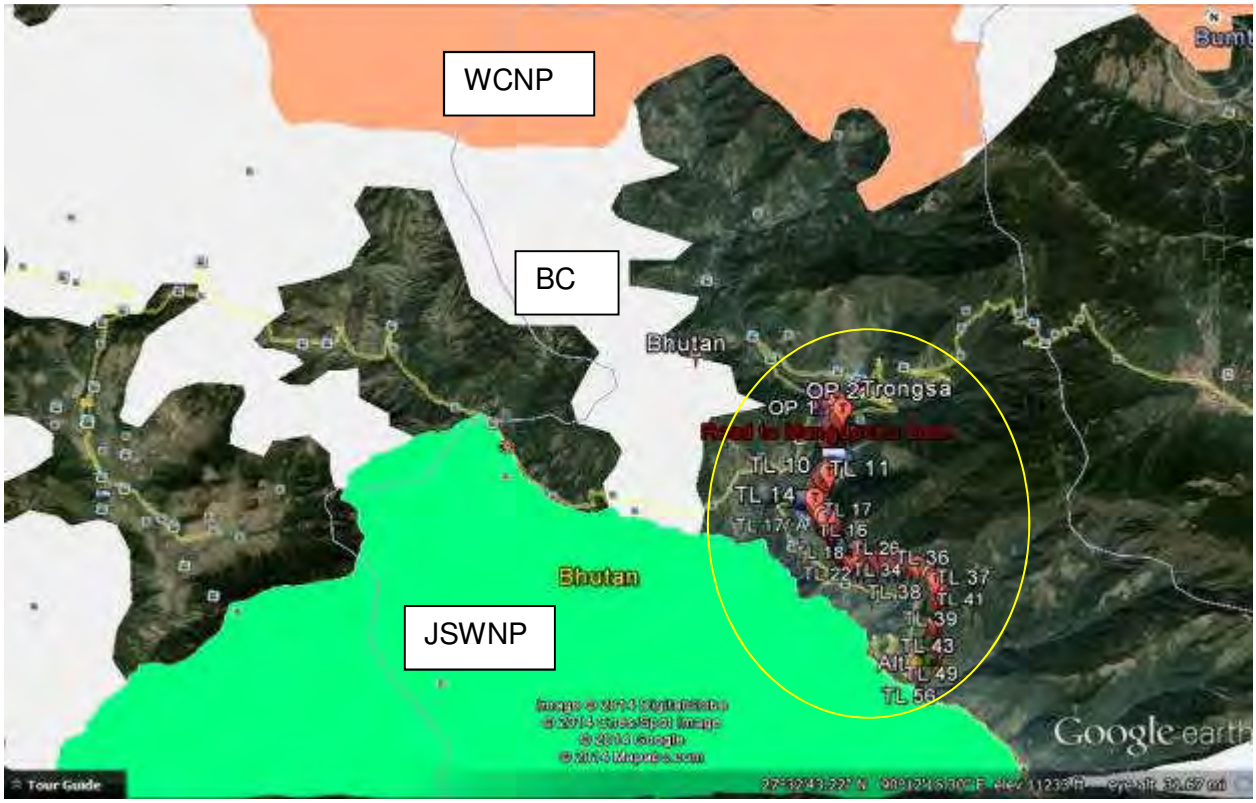


128. The protected areas in Bhutan are all joined by biological corridors, which are intended to maintain the biological connection between each area, and permit the unhindered migration of mammals and other organisms. As noted previously, these are all considered as protected areas by the Department of Forest and are given special protection under the Forest and Nature Conservation Act (1995), although with a lower status than the National Parks themselves.

[10] MOA (2002): Biodiversity Action Plan for Bhutan. Ministry of Agriculture, RGOB.

129. To date around 5,603 species of vascular plants (includes 369 species of orchids and 46 species of rhododendrons), over 678 species of birds, and nearly 200 species of mammals have been recorded in Bhutan (NBC, 2009). This possibly represents a fraction of the species that are present, as Bhutan remains one of the least explored countries in the world. Only 23 species of herpetofauna have been inventoried so far (NBC, 2009). The rich biodiversity is due to the remote nature, geographical relief and climatic heterogeneity of the country, and its location between temperate Eurasia in the north and the tropical Indian subcontinent in the south. The National Parks are intended to protect the most important habitats for this terrestrial biodiversity. The Transmission line is not located in any protected area, Wildlife Sanctuary, Strict Nature Reserve or Biological Corridor (shown below).

Map 5.4: Map showing TL alignment vis-à-vis Protected Area



5.2.2 Forest and Vegetation

Vegetation Types in Bhutan

130. Forests are the most dominant land cover, making up 72.5 percent of the country's territory. Mixed conifers and broadleaf forests are the most dominant forest types and virtually all forests are natural with plantation forests accounting for a mere 0.2 percent of the country's

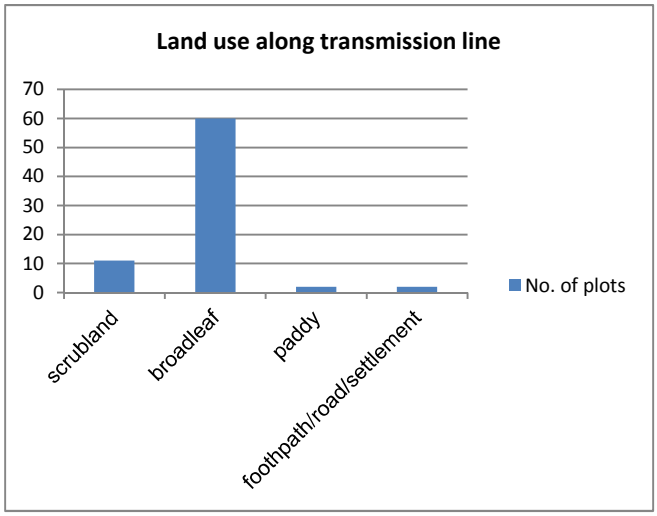
area. Forests are the most dominant land cover, making up 72.5 percent of the country's territory. Mixed conifers and broadleaf forests are the most dominant forest types (NBC, 2009).

131. So far, most of the classifications on forest is based on 12 vegetation types based on the observations in Grierson & Long (1983) who recorded the existence of vegetation types in Bhutan. Within Trongsa Dzongkhag, the majority of the project area falls in the Government Reserve Forest. Forest covers 87.6% of the total land area, a significant degree of coverage. Within the Dzongkhag, the overall distribution of forest types is as follows:

(i) Broadleaf forest (40.5%): these forests are mostly characterized by trees such as *Alnus nepalensis* (alder);
(ii) Mixed conifer (15.1%): prevalent between 2,000 m and 2,700 m, this forest type is dominated by spruce, hemlock and larch, or a mixture of these species;
(iii) Broad leaf and conifer (11.4%): these mixed forests are generally oak mixed with blue pine, or higher altitude broadleaf species mixed with spruce or hemlock, and generally occur between 2,400 m and 3,000 m;
(iv) Scrub forest (9.9%): this is generally forest that has been either de-forested, damaged by fire, or overgrazed, and is more dominated by scrub than trees;
(v) Fir forests (8.8%): this forest type occurs at very high altitudes, between 2,700 m and 3,800 m; hemlock and birch may also be present; towards the timber line, fir stands become stunted, and juniper and rhododendron scrubs become more prominent;
(vi) Chirpine (1.3%): a xerophytic forest type occurring in deep dry valleys under subtropical conditions, between 900 m and 1,800 m;
(vii) Blue pine (0.5%): most common in valleys between 1,800 m and 3,000 m; it is sometime found mixed with oak and rhododendron.

132. Within the project area, the forest type is mostly cool broadleaf forest (altitudes of 11400-2000m and Broadleaf and Conifer forest at higher altitudes (2000m-2400). Along the alignment for the Transmission line a total of 74 plots were randomly selected at intervals of approximately 250m each in December 2013. Survey plots comprised of 10x10m plots for Trees, 5x5m plots for Shrubs and 1x1m plots for ground vegetation. The survey area covered the entire length of the Transmission Line and also extended into the areas beyond (where observations were simply listed). 80% of the alignment fell under broadleaf forest and mixed coniferous forest, while 15% was in Scrub forest and the remaining 3% in agricultural land, community forest, or crossing footpaths or roads.

Graph 5.4: Land use along transmission line



133. Below is a brief description of how the vegetation changes as one proceeds along the transmission line alignment (From TL 1to TL 56).The typical structure of these forests includes the following layers: a top canopy comprising of tall mature trees; a shade-tolerant middle canopy comprising smaller mature trees; shrub layer, comprising mostly woody or herbaceous plants; followed by the ground cover.

134. Within the Warm broadleaf forest, the dominant trees are Oaks, especially *Quercus griffithii, Quercus Lamellosa* and *Quercus Lanata*. Other species include *Alnus nepalensis, Docynia indica, Juglans regia, Lyonia ovalifolia, Exbucklandia populnea, Daphne phyllum, Symplocus ramossima, Maesa chisea* and *Daphne bholua*. The middle shrub layer comprises mostly of younger tree species of Quercus, Rhododendrons, Symplocus and other species like *Ardisia macrocarpa, Berberis aristata, Brassaiopsis mitis, Dichroa fibrifuga, Toricella tiliifolia, Daphne bholua, Leucosceptrum, Viburnum cylindricum, Cinnamomum bejolghota, Samraria nepalensis* and *Arundinaria*. The ground species include mostly common species like *Artemisia vulgaris, Eupatorium adenophorum, Inula cappa, Rubus ellipticus* and *Urtica parviflora*. There are also climbers like *Hedera nepalensis, Agapetes serpens, Orchids, and ferns like Pteridium aquilinium, Diplazium esculentum, Drynaria* and *Pteris wallichiana.* Grass species include *Poa annua, Anthraxon, Borinda, Cynodon dactylon* and *Cyperus cyperoides.*

135. Moving further onwards towards TL14, the vegetation is not as dense as it passes close to the Mangdechu Dam colony area and the Taktse Community Forest. Here the oaks are not as dominant but other tree species such as *Castanopsis hystrix, Daphnephyllum, Ex-bucklandia populnea, Symplocus ramossima, Symplocus glomerta, Lyonia ovalifolia, Maesa chisia, Rhododendron arboretum, Toricellia tiliifolia, Prunus cerasoides, Alnus nepalensis* and *Viburnum* are found. The middle lower trees and shrubs comprise of *Viburnum cylindricum, Eurya acuminata, Dichroa fibrifuga, Daphne bholua* and *Berberis aristata*. The ground vegetation is dominated largely by *Eupatorium adenophorum, Anaphalis triplinervis, Ancelia*

aptera, Cirsium falconeri and ferns like *Pteridium aquilinium, Diplazium esculentum, Pteris wallichiana* and other species like *Smilax, Solanum virginianum* and *Swertia chirata*. Orchids like *Cymbidium, Otochilus lanciliabius, Dendrobium candidium*, and *Coelogyne* are also found.

136. Continuing onwards towards TL25, other trees species such as *Michelia doltsopa, Prunus cerasoides, Persea bootanica, Rhus wallichii,* and Oaks (*Quercus griffithii, Quercus glauca, Quercus semicarpifolia, Quercus lanata*) are observed again with *Sympolocus, Lyonia ovalifolia, Exbucklandia populnea, Maesa chisia* and Rhododendrons. The middles storey is almost the same as before but also including species like *Nellia rubiflora, Lindera pulcherra, Viburnum cylindricum, Edgeworthia gardneri, Ilex aquilinium*, and *Cotoneaster microphyllus*. Additional ground species observed include *Tupistra chinensis, Solanum khasianum, Smilax ovalifolia, Raphidophora, Hemiphragma heterophyllum, Inula cappa, Pilea umbrosa, Potentilla fruticosa, Lycopodium clavatum, Glienchenia gigantean, Vanda cristata* and *Oleandra pistillaris* and *Otochilus* species.

Photo 5:2: Photo showing forest cover along TL

The density of trees is much lower moving towards TL42 as the forest is mostly scrub forest with fewer trees and scantier understory and barren land. Tree species are mostly *Quercus lanata, Quercus semicarpifolia, Quercus griffithii, Alnus nepalensis, Rhus wallichii, Maesa chisia, Lyonia ovalifolia, Castanopsis hystrix, Docynia indica, Symplocus ramossima, Exbucklandia populnea, Rhododendron* and *Schima wallichii*. The scanty shrub layer comprises mostly of *Artemisia vulgaris, Eupatorium adenophorum, Rubus ellipticus, Berberis aristata, Maesa chisia, Leucoceptrum species, Zanthoxylum* and *Indigofera dosua*. Even the ground

vegetation is scanty comprising mainly of *Pteridium aquilinium, Eupatorium adenophorum, Osbeckia stellata, small Rhododendrons, Anaphalis triplinervis, Artemisia vulgaris, Rubus ellipticus* and some grass species like *Poa annua* and *Arthraxon* species.

Photo 5:3: Photo showing vegetation cover along TL

137. From TL 40, the TL passes through private land, plantation forest and scrubland interspersed with forest land. The main trees species are *Castanopsis hystrix, Lyonia ovalifolia, Quercus lanata, Symplocus ramossima, Pinus roxburghii* and *Schima wallichii*. As the elevation drops and the climate is warmer, the vegetation becomes more sub-tropical, with species like *Duabanga grandiflora, Alnus nepalensis, Bischofia javanica, Rhus chinensis, Pinus roxburghii*, *Ficus roxburghii*, *Ficus semicordata*, and *Quercus lanata* in Langthel and Yurmo. Overall tree density is not very high along the TL, with a maximum of 14 trees per 100 m^2.

138. Shrubs include *Berberis aristata, Ardisia macrocarpa, Edgeworthia gardneri, Dichroa fibrifuga, Viburnum erubescens, Mahonia nepalensis, Brassaiopsis mitis, Daphne bholua, Viburnum cylindricum, Maesa chisia, Eurya acuminatum, Rhododendron arboreum, Symplocos glomerata, Viburnum cylindricum, Ilex species, Cotoneaster microphylla, Elaeagnus parvifolia, Rubus ellipticus, Eupatorium adenophorum, Zanthoxylum species,. Vaccinium myrtillus, Rhododendron vaccinoides, Indigofera dosua, Aconogonum molle*, *Datura suaveolens, Adhatoda vasica* and Arundinaria species

139. Herbs include *Artemisia vulgaris, Artemisia indica, Leucas ciliata, Inula cappa, Leucosceptrum species, Eupatorium adenophorum, Urtica parviflora, Anaphalis triplinervis, Cirsium falconeri, Solanum virginianum, Smilax ovalifolia, Swertia chirata, Pilea umbrosa,*

Ainsliaea aptera, Elatostema platyphyllum, Hedychium ellipticum, Elshotzia fruticosa, Osbeckia stellata, Oxalis corniculata, Pilea anisophylla, Colocasia esculenta and *Pilea umbrosa.*

140. Ground cover includes *Polygonum runcinatum, Hydrocotlye javanica, Fragaria nubicola, lycopodium clavatum* (moss), *Poa annua* (turf grass), *Hemiphragma heterophyllum* (creeping plant), *Potentilla fruticosa, Potentilla microphylla, Tupistra chinensis, Osbeckia stellata, selaginella sp (*spike moss*),*

141. Climbers include Raphidophora species, *Hedera nepalensis* and *Agapetes serpens*. Ferns include *Diplazium esculentum, Pteris wallichiana, Oleandra pistillaris, Glienchenia gigantean, Pteridium aquilinium* and *Drynaria propinqua, Adiantum caudatum,* Asplenium sp.

142. Orchids include *Calanthe* sp, *Eria coronaria*, *Phalaenopsis* sp. *Vanda cristata*, Cymbidium cyperifolium, *Gastrochilus* sp., and *Dendrobium candidum*, Coelogyne corymbosa and Bulbophyllum sp.

143. Mushrooms that can be found there include Amanita sp., *Lactarius piperatus, Laetiporus* sp., *Lycoperdon* sp*., Trichaptum abietinum, Boletus sp., Laccaria sp., Ramaria sp.*A list of all species recorded is provided in the Annex.

Human influence/disturbance of the forest

144. The main threat to forest cover and integrity is human activity. In each surveyed plot, the level of human influence in the area was recorded according to the following categories:

0: None (no grazing, fire, logging);
1: Low (undisturbed forest, but with a few signs of human presence);
2: Medium (fairly undisturbed under-story vegetation, but with some signs of human presence);
3: High (forest is grazed, trees cut and under-story vegetation disturbed); and,
4: Very High (very disturbed and degraded habitat; highly disturbed under-story vegetation due to grazing, human activities, lopping of trees).

145. *The most significant finding from the field assessment was that in all plots Disturbance was rated as 'High'.* This reflects the high use of the site for grazing, cutting of trees, collection of firewood or leaves for fodder. This is examined further below. Basically, the TL extends from below and the moves above the National Highway from Trongsa to Zhemgang, and all along the Transmission line alignment, it criss crosses access roads to the Mangdechhu project Dam Axis site runs parallel to the 66KV and 400 KV lines or crosses some footpath.

Table 5.18: Proximity to access roads and other structures along TL

Tower location	Elevation	Accessibility/Adjacent structures along TL

Tower location	Elevation	Accessibility/Adjacent structures along TL
Pothead	2040	Mangdechhu dam site, take off point
OOP1	2067	below national Highway, near grazing land
TL6	2110	Mangdechhu dam axis Road, old footpath
TL7	2060	opposite mangdechu dam colony
TL8	2047	parallel to existing 66KV, T60, T61
TL9	2035	above Highway, Crossing 66KV
TL10	2054	Access road to Mangdechu Dam colony area
TL12	2126	Mangdechu Dam colony top and Taktse Road, old footpath
TL13	2247	Road to cremation ground, Approach road to Taktse College, old footpath
TL21	2104	Parallel to 66KV
TL24	2091	Above 66KV line
TL27-TL42	2060	Access road to Samcholing MSS school and Kuengarabten Nunnery Centre
TL40	2156	under Taktse community forest
TL43-TL50		Old footpath, Approach road to Mangdechu Surge shaft
TL52	1488	Parallel to 400KV/D/C line, private land
TL53	1426	Crossing 400KV D/C line
TL54	1296	Parallel to 400KV/D/C line, private land
TL55	1295	Parallel to 400 KV, D/C line
TL56	1238	Parallel to 400 KV, D/C line

146. The field assessment concluded that the project area does not contain any pristine forest as the entire area has been heavily grazed by the cattle, or used for collection of leaf litter, or revegetated recently as community forests.

Photo 5.4: Photos along transmission line

147. The picture shows the alignment of the existing 66kV line. The proposed 132kV line is aligned parallel to this line just above it. The picture below shows the same 66kV line and the access road to the Mangdechhu colony below it.

Photo 5.5: The village and the Highway just below the TL

Photo 5.6 and 5.7: The vegetation and forest cover along the proposed alignment

5.2.3 Wildlife

148. A wide variety of fauna inhabits the forested areas in Trongsa due to its high forest cover and diversity in elevation and forest types.

149. During the Biodiversity survey, the study of faunal distribution and its occurrence was conducted by looking at specific plots of 10x10m, every 250m along a transect running parallel to the Transmission line. Within each plot, observations on Visual observation of wildlife signs (rooting, feeding, resting, fecal droppings, foot prints, or wildlife sounds were recorded. Also, during public consultation meetings, additional information on wildlife presence was also discussed.

150. From a total of 74 plots, wildlife signs were found in 23 plots. Species signs that were observed during mammal surveys include those of Sambar Deer (footprints), Barking Deer (sighted, as well as foot prints and dung), Wild Pigs (resting/wallowing place, footprints) and Assamese Macaque (sighted). All of these four species are considered as pest species and responsible for crop damage and endless sleep for farmers who spend hours protecting their crops from these species.

Graph 5.5: Percentage of plots with wildlife signs in them

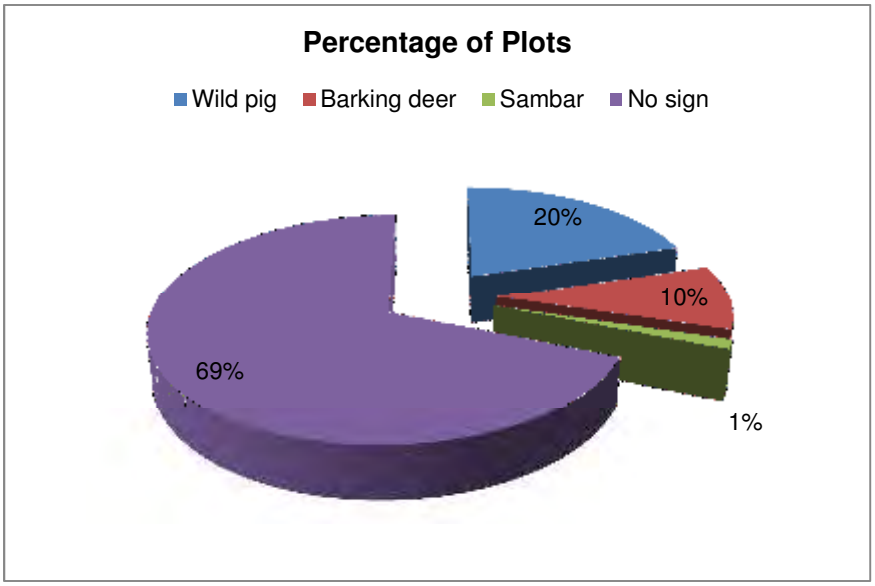


Table 5.19: Types of wildlife signs found during biodiversity survey

Plot No.	Wildlife species	Sign type	No. of signs
1	Wild pig	resting pl.	1
2	Barking deer	dung	1 clump

Plot No.	Wildlife species	Sign type	No. of signs
7	Barking deer	dung	1 clump
7	Wild pig	rooting	1
8	Wild pig	rooting	1
9	Barking deer	footprint	3
12	Barking deer	dung	1
19	Barking deer	footprint	3
25	Wild pig	rooting	1
30	Wild pig	rooting	1
32	Jungle fowl	scratching	many
33	Sambar	footprint	4
34	Barking deer	spotted	1
37	Wild pig	resting place	1
38	Wild pig	rooting	1
39	Barking deer	footprint	1
44	Wild pig	Rooting	1
45	Wild pig	wallowing	1
46	Wild pig	rooting	1
49	Wild pig	wallowing	1
52	Wild pig	nesting	1
55	Wild pig	rooting	1
60	Wild pig	footprint	1
65	Wild pig	rooting	1
	TOTAL plots		**23**

151. Much of the lower slopes in the Project area comprises of Agricultural Land. In the warmer Broad-leaved Forest that occurs along the Trongsa – Zhemgang Road there are signs of high anthropogenic disturbances including heavy grazing and lopping so signs of wildlife are much lower.

152. Based on the forest type and lower level of disturbance higher up on the slopes, the rarer and more elusive species like Leopards, Bears, Capped Langur, Goral, Gray Langur, Himalayan Black Bear, Indian Porcupine, Little Himalayan Rat, Jungle Cat, Leopard Cat and Otter are expected.

Table 5.20: Status of wildlife present in the project area

No.	Common Name	Scientific Name	Expected in project area	Status in Bhutan	IUCN status
1	Leopard	Panthera pardus	Yes	Sch-I	Near threatened
2	Clouded Leopard	Neofelis nebulosa	Yes	Sch-I	Least Concern
3	Leopard Cat	Prionailurus bengalensis	Yes	Sch-I	Least Concern
4	Asiatic Black Bear	Ursus thibetanus	Yes	Sch-I	Vulnerable
5	Wild pig	Sus scrofa	Yes		Least Concern
6	Wild dog	Cuon alpinus	Yes		Least Concern
7	Barking deer	Muntiacus muntjak	Yes		Least Concern
8	Sambar	Cervus unicolor	Yes		Least Concern
9	Indian crested porcupine	Hysterix indica	Yes		Least Concern
10	Grey langur	Semnopithecus entellus	Yes		Least Concern
12	Goral	Naemorhedus goral	Yes		Near threatened
13	Indian gray mongoose	Herpestes edwardsii	Yes		Least Concern
14	Bengal fox	Vulpes bengalensis	Yes		Least concern
15	Assamese macaque	Macaca assamensis	Yes		Near threatened
16	Capped Langur	Trachypithecus pileatus	Yes		Vulnerable
17	Himalayan Serow	Capricornis thar	Yes		Near threatened
18	Jungle cat	Felis chaus	Yes		Least concern
19	Yellow-throated Marten	Martes flavigula	Yes		Least concern
20	Gaur	Bos gaurus	Yes	Sch-I	Vulnerable
21	Little Himalayan Rat	Niviventer eha	Yes		Least concern

Schedule I means that the species is included in the Schedule I of the Species and Nature Conservation Act of Bhutan.*

*** The project area is taken to mean within about 5 km of the specific project component footprints.*

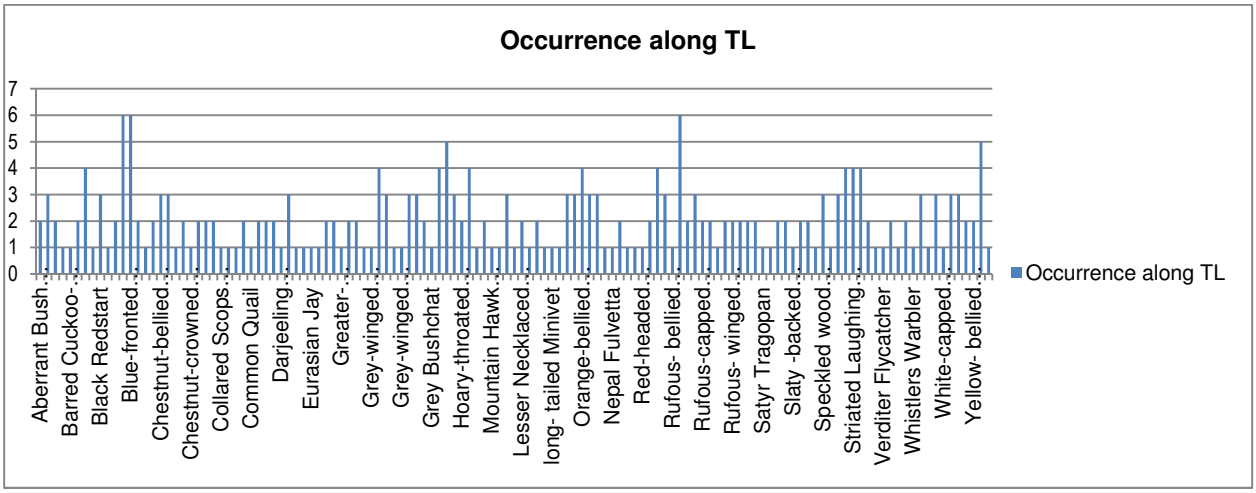
153. Given the presence of the National Highway, the extent of degraded forests and the cleared RoW, and level of human disturbance, it is expected that this area is much less important to the rarer wildlife compared to the undisturbed great expanse of suitable habitat on the higher more remote altitudes away from the villages and the highway.

5.2.4 Birds

154. At total of 123 species of birds were recorded in and around the Project site. These are presented in the table. From these the Rufous-necked Hornbill (Aceros nipalensis) is listed as Vulnerable in IUCN and a totally protected species listed in Schedule-I of the Forest and Nature Conservation Act, 1995. The Satyr Tragopan and the Yellow-rumped Honeyguide are both listed as 'Near threatened' in the IUCN Red List. All of these three species were recorded once during the field survey, the Stayr Tragopan near the Taktse Community Forest area, and the

Yellow-rumped Honeyguide and the Rufous-necked Hornbill (2 Male and 1 Female) near the top of Kuengrabten.

Graph 5.6: Frequency of bird occurrence along transects



155. Many of the species that are found in the project site fall in the "Least Concern" category. These include Thrushes, Bulbuls, Laughing thrushes, Robins, Tree pies, Eagles, Mynas, Minlas, Fulvetta, Honeyguides, Leafbird, Magpie, Fantails, Warblers, Babblers, Pigeon, Wallcreeper, Prinia, Fork tail, Sparrow, Crows, Redstarts, Pheasants and many more. A full list of species is detailed in **Annexure 3.**

5.2.5 Amphibians and Reptiles

156. Till date no specific surveys have been specifically conducted on Amphibians and Reptiles in Trongsa dzongkhag. Thus, there is no baseline information on species that thrive there. During the field surveys, snakes such as Pit viper (*protobothrops*) and Green rat snake (*Ptyas nigromarginata*) were recorded from the Nikachhu project area. Amphibians are usually found in moist places and near water bodies. Flat tailed Gecko (*Hemidactylus platyurus*) and the common Garden lizard (*Calotes versicolor*) can also be found there. Lizards found in Mangdechu include Eastern green calotes (*Calotes jerdoni*), Draco (*Draco dussumieri*), Green Keelback (*Macropisthodon plumbicolor*), Banded Krait (*Bungarus fasciatus*), Python (*Python molurus*) and Common skink (*Mabuya carinata*). (MHEP, no date).

157. The tadpole could belong to an *Amolops* sp. since this group of frogs inhabits mountain rapids. Other species of frogs spotted in the Mangdechu area include East Asian Tree Frog (*Polypedates leucomystax*), Giant tree frog (*Rhacophorus maximus*), Himalayan torrent frog (*Amolops marmoratus*), Himalayan bull frog (*Pea leibigii*), Tree frog (*Polypedates spp*.) and Leaping frog (*Rama erythraea*) (MHEP, no date).

158. There is a good diversity of Macro invertebrates at the project site. These include Flies (Diptera), Beetles such as the Rhinoceros beetle, dung beetle, Ladybird, Stag beetle, (Coleoptera), Grasshoppers and Crickets (Orthopterans), Aphids (Hemiptera), Stoneflies (Plecoptera), Mayflies (Ephemeroptera), Caddis flies (Trichoptera), Dragonflies and damselfly (Megaloptera), Moths and Butterflies (Lepidoptera), Bees and Wasps and Ants (Hymenoptera), Spiders (Araneae), Leeches (Clitellata), Ticks (Acarina) and Worms (Oligochaeta).

159. 49 species of butterflies were reported from the Mangdechhu area. These are mainly from the families Papilionidae, Nymphalidae, Pieridae, Hesperidea and Lyeaenidae.

5.3 Economic development

5.3.1 Land Use, Industry and Agriculture

160. 87.6% of the Dzongkhag is covered by forest, leaving only 5.7% for agriculture, 3.6% Tsamdro (pasture), 0.1% settlements with the remaining 3% covered by rocky outcrops and water bodies. The dominant agricultural practice is Kamzhing or dry land cultivation followed by Chhuzhing or wetland cultivation. Tseri farming (slash and burn cultivation) is also practiced in some areas. The total land cultivated is 2,287.2 km^2 (NSB, 2011).

Table 5.21: Land use cover in Trongsa and the Country

Land use	% cover dzongkhag	% cover National level
Forest	87.16	4.14
Agriculture land	1.26	0.06
Meadows	2.87	0.14
Shrubs	6.21	0.29
Water bodies	0.16	0.01
Snow cover	1.78	0.08
Others	0.56	0.03
	100	4.75

161. In terms of area, the most important crops grown are Paddy, Maize, Buckwheat, Wheat and Barley. Other crops grown to a lesser extent include Potatoes, Chilli, Radish and other green vegetable. The perennial crops consist mostly of Oranges, Guava, Banana and Cardamom (Atlas of Bhutan, 1997).

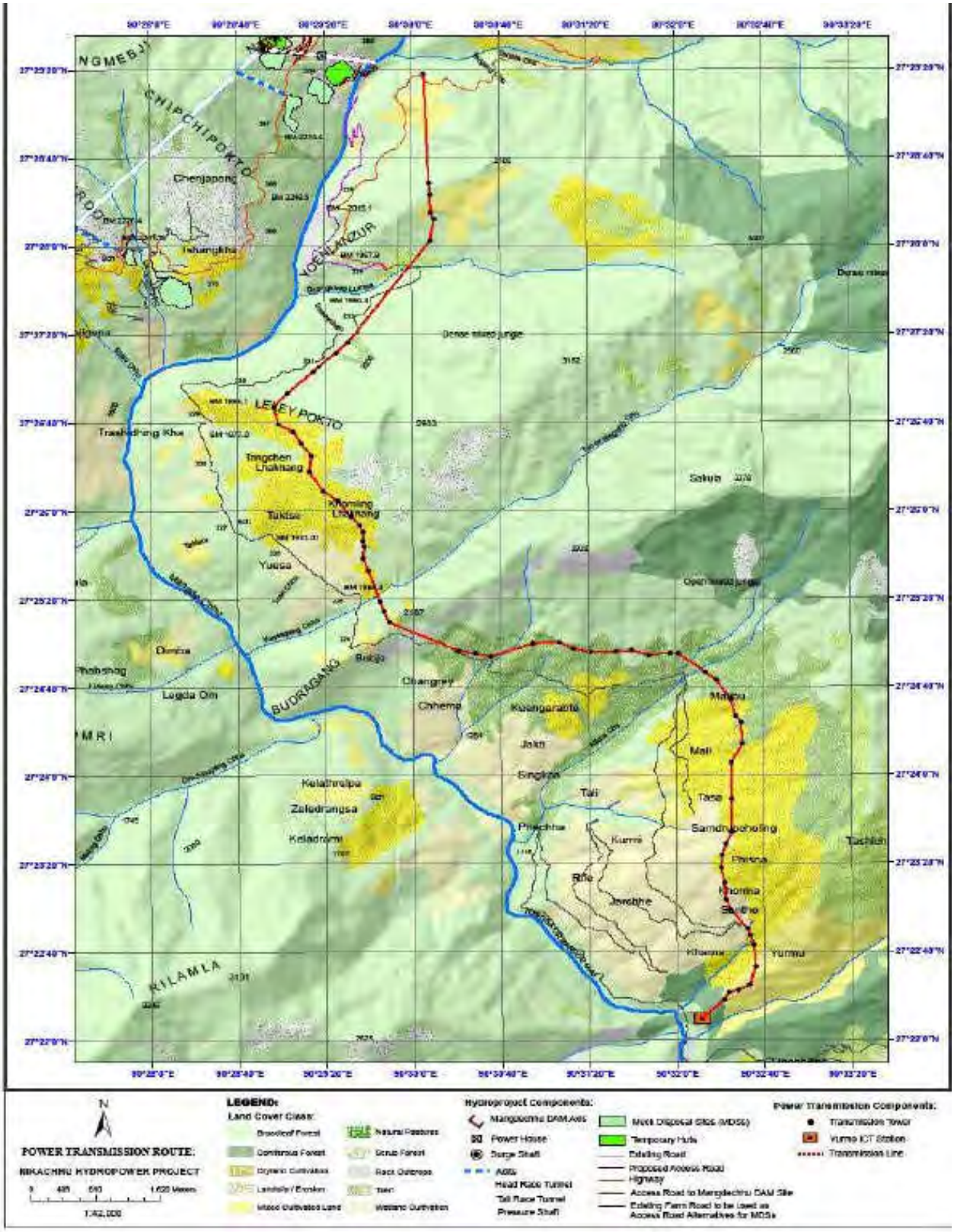
162. Livestock rearing also plays a very important role in supporting the rural livelihood. More than 90% of the households own livestock, which is an important source of cash income for farmers. Livestock also provide farmyard manure and draft power for farming.

163. The town contains six small industries of which two are agriculture based and four forestry based. There are 57 small licensed contractors but not all are operational. The town has ten hotels and eight restaurants, and couple of repair workshops but there is no heavy industry or major manufacturing industry.

Table 5.22: Villages that are crossed along the TL alignment

Section of TL	Villages along the TL
Section 1: Port head Yard (TL1) to Dam colony opposite (T6).	Tashidingka, Eusa
Section 2: Tashidingka(TL7) to Taktse top(TL14)	Tashidingka, Eusa, Taktse.
Section 3: Bubja top (TL15) to kuengarabten(TL26)	Taktse, Eusa,
Section 4: Kuengrabten top (TL27) to Lhakhang Jap (TL42)	Bubja, Changrey, Kuengarabten,Shomchholing,
Section 5: Kompey (TL43) to Raphy (TL50)	Khamey, Raphey top.
Section 6: Raphey top (TL51) – Alternative-Yurmo (TL56)	Raphey, Yurmoo area.

Map 5.5: Land use in Project area



164. Only 67% of Drakteng gewog falls under forest cover as it is one of the more populous areas (population density of 31.9 km^2) but 78% of Langthel is under forest cover. The Trongsa Zhemgang highway runs through the Gewogs acting as a main artery for economic development.

165. Paddy, maize, wheat, and vegetables are the major crops cultivated in the two gewogs with Mandarin more commonly grown in Langthel. Most households rear livestock which is an important source of income. While households earn from farming, some members of the household are involved in business, work in the Civil Service or the Private Sector. The neighboring forests are used for collection of leaf litter and for grazing but households are not totally dependent on the forest for their livelihood. Thus the project is not expected to cause any impacts on livelihood benefits from the forest. In fact, it is more likely that locals will benefit in terms of employment with the Contractor, or with the Project for its Conservation Programs, through rental of rooms to Project staff or through the sale of agricultural and dairy products.

5.3.2 Infrastructure

166. Infrastructure is better developed in the towns because of the technical difficulties presented by the mountainous terrain, and the proportionally high cost of providing services to scattered communities. The government is however committed to providing for the needs of the rural population, and has made significant progress over the past few decades. For example around 97.2% of households have access to safe drinking water through pipes, via household systems in the towns and larger villages, and community standpipes in smaller villages.

167. Like most other Dzongkhags, there is no centralised sewerage system in Trongsa, but 92.6% of the households have self-built pit latrines in the villages, which are normally located in a brick or wooden enclosure away from the house.

168. The MHEP is currently under implementation with major infrastructure works such as tunnels and access roads being constructed. There are three micro-hydel stations at Kuengarabten, Sherubling and Tangsibji.

169. Only 23.6% of Households use electricity for cooking, while 21.8% use LPG, and 54.2% of the households utilise fuel-wood for both cooking. Less than 1 % uses kerosene. The drainage infrastructure in the towns consists mainly of open concrete drains alongside roads and shops. There is a waste disposal system implemented by the District authorities but no such system exists in rural areas where people generally burn their waste, or deposit it on open ground.

170. Every Gewog in the Dzongkhag has a BHU, RNR centers and a School each but the entire district has only one Post Office and one Bank. Almost every household has a mobile phone and 631 households have telephone connections in their house.

5.3.3 Transportation

171. The total road network in Bhutan amounts to 10,578 km. From this, 49.6% comprises of farm roads, many of which were recently constructed during the past decade. The Primary and Secondary National Highway covers 23% of this road network. The remaining 27.3% comprises of district roads, urban forests, forest roads and access roads.

172. The East-West lateral highway and the Trongsa-Gelephu highway passes through Trongsa connecting almost all the Gewogs in the Dzongkhags by motorable roads. The district has a total of 392km of road network. This includes 174.74km of national highway, 24km of district road, 178km of farm roads, and the remaining 14.8km comprises of power tiller tracks, access roads or urban roads. Still there are a number of settlements that are still remote due to lack of feeder roads.

173. Private minibuses provide a service between the main towns, and minibuses run by tour companies ferry tourists to the more popular trekking destinations. There are few vehicles in the villages where transportation is mainly by foot or on horseback.

174. Domestic air travel includes flights from Paro (the only Airport) to Bumthang and Yongphula. From the outside, Paro can be reached via international travel from Bangkok, Bangladesh, Calcutta, Delhi, Singapore and Nepal.

5.3.4 Tourism Industry

175. Before the 1970's only the royal family had the authority to issue invitations to Bhutan, so almost all foreign visitors were royal guests. The first time a large number of foreign visitors entered the kingdom was for the coronation of the fourth king in 1974, and this was followed soon after by the first paying tourists. Paro airport opened in 1983, and the newly formed national airline, Druk Air started operating flights to Kolkata. Tourism grew gradually, and in 1991 the industry was privatised, and numerous tourist agencies were established.

176. Visitor numbers have continued to rise, particularly over the past few years, despite the requirement for all tourists to pay a non-refundable daily tariff of US $200 to the tour operator, for the cost of accommodation, food and internal travel.

177. There are a total number of 741 registered tour operators in the country but only 318 were operational in 2010. There are at least 8,818 people directly employed and 13,227 indirectly employed by the Tourism industry (Bhutan Tourism Monitor, 2011). The highest number of tourists visiting Bhutan was recorded in 2012, with visitor arrivals peaking at 105,407, representing a growth of 64.62% over the previous year. From the International segment, Japanese arrivals surpassed US arrivals for the first time by contributing 15.98% followed by USA with 13.67% of total international visitors. China remained the third biggest contributing 8.57% in 2012. There was also significant increase in visitors from other countries too.

178. Because of the difficulty of internal travel in Bhutan, requiring long journeys on winding roads between and over mountains, only relatively fewer tourists venture to the east of the country where there are few hotels or major attractions. Tourism has little impact in the villages because of the difficulty of reaching most locations, so most villages remain much as they have for the past few centuries.

179. Trongsa town being located right on the National highway has many visitors. In terms of visits to the districts, Trongsa ranked 6th in terms of visitors with 7,435 visitors in 2012, of which over 50% visited during the months of September-November, and 27% visited during March-May. About 7 % visited during the winter (December-February) and 6% during summer (June- August).

5.4 Social and Cultural Resources

5.4.1 Demography

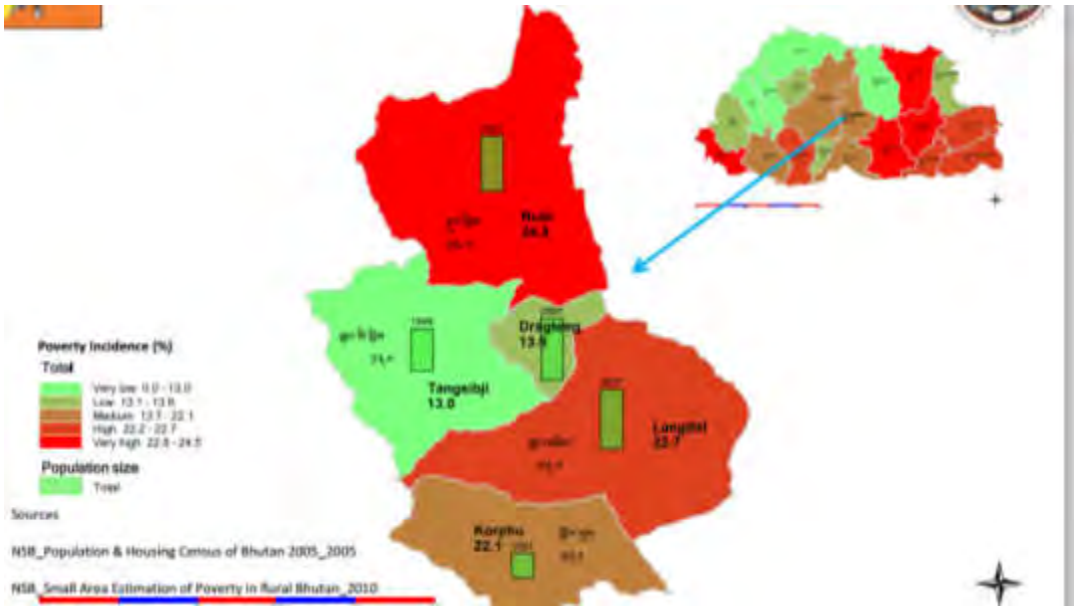
180. The demographics of Bhutan show that it is a country with a low and relatively dispersed population, with the 2013 census[11] reporting a total of 733,004 people living at an average density of 16 persons/km^2. However, population density in districts like Trongsa is much lower, 8 persons/km^2. This is probably due to rural urban migration of the younger generation from the countryside into towns to seek better economic rewards. The population growth rate is 1.3% per year.

181. Trongsa is typical of most Dzongkhags, as it contains a small main town and large areas of countryside in which people live in small scattered communities. The total projected population for the Dzongkhag in 2009 was 14,712 with an annual growth rate of 1.4%, with almost equal number of males and females. The rural character is shown by the fact that there are 56 villages with a total of 2,739 households.

182. The population of Bhutan includes many ethnic groups such as the Sharchops from the east, Ngalongs from the west, Khengpas from the central region, nomads from the north and Lhotshampas from the south. These (and others) are all found in Trongsa dzongkhag, especially due to the large influx of non residents. Because of the mix of ethnicities a wide variety of dialects is spoken, of which Dzongkha, Khengkha,Mangdep, Sharchop and Nepali are the most common.

[11] Population and Housing Census of Bhutan 2005: National Statistics Bureau, RGOB, Thimphu.

Map 5.6: Map showing the different gewogs in Trongsa



Source: NSB_Population & Housing Census of Bhutan 2005

5.4.2 Health and Education

183. As in most other Dzongkhags, the main administrative centre is housed in the Dzong (originally a fort or monastery). Apart from a hospital and government offices, there are few other public facilities in the town, which is very small and contains shops and restaurants, hotels, and a small number of permanent houses. Expansion of the town has largely been constrained by the steep topography.

184. The only hospital is in Trongsa town, which has two doctors and has room for 20 beds. There are 6 Basic Health Units (BHUs- level II) in the gewogs, plus 21 Out-reach Clinics (ORCs) in some of the larger villages. There are also 2 Units that provide Indigenous treatment and services.

Table 5.23: Medical Facilities in Trongsa and the entire country

Medical facility	No. in Trongsa	Total in the country
Hospitals	1	32
BHUs	6	181
ORCs	21	518

185. There is only one Higher Secondary School, Two Middle Secondary Schools, Two Lower Secondary Schools, 4 Primary schools and fifteen Community schools totalling 24

schools in the district. At present 3,822 students were enrolled in these schools last year with a teacher student ratio of 1:16.There is a further forty six Non-formal education centres

Table 5.24: Types of schools in Trongsa and the entire country

Type of School	No. in Trongsa	Total in the country
Primary School	19	353
Lower Secondary School	2	93
Middle Secondary School	2	59
Higher Secondary School	1	48
	24	553

186. The entire country has 139 Agricultural Extension Centers (of which 5 are in Trongsa) and 4 Regional Research Centers. Within each District Agriculture Extension services are provided by the Agricultural sector.

5.4.3 History and Culture

187. Till early 17th century, Bhutan was the battleground of warring tribes that were later unified by Shabdrung Ngawang Namgyal, a Tibetan lama and military leader, who came to Bhutan in 1616. He established the dual system of government where the power was shared by an administrative leader and a spiritual leader together. Ugyen Wangchuck, the Penlop of Trongsa, was the first hereditary monarch of Bhutan. He came to power in 1907 and since then Bhutan has had five Monarchs. From a constitutional monarchy, the country transitioned to a democracy after its first elections in March 2008.

188. Bhutan places very high emphasis on its culture and believes that its future sovereignty as a nation state will continue to depend on its cultural identity (Planning Comission 1999). Bhutanese traditions include the rituals, customs, dress, code of etiquette, religious ceremonies, and customs, among others (Chophel, S, 2012) and its traditional values have always been largely shaped by Buddhist concepts. To preserve its unique age-old culture and traditions, the Institute for Culture was established as early as 1961. The country is dotted with numerous Buddhist religious and cultural sites some of them dating back to the 17th century. Each district has special religious celebrations called Tsechus where traditional mask dances are performed on auspicious days. These dances and festivals provide an important means to impart knowledge to the public.

189. Trongsa has the famous Dzong which was built in 1648. This was the seat of power over central and eastern Bhutan during the reign of both the first and second kings. All four kings were invested as Trongsa Penlop (“governor”) prior to ascending the throne. It currently holds 28 religious altars in its premises.

190. Another famous structure is the Ta Dzong, a watchtower, built in 1652, which once guarded Trongsa Dzong from internal rebellion. It has four observation points resembling Tiger, Lion, Garuda, and Dragon. It is now a fascinating museum for visitors and locals.

191. The Threupang Palace is the birthplace of the Late King Jigme Dorji Wangchuck and he also spent most of his early childhood days here.

192. The Chendebji Chorten lies en route to Trongsa. It is patterned on Kathmandu's Swayambhunath Stupa, with eyes painted at the four cardinal points. It was built in the 18th century by Lama Zhida, to cover the remains of an evil spirit that was subdued at this spot.

193. Kuenga Rabten palace was constructed on 1929. It is located in Kuenga Rabten, Drakteng Gewog, Trongsa District, about 24 km south of the main town of Trongsa on the road going to Zhemgang and Gelephu, situated on a slope overlooking the main road. During the first half of the 20th century, the palace served as winter residence for the second King, Jigme Wangchuck and his senior Queen, Ashi Phuntsho Choden. At present, the palace is looked after by monks from the central monastic body in Trongsa. Around fifty monks are living at the palace, including two teachers.

6 Anticipated Project Impacts

6.1 Introduction

194. The environmental, social and economic impacts of the project were assessed: to help determine the acceptability of the project, and to ensure that any residual impacts are properly recognized and addressed by appropriate mitigation measures. The process involved looking at the environmental baseline features, uniqueness, potential vulnerabilities and the nature, location, and duration of construction activities, and project design features in effect throughout operation.

195. A process of examining all possible interactions between all project components, in all phases (pre-construction, construction, and operation) and the environmental and socio-economic features in and around the project (5km) was then used as a "filter", to sharpen the impact assessment and focus on the critical interactions, and to separate out the less important interactions. Less important interactions are usually the ones that self-correct over time, due to the short-term nature of some interactions and the resilience of certain features.

6.2 Determining the degree of potential impacts

196. The degree of impact of the proposed transmission line is determined by the following factors:

(i) The degree of disturbance that already exists in the project site;
(ii) The uniqueness of the resources or protected nature of the habitat/forest/landscape;
(iii) The threat of future disturbance or considering how this project will affect land use in the future;
(iv) Duration of the impact or activity. Long term impacts exist as long as the Transmission line is in place, while temporary impacts occur only during pre-construction and construction phases or at infrequent intervals during operation phase (in case of accidents or repair or RoW maintenance).

197. To be clear on the nature of the impacts, the following definitions of impacts that embody the concept of recovery from impact are used:

198. A *major impact* can be considered as follows: (for environmental resources) the project affects an entire population or species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any other populations or species dependent upon it, to its former level within several generations; or (for social values), the project affects a subsistence or commercial resource use, business activity, or social behavior to the degree that the well being of the user or local community is affected over the long term. These kinds of impacts are difficult to mitigate, except by changing location or significantly altering project design.

199. A *moderate impact* (less significant) can be considered as follows: (for environmental resources) the project affects a portion of a population or habitat and may bring about a change in abundance and/or distribution over one or more generations, but does not threaten the integrity of that population, or any population dependent upon it; or (for social values), a short-term effect upon the social and economic well being of resource users or local communities using the project area may also constitute a moderate impact, but from which recovery is expected within 3-6 months. These kinds of impacts can be mitigated or may be acceptable without mitigation, if recovery can be assured.

200. A *minor impact* can be considered as follows: (for environmental resources) the project affects a specific group of localized individuals (plants and animals) within a population or a habitat over a short time period (one generation or less), but does not ultimately affect other trophic levels or the population itself; or (for social values), activities of resource users or local communities in the project area are not affected measurably beyond a minor disturbance of resource use or local activities, from which recovery is relatively quick. Impacts of this nature are often amenable to mitigation, or require no mitigation at all.

201. Some aspects of the environment that are not expected to be significantly affected by the construction process have been screened out and will not be mentioned further in assessing the impacts of the construction process (see **Table 6.1**).

Table 6.1: Fields in which construction is not expected to have significant impacts

Field	Rationale
Climate	Short-term production of dust is the only effect on atmosphere
Geology and seismology	Excavation will not be large enough to affect these features
Industries	There are no major industries in any areas to be affected by the project
Tourism	Tourists mostly drive by the villages located as these are located on the highway
Population and communities	Construction will not affect population numbers, location or composition

202. Basically, a habitat or population that can recover fairly quickly from a project impact is not considered to be significantly impacted. Also, if the habitat or population affected is only a small percentage of the total population or habitat in the immediate area (perhaps 1-2%), and there is continuity of habitat in affected areas with adjacent habitat in unaffected areas (providing a refuge for affected species), then the impact can also be considered insignificant, as it would likely not be visible or measureable within the spatial and temporal variability of habitat quality and function, and it would not create a barrier (at this scale) to access to adjacent similar habitat, which can provide a buffer or compensating function. To help assess impact significance, for each project activity, all possible interactions with the environment are considered; this means direct and indirect impacts (the latter requiring other conditions to be in place for an impact to occur), and cumulative impacts (the results of project interactions being added to the possible environmental impacts of other projects and planned development in the area). With regard to socioeconomic parameters, if a project activity causes a negative impact

in one parameter that can be compensated by an overall positive development impact, then the impact can usually be considered to be acceptable.

203. All impacts are identified by phase and in three main categories;

(i) Economic impacts
(ii) Social impacts
(iii) Environmental Impacts
(iv)

6.3 Impacts during Pre-Construction

6.3.1 Economic Impacts

6.3.1.1 Impact from Temporary and Permanent Land Acquisition

204. There will be two kinds of land acquisition. Temporary land requirement will last at the most 18 months for the construction of labour camps, and for storage of construction materials and machinery. Permanent land acquisition is required for clearing the RoW for the TL.

205. Special care was taken when surveying the transmission line route to avoid settlements, private land, wetland, monuments, common property resources and public utilities. Of the 61 transmission towers to be constructed, 55 towers fall on government land and 6 towers fall on private land. 60 decimal of land will have to be acquired from 6 displaced households that will lose 10 decimal of land each towards the footprint of the 132 kV transmission towers. **Table 6.2** gives the details of land acquisition. Thus, the permanent land requirement is only 0.6 acres all of which falls in dryland (Kamzhing). **Table 6.3** gives the temporary land requirement.

Table 6.2: Details of project land acquisition

No.	Name of owner	Village	Thram No.	Land required	Land type	Dryland	Wetland	Total Land	% of total land
1	Phurpamo	Yurmung	284	0.1	dryland	3.4	2.462	5.862	1.7
2	Lemo	Yurmung	274	0.1	dryland	3	0	3	3.33
3	Tshering Mo	Refe	361	0.1	dryland	2	1.642	3.641	2.75
4	Tshering Dema	Refe	52	0.1	dryland	3	3	6	1.67
5	Sangay Wangdi	Refe	357	0.1	dryland	3.65	1.95	5.6	1.78
6	Tashi Wangmo	Kinga Rabten	372	0.1	dryland	2.13	2	4.13	2.42

206. The project does not displace any private fruit trees, standing crops, structures (homesteads/house or living quarters, other physical structure, commercial or industrial structure, business establishments, and rented or occupied commercial premises) religious,

community or cultural sites, or any common property resources. The only asset that is displaced by the project is land. Also, no indigenous people are displaced by the project.

207. As is indicated in **Table 6.2**, none of the households will lose more than 4% of their total land holding to the project so there will be no impact on incomes arising from land acquisition. The private land to be acquired is either barren or fallow land with no crops being grown on them so there will be no impacts on fruit trees or standing crops.

208. Given that the total amount of land required is minimal and that there are provisions in the Law for providing compensation, the impact of permanent project land acquisition are deemed to be acceptable. The direct impact of project land acquisition (temporary and permanent) requires compensation for loss of land (permanent) and loss of access to land. Compensation (as already worked out) will prevent any additional vulnerabilities for the affected households.

Table 6.3: Temporary land requirement

No.	Description	Area, acres	Remarks
1	Storage Sites	1.8	
2	Workers camps	0.8	5 sites
3	Material stocking yard	0.8	
4	Site office	0.2	
	Total area required	3.6	

209. Temporary land is required from the Dzongkhag for setting up Contractor facility establishment, storage site and worker camps. This only amounts to 3.6 acres and will not be acquired but shall be taken on lease from the private land owners. It is expected that the Contractor Facility and storage sites will be selected at the last point along the Highway or access road (closest site to the TL alignment) to reduce transportation costs. The 230 workers during the peak construction shall be distributed in 5 gangs and their camps will be selected and scattered along the TL in the Government Reserved Forest.

210. Given the fact that both types of project land acquisition are less than 1% of the map area, and that temporary land acquisition will actually result in rehabilitated and re-vegetated, the net impacts of temporary and permanent project land acquisition are deemed to be acceptable.

6.3.2 Employment Opportunities

211. The positive impact of the project is that it will create opportunities for employment and supplier business, for the duration of the project construction through increase in demand for vegetables, milk products and meat. In addition, the project will be able to provide job

opportunities to the locality. The skilled labourers shall be hired from outside the locality or from India but the unskilled labour shall be given priority to the local people and the affected people, in particular. Job opportunities include clearing the RoW, transportation of materials, involvement in compensatory forestation programs and land management programs. The main requirement of local labourers shall be for headloading of materials.

6.3.3 Mobilization of Construction Equipment and Materials

212. Surveys in July 2012 indicated that in the Thimphu-Trashigang National Highway, the average number of vehicles passing is about 100 vehicles/day, which have already increased due to the construction of MHEP. For the construction of the TL, only few trucks shall be required to transport construction materials mainly the transmission tower parts. However, the trucks shall be hired as and when required only. For transportation at the site from the road points, headloading shall be done eliminating the need of any vehicle.

213. Thus, the impacts of mobilization of construction equipment are marginal since large numbers of heavy vehicles and machines shall not be deployed compared to MHEP.

6.3.3.1 Influx of Project Staff and Contract workers

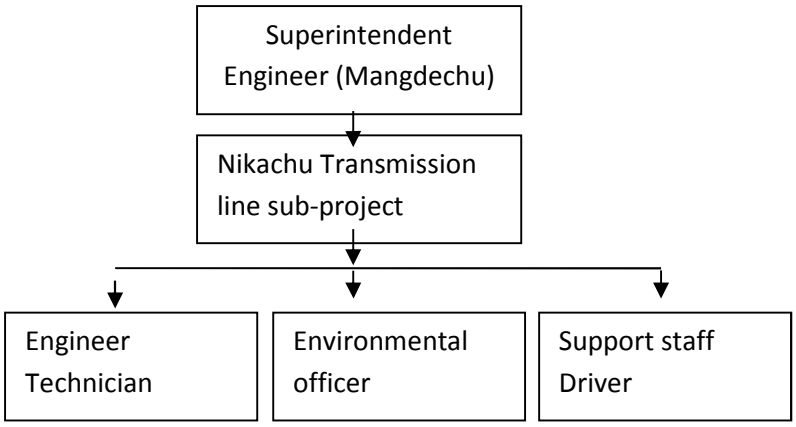
214. It is estimated that 14 staff will be hired/deputed during the pre-construction and construction stage excluding security (see **Table 6.4**). This does not include Contractors and their regular staff plus migrant workers.

Table 6.4: Staffing requirements by BPC for the Project

No.	Description	No.
1	Project Manager	1
2	Assistant Engineer/Junior staff	3
3	Accountant/ Store In-charge/ Supervisor/ Foreman/Office Assistant/Driver (Type-II)	7
4	Temporary/casual staff	2
5	Environmental Monitoring Officer	1
Total		**14**

215. The Project office will be headed by the Superintending Engineer (SE) or Senior Project Manager (SPM) who is currently responsible for the Mangdechu Transmission Component. He will be assisted by an Assistant Engineer, Environmental Officer and other Administrative and Support Staff (see **Figure 6.1**).

Figure 6.1: Organogram of the Project Management Unit



216. Since these staff are already currently at site working for the MHEP transmission line component, there will be no requirement for construction of project infrastructure, office or stores.

217. Contract workers under an individual contractor will come in two phases; during the pre-construction phase to undertake the land clearing and preparation (relatively small numbers) and during the peak construction phase, for all project components, when numbers may rise to about 230. For works which require skills such as foundation work, tower erection and stringing, skilled labourers shall be hired from outside the locality or even the foreign labourers. But for those works such as benching, headloading and clearing, local people shall be hired. This shall not only minimize the influx of foreign labourers but also provide job opportunities to the affected people.

218. With the likelihood to influx foreign workers, the main concerns include:

(i) Possible social instability (poor mingling of workers from outside the district, or from outside Bhutan, with local communities, although Bhutanese have increasing experience with worker influxes and seem to handle them with equanimity);
(ii) Increased pressure on housing, infrastructure, and services;
(iii) Risk of communicable diseases spreading in the local community;
(iv) Waste and sewage entering the local environment;
(v) Health concerns in the camps (communicable diseases, poor air quality), and
(vi) Safety issues at the work sites.

219. The contractor shall be mandated to brief the foreign labourer on the rules and regulations of the country including the code of conduct, forest and nature conservation requirement and even the regulation on occupational health safety and welfare and waste management. Most of the worker camps will be located along the RoW of the TL. There will be five campsites that will be spaced out depending on access and proximity to water sources,

approximately 3.5 km away from each other. The maximum number of workers at each campsite is not expected to exceed 50.

220. Since the number of workers immigrating shall be less, the impact on society will not be significant and with the camps located away from the community and the highway, the chances of workers mingling with the local people is minimum. While the economic impacts may be positive, temporary social impacts must be mitigated through proper planning to reduce the risk of possible social instability, risks of communicable diseases and health concerns.

6.3.3.2 Cultural and religious sites

221. While there are no cultural and religious sites along the RoW, there are a few religious and cultural sites within the Project area. For instance, towards the first quarter of the transmission line, there is a nunnery, the Karma Drupdey Palmo Chokyi Dinkhang below Tower TL28 (see **Photo 6.1**). Other religious sites are the cremation ground and the Lhakhang near TL 32. **Table 6.5** gives the details of the cultural and heritage sites.

Photo 6.1: The Karma Drupdey Palmo Chokyi Dinkhang Nunnery

Table 6.5: Cultural and heritage site details

SITE	Location	GPS (E)	GPS (N)	Site listed with Department of Culture
Cremation ground	TL13	27.44438	90.48647	No
Kuengrabten Nunnery centre	Tl28	27.38964	90.54028	Yes
Lhakhang Jap	TL32	27.41675	90.52747	No

222. During the design stage, extra care was taken to ensure that religious structures/public property was avoided. As can be seen from Photo 6.1, the TL towers are not located adjacent to the Nunnery and will not in any way or manner hinder any religious or cultural practices.

223. The net impacts of the Project on religious and cultural sites is small and transient because firstly, the District and local community place high emphasis on such sites and will not allow any infrastructure to obstruct them. Also, care has been taken during the survey to avoid any proximity to these sites. In addition, the EMP will include mitigation measures to minimize any unanticipated impacts on social and cultural resources and disturbance during festival or religious prayers during construction work.

6.3.4 Environmental Impacts

6.3.4.1 Impacts on air quality

224. With its high forest cover of 87%, low population density and little industry, the air quality of Trongsa is relatively good. Baseline data on PM_{10} in NHPP area was between 20.3 - 24.6 $\mu g/m^3$, only about one-third of the standard for Bhutan (75 $\mu g/m^3$); SO_x and NO_x levels were not detected while analyzing (reflecting the low population density, absence of heavy industry, and low traffic levels).

225. With the current ongoing construction works in MHEP, it is expected that air quality will be impacted due to cumulative impacts of additional machines and vehicles from NHPP. The only source for air pollution from the TL construction shall be the excavation which shall be carried out during benching and foundation work. However, with only about 9mx9m area to be excavated, the amount of dust generated will be minimal.

6.3.4.2 Increase in demand for water resources

226. It is estimated that about 230 workers will be deployed at various locations along the TL during the peak pre construction and construction period. According to the World Health Organization (WHO), 50 to 100 liters of water per person per day are needed to ensure that most basic needs are met and few health concerns arise. Assuming usage of 50 litres of water

per day for each worker (as communal kitchens and pit latrines are expected to be used), the total water requirement during peak construction period is 12,500 liters per day. **Table 6.6** presents the water requirements.

Table 6.6: Total quantity of water required for domestic and construction purposes

No.	Purpose	No of staff/workers	Water Requirement (liters per day)	Total water required (in liters per day)
1	Project staff requirement	14	50	700
2	Contractor facility and workers	230	50	11500
3	Construction works		300	300
	Total water required			**12,500**

227. While the water in the labour camps shall be required throughout the peak construction, for construction work water shall be used only for concreting. About 300 litres/day of water shall be used in concrete works. However, concreting shall be done only for laying foundation for the tower.

228. About 50 liters of water will be also required for sprinkling on to the area of excavation to suppress dust. However, this shall be required only during the excavation at tower foot. All water requirements will need to be met from nearby streams, which have been identified in the EMP.

229. The net impacts of the Project activities on water resources is small and transient because the only use of water for construction of the TL is to serve for domestic purposes and several stream runs through the project area from Tashidingkha to Yurmo. Water use has been calculated for the peak period and could be considerably lower than the estimated quantity depending on number of workers at each site.

6.3.4.3 Risk of poaching by workers

230. With increasing intrusion of workers in remote locations, the risk of poaching is quite real, especially since the project site is far from town (> 50 km), and meat is not readily available in the rural areas. Also, these areas are not frequented by Forestry Personnel so monitoring may not be quite as often.

231. The net impacts from poaching, although transient, can become significant if these risks associated with a worker influx are not addressed at the beginning of the Project with good planning and suitable awareness measures along with monitoring of project sites by Forestry Personnel.

6.4 Impacts during construction phase

6.4.1 Economic Impacts

232. The project will create opportunities for employment and supplier business, for the duration of the project construction. These will be through increase in income generating sources. The project will bring positive benefit if the Project and Contractors give first priority when employing the displaced persons in work such as forest clearance along the RoW, road repair and maintenance, water supply work, afforestation, planting of seeds, nursery work, fencing, construction of retaining walls etc. These do not require much expertise and can easily be taken up by locals.

233. Another source of income may be through increase in sales of fresh vegetables, dairy products and food to workers and travellers through roadside stalls or small outlets/shops near worker camps.

6.4.2 Social Impacts

6.4.2.1 Impacts from Influx of more workers

234. The social impacts described in the pre-construction phase will continue into the Construction Phase with more workers, increased number of work locations, more frequent transportation of construction materials as additional workers are brought in to complete the work, the risk of social conflicts, risks of spread of communicable diseases, health and safety risks, waste generation and sewage and increased pressure on resources, are all expected to increase.

6.4.2.2 Mobilization of more construction equipment and vehicles

235. No heavy vehicles shall be deployed regularly for the project construction. Transporation shall be done as and when required, because the quantity of materials required are limited to basic tower structure materials like steel lattice, insulators, conductors and accessories, the impact on the society is not forseen. Moreover, transportation of materials to work site shall be done through manual headloading, the impact become even lesser and benefits greater with employment opportunities.

236. Also, construction materials such as aggregates, cement and sand are only required for 61 tower foundations. The delivery of all materials can be completed by early part of the construction phase. Since no new road construction is required, there will be no disturbance to wildlife and the local communites residing along the National Highway and access roads for MHEP.

6.4.2.3 Potential damage to the highway due to heavy equipment and truck traffic

237. From an average of 100 vehicles a day on the Thimphu-Trashigang, the NHPP and the TL component is expected to add another 150 vehicles to the traffic load. This will increase traffic density from the current 8 vehicles per hour to about 20 vehicles/hour (at times), or one vehicle every 3 minutes, in the worst scenario. This may lead to some confusion about rights of way, and will certainly increase the risk of accidents and will delay the traffic flow, making local

journeys longer. The heavy equipment may also stress the load factor of the current highway (some equipment may be 16 tonnes). Currently, the existing highway between Trongsa towards Zhemgang is already damaged due to the heavy traffic from MHEP. There are sections of the highway where dust generation is a problem already.

238. The additional burden of vehicles is expected to excarbate the existing situation and further damage the highway. With no requirement for regular transportation, the extent of damage to highway solely due to the construction of the TL shall be marginal. However, the repair and maintenance of the Highway is under the scope of NHPP.

6.4.2.4 Noise, dust and access issues during vegetation clearing

239. Clearing of vegetation for the RoW is expected to generate noise, dust, and sometimes impeded access for workers or wildlife. The impact from this, however, is small as it is localized and limited to the area along the RoW. The impacts from vegetation clearing activities can also be reduced through mitigative measures.

6.4.2.5 Loss of visual aesthetics

240. Visual impacts are generally considered significant where they affect large numbers of people and tourists. The main negative impact on visual aesthetics in the project area will occur during construction, as a result of clearing, site work, and heavy equipment and vehicles on the road. Specifically to this TL, the visual impacts are not expected to be significant because the TL is aligned parallel along an already existing 66 kV transmission line from Trongsa to Yurmo. The forest itself provides a good natural screen to hide the TL from the highway.

6.4.2.6 Occupational health and safety

241. The main health and safety risks are associated with construction activities, and the risks are faced by workers. Clearance of the RoW is an activity in which there is a significant element of danger, particularly to workers, but also to inhabitants of villages. Workers also face other health risks and concerns in the camps (e.g., communicable diseases, poor air quality). The major issue shall be safety when working on foundation tower or felling of trees to clear the RoW both for workers as well as local community using the area and even during stringing. Working at height should have proper occupational and health safty (OHS) measures.

242. These impacts are not significant as long as they can be mitigated through proper OHS. If the Contractor is made to follow and OHS Plan, these impacts will be removed once the construction phase is completed.

6.4.3 Environmental Impacts

6.4.3.1 Loss of forest cover and habitat for wildlife

243. The biggest impact of the TL is the loss of forest cover and destruction of habitat for wildlife (see **Table 6.7**). For 132 kV transmission line only 6.1 m ground clearance is required from the lowest conductor. The shrubs over 3 m can be allowed to grow. With about 3.6 km shrub forest, the total amount of forest to be cleared is 100 acres or 0.4 km^2 (27x15 km) within

the project area.This amounts to 0.03% of the total forest land in the dzongkhag (total forest cover in Trongsa is 1,588 km^2.

Table 6.7: Area of land use along transmission line ROW

Facility	Wetland	Dryland	Mixed Broadleaf forest	Coniferous forest	Scrubland	Orchards	Exposed rock	Total
Transmission line length (km)		0	15 km	0	3.6	0	0	18.6 km
Actual corridor to be cleared			0.045 km^2		0.0972 km^2			0.50 km^2

244. Despite the size of the forest area requiring clearance, the net impacts on forest cover is not considered significant for the following reasons:

(i) The proposed TL will be aligned parallel to the existing 66 kV transmission line from Trongsa to Yurmo so the actual area that will be cleared is less than 123 acres, especially where the TL runs through scrubforest and agricultural land.
(ii) Along this alignment, the RoW has already been cleared for the 66 kV line and forest cover along most of the alignment is sparse with low tree density and scanty shrub and scrub forest.
(iii) Where the TL spans gullies and valleys, it is not necessary to clear the 27 m RoW but rather clearing a smaller RoW of 4 m is practiced by BPC (to allow for operation and maintenance works).
(iv) The project site is not unique in terms of biodiversity or located in a protected area. The closest Park is the Jigme Singye Wangchuck National Park located over 50 km away.

245. As with other project areas where trees will be cut, the potential loss of bird and wildlife habitats can be countered by habitat enhancement in areas adjacent to the RoW, and replanting twice the size of the area cleared through Compensatory Afforestation where suitable local trees are planted in currently degraded areas.

246. The removal of trees and other vegetation along the RoW of the TL will also have ecological impacts as it will destroy forest habitat and displace species that are living in these areas. This could affect large and small mammals, birds, reptiles, amphibians, insects and other invertebrates. Some inhabitants will simply move away to other areas, but some could be damaged or killed during the clearing process. The biodiversity survey along the TL line indicates that a high level of disturbance already exists in the area, from grazing, lopping of trees, fodder leaf collection by local communities in the area.

247. At the same time, there is also a high diversity of birds in the area. Like many other hornbills (e.g., Rufous-necked) depend greatly on mature, large trees for feeding and nesting, as well as large expanses of forest. Little is known about the population trend of Yellow-rumped Honeyguide (*Indicator xanthonotus*), considered Near Threatened, but declines have been suspected to be occurring due to habitat loss, degradation and human exploitation of Giant Honey Bee (*Apis dorsata*) colonies with which it has very strong association. The Satyr Tragopan (*Tragopan satyra*) is considered the least threatened of all Tragopan species, but it is still classified as Near Threated because of hunting pressure over most of its range and habitat loss from logging (Birdlife International, 2014). Birds are good indicators of the health of forests.

248. While clearing of forest areas can have huge consequences on the species' abundance (wildlife, birds, insects) and these pressures may be further exacerbated by hunting/poaching by outsiders, the forest cover along the alignment is quite scanty and tree density is not very high (the highest tree density was 14 per 100m^2). Thus, using this higher value of tree density, the total number of adult trees that will be felled along the 18.6km TL is 7,030 trees.

249. The net impacts of the Project on forest cover may be low but ecological impacts are more significant. Mitigation measures must compensate not only for loss of trees (and forest cover) but also include measures to collect more information and conduct research on the rarer and near threatened species so that specific conservation measures can be implemented.

6.4.3.2 Impacts on air quality

250. Normally with its high forest cover of 87%, low population density and little industry, the air quality of Trongsa is relatively good. Baseline data on Particulate matter (PM_{10}) in the Nikachhu project area was between 20.3 - 24.6 µg/m^3, only about one-third of the standard for Bhutan (75 µg/m^3) while SO_x and NO_x were not detected while analyzing (reflecting the low population density, absence of heavy industry, and low traffic levels).

251. One of the complaints of the households from the ongoing construction of MHEP was dust pollution. It is expected that air quality will be impacted due to cumulative impacts of additional machines and vehicles from NHPP. Other sources of air contaminants during construction of TL will be from the fugitive dust emission during benching of ground level at the tower foot.

252. The net impact of the Project on air quality is not significant and temporary, and will be limited to Construction Period.

6.4.3.3 Risk of poaching by workers

253. With increasing intrusion of workers in remote locations, the risk of poaching is quite real, especially since the project site is far from town (> 50 km), and meat is not readily available in the rural areas. Also, these areas are not frequented by Forestry Personnel so monitoring may not be quite as often. The risk of poaching by workers is high but temporary and preventable through appropriate mitigative measures.

6.4.3.4 Impacts from excavation works and muck disposal

254. About 12,810 m^3 shall be generated from excavation works of 61 towers along the 18.6 km stretch. The volume of excavated material is at dispersed locations and is considered low. About 50% of the excavated material from the pits will be reused to fill the foundations of the tower footing to stabilize it. The concerns here include the slope stability and proper containment and stockpiling of excavated materials to prevent interference with drainage paths and to minimize the risk of sediment entry to local creeks and the river. The net impact of the excavation and muck generation is small and temporary due to the following:

(i) Not all tower sites are located on steep slopes or near streams, so excavation is not expected to cause large quantities of silt/soil to be washed into the river or streams during rain;
(ii) Tower sites are dispersed and spaced at least 300 m away from each other and will generate only 186 m^3 of muck per site.

255. The excavation and muck generation is small, site specific and temporary in nature.

6.4.3.5 Risk of slope instability

256. The concern for slope stability only arises for excavation work carried out at localized tower sites. The design and planning of the TL requires detailed investigation of the geology (geotechnical hazards and soil of each tower footing site to ensure that there are no risks associated with stability of tower foundations.

257. The aim of the site reconnaissance survey was to identify potential site conditions at the support sites. The survey report indicates that there are no geological disturbances at all segments of the TL alignment. Marshy area has been noted at TL 9 for would require mitigation measures to ensure the stability of foundation.

258. The net impact from slope stability is small because this forms an important component of the design and planning process for each tower foundation site based on a good understanding of the known ground condition.

6.4.3.6 Impacts on community forest

259. Some parts of the TL route traverse Taktse and Samcholing Community Forest (CF), thus mitigation measures will be needed to ensure that no loss will be incurred to the community. To minimize impacts on community forestry, the project will consider the following: a) provide funds for compensatory plantation so that the locals can undertake this work themselves; and, b) provide incentives for improvement of the existing community and for forest management group. Incentives could include provision of equipment, water supply, fencing, nursery development or in-country tours to other community forests.

6.4.3.7 Impact on surface waters

260. The impact on surface water is directly linked to slope instability and therefore impacts on surface water will also be negligible if towers are located at a safe distance of at least 30 m away from surface water sources. Other impacts on surface water will arise from improper waste disposal and sewerage from the workers camps, improper sourcing of water, washing dishes and clothes or bathing along streams.

261. Like the risk of slope stability, the net impact on water quality will be small provided mitigation measures restricts the distance of towers and workers camps away from the rivers and streams, and prohibit and enforce measures to minimize pollution of surface water.

6.4.3.8 Impacts from improper storage of fuel

262. Since the material requirements for this project need to be supplied prior to construction period (to allow tower foundation, erection and stringing works to commence), there is no need for large quantities of fuel as material drop off is limited to this period alone. Thus, there are no risks of improper storage of fuel and spillage resulting in contamination of groundwater and surface water. Vehicles can get the required fuel from the local depot at Trongsa and no fuel is required for the construction work itself.

6.4.3.9 Impacts from improper closure of project work sites

263. To ensure that project components will not pose future threat to human health or to the environment, Contractor(s) will be required to ensure proper closure of pre-construction and construction project activities such as worker camps and storage sites along the TL.

6.5 Impacts during Operation Phase

6.5.1 Economic Impacts: Decrease in income opportunities

264. The routine maintenance of the RoW will not have economic impacts as it will not affect agricultural areas or farm roads used by locals for transporting produce. If a line failure requires the repositioning of towers, it should not be necessary to purchase land for the new foundations, as the new foundations maybe dug close to the old ones, involving the same land owners so exchange of land can be possible and the previously used area can be returned. At the local level though, once the major construction works are completed, and as Contractors and migrant workers leave, there will be a huge decrease in demand for agricultural products such as vegetables, dairy products etc.

265. At the national level, the evacuation of power from NHPP will have significant positive economic impacts in terms of increasing its income generation from the sale of power to India.

6.5.2 Social Impacts

6.5.2.1 Reduced pressure for local resources

266. During the operation phase, no negative social impacts are anticipated. Instead, the local district authorities will benefit positively due to reduced pressure on health, water,

resources such as LPG, kerosene, diesel and fuelwood, as well as reduced incidences of poaching, and anti-social activities.

6.5.2.2 Risk of electrocution and accidents during maintenance works

267. As the proposed transmission line carrying 132 kV runs over an area where people bring their cattles for grazing, the project has to pay special attention to the safety of people during maintenance works. Those working under the power lines are directly or indirectly exposed to potential safety risks.

268. During maintenance works, people should take precautionary measures to protect themselves keeping the maximum distance over 15-17 feet between themselves/objects in their hands or physical contact and the power line.

269. The main hazard to people from the operation and maintenance of the completed TL system is the risk of electrocution. Electrical injuries consist of four main types: electrocution (fatal), electric shock, burns, and falls caused as a result of contact with electrical energy. All workers are exposed during the performance of their duties such as repairing towers, transmission lines and its associated components. Locals can also be at risk especially as they are unaware of the risks and potential hazards which make them vulnerable to the danger of electrocution. Impacts during the operation and maintenance phase will be reduced through the implementation of BPCL's Operation and Maintenance Procedures wherein all Lines are shut down prior to conducting maintenance work. This risk is further reduced by adherence to the Occupational Health and Safety Guidelines issued by BPC for the O& M of all transmission lines in the country.

6.5.2.3 Electromagnetic Field (EMF)

270. There has been much research on the health and environmental impacts of EMF since the 1970s, but most research and laboratory studies have failed to show strong associations between exposure to EMF and health effects. A number of scientific panels convened by national and international health agencies and the U.S. Congress reviewed the research and concluded that there was insufficient evidence to prove the same. However, they also concluded that there is insufficient evidence to prove that EMF exposure is safe (Minnesota State Interagency Working group, 2002).

6.5.2.4 Risk and hazards associated with TL

271. The transmission line runs parallel to the existing 66 kV line that has been in operation for over 7 years. Till date there have been no recorded incidents of any landslides or earthquakes damaging the existing 66 kV line. The impacts from disaster and hazards to the transmission line cannot be predicted, thus, all the associated structures will be designed and constructed to withstand the impacts of catastrophes.

6.5.3 Environmental Impacts

272. Operations and maintenance of the RoW will not incur major ecological impacts as there will no new towers to be erected. Maintenance works will be very small in scale and infrequent, and involves few changes to the existing situation. The practice of allowing some re-growth of vegetation along the RoW will also have ecological benefits as it will allow plants and animals to re-colonise. Because the forest canopy is now open in these areas the species will be different from those that were originally present, which may be seen as a further gain as this will increase the diversity of habitats.

6.5.4 Electrocution of raptors and other large birds

273. The risk of electrocution of large birds by transmission line is real as they provide a structure for birds from which they can hunt and roost. This is more so in places where there are few natural perches for the birds to use. Electrocution occurs when a bird comes in contact with two wires or when it perches on a conductive pylon and comes into simultaneous contact with a wire. Collisions may also occur if the transmission lines are difficult to see. While there has been no documented evidence in Bhutan that existing transmission lines have caused electrocution of large birds, this risk needs to be considered. The impact of electrocution of birds depends on the electrotechnical design of a pylon and the natural features surrounding it. The net impact of electrocution of large birds is not considered significant because (a) there has been no documented evidence of large bird kills from the existing 66 kv TL line in the same project area; (b) the existing design incorporates construction of cage boxes for conductors to prevent birds from sitting or making nests; and (c) other mitigative measures are proposed to lessen any unforeseen or impacts

7 Environmental Mitigation and Management Plan

274. This chapter discusses the mitigation and management plan for the impacts associated with the transmission line and the required management plans. Specific details associated with each proposed mitigation measure, including the institutional and financial requirements to ensure proper implementation, accountability and monitoring is also detailed out. The identification of impacts covers both the immediate project area as well as adjoining areas within 5 km in the immediate vicinity of the Project.

7.1 Management plan for loss of private land and livelihood

275. Since all designated forest is owned by the state there is no need to purchase land for the TL where it runs through the forest. The project will not affect any infrastructure or private homes but 6 towers will have to be built on private land. The displaced households that will lose 10 decimal of land each to accommodate 1 transmission tower are from Drakten gewog (4 households) and Langthel gewog (2 households). Thus, the total project land requirement is only 0.6 acres all of which falls in Dryland (Kamzhing) (see **Table 6.2**).

276. Land compensation is guided by the "Land Compensation Rates (2009)" and the Land Act of Bhutan (2007). The compensation rates also apply for compensating structures and fruit trees. There are three classes of land under the rural category, based on distance from the municipal boundary. As the Project falls within Class C of rural land, the compensation rate per decimal (= 40.47 m^2) is Nu 2,262.54, which means one acre will cost Nu 226,254. Chapter 7 of the Land Act 2007, specifically pertains to land that will be acquired by the Government for wider public interest. It states:

(i) acquisition shall entail fair compensation;
(ii) The compensation can be in cash or land or a combination of both (the land owner shall have the discretion to opt for one or the other);
(iii) All the compensation process should be completed before the actual start of the project on the ground;
(iv) If land is provided as compensation, the certificate for new land shall be made available so that the affected people do not encounter any problems in the future. The project shall ensure that no tower construction will take place until the compensation process is completed and the affected are fully compensated.

277. If affected households are not satisfied with the proposed compensation, thier grievances shall be redressed through so called the "Grievance Redressal Mechanism" to the Grievance Redressal Committee constituted under Tangsibji Hydro Energy (THyE) for NHPP.

278. Due to the type of land being acquired as well as the extent of land acquisition, no significant impacts on the income of the displaced households is anticipated as a result of the acquisition. There may be minor impacts on incomes arising from land acquisition because the

6 households losing land to the transmission line towers will face some restrictions on their land use owing to the transmission tower footing on their land and the overhead transmission line that will pass through their land. Due to this they will not be able to make optimal use of their land. To compensate them for the restriction of land use, an entitlement of 20 percent of the total cost of the impacted land will be paid (at PAVA's rates) as compensation for causing restricted land use. The total compensation to be paid under this entitlement amounts to Nu. 27,150.48. The 6 displaced households will receive Nu. 4,525.08 each as an additional 20 percent of the cost of their displaced land. These 6 households will lose 10 decimals of land each to the 6 transmission line towers footing.

279. Land that shall be used temporarily for storage of materials, construction of labour camps only totals 3.6 acres. These, the labour camp particularly, shall be located on GRF land at five different places. The stores shall be located near the highway. Private land shall be taken up for storage of materials on lease depending on the interest of the people.

280. In the case of temporary land leased for the project (18 months at most), the project requires that on completion of all construction work, all temporary land utilized will be rehabilitated, re-vegetated and in turn become possibly more useful land for local communities.

- Revenue sharing arrangements wherein a) 12 – 15 percent of royalty revenue generated from the export of power from NHPP will be used to provide free electricity (of 100 units per month) to rural households by the RGoB; b) the RGoB will provide free electricity of 10,000 kWh per annum for every acre of land (or prorated thereof) acquired for the project from the Royalty Energy after the project comes into commercial operation till the end of the initial Concession Agreement (CA). The land owner may either avail free electricity or cash in lieu thereof at the export rates from the project. This benefit will continue beyond the concession period.

7.2 Employment opportunities

281. The project will be able to provide job opportunities to the local people. Since, the construction of TL shall not construct access roads, transportation of construction materials from the nearest road point shall be done through manual headloading. This shall require several workers and the preference shall be given to those affected by the project. Further, the affected people shall also be provided employment in construction work depending on their skills and qualification. Job opportunities include working for Contractors, for clearing the RoW, transportation of materials, involvement in compensatory forestation programs and land management work initiated by the project.

282. The project will also bring in new opportunities to sell locally grown vegetables, milk products and meat. Renting of living quarters and office space to project contractors and their employees, leasing of vehicles and equipment to the project contractors, or leasing of private land to project contractors are some other ways for locals to earn increased incomes.

7.3 Management of impacts from mobilization of equipment, construction materials and their storage

283. Construction materials include aggregate, sand, cement and steel lattice structures for tower. These materials requirement are not huge for only 61 towers. Therefore, the materials shall be transported through trucks hired as and when required. No heavy vehicles or machines shall be deployed regularly for the construction of the TL. These materials shall be stored near the nearest road point and shall be headloaded at the actual site during the construction, at least 15 days ahead of the activity. The material shifting will be in accordance to the progress of the activity to avoid congetion of space at the site. Since, there is no requirement of huge number of vehicles and machines, the impact on the existing highways is not significant. Moreover, repair and maintenance of the National-Highway shall be undertaken as a part of overall Nikachhu Hydropower Project.

7.4 Management of Social Impacts

284. The project may cause a conglomeration of internal and external labour in the project sites. Workers may come from either the same locality or from other areas. There would be workercamps established. The impacts from these would increase opportunities for employment for the local people which is a positive move but on the negative side the accumulation of waste both liquid and solid, intrusion to the village life etc. should be managed. Waste disposal should be properly organized so that there would not be any littering and pollution of nearby water bodies. All the construction sites, stores of materials, temporary and permanent building, utensils used for cooking etc. should be carefully maintained. All the disposals should be properly supervised.

7.5 Management of workers/worker camps

285. The impacts due to influx of workers will begin from the pre-construction phase and will continue at an expanded scale in the construction phase. This means more workers at each work location, and more frequent movement of construction materials and equipment. Proper planning and experience in the pre-construction phase will set the stage for effective planning and mitigation measures in the construction phase. The main concerns with an influx of workers include:

(i) Risk of communicable diseases spreading in the local community;
(ii) Waste and sewage entering the local environment;
(iii) Safety issues at the work sites.
(iv) Possible social instability;
(v) Health concerns in the camps (communicable diseases, poor air quality).

a) Risk of communicable diseases spreading in the local community

286. To avoid or at least to minimize the spread of communicable diseases to the local community, the following management measures shall be taken up:

(i) **Screening and regular unannounced checking of workers.** As per the procedure for hiring foreign workers, all contractors and labour agencies are required to make all prospective workers undergo medical tests to screen for diseases and sicknesses, prior to selection and employment of any foreign worker. The contractor is also responsible for ensuring that no foreign worker who has a criminal record is employed at the project site. It will be ensured that all workers undergo medical tests to screen diseases at source and at sites in consultation with the Trongsa hospital Dzongkhag Health Officer.
(ii) **Checking of workers**. In addition to this, the Project Management will also undertake sudden, unannounced checks on workers to look for diseases such as HIV, STDs, and hepatitis. This is being suggested because surprise checks in projects like Mangdechhu have resulted in workers being detected as positive for HIV and STD. If such cases are detected, the contractor will be required to immediately release the worker from the site (as this indicates that proper screening was not conducted).

b) Increased pressure on housing, infrastructure, and services

1. Ensure Minimal Land clearing and Removal of Vegetation for housing

287. The project will ensure that wherever possible no land conversion will be required for additional housing. This can be done through worker camp selection in already degraded/semi cleared forests in discussion with the Dzongkhag authorities.

2. Housing and sanitation for workers

288. The main mitigation approach is proper siting and design of the temporary worker camps, and to get these built quickly (accommodating at least 50 workers at a site). The relative isolation of the worker camps (quite far away from local communities) will help to minimize an overloading of worker-local community interactions, which should help reduce social and cultural conflicts, as well as the risk of spread of communicable diseases.

289. Prior to beginning the construction works, the general layout of the labour camps at each construction site should be designed to plan for location of important structures like:

(i) drinking water storage tanks or taps
(ii) communal kitchens
(iii) Pit latrines and soak-aways (as far away from watercourses as possible),
(iv) proper site drainage
(v) a solid waste storage area (for onward transfer to the local landfill).

290. The use of communal kitchen and communal toilets will help to reduce both the demand for fuel, water and minimize pollution and allow centralized waste and wastewater management.

3. Provision of Drinking water

291. It is estimated that about 230 workers will be deployed at various locations along the Transmission line during the peak pre construction and construction period. According to the World Health Organization (WHO), 50 to 100 liters of water per person per day are needed to ensure that most basic needs are met and few health concerns arise. Assuming usage of 50 litres of water per day for each worker (as communal kitchens and pit latrines are expected to be used), the total water requirement during peak construction period is 12,500 liters per day (see **Table 6.6**).

292. While the water in the labour camps shall be required throughout the peak construction, for construction work water shall be used only for concreting. About 300 litres/day of water shall be used in concrete works. However, concreting shall be done only for laying foundation for the tower.

293. About 50 liters of water will also be required for sprinking on to the area of excavation to suppress dust However; this shall be required only during the excavation at tower foot. All water requirements will need to be met from nearby streams, which have been identified in the EMP.

Mitigation Measure

294. Drinking water will be sourced and provided for each worker camp as shown in **Table 7.1**.

Table 7.1: Streams near the Project site and their availability

No.	Stream	Min. Discharge (cumec)	Min. Discharge (litre/sec)	Min. Discharge (litre/day)	Requirement	Percentage to be drawn
1	Dzongkha Lumpa	1	1,000	86,400,000	3,000	0.003%
2	Sesaychen Chu Stream between Dzongkhag Lumpa and DOR camp at Trasidingkha-Sesechen stream	0.011	11	950,400	2,300	0.242%
3	Yusagang Chu	1	1,000	86,400,000	2,300	0.003%
4	Nikhachu Stream	0.025	25	2,160,000	2,300	0.106%
5	Migthichu Stream	3	3,000	259,200,000	2,300	0.001%

295. The amount of water available in the project area is sufficient to meet the requirement of the project. Although, it is been estimated as above, the actual quantity of use shall be even lesser due to use of communal kitchen and pit latrines. All labour camps shall be located near the streams and water extracted through PVC water pipes. The labourers shall be distributed

into 5 gangs at different locations of towers and shall be provided each with a camp, a communal kitchen and two pit latrines.

Method of Water Extraction

296. The water shall be extracted through Gravity-Fed System. The system works on gravity which allows the water stored in the tank to move down by its own weight inside the pipes and run out from the taps. The water from the nearest stream shall be tapped into the Header Tank/the collection which shall then be passed into a Rapid sand filter and then into storage tank. The main distribution pipe shall be connected to the storage tank through which water shall be distributed into the secondary distribution pipes into labour camps, kitchen and common tap.

4. Waste and sewage entering the local environment

297. The source of the waste will be from the temporary colonies of labour, and construction sites. Waste includes PET bottles, papers, plastics, glass, organics, metal, batteries etc. Improper segregation and dumping of waste will result in negatively impacting the visual aesthetics, pollute nearby streams as well as invite vectors to transmit diseases.

298. As per the Waste Prevention and Management Act 2009, all implementing agencies must ensure that the reduction, reuse, recycling and disposal of non-hazardous waste are addressed in an environmentally sound manner.

299. The project will implement the following waste management:

(i) **Waste Reduction** through promoting the use of electricity instead of firewood wherever possible.
(ii) **Waste Reuse** by promoting the reuse of large plastic containers, jars and bags wherever possible in worker campsites.
(iii) **Waste Recycling** especially organic waste which can be recycled to make compost at a suitable location. Otherwise the organic waste cans also be given to the nearest household to be fed to cattle and pigs.
(iv) **Waste segregation for recycling** Each site (including offices, colonies and worker camps) will be provided with 2 separate bins for degradable and non-biodegradable waste. Only Waste that cannot be reused or recycled will be disposed. This residual solid waste will have to go to a designated landfill site, away from settlements and water sources. The current landfill for Trongsa area is filling up and plans for creating a new landfill in either Langthel or Drakten is underway by the Dzongkhag. A waste collection protocol will be established for each site so that waste does not pile up and cause problems to the environment or workers. The waste from the labour camps and construction sites shall be brought to the nearest road side from where it shall be collected by the Compactor truck of MHEP which collect wastes from the entire gewog. Since, the labour camps shall be located away from the highway; the waste generation shall be less mainly the packaged foods and PET bottles. The solid waste shall be gererated only from the covers of basic grocery items and kitchen waste.

(a) **Site drainage and sewage**. At each campsite, the pit latrines and sewage shall be located at least 30 m from watercourses. The sewage treatment on-site, and proper management of worker camps should minimize the risk of contamination of surface.. Washing of clothes and dishes directly in streams shall be prohibited to prevent pollution in case there are downstream users. At each worker camp two pit latrines shall be provided as required by the Regulation on Occupational Health Safety and Welfare prescribed by Ministry of Labour and Human Settlement.

(b) **Awareness**. The biggest cause of improper waste management is due to lack of awareness on waste and waste management. The Project will conduct awareness meetings and campaigns through posters or talks to make workers aware of the 4R's: Reduce, Reuse and Recycle and Responsibility.

(c) **Site inspections**. Monitoring of waste management at all sites will include visual inspections of the camps and work sites. This will be conducted by the Environmental officers of BPCL.

(v) Safety issues at the work sites

300. Occupational Health and Safety covers all personnel working under the project and will be in line with the General Rules and Regulations on Occupational Health and Safety (OHS) in Construction, Manufacturing and Mining and Service Industries, 2006 (RGOB). Chapter IX of the Labor and Employment Act of Bhutan (2007) clarifies details on the Occupational Health and Safety of workers, which are mandatory in the Construction Industry.

301. The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by: addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces.

a) Nomination of a Health and Safety Focal Person

302. Within each site the Contractor must nominate a Health and Safety Focal Person who will Function as the focal person/representative for all health and safety matters at the workplace, be responsible for maintaining records of all accidents and all health and safety issues at each site, the number of accidents and its cause, actions taken and remedial measures undertaken in case of safety issues. He will be the link between the contractor and all workers and submit grievances of the workers to the contractor and instructions/directives on proper health care and safety from the contractors back to the workers. He will also ensure that

all workers are adequately informed on the requirement to use Personal Protective Equipment and its correct use.

b) Minimizing hazards and risks at the workplace.

303. To ensure safety at all work sites, the following will be carried out:

(i) Installation of signboards and symbols in risky and hazardous areas, to inform workers to be careful;
(ii) Ensuring that materials are all stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse;
(iii) Removing all scrap and waste material from the immediate work area as the work progresses. All excavated earth must be stockpiled at least 2 feet from the pit to avoid material such as loose rocks from falling back into the excavated area and injuring those working inside excavated sites;
(iv) Where scaffolds are required, ensuring that each scaffold or its components shall be capable of supporting its own weight and at least 4 times the maximum intended load applied or transmitted to it. The platform/scaffold plank shall be at least 15 inches (46cm) wide and 1.5 inches thick. The rope should be capable of supporting at least 6 times the maximum intended load applied or transmitted to that rope. Pole scaffolds over 60 feet (5.6m) in height shall be designed by a registered professional engineer and shall be constructed and loaded in accordance with that design;
(v) Use only trained staff to construct, install and repair all electrical equipment to prevent risks of electrical shocks and electrocution;
(vi) Install fire extinguishers and/or other fire-fighting equipment at every work site to prepare for any accidental fire hazards.

c) Provision of Personal Protective Equipment

304. Risks to the health and safety of workers can be prevented by provision of Personal Protective Equipment (PPEs) to all workers (see **Table 7.2**). Personal protective equipment like safety gloves, helmet, mufflers etc. will be provided during the construction period and during the maintenance work. This will be included in the construction cost for each Contractor. Depending on the nature of work and the risks involved, contractors must provide without any cost to the workers, the following protective equipment:

(i) Helmet shall be provided to all workers, or visitors visiting the site, for protection of the head against impact or penetration of falling or flying objects.

(ii) Safety belt shall be provided to workers working at heights (more than 20 ft) such as stringing and conductor installation;

.

(iii) Safety boots shall be provided to all workers for protection of feet from impact or penetration of falling objects on feet;

(iv) Ear protecting devices shall be provided to all workers and will be used during the occurrence of extensive noise.

(v) Eye and face protection equipment shall be provided to all welders to protect against sparks;

(vi) Respiratory protection devices shall be provided to all workers during occurrence of fumes, dusts, or toxic gas/vapor;

(vii) Safety nets shall be provided when workplaces are more than 25 feet (7.5 m) above the ground or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors or safety belts is impractical;

(viii) First aid facilities will be made available with the labor gangs and doctors called in from nearby towns when necessary.

(ix) The safety and emergency procedures manual will be kept. Necessary training regarding the safety aspects of the personnel working at the project site will be provided.

Table 7.2: Specific PPE requirements for each type of work

Type of Work	PPE
Elevated work	Safety helmet, safety belt (height greater than 20 ft), footwear for elevated work.
Handling work safety	Helmet, leather safety shoes, work gloves.
Welding and cutting work	Eye protectors, shield and helmet, protective gloves.
Grinding work	Dust respirator, earplugs, eye protectors.
Work involving handling of chemical substances	Dust respirator, gas mask, chemical-proof gloves. Chemical-proof clothing, air-lined mask, eye protectors.
Wood working	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Blasting	Hard hat, eye and hearing protection.
Concrete and masonry work	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Excavation, heavy equipment, motor graders, and bulldozer operation	Hard hat, safety boots, gloves, hearing protection.
Quarries	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.

d) Record maintenance and remedial action

305. The Project Management will maintain a record of all accidents and injuries that occur at the work site. This work will be delegated by the contractor to the site supervisor and regularly reviewed every quarter by project management. Reports prepared by the contractor shall include information on the place, date and time of the incident, name of persons involved, cause of incident, witnesses present and their statements. Based on such reports, the management can jointly identify any unsafe conditions, acts or procedures and recommend for the contractor to undertake certain mitigative actions to change any unsafe or harmful conditions.

e) Compensation for Injuries and Death

306. Any casualty or injury resulting from occupational activities should be compensated as per the Labor and Employment Act of Bhutan (2007). Where compensation is sought by the injured party, proper procedures for documentation of the case will be followed, including a detailed report on the accident, written reports from witnesses, report of the examining doctor and his/her recommendation for treatment. Each individual contractor will be responsible for ensuring compensation for the respective workers.

(vi) Possible social instability

307. Another concern with an influx of workers includes possible social instability (poor mingling of workers from outside the district, or from outside Bhutan, with local communities, although Bhutanese have increasing experience with worker influxes and seem to handle them with equanimity). There is also the risk of spreading communicable diseases to host communities.

308. Although the number of foreign workers for the TL shall not be huge, the following management measures shall be taken up to eliminate or at least to minimize the impacts of worker influx to social instability:

a) Awareness of the Code of Conduct for workers

309. The Project management will undertake awareness programs through posters, talks, and meetings with the contractors to clarify the rights and responsibilities of the workers regarding interactions with local people (including communicable disease risks, such as HIV/AIDS), work site health and safety, and to make workers aware of procedures to be followed in case of emergencies such as informing the focal health person who in turn will arrange the necessary emergency transportation or treatment.

310. The Contractor will be required to instruct the site supervisor on the code of conduct and ethics for foreign workers. As per the Regulations on working conditions of the Department of Labour, 2012, all foreign workers are required to respect the values, traditions, culture and law of the country and respect all regulations and rules. No worker will be allowed to enter areas restricted for foreigners without specific permits.

7. Management of health concerns in the camps

311. All workers living in temporary camps will also face health concerns in the camps such as risk of communicable diseases and poor air quality. The provision of communal kitchens will ensure that workers do not have to be exposed to emissions from individual kitchen. To address health concerns of workers, the Contractor must institutionalize procedures to deal with emergencies such as sudden illness or accidents.

312. First aid kits must be made available at all times throughout the entire construction period. This is very important, because all work sites are quite far from the nearest Basic Health Unit. In addition to the first aid kits, the following measures should be in place:

(i) Provisions of a vehicle on standby from the Project Office/Contractor, or provisions to hire vehicles during emergencies to take the severely injured/sick workers to the nearest BHU or Trongsa Hospital for immediate medical attention;

(ii) Communication arrangements, such a provision of radios or mobile communication for all work sites, for efficient handling of emergencies, will be made;

(iii) The designated focal health persons' contact number will be posted at the work site for speedy delivery of emergency services. The focal person should know what medical facilities area available at the Trongsa Hospital and the BHU.

7.6 Management of impacts on cultural and religious sites

313. It is expected that there will be no impact on Cultural and Religious sites because during design stage extra care was taken to ensure that religious structures/ public property were avoided. However for extra precaution, efforts should still be made to reduce the level of disruption where possible**.** To achieve this, the BPC shall:

i) Determine the location of all sites that are of local social or cultural importance (temples, shrines, meeting places, etc) and ensure that no towers are located in the vicinity, and no conductors are strung overhead. This has been done during the survey stage;

ii) Consult all affected communities in advance to inform them of the purpose, nature, duration, extent and timing of all work in and around their village, and explain to them the purpose of the Project and its activities along with the workplan and schedule of activities;

iii) Consult the custodians of all social and cultural facilities (monasteries, nunneries) on the proposed alignment and plan the work to avoid sensitive times (such as key dates in the religious calendar, festivals etc);

iv) No towers shall be located near the cultural heritage sites and no transmission line shall be stringed above the structures.

7.7 Air Quality Management

314. The following measures shall be taken up to mitigate the impacts on air quality during construction phase:

(i) The fugitive dust generation at each excavation sites shall be suppressed by sprinkling water periodically.
(ii) Those trucks carrying construction materials shall be covered while transporting. This shall help prevent the dust particles being blown away by the wind;

(iii) Risks to the health and safety of workers can be prevented by provision of PPEs to all workers ;
.
(iv) Leave a covering of grass and/or other naturally occurring low-growing vegetation where possible along the RoW to reduce dust;

(v) Avoid burning waste vegetation and instead leave this material *in situ* after cutting, to rot down gradually, and discourage re-growth whilst it is decomposing;

(vi) An Ambient Air Monitoring Program to monitor Air quality and noise levels will be implemented as part of the overall EMP by the BPC. The purpose of the monitoring program will be to observe air pollution levels and detect sources of air pollution so that remedial measures can be undertaken. The data collected will be compiled every month and, accordingly, if the air quality and noise levels exceed acceptable standards, this could potentially have health impacts, and require remedial planning and management.

- Parameters that will be measured include: total suspended particulate matter, PM_{10}, SO_x, NO_x, CO, and noise levels.

7.8 Management of Noise generation

315. To minimize disturbance to the community and the potential increase in ambient noise levels, the Contractor shall be mandated to meet the noise level standard prescribed by National Environment Commission. The impact of noise level on the community shall not be adverse in the case of Transmission Line construction as the project site is located way away from the villages and settlements. Moreover, the forest belt itself shall serve as a buffer and attenuate the noise level.

316. The only towers located near the Highway are the TL 28 to TL 31. However, at these locations with the vegetation being shrubs, ROW clearing shall not be required and thereby the noise generation is not envisaged.

317. The workers shall be mandated to wear PPE including ear muff during work at site to prevent occupational diseases. Further, the standard noise exposure limt, prescribed by Ministry of Labour and Human Resource (MoLHR), shall be strictly adhered to. The standard permissible limit, with PPE, is given in **Table 7.3**.

Table 7.3: Maximum exposure periods specified by MoLHR

Hour/Day	Sound Level (dB)
8	90
6	92
4	95
3	100
2	102
1.5	105
1	110
0.5	115
0.25	120
No exposure permitted at or above this level	>140

7.9 Management of Aesthetics

318. Visual impacts are generally considered significant where they affect large numbers of people and tourists. The main negative impact on visual aesthetics in the project area will occur during construction, as a result of clearing and site preparation works. This will stop when the project construction is completed. The visual impacts here will not be significant because the TL will be aligned parallel to the already existing 66 kV TL. Also, at some locations, the forest itself will provide a good natural screen to hide the TL from the highway.

319. During construction, dumping of excavated material down the hill may impact the asthetics of the area. Therefore, management of muck shall be carried out appropriately as explained under Muck Panagement Plan..

7.10 Occupational Health and Safety

320. The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by: addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces. The mitigation measures detailed earlier will be followed to minimize hazards and risks at the workplace and ensure the health and safety of workers. The contractor shall be manadated to abide by the Occupational Health and Safety Rules, Regulation on Occupational Health Safety and Welfare, 2012 and Occupational Health and Safety for Construction Industry, prescribed by Ministry of Labour and Human Resource. This requirement shall be incorporated in the Tender Document inorder to assure safe working environment.

321. The contractor shall:

(i) Ensure health and safety of all employees and any person at the workplace;

(ii) Improve working conditionthat are hazardous to health and safety;

(iii) Provide and maintain PPE in good condition and ensure they are used by the employees;
(iv) Provide to the employee the information, instruction and supervision.

322. The First Aid Box shall be available at each work place under the charge of one trained First Aider. As per the regulation on Occupational Health Saftey and Welfare, 2012, there shall be one First Aider for every 50 employees.

7.11 Forest Conservation

323. Inorder the minimize the adverse impacts of clearing the forest cover, Contractors shall be made aware of the exact delineation of the RoW and only those trees marked per directives/delineation of Forestry staff within the RoW shall be cleared. Moreover, the actual ground clearance required for 132kV TL is 6.1 m from the lowest conductor. Therefore, all those trees which do not exceed the clearance shall be left undisturbed.

Compensatory Afforestation

324. The loss of trees will be addressed according to the current guidelines in Bhutan, with compensatory planting of trees in an area that is twice the size of the area cleared, allowing for up to 40% damage or mortality. Therefore, the total area that must be afforested is approximately 200 acres, although the actual deforestation may be far lesser.

325. To undertake Compensatory Afforestation the project shall develop a mutually agreeable proposal or a Memorandum of Understanding (MoU) between the DoFPS and the BPC, covering project activities for financing and execution. The Territorial Divisions, Dzongkhag Forestry Sector and the BPC shall be responsible for planning and implementation of afforestation activities, based on the MOU. The Social Forestry and Extension Division will be the focal agency for all the technical matters, including need-based monitoring and evaluation from the headquarters and reporting of these to the BPC.

326. The project will focus on deforested areas in and around the project site, but it will not be restricted to project areas if enough sites are not available; it will extend to other degraded areas, landslide prone areas, or areas where the muck excavated is disposed and terraced (especially in remote areas where it is not economically feasible to transport muck away from the tower foundation sites).

327. Within the Warm broadleaf forest, the dominant trees are Oaks, especially *Quercus griffithii, Quercus Lamellosa* and *Quercus Lanata*. Other species include *Alnus nepalensis, Docynia indica, Juglans regia, Lyonia ovalifolia, Exbucklandia populnea, Daphne phyllum, Symplocus ramossima, Maesa chisea* and *Daphne bholua*. The middle shrub layer comprises mostly of younger tree species of Quercus, Rhododendrons, Symplocus and other species like

Ardisia macrocarpa, Berberis aristata, Brassaiopsis mitis, Dichroa fibrifuga, Toricella tiliifolia, Dapne bholua,Leucosceptrum, Viburnum cylindricum, Cinnamomum bejolghota, Samraria nepalensis and *Arundinaria*. The ground species include mostly common species like *Artemesia vulgaris, Eupatorium adenophorum, Inula cappa, Rubus ellipticus* and *Urtica parviflora*. There are also climbers like *Hedera nepalensis, Agapetes serpens, Orchids, and ferns like Pteridium aqulinium, Diplazium esculentum, Drynaria* and *Pteris wallichiana.* Grass species include *Poa annua, Anthraxon, Borinda, Cynodon dactylon* and *Cyperus cyperoides.*

328. Moving further onwards towards TL14, the vegetation is not as dense at it passes close to the Mangdechu Dam colony area and the Taktse CommunityForest. Here the oaks are not as dominant but other tree species such as *Castanopsis hystrix, Daphnephyllum, Ex-buklandia populnea, Symplocus ramosissima, Symplocus glomerta, Lyonia ovalifolia, Maesa chisia, Rhododendron arboretum, Toricellia tiliifolia, Prunus cerasoides, Alnus nepalensis* and *Viburnum* are found. The middle lower trees and shrubs comprise of *Viburnum cylindricum, Eurya acuminata, Dichroa fibrifuga, Daphne bholua* and *Berberis aristata*. The ground vegetation is dominated largely by *Eupatorium adenophorum, Anaphalis triplinervis, Ancelia aptera, Cirsium falconeri* and ferns like *Pteridium aquilinium, Diplazium esculentum, Pteris walliciana* and other species like *Smilax, Solanum virginianum* and *Swertia chirata*. Orchids like *Cymbidium, Otochilus lanciliabius, Dendrobium candidium*, and *Coelogyne* are also found.

329. Continuing onwards towards TL25, other trees species such as *Michelia doltsopa, Prunus cerasoides, Persea bootanica, Rhus wallichii,* and Oaks (*Quercus griffithii, Quercus glauca, Quercus semicarpifolia, Quercus lanata*) are observed again with *Sympolocus, Lyonia ovalifolia, Exbucklandia populnea, Maesa chisia* and Rhododendrons. The middles storey is almost the same as before but also including species like *Nellia rubiflora, Lindera pulcherra, Viburnum cylindricum, Edgeworthia gardneri, Ilex aquilinium*, and *Cotoneaster microphyllus*. Additional ground species observed include *Tupistra chinensis, Solanum khasianum, Smilax ovalifolia, Raphidophora, Hemiphragma heterophyllum, Inula cappa, Pilea umbrosa, Potentilla fruticosa, Lycopodium clavatum, Glienchenia gigantean, Vanda cristata* and *Oleandra pistillaris* and *Otochilus* species.

330. Moving towards TL42 as the forest is mostly scrub forest with fewer trees and scantier understory and barren land. Tree species are mostly *Quercus lanata, Quercus semicarpifolia, Quercus griffithii, Alnus nepalensis, Rhus wallichii, Maesa chisia, Lyonia ovalifolia, Castanopsis hystrix, Docynia indica, Symplocus ramosissima, Exbucklandia populnea, Rhododendron* and *Schima wallichii*. The scanty shrub layer comprises mostly of *Artemesia vulgaris, Eupatori adenophorum, Rubus ellipticus, Berberis aristata, Maesa chisia, Leucoceptrum species, Zanthoxylum* and *Indigofera dosua*. Even the ground vegetation is scanty comprising mainly of *Pteridium aquilinium, Eupatorium adenophorum, Osbeckia stellate, small Rhododendrons, Anaphalis triplinervis, Artemesia vulgaris, Rubus ellipticus* and some grass species like *Poa annua* and *Arthraxon* species.

331. From TL40, the TL the main trees species are *Castanopsis hystrix, Lyonia ovalifolia, Quercus lanata, Symplocus ramosissima, Pinus roxburghii* and *Schima wallichii*, *Duabanga*

grandiflora, Alnus nepalensis, Bischofia javanica, Rhus chinensis, Pinus roxburghii, *Ficus roxburghii*, *Ficus semicordata*, and *Quercus lanata* in Langthel and Yurmo

332. Shrubs include *Berberis aristata, Ardisia macrocarpa, Edgeworthia gardneri, Dichroa fibrifuga, Viburnum erubescens, Mahonia nepalensis, Brassaiopsis mitis, Daphne bholua, Viburnum cylindricum, Maesa chisia, Eurya acuminatum, Rhododendron arboreum, Symplocos glomerata, Viburnum cylindricum, Ilex species, Cotoneaster microphylla, Elaeagnus parvifolia, Rubus ellipticus, Eupatorium adenophorum, Zanthoxylum species,. Vaccinium myrtillus, Rhododendron vaccinoides, Indigofera dosua, Aconogonum molle*, *Datura suaveolens, Adhatoda vasica* and Arundinaria species

333. From the above listed species, selection of species for plantation shall be decided by the Social Forestry Division and Local Forestry Office based on the climatic and edaphic conditions of the selected site, ensuring composition of different species (trees and shrub) for successful growth.

- **Methodology for plantation**

334. The compensatory afforestation shall be carried out as an integrated afforestation program which would include soil conservation, fencing, protection, awareness, monitoring and evaluation along with maintenance for at least five years period. A properly planted tree or shrub is more tolerant to adverse condition and requires much less management than the one planted incorrectly. Successful tree growth involves proper planning, proper site preparation, selection of plant species, plantation methodology and plantation maintenance.

335. The best time for plantation would be early spring or autumn during which weather conditions are cool and allow plants to establish roots in the new location.

336. During the monsoon, the sapling shall be exposed to stress from hot weather and extreme rain soon after their plantation when the saplings are in their juvenile stage and during winter extreme cold will stress the seedling. Hand planting shall be adopted for planting saplings. Holes will be dug large enough (not to shallow and not to deep) with the shovel or hoes, for accommodation of root system, will be backfilled by the soil and compost, if required, and watered.

337. The saplings shall be planted as soon as possible after receiving from nursery to avoid reduced survival rate. Should the plantation be done later, the stocks shall be stored in cool, dark places to minimize loss of root moisture.

338. Organic mulching shall be done which helps not only to control weed but also helps retain moisture around the plant and provide nutrient as they decay. However, care shall be taken that the mulches are few centimeters away from the tree trunk to avoid trunk rotting.

339. The saplings shall be fenced using protective tree guard such as 'Performed Weld Mesh Tree Guards' or block plantation with iron barbed wire or others whichever is found suitable to prevent biotic interference.

- **Nursery Development**

340. The need for nursery development is not envisaged since Zhemgang Forest Division under the Department of Forest and Park Services had established a nursery at Tingtibi to cater seedlings to Chamkharchhu HEP, Mangdechhu HEP and NHPP. Seedlings shall be bought from the Nursery directly and plantations done in consultation with Department of Forest and Park Services.

7.12 Biodiversity Conservation

341 It is expected that no significant irreversible change in local biodiversity will occur as a result of the project. No specific unique wildlife habitats will be affected by the project, as the TL will not create any large barriers to wildlife and bird movements. While the transmission line alignment does not pass through any significant wildlife habitat (much of it is barren or common broadleaf forest) and is not expected to cause any net loss of species. Any disruption of wildlife behaviour will be temporary (just during pre-construction and construction), and animals (including birds) will be able to move around or over construction sites. Still there is always the risk that avifauna vulnerable or endangered species may be affected due to reduction in habitat size, disturbance in their daily movements, and will be at risk from poaching (construction workers).

342 The vertical distance between two conductors shall be about 4 m and horizontally it is about 10 m. Further, as the tallest tree underneath the line shall be not more than 4 m, it is very unlikely that the birds or even monkeys could be electrocuted by contacting these lines. As well, the distance to the nearest tree is 13.5 m from the centre on either side, this does not allow animals to jump to the line from nearby trees.

343 However, the following measures aim to minimize project impacts on rare, endangered or threatened species (if any) and for overall habitat management:

a. Ensure Minimal Land clearing and Removal of Vegetation by working closely with the Department of Forest to ensure that that there is no rampant clearing or felling of forest in and around work sites. Also, only those trees identified and marked by the Department of Forest will be felled and removed from the site;

b. Provide funds to the Department of Forest to conduct repeated surveys in the forest areas to determine the distribution and population of Rarer and endangered Bird Species (to be prioritized by Forestry Office), and to conduct ecological studies to determine the precise habitat requirements, feeding, breeding and impacts on species distribution from habitat fragmentation;

c. Seek the assistance of the Zhemgang Forestry Division, Dzongkhag Forestry Officer and other technical institutes like College of Natural Resources or Ugyen Wangchuck Institute for Conservation and Environment (UWICE); National Biodiversity Centre, to conduct Biodiversity surveys in and around the project site and create permanent

Monitoring Plots to look at the trend in Fauna and Avifauna and the change in use of habitat;

d. As much as possible, large trees on the edge of the right-of-way should not be disturbed or damaged, as these are favoured habitat of the rufous-necked hornbill (which is protected). As with other project areas where trees will be cut, the potential loss of bird and wildlife habitats can be countered by planting suitable trees at other locations which are currently degraded (habitat enhancement in those areas). For example, for rufous-necked hornbills, which are largely frugivorous (feeding mainly on berries, drupes of Lauraceae, Meliaceae, Myristicaceae, Annonaceae and Moraceae - figs), this would involve replanting of fig species and well as species like *Ficus roxburghii*, *Ficus hookeri*, and *Ficus altissima*, to compensate for the loss of felled species;

e. Allow the vegetation along the alignment to grow back to at least 2 meters height, which will provide cover for most wildlife that need to move through the right-of-way;

f. Collaborate with Nikachu and Mangdechu Wildlife and biodiversity Conservation Programs

344 The TL is an essential component of NHPP but only the hydropower plant will be financed by ADB. Nonetheless, the conservation activities of NHPP and MHEP will become part of the TL.

- Join as a member of the Biodiversity Management Committee recommended in the Nikachu Project EMP;

- Collaborate in the Rescue and Release Program. Rescue and conserve any botanical species deemed worth conserving and cultivating for scientific and educational purposes in Collaboration with MHEP or NHPP (as per their EMP);

- Collaborate in the Wildlife Conservation program for capturing, treating/rehabilitating, and releasing wild animals found in pain or distress, particularly as a result of human interference and project activities, has been proposed under the Nikachu project to be initiated with the DoFPS. The primary goal will be to treat and rehabilitate the wildlife and release them back to the habitat from which they were collected (or safe adjacent areas). Wherever land clearing may result in encounters with wildlife and birds; all wildlife encounters must also be logged;

- Collaborate on the Biodiversity Conservation and Management Plan for the Nikachhu project that is aimed at conserving and preserving natural ecosystems around the

proposed project, and developing the information database on biodiversity at the project site.

Anti-Poaching Measures

345 The biggest risk with intrusion of workers into new rural forested areas is the risk of poaching. Therefore efforts must be made to prevent this from the beginning of the project.

1. Awareness Raising

346 Awareness-raising will be an important means to mitigate this risk. The Contractor and his workers must be informed on the Forest and Nature Conservation Act, Rules and Regulations and copies of these must be made available to them. Workers must be made aware of the fines and penalties for poaching, as well as the risk of job loss, if caught in these illegal activities.

2. Strengthen Patrolling

347 To minimize the risks of poaching, awareness programs will be combined with an increase in patrolling by local forestry staff. To support enhanced patrolling, the project discuss possibilities for strengthening patrolling or monitoring of illegal activities in the project sites with local forestry staff. The use of 'risups' or village forest guards to alert forestry officials of any illegal activities in the worker camps or at project sites can also be used.

7.13 Muck Management

341. The impacts of excavation work and muck disposal are limited to Tower foundation sites. Since some of these sites are too far from the nearest access road, and all tower locations are dispersed at least 300m from each site, it is not economically feasible to select one muck disposal site. Also, it is impractical without access roads since the cost of transporting soil from excavated site would be too high.

349 Maximum of the muck shall be generated during benching which involves clearing and excavation of average 2 m below ground for foundation work. Small part of the muck shall be generated from pit excavation for construction of tower foot foundation. The total area of each tower foot shall be 81 m^2 and excavating 2 m below ground would generate about 162 m^3 of muck at each tower foot during benching. Additionally, one pit each for four tower legs shall be excavated. Each pit shall be 4 m^2 and an average 3 m depth shall be excavated from which an average 12 m^3 of muck shall be generated totaling to 48m^3 from the four pits. Therefore, taking a total excavated material as 210 m^3 from each tower foot, the total muck generated from 61 towers shall be 12,810 m^3 over 18.6 km stretch.

350 To reduce the quantity of muck generated, about 50% muck from each pit shall be reused in backfilling the pits. Therefore, 24 m^3 at each tower base shall be reused and for 61 towers, the total muck reusable is 1,464 m^3 leaving a balance of 11,346 m^3.

351 Since 24 m^3 of muck shall be reused at each tower foot, only 186 m^3 shall require disposal. Given that the amount of muck generated shall be extremely low, the muck shall be disposed of near the tower foot, leveled and vegetated.

352 Disposal planning and management is very important, to mitigate the possible environmental impacts of improper disposal resulting in increased sedimentation of streams and damaging the visual aesthetics of the area.

Mitigation measure

(i) Locate all towers at a safe distance from water sources so that excavation work does not cause large quanities of soil to be washed into the streams;

(ii) Stockpile all excavated muck at a safe distance from the foundation site, to minimize the risk of soil falling back into the pits, or blocking access to the pit;

(iii) Unused muck remaining after backfilling of tower foundation sites must be dumped at a selected location nearby, preferable a degraded area. To minimize the creation of dust, dumping will be avoided during the high speed winds, so that suspended particulate matter (SPM) levels are not excessive. It is expected that the amount of soil to be disposed will not be large enough to require construction of retaining walls, and compaction of muck in contours (following the local topography) can be done with small equipments;

(iv) To stabilize the muck and restore the disposal sites, local fast growing plant species are recommended but final species depends on terrain, soil, and drainage conditions of the sites. This must be done in consultation with forestry staff as this dumped area can be included under the Compensatory Afforestation Program

7.14 Managing risk of slope instability and impact on surface waters

353 If excavation along tower footings is on steep slopes, there are chances of slope stability and landslides. There could also be impacts on aquatic ecology and fisheries if large quantities of silt are washed into the stream during rain.

354 All the angle tower locations (at turning points of the line route) are already decided while exact positions of suspension towers will be decided in a later stage after completion of the ground profile survey along the line route.

355 As a preconstruction measure, no tower will be sited close to reservations of public streams, rivers or any other water bodies. It will avoid disruption of existing drainage paths and reduce possibility of meeting surface runoff with water body which will eventually increase turbidity levels.

342. As line traverse in hilly terrain, excavation for tower footings will expose soil in slopes and aggravate soil erosion in rainy season. Once the soil is excavated for tower foundations, the earth should be backfilled or removed from the site. The loose soil should be protected with mulch or covered with water-proof materials such as tarpaulins.

343. Considering the relatively small amount of excess soil a proper place/s for dumping excess soil would be located nearby the work site and levelled properly.

344. Care shall be taken not to obstruct any natural process such as surface water runoff and stream water flow, during construction works. No tower shall be located near the streams and atleast 30m buffer shall be maintained from any water body. Earth retaining structures will be built with necessary drainage facilities around the towers located in sloping areas or any locations disturbed by the project implementation. Once the towers are constructed, the loose soil shall be covered with vegetation as much as possible to avoid soil erosion and sedimentation. Also to protect the tower footing, revetment walls shall be constructed at locations wherever necessary depending on the site conditions.

Mitigation measures

(i) All towers must be located at least 30 m from the nearest water source to avoid polluting the waters and reduce the flow of sediments;

(ii) Tower footings will be located at stable locations, and site preparation will ensure that sediments are not mobilized. Once the tower footing foundations are poured, sediments will be placed back against the footing, and the site re-vegetated (low elevation species), to reduce the erosion risk;

(iii) Tree cutting must be undertaken, as much as possible, in the dry season and before the monsoon, when tree cutting work could create additional damage and muddy run-off in the forest;

(iv) Within the RoW, allow ground vegetation, shrubs and naturally occurring low-growing vegetation to regenerate to reduce visual impacts as well as reduce erosion, dust and sediment mobilization;

(v) Water quality monitoring will be conducted at key streams along the alignment at least twice a year. These samples will be compared to the baseline data. Parameters that will be measure include: ambient temperature (°C), pH, conductivity (µmhos/ cm), total suspended solids (mg/l), total phosphorus (mg/l), dissolved oxygen (mg/l), biological oxygen demand (mg/l), chemical oxygen demand (mg/l), total sulphate (mg/l), fecal coliform count (MPN Index)

7.15 Closure Plan

345. To ensure that project components not pose a future threat to human health or to the environment and to allow the natural environment to recover and flourish again, all elements of closure for each of the pre-construction and construction project activities have already been identified. The closure details are summarized below, and can serve as a checklist for completion of all pre-construction and construction activities.

Temporary land use for storage of materials and machines

346. Areas that have been used and rehabilitated through the Compensatory afforestation program will be identified and transferred back to the District with proper handing taking signed by both the Project and the District Authorities.

Labour Camps

(i) All buildings and service infrastructure will be de-constructed and recycled, or disposed as solid waste;

(ii) All equipment, debris, residual waste, etc. will be cleared from the site and disposed according to the project solid waste management plan;

(iii) Septic tanks will be cleaned, filled and covered;

(iv) The remaining area, once cleared as described above, will be graded and prepared for re-vegetation (a target for compensatory afforestation);

(v) All camp sites will then be inspected, documented, and photographed as evidence of full camp closure;

(vi) Sites will be handed back to the Department of Forest or District whichever has the ownership

Tower foundation sites

347. Any material left after excavation and erection of the towers will be removed and low-growing vegetation will be allowed to flourish for slope stabilization.

7.16 Mitigating risk of electrocution and accidents during maintenance works

348. The main hazard to people from the operation and maintenance of the completed TL system is the risk of electrocution. This is a danger to the BPCL staff when repairing towers, transmission line and its associated components.

Mitigation Measures

349. It is recommended that the Operational Health and Safety measures outlined in the Construction Phase are followed. This covers the following:

(i) Securing the workplace;
(ii) Use of PPE;
(iii) Procedures to follow for emergencies and Compensation procedures in case of accidents

350. BPCL has its own set of OHS safeguards and compensation procedures, which are being followed to ensure safety of workers in all other sites, and will apply to the TL as well.

7.17 Electromagnetic Field (EMF)

351. When people are passing directly below a high voltage power line, they can be exposed to an electric field between 2 to 5 kV/m and to magnetic fields of less than 40 µT. The strength of the electric and magnetic field diminishes rapidly with distance to the line.

352. In homes not located near power lines this background field may be up to about 0.2 µT. Directly beneath power lines the fields are much stronger. Magnetic flux densities at ground level can range up to several µT. Electric field levels underneath power lines can be as high as 10 kV/m. However, the fields (both electric and magnetic) drop off with distance from the lines. At 50 m to 100 m distance the fields are normally at levels that are found in areas away from high voltage power lines. In addition, house walls substantially reduce the electric field levels from those found at similar locations outside the house.

353. Countries set their own national standards for exposure to electromagnetic fields. However, the majority of these national standards draw on the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). This non-governmental organization, formally recognized by WHO, evaluates scientific results from all over the world. Based on an in-depth review of the literature, ICNIRP produces guidelines recommending limits on exposure. These guidelines are reviewed periodically and updated if necessary.

354. Electromagnetic field levels vary with frequency in a complex way. Listing every value in every standard and at every frequency would be difficult to understand. **Table 7.4** gives the summary of the exposure guidelines for the three areas that have become the focus of public concern: electricity in the home, mobile phone base stations and microwave ovens. These guidelines were last updated in April 1998.

Table 7.4: Summary of the ICNIRP exposure guidelines

	Europe Power frequency		**Mobile phone base station frequency**		**Microwave oven frequency**
Frequency	50 Hz	50 Hz	900 MHz	1.8 GHz	2.45 GHz
	Electric field (V/m)	Magnetic field (µT)	Power density (W/m^2)	Power density (W/m^2)	Power density (W/m^2)

	Europe Power frequency		Mobile phone base station frequency		Microwave oven frequency
Public exposure limits	5 000	100	4.5	9	10

- **EMF Regulations in Bhutan**

355. There is no specific regulation on EMF for high voltage transmission line in Bhutan. According to Safety Code, 2008 issued by Bhutan Electricity Authority, the clearance of 132 kV line should be 2.1 m horizontal and 5.5 m vertical distance from any buildings (see **Table 7.5**). Since the entire stretch of 132 kV transmission lines of NHPP passes far away from the settlements, it does not violate any such safety requirements.

Table 7.5: Overhead Electric Conductor Clearance

Particulars	220 kV	132 kV	66 kV	33 kV	11 kV	LV
Ground clearance						
Across street	7.0 m	6.1 m	6.1 m	6.1 m	6.1 m	5.5 m
Along street	7.0 m	6.1 m	6.1 m	5.8 m	5.8 m	5.5 m
Elsewhere	7.0 m	6.1 m	5.5 m	5.8 m	5.8 m	4.6 m*
Separation between phases						
Horizontal	8.4 m	6.8 m	3.5 m	1.5 m	0.7 m	#
Vertical	4.9 m	3.9 m	2.0 m	1.5 m	0.6 m	#
Clearance from buildings						
Horizontal	3.7 m	2.8 m	2.1 m	1.8 m	1.2 m	#
Vertical	5.5 m	4.6 m	4.0 m	3.7 m	2.5 m	#

Safety Code, 2008- Bhutan Electricity Authority

356. No effect on environment and human is envisaged due to EMF from 132 kV line of NHPP. The line is routed far away from the settlement and the RoW of 27 m shall be adopted for the line as per the National and International Standard.

Mitigation measures

357. **Distance from TL**. The strength of magnetic fields varies depending on a) magnitude of the current and b) proximity to an EMF source. The impacts of EMF are considered during the design stage and mitigation options for Transmission lines include increasing the distance of local communities, populated areas, other occupied buildings and wildlife and vegetation from the EMF source. Much of the transmission lines guidelines are derived from the Indian Standard IS 5613 (BPC, 2014). **Table 7.6** and **Table 7.7** indicate the minimum distances that are

incorporated in the design of the TL. This takes into account distance from the ground, vertical and horizontal distances from buildings and crossing with telecommunication lines.

358. The minimum distance requirements ensure that no households are within the minimum distance of 27 m (13.5m on each side) and at a minimum clearance of 6.1m from the ground vegetation of moving workers and wildlife.

Table 7.6: Minimum distance to be maintained from the TL

Particulars	Minimum Clearance (m)
Minimum RoW to be maintained	27
Clearance to ground	6.1
Clearance to Buildings a)Vertical: From highest object	4.58
b)Horizontal: from nearest point	2.75
Crossing with Telecommunication lines	2.75

359. A minimum distance has to be maintained for line crossing at different voltage levels. Since the RoW for 66 kV lines is 16 m and RoW for 132kV lines is 27 m, a minimum distance of 20 m (8m+12.5m) is required to between the 66 kV line and the 132 kV line.

Table 7.7: Line crossing at different voltage levels

Particulars	Minimum Clearance (m)
Up to 66KV	3.05
132KV	3.05
220KV	4.58
400KV	5.49

360. **Phase cancellation**. Another option to significantly reduce EMF from transmission lines is Phase Cancellation. This can be accomplished by bringing the conductors close together, vertical double circuiting, or placing independent wire conductors between the TL and an area of exposure. Phase Cancellation is most effective when the three phases have the same current flow.

361. **Conductor separation**. A commonly used method to reduce EMF is to decrease the distance between the conductors. This reduces the magnetic fields created by each of the three conductors because the fields are out of phase with each other and thus cancel each other. Bringing the conductors closer together requires the supporting structures to be closer together to prevent arcing and shorting out between conductors. This adds additional construction and material cost to the line.

362. **Vertical Double-circuiting**. Vertical double circuiting includes attaching a set of three conductors, one above the other to each side of the transmission tower. Electromagnetic fields can be reduced by 50% by reversing the phase order of the other circuit. Partial cancellation of both magnetic and electric fields can be achieved. The effectiveness of the arrangement is dependent on the current flowing through each circuit.

Conductor and OPGW spacing and clearance

363. For all towers, the clearance from conductors, jumper loops and all live metal to the tower steel work shall not be less than those specified in table below 'Minimum clearance from live metal to earthed metal', under still air conditions and at assumed maximum swing of jumpers. Where uplift occurs at tension tower positions the minimum clearance between any arcing horn and the jumper loop of the phase immediately above it shall not be less than the minimum still air clearance from live to earth metal stated below. The length of angle tower cross arms shall provide for the distances between conductors of the two sides at straight line structures to be maintained in a plane normal to the conductors (see **Table 7.8**).

364. **Selection of conductors and OPGW**. Conductors and OPGW tensions shall be so selected that the sag of the OPGW at mid-span of basic span at everyday tension provides a minimum clearance to the top conductors. The sag of the OPGW shall not be more than 90% of the sag of the line conductor at mid span under all conditions.

Table 7.8: Minimum clearance from live metal to earthed metal

Particulars	Minimum Clearance (mm)
For Single Suspension String:	
Still air-no swing	1530
For 15 degree swing	1530
For 30 degree swing	1370
For 45 degree swing	1220
For Double Suspension String	1530
For Tension String (Single/Double)	1530
Still air-no swing	1530
For 10 degree swing	1530
For 20 degree swing	1070
Minimum Creepage Distance	25 mm/kV

7.18 Mitigating risk and hazard associated with TL

365. The transmission line runs parallel to the existing 66 kV line that has been in operation for over 7 years. Till date there have been no recorded incidents of any landslides or earthquakes damaging the existing 66 kV line. Thus it is not expected that the TL will be impacted easily by any earthquake.

Mitigation measures

(i) During the design and Survey stage, selection of tower foundation areas are based on the soil conditions, topography and geological features along each of the sections of the transmission corridor and areas of potential slope instability, potential seismic risk, debris flows, and rock fall hazards are avoided at this stage to prevent mishaps in Operation and Maintenance;

(ii) On the upper slopes of the TL, it may be necessary to cut down trees that may fall outside the range of required corridor. In such area(s), all trees/obstacles that may hit the conductor and or the transmission tower shall be felled. This will mitigate any risks of Trees or their branches from upper slopes falling on the TL during an earthquake or landslide;

(iii) BPC must enforce appropriate building codes and infrastructure design to increase the ability of physical structure to withstand the impact of catastrophes;

(iv) Raise public awareness of about disasters, their risks and ways to cope with them;

(v) Developing emergency protocols to be followed during emergencies cause by disasters/catastrophes;

(vi) Conduct regular check and maintenance. BPC conducts regular Operation and Maintenance of all TL lines to check on the conditions of all Tower locations and along the TL to ensure that towers are in good condition and wherever needed, retaining structures are constructed to stabilize these. Routine checks must also include removing overhanging trees and branches from upper slope likely to fall on the Conductors, and remove these to prevent damaging the power line.

7.19 Mitigating electrocution of raptors and other large birds

366. The risk of Electrocution of raptors or other large birds is more pronounced in areas where the vegetation is low and the terrain is flat, as Power Poles provide structures from which to hunt and roost, especially where few other perches exist (Manville, 2005). The advantage of

the project site is that there are ample trees beyond the RoW to provide for roosting and nesting. Still mitigation measures to minimize the risk of electrocution include:

(i) Construction of cage box on conductors to prevent birds from sitting or making nest on the towers;

(ii) Placing colorful/fluorescent tape on the towers to make them conspicuous enough to enable birds to see them and avoid these while flying overhead or using marking devices of various shapes that can be attached to phase conductors;

(iii) Aligning the TL close to the 66 kv line reduces the need for birds to duck two power lines at the same time;

(iv) Sufficient phase-to-phase and phase-to ground wire spacing is critical for large winged birds. Jumper wires on all electrical equipment should be insulated including at tap and dead-end locations;

(v) Silhouette/Predator scaring method. Use of silhouettes of predators (falcon/hawk) as scaring devices for repelling birds has been used in Netherlands, and proved to result in significant decrease in collision frequency;

(vi) Work closely with the Department of Forest to collect information on any reports of bird collisions/accidents due to the TL, to assess sensitive areas so that specific mitigation measures for high risk areas can be undertaken. Also, the project can fund studies to be conducted on distribution of birds and density, seasonal patterns and migration corridors will help better design future mitigation measures.

8 Environmental Monitoring Program and Institutional Responsibilities

8.1 The Environmental Monitoring Program

367. The main objectives of environmental monitoring program are:

(i) To assess the changes in environmental conditions,
(ii) To monitor the effective implementation of mitigation measures,
(iii) To warn about significant deteriorations in environmental quality so that further prevention action can be undertaken.

368. The DGPCL and BPCL Environmental Units will be responsible for ensuring the implementation of the environmental management plan (EMP). **Table 8.1** shows the proposed EMP which specifies the various monitoring activities to be conducted during all phases. Some of the measures have been consolidated to avoid repetition, and there has been some re-ordering to present together those measures that relate to the same activity or site. The EMP describes:

(i) Impact
(ii) Mitigation measures,
(iii) Responsibility for mitigation
(iv) Location,
(v) Monitoring method,
(vi) Frequency of monitoring and
(vii) Responsibility for monitoring

369. **Table 8.2** presents the environmental monitoring plan while **Table 8.3** shows the environmental costs.

Table 8.1: Environmental impacts, significance, duration and their mitigation

(sign= significance; S: Significant Impact, M: Medium impact; NS: Impact Not significant
(Dur= Duration; P: Permanent; T: Temporary)

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
PRECONSTRUCTION PHASE						
ECONOMIC IMPACTS						
1	Acquisition of private land	0.6 acres of dryland required permanently for tower footings from 6 Households	M	P	Selection of chosen TL alignment to avoid wetland; Compensation as per Land Act 2006; Complete transfer of land ownership process Project Construction Phase; Follow Grievance Redress Mechanism.	BPC and Dzongkhag, NLC
		7.5 acres of land required temporarily for construction of contractors site office, storage site an worker camps	M	T	Encourage Contractors to lease private land instead of using government land; If government land is to be leased, select land from cleared areas; Follow Closure Plan to revegetate land prior to handing it back to the Dzongkhag;	BPC and Contractor
PRECONSTRUCTION PHASE and CONSTRUCTION PHASE						
ECONOMIC IMPACTS						
2	Recruitment of local workers by Contractors	Positive increase in income and livelihood source	S	T	Project must employ as many locals as possible	BPC

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
SOCIAL IMPACTS						
3	Influx of construction workers	Risk of Communicable Diseases	M	T	Contractors should be encourage to recruit locals; Initial screening of workers for HIV/STD; Provide camp clinics and regular screening for infection	Contractor
		increased pressure on housing, infrastructure, services	S	T	Provision of adequate housing Provision of communal kitchen and sewerage facilities	Contractor
		increased pressure for water and fuelwood and LPG			Provision of drinking water, Request of quota for LPG, Fuel	Contractor, BPC
		Health and safety issues Workers at risk from accidents on site			Nomination of a Health and Safety Focal Person Follow Occupational Health and Safety Plan and BPC prescribed work safety measures; Provide PPE to all workers; Workers must be informed of risks at workplace Minimize hazards at the workplace Use signage and barricades at risky sites Ensure proper transportation, storage of hazardous materials Provision of vehicles on standby, communication and emergency procedures Maintain record of accidents Provide compensation for injuries and accidents	Contractor, BPC
		Possible social instability	M	T	Locate Worker camps away from villages Workers briefed on required behaviour towards host community and Codes of Conduct to be followed; Penalty for irresponsible behaviour may result in unemployment	BPC, Contractor
4	Mobilization of Construction Equipment and Materials	Congestion and risk of accidents due to increase in vehicles and machines, and traffic	M	T	Stage delivery of required materials and equipment Store all construction equipment and materials at “off road” sites Post signs along the National Highway and use flag persons Move heavy machines only early mornings and late evenings	Contractor
		Workers exposed to air and noise pollution	M	T	Provide PPE for workers	BPC, Contractor
5	Impact on Cultural and Religious sites	Encroachment or disturbance to nearby religious and cultural sites	S	T	Locate no towers are located in the vicinity Consult all affected communities Consult the custodians of all social and cultural	BPC,Contractor

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
					facilities	

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
6	Construction of TL	Reduction in visual aesthetics	NS	P	Green belt plantation	BPC, DoFPS, Local Forestry staff
7	Forest clearance activities	Work may create noise, dust & impede access	M	T	Work only during day time, Retain ground vegetation in RoW to reduce dust	Contractor
		Loss of visual aesthetics	NS	T	Green belt development	BPC, DoFPS, Local Forestry staff
ENVIRONMENTAL IMPACTS						
8	Influx of construction workers	Impact on forest if land is required to be cleared for worker camps	M	T	Locate worker camps in degraded sites where no clearing will be required	Contractor, BPC
		Increase in demand for firewood			Liaise with the Deptt. of Forest to utilize felled unusable trees as fuelwood	Contractor, BPC
		Emissions from stoves in worker camps	M	T	Provide electricity for cooking if possible; Use centralized kitchen to reduce use of fuelwood Air quality monitoring	BPC, Contractor
		Water Pollution and waste generation from construction camps	M	T	Follow Solid waste management system Provide sanitation facilities and sewerage collection and disposal	Contractor
		Increase in demand for Water	M	T	Water sourcing and provision for all worker camps	Contractor
		Increase in risk of poaching by workers	M	T	Prohibit workers from hunting, fishing and enforce strictly; Brief workers on Forest and Nature Conservation Rules and penalties through awareness meetings/programs	Contractor, BPC
9	Mobilization of Construction Equipment and Materials	Air emissions and increased air pollution	M	T	Permit only those vehicles passing emission control tests by RSTA	BPC, Contractor
		Noise pollution from increase in traffic	M	T	Use of mufflers and emission control	BPC, Contractor
		Risk of landslides and erosion	M	T	Construct retaining walls and implement land	BPC, DoFPS,

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
					management plan	Local Forestry staff
		Potential disturbance to wildlife	M	T	Use noisy equipment only during daytime	Contractor

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
10	Forest clearance for Row	Reduction of forest cover by 100 acres	M	P	Implement Compensatory Afforestation plan, revegetate twice area deforested; Reduce RoW on valleys where it doesn't cause shorting risk Collaborate with MHEP and Nikachu on land management	BPC, DoFPS, Local Forestry staff
		Impacts on wildlife and bird habitat and distribution	M	P	Avoid felling of trees beyond RoW; Fell only trees marked by Forestry Field staff; Dispose of cut trees as required/instructed by Forestry Officials Provide funds to DoFPS to conduct research and surveys Collaborate with Nikachu project for a) Biodiversity Conservation; b) Rescue of endangered flora and fauna c) Human wildlife conflict; d) land management Collaborate with DoFPS on a) strengthening research on wildlife/bird species distribution, habitat use; b) strengthen antipoaching and patrolling; c)ensure minimal clearing and disturbance of forest; d) revegetation of cleared areas on project completion	BPC, DoFPS, Local Forestry staff
		Impacts on air quality Dust may blow from areas cleared of vegetation in RoW	M	T	Retain short trees, shrubs and ground vegetation in RoW Allow cut materials to rot down in situ and do not burn Air quality monitoring	BPC, DoFPS, Local Forestry staff
		Workers could damage species & habitats outside RoW	M	T	Mark the boundaries of the RoW with tape and prohibit trespass outside Collaborate with Nikachu Hydropower project on all Biodiversity Conservation and Wildlife Management Plans	BPC, DoFPS, Local Forestry staff
11	Tower foundation	increase in demand for water	M	T	Source water from nearby streams/rivers for	

	construction	for construction and curing works			construction activities	
		Muck generation from excavation works	M	T	Muck disposal and revegetation at all tower sites; Construct retaining walls and bio-engineering if required	BPC, DoFPS, Local Forestry staff
		Risk of erosion and sedimentation of nearby streams	M	T	Keep all machines, fuel storage 30m from streams Water quality monitoring	Contractor
		Risk of slope instability	S	P	All towers must be located at least 30m from the nearest water source Tower footings will be located at stable locations, Site preparation must ensure that sediments are not mobilized. Implement tree cutting during dry season or before monsoon Allow ground vegetation shrubs to grow	BPC and Contractor
12	Stringing of Transmission lines	Possible obstruction and disturbance to wildlife from materials stored along the Length of TL	M	T	Remove all stored materials as soon as work is completed; Inform locals in advance of work schedule	Contractor
13	Construction of TL	EMF impacts			Phase cancellation Conductor separation Vertical Double-circuiting Conductor and OPGW spacing and Clearance Selection of conductors and OPGW. Maintain minimum distances and clearances as per standard norms	
14	Post Construction	Improper closure of project site sites	M	P	Follow closure plan for all worker camps, Contractor and storage sites, muck sites	Contractor, BPC

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
OPERATION PHASE						
ECONOMIC IMPACTS						
15	Removal of workers from site	Reduction in income from sale outlets	S	P	Local must be brief on project period and schedule	BPC
		Reduction in employment opportunities	S	P	Make locals aware from outset about temporary nature of employment	BPC
SOCIAL IMPACTS						
16	Removal of workers from site	No anticipated impacts		T		
17	Regular clearing of RoW	Risk of electrocution of Maintenance workers	M	T	Provide PPE to workers Follow OHS and emergency procedures in case of emergencies	BPC, Contractor
18	Operation and Maintenance of TL	Risk of electrocution of Maintenance workers and locals	M	T	Follow OHS and emergency procedures in case of emergencies Secure the workplace and shut down Power Use of PPE Inform locals in advance of maintenance work being carried out Educate Public and locals on risks of TL	BPC
ENVIRONMENTAL IMPACTS						
29	Regular clearing of RoW for maintenance	Permanent openings within Forest		P	Compensatory Afforestation	BPC, DoFPS, Local Forestry staff
		Visual impacts		P	green belt plantation	BPC, DoFPS, Local Forestry staff
20	Incomplete removal of project materials	Risk of soil, water, waste impacts from residuals left after project completion	M	P	Clean up of all worksites/work camps after project completion; Revegetation of all sites and hand over to Dzongkhag	BPC, Contractor
21	Electrocution of birds	Birds accidently hitting the TL leading to injuries and death			Construction of cage box on conductors Placing colourful/fluorescent tape on the Towers Aligning the TL close to the 66kv line Sufficient phase-to-phase and phase-to ground wire spacing	BPC, Contractor

					Silhouette/Predator scaring method. Collect information on bird collisions/accidents	

	Activity	Potential Negative Impacts	Sign	Dur	Mitigation Activities and Method	Responsibility
22	Disasters	Risks and hazards from catastrophes			selection of tower foundation areas based on detailed geological studies cut trees that may fall on TL from upper slopes enforce appropriate building codes and infrastructure design public awareness of about disasters, developing emergency conduct regular check and maintenance	BPC

Table 8.2: Environmental Monitoring Plan

Impact	Mitigation Measure	Responsibility	Location	Monitoring	Monitoring Frequency	Monitoring Responsibility
	ECONOMIC					
Land compensation	Compensation as per Land Act 2006	BPC	Villages	Compensation report	as needed	BPC
Local employment	Project must employ as many locals as possible	BPC	Villages	Contractors meeting, Public consultation	every 6 months	BPC
	Local must be aware of project period	BPC	Villages	Public consultation, Surveys	Start of Project	BPC
	Make locals aware from outset about temporary nature of employment	BPC	Villages	Public consultation, Surveys	Start of Project	BPC
SOCIAL IMPACT MITIGATION						
Employment	Project must employ as many locals as possible	BPC	Villages	Contractors meeting, Public consultation	every quarter	BPC
Worker camps	locate Worker camps away from villages	BPC, Contractor	Villages	Field observations	every quarter	BPC
Housing and sanitation	Provision of adequate housing and sanitation facilities	Contractor	Worker camps	Field observations	every quarter	BPC
Drinking water	Water sourcing and provision for	Contractor	Worker	Field	every quarter	BPC

Impact	Mitigation Measure	Responsibility	Location	Monitoring	Monitoring Frequency	Monitoring Responsibility
	all worker camps		camps	observations		
Pressure on resources	Provide electricity for cooking if possible; Use centralized kitchen to reduce use of fuel wood	BPC, Contractor	Worker camps	Field observations	every quarter	BPC
Waste generation	Follow Solid waste management system	Contractor	Worker camps	Field observations	every quarter	BPC
Sewerage	Provide sanitation facilities and sewerage collection and disposal	Contractor	Worker camps	Field observations	every quarter	BPC
Social conflict	Only locate worker camps in already cleared, disturbed areas	BPC, Contractor	Worker camps	Field observations	every quarter	BPC
Poaching	Prohibit workers from hunting, fishing and enforce strictly	Contractor	Worker camps	Observations, reports	every quarter	BPC
	Brief workers on Forest and Nature Conservation Rules and penalties	Contractor	Worker camps	Observations, reports	every quarter	BPC
Worker health risks	Initial screening of workers for HIV/STD	Contractor	Worker camps	Observations, reports	every quarter	BPC
	Provide camp clinics and regular screening for infection	Contractor	Worker camps	Observations, reports	every quarter	BPC
Worker safety	Provide PPE (masks, gloves, boots) for workers	BPC, Contractor	Work site	Observations, reports	every quarter	BPC
	Workers must be informed of risks at workplace	Contractor	Work site	Observations, reports	every quarter	BPC
	Use signage and barricades at risky sites	Contractor	Work site	Observations, reports	every quarter	BPC
	Ensure proper storage, transportation of materials	Contractor	Work site	Observations, reports	every quarter	BPC
	Encourage project workers and Contractors to minimize travel and drop off for all construction materials	BPC, Contractor	Highway	Observations, reports	every quarter	BPC
Impact on Religious sites	No Towers will be located nearby Such sites	BPC, Contractor	Villages	Public consultation, Field observation	during construction of towers	BPC
	Discuss with custodians/In-	BPC, Contractor	Villages	Public	during	BPC

Impact	Mitigation Measure	Responsibility	Location	Monitoring	Monitoring Frequency	Monitoring Responsibility
	charge of Nunnery to inform about project activities			consultation, Field observation	construction of towers	
ENVIRONMENTAL IMPACT MITIGATION						
Air pollution	Air and noise monitoring stations	BPC	designated sites	Field Observation	every quarter	BPC
	Sprinkle water during excavation at tower footings	Contractor	Each tower foot	Field Observation	daily	BPC
Water sourcing and impacts on streams	Source water from nearby streams/rivers for construction activities		Work sites	Field Observation	every quarter	BPC
	Keep all machines and fuel stored 30m from streams	Contractor	Work sites	Field Observation	every quarter	BPC
	Muck disposal and revegetation plan	BPC, DoFPS, Local Forestry staff	Tower foundation site	Field Observation	every quarter	BPC
	implement land management strategy	BPC, DoFPS, Local Forestry staff	Tower foundation landslide areas	Field Observation	every quarter	BPC
Impact on Forest cover	Compensatory Afforestation	BPC, DoFPS, Local Forestry staff	Entire project area	Field Observation	every quarter	BPC
Disturbance to wildlife and Biodiversity	Biodiversity Conservation and Wildlife Management Plan	BPC, DoFPS, Local Forestry staff	Entire project area	Field Observation	every quarter	BPC
	Reduce RoW on valleys where this does not increase shorting risk	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Retain short trees, shrubs and ground vegetation in RoW	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Allow cut materials to rot down in situ and do not burn	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Avoid felling of trees beyond RoW	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Fell only trees marked by Forestry Field staff	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC

Impact	Mitigation Measure	Responsibility	Location	Monitoring	Monitoring Frequency	Monitoring Responsibility
	Dispose of cut trees as required/instructed by Forestry Officials	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Mark the boundaries of the RoW with tape and prohibit trespass outside	BPC, DoFPS, Local Forestry staff	RoW	Field Observation	every quarter	BPC
	Work only during day time, Retain ground vegetation in RoW	Contractor	RoW	Field Observation	every quarter	BPC
Visual aesthetics	Green belt plantation	BPC, DoFPS, Local Forestry staff	Along highway	Field Observation	every quarter	BPC
Project Completion and Closure	Remove all stored materials as soon as work is completed	Contractor	All work sites	Field Observation	on completion of work	BPC
	Clean up of all worksites/work camps after project completion	BPC, Contractor	All work sites	Field Observation	on completion of work	BPC
	Revegetation of all sites and hand over to Dzongkhag	BPC, Contractor	All work sites	Field Observation	on completion of work	BPC
EMF mitigation	-Phase cancellation -Conductor separation -Vertical Double-circuiting -Conductor and OPGW spacing and -Clearance -Selection of conductors and OPGW. -Maintain minimum distances and clearances as per standard norms	BPC	All towers	Field observation	During construction	BPC
Disasters	selection of tower sites	BPC	Tower foundation	Field observation	Pre-construction	BPC
	cut overhanging trees	BPC	RoW	Field observation	Pre-construction	BPC
	enforce appropriate building codes	BPC	Tower sites	Field observation	Construction	BPC
	public awareness	BPC	Local community	No. of meetings	Construction	BPC
	regular check and maintenance	BPC	Entire site	Field report	Operation	BPC

Impact	Mitigation Measure	Responsibility	Location	Monitoring	Monitoring Frequency	Monitoring Responsibility
Operation & Maintenance	Follow OHS and emergency procedures in case of emergencies	BPC	Work site	Observations, reports	every quarter	BPC

Table 8.3: Environmental Costs

Sl. No	Category	Unit	Quantity	Cost (in Nu.)
1	**Waste Management (Dust bins)**	no	10	73,000
2	**Biodiversity Conservation**	lumpsum		500,000
3	**Compensatory Afforestation**	Acres	200	7,284,600
			TOTAL	**7,857,600.00**

8.2 Institutional Responsibilities

370. The implementation of the TL will be managed within the institutional framework that already exists in BPC. Main agencies and their roles will be as follows:

(i) DGPCL is the Executing Agency (EA) responsible for management, coordination and execution of all activities funded under the loan.

(ii) BPC is the Implementing Agency (IA), responsible for the successful construction and subsequent operation of this subproject. Implementation will be managed centrally by the Transmission Department, located in the BPC head office in Thimphu, who will appoint a Project Manager and other senior and junior staff from the existing personnel who will be responsible for local implementation of the project

(iii) The DGPCL, BPC, NHPP, DOFPS and District Land Officers and the Gup will be responsible for executing all Land Compensation Measures, transfer of Thram (land title) as well as assisting farmers in developing the newly exchanged land into agriculturally productive parcels of land. All grievances will also be dealt by these offices.

(iv) DGPCL, BPC and selected contractors will be responsible for the following:
- Proper siting of all project offices, labor camps,
- Provision of water, fuel wood, gas, electricity for all temporary offices and worker camps
- Sewerage and sanitation of all sites
- Waste management
- Staging and movement of machines and vehicles and construction materials to project sites
- Development of muck disposal sites,
- Fuel storage
- Operational Health and Safety of all workers
- Closure of all work sites, staff quarters, temporary storage sites

(v) Contractors will be held responsible by the BPC for the following;
- Screening of all workers prior to being employed
- Provision of PPE for workers and availability of first aid, emergency health care
- Prohibiting workers from a) social instability and mingling with locals, poaching and fishing restrictions, health risks and safety issues

(vi) The DGPCL, BPC will ensure that this project will work closely with the Nikachu Project, MHEP project, SFD, DOFPS, UWICE, NBC, Zhemgang Forestry Division, CNR, JSWNP and dzongkhag Forest officer to develop and collaborate on the following;
- Compensatory Afforestation
- Development of a greenbelt
- Wildlife and Biodiversity Conservation Plan

- Development of nurseries for tree plantation
- Rescue, treat and release of Wildlife species
- Rescue and conserve endangered or rare flora
- Land management especially along steep slopes and landslide prone areas
- Permission for clearing the forest along the RoW, tree marking and removal.
- Permission to use felled trees as fuel wood for worker camps
- Surveys and study on distribution and habitat use by birds

9 Grievance Redress Mechanism

371. The grievance redress mechanism at NHPP will follow the process described in Table 9.1 in case locally displaced persons are not satisfied with the compensation process.

Table 9.1: Grievance Redress Mechanism

Grievance redress procedure
Step 1: The aggrieved DP submits his/her grievance in writing to the Grievance Redress Committee comprising of the members of the Dzongkhag Land Acquisition Committee, the Gup of the respective gewog, and the Project Manager of NHPPP GRC deals with grievance **within 15 days** of receipt of complaint from AP. If unresolved; **Step 2:** The aggrieved DP is not satisfied with the decision rendered by the GRC or,if he/she does not receive a response within 15 days; he/she can approach the senior management of DGPCL, and can ultimately appeal to His Majesty the King through the existing local governments such as the Geog Tshogde and the Dzongkhag Administration.

10 Information Disclosure, Consultation, and Participation

372. Consultation and information disclosure are important components of NHPP including the associated transmission line to evacuate power to the national grid. **Table 10.1** gives the details of public consultation conducted for NHPP.

A. Project stakeholders

373. Most of the main stakeholders have already been identified and consulted during preparation of the EIA, and any others that are identified during project implementation will be brought into the process in the future. Primary stakeholders are:

- Households that are directly affected by this subproject
- Local communities and users of cultural and religious facilities along the alignment

B. Secondary stakeholders

- Trongsa Dzongkhag as the Dzongkhag authority
- DGPCL as the Executing Agency;
- BPC as the Implementing Agency;
- DoF as the custodian of the all forested areas through which TL must pass;
- NEC as the agency granting Environmental Clearance;

- Other government agencies whose remit includes areas or issues affected by the project;
- The ADB.

374. Public consultation is mandatory as per **Article 16 of the EA Act 2000**, and **Section 31 of the Regulation for the Environmental Clearance of Projects 2002**. As required by the ADB, The census of DPs and socioeconomic survey was carried out during the month of July 2012, and a re-survey was conducted in April 2014 to include the changes in the people displaced. The NHPP has been extensively discussed and along with the associated transmission line.

Table 10.1: Details of Public Consultation

No.	Date	Objective
1	25 July, 2013	To discuss the Nikachu project with the local community
2	18 September, 2013	To present and discuss the draft ESIA for Nikachhu Hydropower (included the TL component as well)
3	30 October, 2013	To present and discuss the ESIA especially the EMP
4	9 December, 2013	To discuss the ESIA to the Dzongkhag and community leaders (Minutes of meeting in Dzongkha)
5	27 December 2013	To present and discuss EIA with NEC and other stakeholders
6	27 January, 2014	To discuss the project with Local community and seek consensus (Minutes of the Meeting are in Dzongkha)
7	7 April, 2014	Meeting in Tshangkha with Representatives of the Displaced Households
8	9 April, 2014	Meeting in Drakten with Representatives of the Displaced Households

Summary of public consultations and key issues

375. The first meeting on the 25 July, 2013 was aimed at presenting the proposed project and seeking local people's views about the project. Participants were given an orientation of the project activities, location of project infrastructure facilities such as dam construction, ancillary facilities, access roads, adits, power house, muck disposal sites, staff colonies, potential quarries, and temporary camps using maps on the walls. The idea was to give local people an idea of the project footprint. The number of affected persons and type of land impacted that had been identified was presented and discussed and questions and clarifications were encouraged. Discussions were also held on existing problems in the villages.

376. **Key Issues**: Most people were concerned about minimizing the impact on their land as well as the environment in general and much of the discussion revolved around land being affected and compensation Participants felt that the meeting was very timely and proper land requirement by the project should be conducted and compensation issues should be sorted out well in advance of project implementation and infrastructure development. Employment for locals, opportunities for businesses, up gradation of the local school and learning from other existing projects like Punatsangchu and Mangdechu were emphasized.

377. The second meeting held on the 18th of September, 2013 was organized by the DGPCL and BHUCORE (local consultant) to present the ESIA to all stakeholders at Hotel Migmar. Feedback was sought from all stakeholders to improve the ESIA.

378. **Key Issues:** There were a number of recommendations from various stakeholders such as incorporation of studies already done by Park, taking care to ensure measures are in place for endangered species, local employment, acceptance of project by local communities, revisiting some of the figures in the report, allocation of funds to avoid duplication with other government projects, study on aquatic ecology and environmental flow, diversification of plantations during afforestation, allocation of more budget for afforestation, waste management and impacts by construction workers.

Action: All the issues raised have been incorporated into the revised ESIA.

379. The third and fourth meetings involved two public consultations organized on the 30th of October, in Tshangkha and Tangsibji Villages. A total of 90 participants attended the consultation. The Gewog Administrative Officer introduced the local consultant and explained the objectives of the meeting. He briefly explained how the Royal Government and DGPCL were seeking funds to implement the Nikachu Hydropower project with funding from ADB and the various studies being conducted. The Project Manager explained the various components of the project and the local consultant presented the EMP from the draft ESIA. A summarized EMP translated in the local language, Dzongkhag was handed over to the Gewog Administrative officer to keep in the Gups office for all to see and distributed to interested participants.

380. **Key Issues**: Discussions were held on location of project components such as access roads, tunnels, infrastructure and the impacts on locals. The project manager explained how the location of infrastructure was conducted to minimize the number of affected households. With respect to environmental impacts of the project, participants were of the view that since they did not know much about this the NEC and Department of Forest were the best agencies to take care of these issues. People were already preparing for the project in terms of building houses to rent to staff and planting crops and selling products. A discussion on the public consensus and what it meant versus no objection from affected persons followed by participants signing the consensus form.

381. **Action**: EMP has been revised to incorporate comments by the villagers on minimizing environmental impacts such as blasting, revision of the road alignment by project management and employment of locals.

382. A fifth meeting was organized on 9th December, 2013 by the DGPCL and Dzongkhag together. The objective was to get all the District officers as well as gewog staff and representatives on the same page with respect to the ESIA. The Director of DGPCL detailed all the project components and activities to the participants and the Environmental Officer presented the ESIA and EMP. Feedback was sought from participants on this. The minutes of

the meeting were prepared in Dzongkhag as it was being circulated to District officials and local representatives.

383. **Key Issues**: There were no serious issues as most stakeholders were already aware of the project. There was a query on the amount of budget allocated for EMP and it was explained that EMP budget was being increased. There were some discussions on the need for afforestation and monitoring of degraded areas, social compensation rates and appropriate timing of the compensation program before the project activities are implemented, generation of local employment and businesses for affected people, as well as provision of free electricity for affected persons, Other discussions revolved around inclusion of more budget and activities for conservation activities and a need to learn from the existing Mangdechu Project. The Dzongkhag officials said that the land assessment and finalization of Thrams were underway and almost completed so the exact size of land affected and affected households could be determined.

384. **Action**: These have all been incorporated in the revised ESIA and EMP

385. The ESIA was presented to national level stakeholders on 27 December 2013 at the NEC hall in Thimphu. NEC had invited all stakeholders from various government agencies to attend the presentation on the EIA and EMP. Discussions were held on the same and NEC informed the house that the Minutes of the Meeting would be circulated to all stakeholders and sent back to DGPCL. Also a field visit to the project site would be conducted following which more comments on the EIA would be further incorporated. The field trip wasfrom March 10-14, 2014. After resubmission of the final EIA and EMP, NEC will either request for more changes/information or grant clearance to the project.

386. **Key Issues**: The general opinion was that the ESIA was good and incorporated quite a bit of primary data. Data for four seasons is actually required and DGPCL said that they would collect this as the project progressed. A number of recommendations to improve the EMP were suggested.

387. **Action**: Data deficiencies were addressed and EMP revised according to comments

388. During the 7th Meeting, the DGPCL made a detailed presentation on Nikachhu Hydropower Project's (NHPPP) various components and infrastructure to be constructed, its environmental and social impacts, benefits of the project, mitigation measures to address adverse impacts, entitlements, compensation, and community development programs. The minutes of this meeting is in the Annex in Dzongkha.

389. Two more meetings (8 and 9th) were held at Tshangkha and Drakteng in April, 2014. Meetings were organized with representatives of the displaced families. In the meetings issues related to project components, land acquisition, land replacement, adequate and fair compensation, assistance to the gewog, wildlife damage to crops, and opportunities for displaced people were discussed. Details of the meetings can be referred to in the minutes of the consultations contained in appendixes.

390. Apart from the meetings, the local social consultant also contacted the gewog Tshogde (administration) at their office in Trashiling, Drakten and Langthel. Focus groups were carried out with them to discuss development potential of the gewog, solicit their views on the project, anticipate positive and negative impacts of the project, land acquisition and replacement, entitlement packages, compensation rates, and their participation in the project. The study team also met village representatives in five locations namely Sherpuchen, Tangsibji and Tshangkha, Drakten, and Langthel. Issues discussed were similar to those discussed with the gewog administration. It is vital to ensure prior information dissemination and transparency in all resettlement related activities of the project including land acquisition, land replacement, project impacts,

391. In conclusion, the people in the project area are aware of the potential project impacts and benefits, particularly related to land acquisition, compensation and resettlement

392. Based on the study a Resettlement Plan was prepared by assimilating information from a census of affected households, verification of affected land, focus group discussions with local administration, key informant interviews with village leaders and consultations carried out with affected persons, local communities and local government officials.

393. In the meetings issues related to project components, land acquisition, land replacement, adequate and fair compensation, assistance to the gewog, wildlife damage to crops, and opportunities for displaced people were discussed. Details of the meetings can be referred to in the minutes of the consultations contained in appendixes following this RP.

394. The gewog Tshogde (administration) was also consulted at their office in Trashiling, Drakten and Langthel. Focus groups were carried out with them to discuss development potential of the gewog, solicit their views on the project, anticipated positive and negative impacts of the project, land acquisition and replacement, entitlement packages, compensation rates, and their participation in the project. The study team also met Village representatives in five locations namely Sherpuchen, Tangsibji and Tshangkha, Drakten, and Langthel. Issues discussed were similar to those discussed with the gewog administration. It is vital to ensure prior information dissemination and transparency in all resettlement related activities of the project including land acquisition, land replacement, project impacts,

395. The people in the project area are aware, and generally supportive, of the project. DGPCL officials and the Social Safeguard Development consultant have conducted a series of meetings and consultations (seven consultations in total) with DPs and Dzongkhag Administration officials. Local residents and DPs are fully aware of the potential project impacts and benefits, particularly related to land acquisition, compensation and resettlement

396. The draft RP will be disclosed to the DPs, public, and stakeholders at the end of May 2014 for review and comments on the various mechanism and entitlements suggested for the implementation of the RP. The intention of this procedure is to receive comments from the project displaced families in particular so that appropriate suggestions can be incorporated in

the RP and also at later stages of implementation. Relevant components of the draft RP will be translated into Dzongkhag in a booklet form and will be distributed to all DPs, the Dzongkhag officials, and Gups one week prior to the RP disclosure consultation so that DPs and stakeholders have sufficient time to review the RP and discuss it among themselves before the actual disclosure consultation is held. Copies of the Dzongkha booklet will be placed at the Dzongkhag office, gewog offices, and office of the NHP. It will also be uploaded in the website of DGPCL.

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