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Royal Government of Bhutan
Ministry of Agriculture and Forests
Department of Forests and Park Services
Divisional Forest Office
Pemagatshel

FOREST MANAGEMENT PLAN

FOR

KHENGZORE FOREST MANAGEMENT UNIT

(1st January, 2019 – 31st December, 2028)

Prepared by:

Rabten, Forestry Officer, Pemagatshel Forest Division

Lhab Tshering, Forestry Officer, FRMD, Thimphu

Ugyen Wangchuk, Chief Forestry Officer, Pemagatshel Forest Division

Tashi Norbu Waiba, Sr. Forestry Officer, FRMD, Thimphu

Ugyen Tenzin, Sr. Forest Ranger, Pemagatshel Forest Division

Department of Forests and Park Services

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st January, 2019 – 31st December, 2028.

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of this Plan was given to the Divisional Forest Office (DFO), Pemagatshel, Department of Forests and Park Services (DoFPS), Ministry of Agriculture and Forests, Royal Government of Bhutan.

PROVISION FOR REVISIONS AND CHANGES

This Plan may be revised during the period when it is in effect. The Director, DoFPS has the authority to revise and approve Plan if major changes occur in the Forest Management Unit (FMU), or if new information becomes available that may have significant bearing on the implementation of the Plan. The CFO, Pemagatshel may be requested to prepare revisions and changes to the Plan for submission to the Director, DoFPS.

APPROVAL

This Plan was examined by a wide section of user groups, clients and organizations. The final version of the Plan was reviewed and technically cleared by the Head, FRMD and an environmental clearance was obtained from National Environment Commission Secretariat. It was then submitted to the Director, DoFPS, who, after further review and amendments, forwarded with his recommendation for approval to the Secretary, MoAF. The Secretary, MoAF, further reviewed and submitted the Plan to the Minister, MoAF for his approval for implementation.

Submitted for Approval:

Chief Forestry Officer
Forest Resources Management Division

Recommended for Approval:

Director
Department of Forests and Park Services

Recommended for Approval:

Secretary
Ministry of Agriculture and Forests

APPROVED

Minister
Ministry of Agriculture and Forests
Date:.....

རྒྱལ་ཡོངས་མཐའ་འཁོར་གནས་སྐྱངས་སྐྱོབ་ཚོགས།
དཔལ་ལྡན་འབྲུག་གཞུང་།
National Environment Commission
Royal Government of Bhutan

NECS/EACD/Dzo-PGatshel/3707/2019/ 1065

May 24, 2019

ENVIRONMENTAL CLEARANCE

In accordance with Section 34.1 of the Environmental Assessment Act 2000 this Environmental Clearance (EC) is hereby issued to Forest Resources Management Division (FRMD), Department of Forests and Park Services for the operation and management of Khengzore Forest Management Unit (FMU) measuring an area of 4096.35 hectares with annual allowable cut of 4,100 m^3 (Four Thousand One Hundred cubic meter) at Khengzore under Choekhorling and Khar Gewog, Pema Gatshel Dzongkhag with the following terms and conditions:

I. General

The holder shall:

1. comply with provisions of the National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation;
2. ensure that the operation and management of FMU is in line with Environmental Impact Assessment and Management Plan submitted for EC;
3. ensure that Annual Allowable Cut is fixed to 4100 m^3 (Four Thousand One Hundred meter cube) only;
4. ensure that no extraction of timber is carried out at the critical watershed;
5. ensure that local communities, properties and any religious, cultural, historic and ecologically important sites are not adversely affected by the operation and management of FMU;
6. restore the damage to any public or private properties caused by the operation and management of FMU;
7. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious, archeological, and/or ecological importance; and
8. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address.

II. Environmental standards

The holder shall comply with the Environmental Standards 2010.

III. Import and use of secondhand equipment and ODS

The holder shall:

1. ensure that import and use secondhand equipment and machineries are strictly prohibited; and

NEC, PO Box 466, Thimphu, Bhutan
T: (975-2) 323384/325856/324323/326993 Fax: (975-2) 323385
www.nec.gov.bt

2. ensure that import and use ODS are in line with the Revised Regulation on the Control of ODS 2008.

IV. Protection and management of water resources

The holder shall:

1. ensure that operation and management of FMU does not disrupt the water flow and pollute the water bodies; and
2. ensure that 30 meter or 100 feet buffer is maintained from the water resources at all times.

V. Waste prevention and management

The holder shall manage wastes generated from the project (labour camps, offices etc.) with the application of 4R (Reduce, Reuse, Recycle, Responsibility) principle and other environmentally friendly methods of waste management.

VI. Management of excavated materials and run-off

The holder shall:

1. dispose excess excavated materials generated during construction of access road and operation and management of FMU only at the pre-identified approved dumpsite; and
2. put appropriate measures for management of surface run-off to avoid erosion and landslides.

VII. Implementation plan

The holder shall prepare a detailed implementation plan focusing on the implementation of terms and conditions of this EC and submit to NECS within three (03) Months from the date of issue of this EC as per the reporting format attached herewith.

VIII. Monitoring and reporting

The holder shall ensure that the effective day-to-day monitoring of the EC terms and conditions are carried out by the environmental unit or designated environment focal person;

IX. Renewal and modification

The holder shall:

1. ensure that renewal of this EC is processed at least three months prior to its expiry along with a copy of EC and a report on the implementation of its terms and conditions as per the format attached herewith; and
2. obtain prior approval from NECS for any modification to the existing proposal/application.

NATIONAL ENVIRONMENT COMMISSION SECRETARIAT THIMPHU : BHUTAN

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Reservation

1. The NECS may stop the activity or impose additional terms and conditions, as may be deemed necessary; and
2. The EC shall be subject to periodic review and modifications as per Article 25 of the EA Act 2000, without any liability on the part of the Royal Government.

The holder may adopt best practices in executing these terms and conditions to avoid adverse environmental impacts.

Failure to comply with any of the above terms and conditions shall constitute an offence and the proponent shall be liable in accordance to the Environmental Assessment Act 2000 and/or existing environmental laws.

Validity:

This EC is issued with valid from **May 24, 2019 until May 23 2024** to Forest Resources Management Division (FRMD), Department of Forests and Park Services for the operation and management of Khengzore Forest Management Unit (FMU) measuring an area of 4096.35 hectares with the annual allowable cut of 4,100 m^3 (Four Thousand One Hundred cubic meter) at Khengzore under Choekhorling and Khar Gewog, Pema Gatshel Dzongkhag.

(Phento Tshering)
DIRECTOR

NATIONAL ENVIRONMENT COMMISSION
THIMPHU : BHUTAN

To,
The Chief Forestry Officer
Forest Resources Management Division
Department of Forests and Park Services
Thimphu

Copy to;

1. The Director, Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu for kind information.
2. The Regional Manager, Natural Resource Development Corporation Limited, Pema Gatshel for necessary action.
3. The Dzongkhag Environment Officer, Pema Gatshel Dzongkhag for necessary action.
4. Guard File (Dzo-PGatshel/3707/2019), EACD, NECS for record.

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ACKNOWLEDGEMENT

We would like to express my gratitude and appreciation to all the people who were involved in making this plan writing process a success. An immense appreciation goes to the staffs of Divisional Forest Office, Pemagatshel and Inventory Mobile team, FRMD, Thimphu for their assistance and support during data collection and information gathering.

We also would like to thank the officials of Forest Resources Management Division, particularly Mr. Lobzang Dorji, Chief Forestry Officer, Mr. Arun Rai, Dy. Chief Forestry Officer and Mr. Dawa Zangpo, Sr. Forestry Officer for their technical guidance during functional mapping and at various stages of plan writing. Immense gratitude is due to Mrs. Kezang Choden, Dy. Chief Forestry Officer and Mrs. Kunzang Lhamo, Sr. Fr for analyzing the inventory data.

Let us also not forget to thank Local Government Officials of Khar and Choekhorling Gewog for helping us export the data during the inventory. Immense gratitude is due to Tshogpa of Khalatsho and Khengzor village for helping us with all the necessity during the general inventory.

LIST OF ABBREVIATIONS

%	Percent
AAC	Annual Allowable Cut
CF	Community Forest
KFMU	Khengzor Forest Management Unit
CFO	Chief Forestry Officer
CGI	Corrugated Galvanized Iron
cm	Centimeter
DBH	Diameter at Breast Height
DFO	Divisional Forest Office
DoFPS	Department of Forests and Park Services
EIA	Environmental Impact Assessment
FMP	Forest Management Plan
FMU	Forest Management Unit
FNCA	Forest and Nature Conservation Act
FNCRR	Forest and Nature Conservation Rules and Regulations of Bhutan
FRMD	Forest Resources Management Division
GIS	Gewographic Information System
Ha	Hectare
km	Kilometer
LULC	Land Use and Land Cover
m	Meter
m^3	Cubic Meter
MC	Management Circle
mm	Millimeter
MoAF	Ministry of Agriculture and Forests
NEC	National Environment Commission
NRDCL	Natural Resources Development Corporation Limited
Nu.	Ngultrum
NWFP	Non-Wood Forest Product(s)
OB	Over bark
OP	Operational Plan
RGoB	Royal Government of Bhutan
RM	Regional Manager
RME	Reliable Minimum Estimate
RNR	Renewable Natural Resources
sp.	Species
TMB	Tree Marking Book
UIC	Unit-In-Charge
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
WC	Working Circle

EXECUTIVE SUMMARY

This is the first Management Plan for Khengzor Forest Management Unit. The Plan structure is as per the guidelines on forest management plan reflected in the Forest Management Code of Bhutan, 2004. It comprises of three parts:

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION
PART 2: FUTURE MANAGEMENT
PART 3: IMPLEMEMTATION OF THE PLAN

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

- The Khengzor Forest Management Unit (KFMU) is located in Pemagatshel Dzongkhag. Its boundary stretches covering certain parts of Choekhorling Gewog till the top of Khar Gewog. The Forest Management Unit falls within 91˚23´42.98″ and 91˚25´55.18″ East and 26˚51´36.02″ and 26˚58´46.74″ North.

- The total area of the FMU is 4,096.35 ha.

- The general terrain of KFMU ranges from moderate to steep landscape. The elevation of KFMU ranges from 300 m at the base to about 2,300 m at the ridge top near Dungkhar Goenpa, Khar Gewog.

- Although there is no settlement within the KFMU area, Khalatsho and Khengzor villages lie nearer to the FMU boundary. They have been depending on their community forest for the timbers and any other forestry products at the present days.

- Forest in KFMU consists of only broadleaf tree species such as *Quercus* sp., *Alnus* sp., *Nyssa*, *Betula* sp., *Altingia*, *Terminalia,* and etc.

- Total workable AAC of the Management Plan is 4,100 m^3. From this standing volume, 3,700 m^3 and 400 m^3 shall be allotted for commercial use and rural use respectively.

PART 2: FUTURE MANAGEMENT

- The overall Goal of the Management Plan is ***"to manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection"***.

- To facilitate the planning, implementation and recording of activities, the Khengzor FMU is divided into blocks and compartments. The FMU area is divided into four blocks: Dungkhar, Kharpadang, Pondure, and Khalatsho which have been further divided into compartments.

- Using forest function mapping Khengzor FMU has been divided into three Management Circles; Protection, Production and Non-production Management Circle. As Khengzor FMU has only one forest type, i.e. broadleaved forest, the Production Management Circle constitutes only one Working Circle.

- The prescribed Silvicultural System for the commercial harvesting is the Patch Cut System. Patch openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conducive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the patch and laying out annual coupes are given in detail in the Plan. For local use area, single tree selection system will be adopted.

- Working Annual Allowable Cut for the plan is 4,100 m^3. Out of which, 3,700 m^3 shall be allocated for commercial use and 400 m^3 for rural use.

- The harvesting of commercial timbers by NRDCL must be limited till Dungkhar Block, Compartment I, II and III only for the current plan period and in no case the harvesting should be diverted to other compartments unless approved by Head of the Department.

- In collaboration with the NRDCL, the Divisional Forest Office, Pemagatshel carried out detailed EIA and its findings are incorporated in preparing the Forest Management Plan. Using a series of environmental criteria outlined in the Environment Assessment Act, 2000 and adopted by the National Environment Commission, the guidelines recommended have been examined to ensure that the practice within KFMU meets the requirement.

- A 10 year financial forecast has been prepared for the FMU summarizing the total cost, revenue and royalties for NRDCL and the treasury (via CFO) for the plan period. The forecast is a projection based on the plan prescriptions and may not reflect the actual workings during the plan period.

PART 3: IMPLEMENTATION OF THE PLAN

- The CFO, Pemagatshel will be responsible for the implementation of this management plan and he will be assisted by the Forest Management Planner, Unit In-charge and other Unit staff.

- The Operational Plan will be prepared by the Unit In-charge annually in consultation with the CFO, Pemagatshel and NRDCL counterpart to facilitate the timely implementation of this management plan.

- FMU-level Management Committee chaired by CFO, Pemagatshel has been established to assist in objective setting and to ensure the smooth implementation of the Management Plan. The FMU-level Management Committee is comprised of the stakeholders of the FMU and each member has an equal right to say in the recommended management and implementation of the FMP. Planned activities to achieve the FMU management objectives will be discussed in the FMU-level Management Committee meetings.

- The Operational Plan activities will be reviewed annually whereas the mid-term review will take place every after fifth year of plan implementation. The final evaluation shall be carried out during the final year of plan implementation. FRMD will be responsible to initiate evaluation of activities in the FMU.

- Unforeseen circumstances may warrant deviations from Plan prescriptions and in such an event the CFO, Pemagatshel must obtain prior written approval from Head of the Department. The reasons for the deviations must be fully justified and approved deviations must be incorporated into the Management Plan during the next scheduled revision.

Actions Required by the FMU Plan	Responsibility
Implementation and Review	
The CFO Pemagatshel, will be responsible for the implementation of this Management Plan, assisted by Forest Management Planner, Unit-In-charge and other Unit staff.	CFO
A FMU-level Management Committee chaired by the CFO, will be established to ensure the smooth implementation of the Management Plan.	CFO
The CFO and UIC will ensure that only the silvicultural systems described in the plan will be implemented thoroughly and correctly.	CFO & FMU UIC
The CFO, FRMD, will ensure that the Plan is reviewed five years after implementation (mid-term review), and at the end of the plan period (end-of-term review)	CFO, FRMD
Monitoring and Evaluation	
The CFO will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD	CFO
The CFO, FRMD will ensure that evaluation is carried out at five years interval, based on the information collected by annual monitoring and other relevant information.	CFO, FRMD
Operational Planning	
A bi-annual Operational Plan will be prepared by the CFO to facilitate the timely implementation of this Management Plan, and should be submitted to FRMD by 2nd October every year, before the start of operating year.	CFO RM, NRDCL

The budget in the operational plan should be jointly developed by the CFO and RM, NRDCL and agreed by both.	CFO RM, NRDCL
The UIC will determine the location and extent of cable lines in the Compartment to be harvested annually, in consultation with NRDCL staff, as prescribed in the Operational Plan.	FMU UIC
The CFO and the RM, NRDCL will cooperate and coordinate to ensure that the logging operation and log out turn are conducted smoothly and in accordance with local and other demands.	CFO RM, NRDCL
The FMU UIC will ensure that stocking regeneration surveys are conducted as and when required.	FMU UIC
Artificial regeneration/plantation shall be carried out by NRDCL immediately right after commercial harvesting operations are completed.	RM, NRDCL
Fencing or other action to protect regeneration until their establishment shall be carried out by NRDCL in consultation with the FMU UIC.	RM, NRDCL
The FMU UIC will inspect the coupes when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	FMU UIC
Road survey, design and construction will be carried out by NRDCL.	NRDCL
NRDCL road engineers must follow acceptable standards, designs, estimates and provide supervision during construction to ensure that the standards are met.	NRDCL staff
Regular inspection will be conducted by the FMU staff to detect and report any pest and disease outbreaks to enable earliest possible remedial or preventive measures to be initiated.	FMU staff
Participatory Forest Management	
Records of all trees marked and issued for rural use from the Blocks and Compartments will be maintained by the Unit staff and furnished monthly to the CFO, Pemagatshel.	FMU UIC
Timber and non-wood forest products, including fuel wood, daphne bark, cane, rubia, and bamboo, can be allotted to *bona fide* local villagers.	FMU UIC, via Operational Plan
The views of stakeholders will be incorporated into the operational plans through the stakeholder representatives in the FMU-level Management Committee.	CFO
The FMU Management Committee Meeting shall be conducted as and when required to discuss and solve the emerging issues.	All FMU Committee Members

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PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location and Extend

The Khengzor Forest Management Unit is located in Pemagatshel Dzongkhag and it stretches from Choekhorling till Khar Gewog. The major portion of the area is situated in Khar Gewog (Map 1). The Forest Management Unit falls within 91˚23′42.98″ and 91˚25′55.18″ East and 26˚51′36.02″ and 26˚58′46.74″ North. The altitudinal range of the FMU ranges from about 300 m to 2300 m above sea level.

1.2 Area Statement

As per the Land Use and Land Cover map (LULC) classification, almost all of the FMU area is covered by forest (Map 2). About 99.34% of the land is covered by broadleaf forest followed by 0.56% by shrubs and 0.10% by landslides (Figure 1).

Table 1: Area Statement by Land Use

Land Use	Area (Ha)	Percentage Area
Broadleaf	4,069.15	99.34
Cultivated Agriculture	0.11	0.00
Shrubs	22.93	0.56
Landslides	4.16	0.10
TOTAL	**4,096.35**	**100.00**

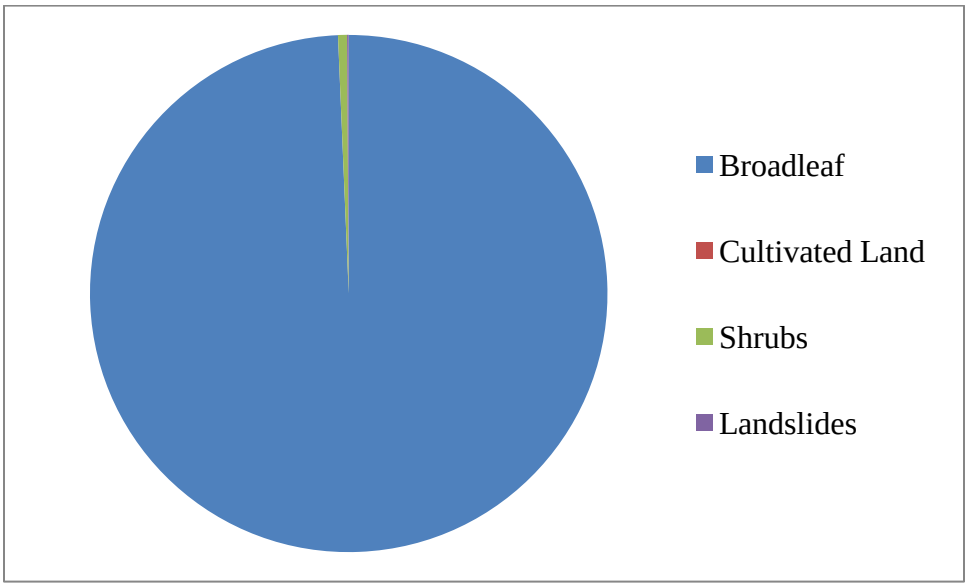
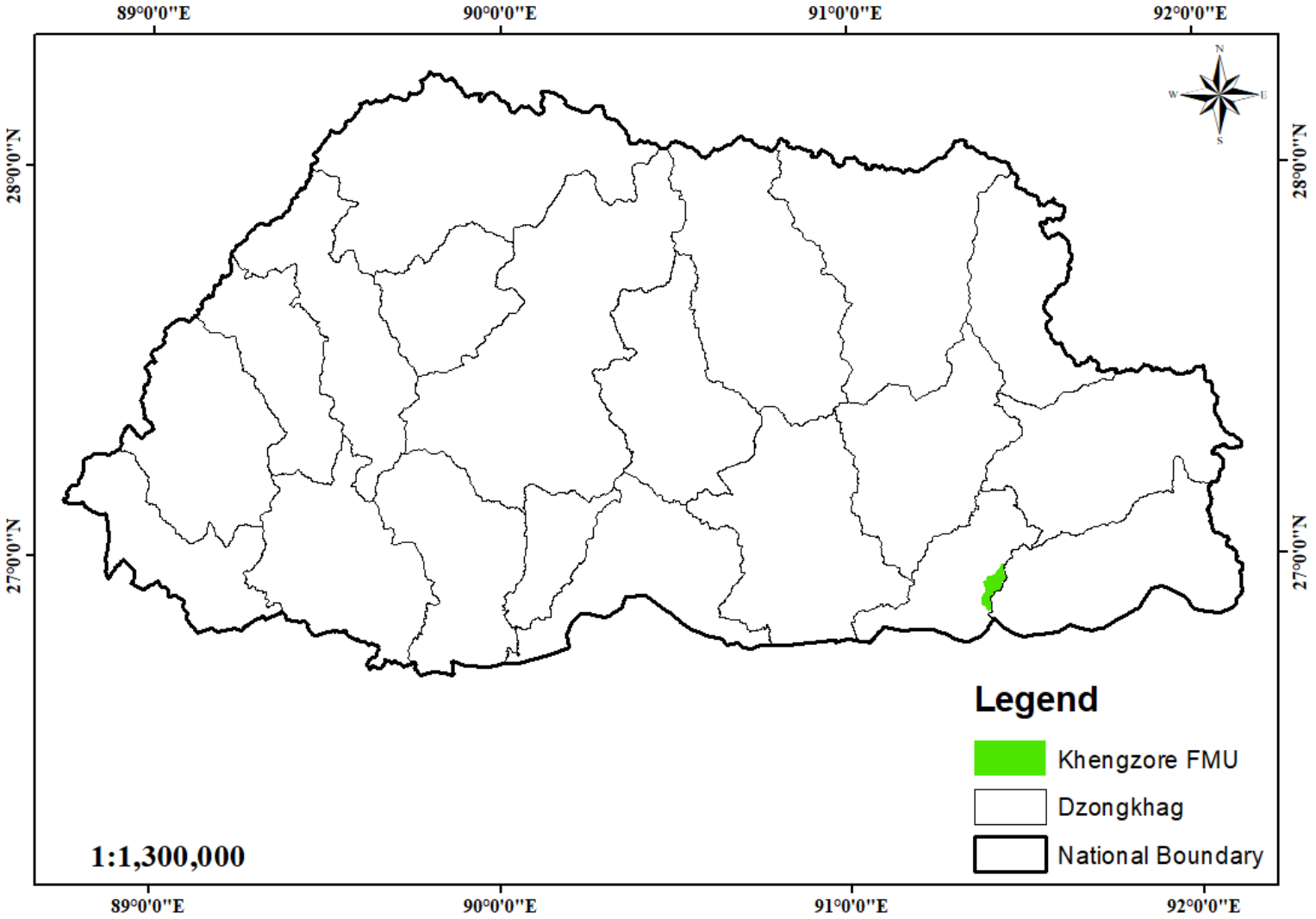
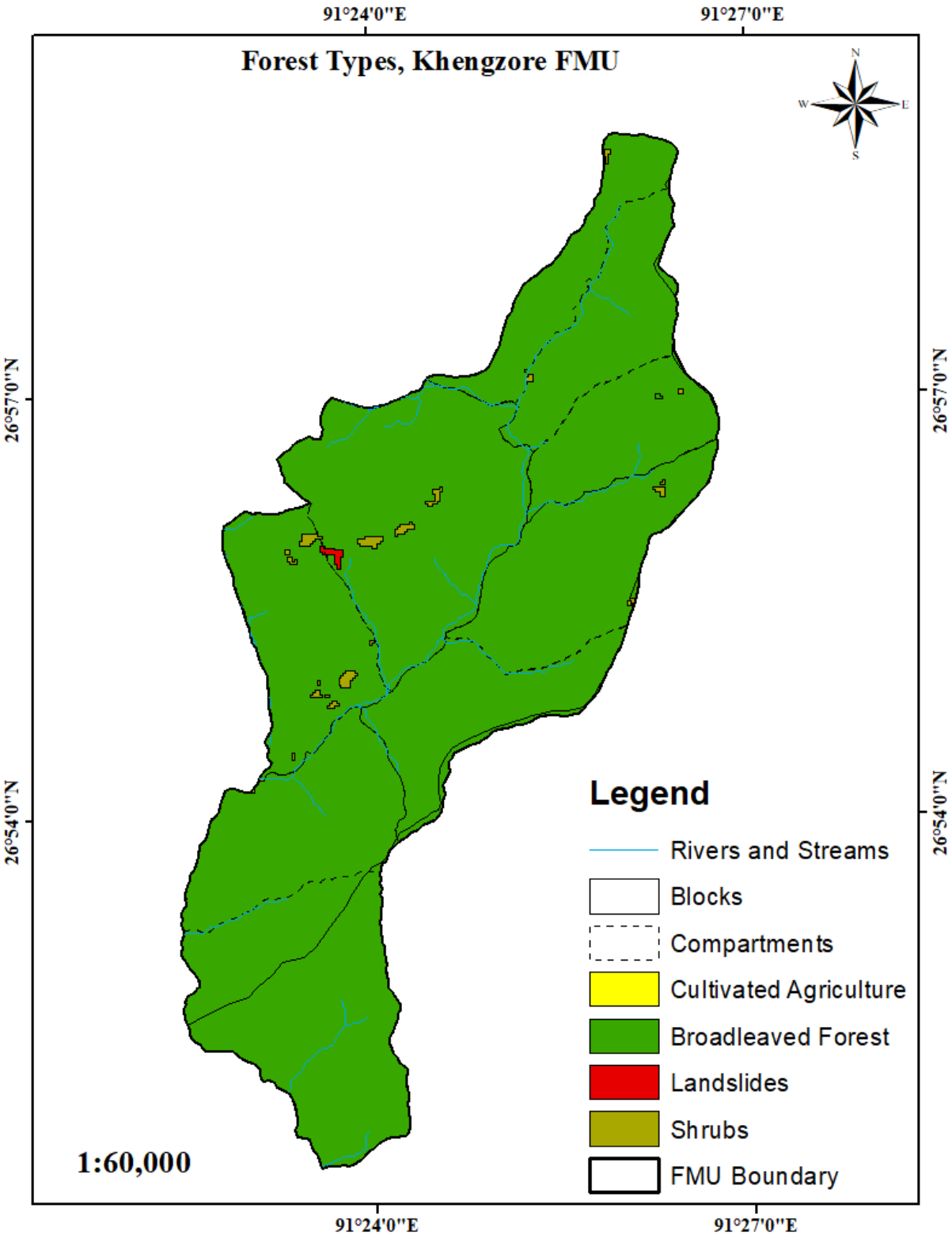


Figure 1: Figure Showing Land use by Percentage

Map 1:Location of Khengzor FMU



Map 2: Land-use and Land Cover



1.3 Historical Background

The local communities have been free access to the forest for timber, firewood and other non-wood forest produces since the time immemorial. However, there is no written plan for scientific timber harvesting from the Forest Management Unit till date. Timbers marking were done on an ad-hoc basis by the concerned Divisional Forest Offices.

Currently, the Divisional Forest Office, Pemagatshel is under pressure to meet the timber supply for new Dzong construction project and upcoming Denchi town in the Dzongkhag. The Dzong is still under construction and the structure of the new town is yet to start. In connection to this, the division was asked by the Dzongkhag Administration to come up with a FMU to meet the timber demand in the Dzongkhag.

Therefore, the division has come up with Khengzor FMU this year solely to meet the rising demand of timbers in the Dzongkhag. This FMU has almost 50/50 production and protection area due to the steep natural terrain. A medium resolution DEM (30m) was used during data analysis in GIS. The area is declared as FMU since the Dzongkhag has no other production scheme to meet the timber demand for Dzong construction and upcoming Denchi town.

The FMU is divided into four blocks which is further divided into nine compartments based on natural features. The production management circle constitutes of single working circle due to presence of only broadleaf forest. Working Annual Allowable Cut for the plan is 4,100 m^3, out of which, 3,700 m^3 shall be allotted for commercial harvesting and 400 m^3 for rural use.

1.4 Forest Condition

Khengzor FMU is almost a virgin forest in the Dzongkhag. No evidence of harvesting during the general resource inventory was found. The area has good stock but most of the areas are inaccessible due to steep natural terrain.

The FMU is rich in biodiversity. Besides some good quality timber tree species, it is also home for elephant, gaur, bear, sambar, deer, monkeys, reptiles, leopard and a tiger. Some evidence of direct sighting of wildlife has been reported by the inventory team.

1.5 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act, 1995, defines forests as ***"any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable right of use and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as Tsamdrog (grazing***

land) or Sokshing (woodlot for collection of leaf litter)". All such areas are considered as Government Reserved Forest and the entire KFMU falls within this category of state reserved forest.

1.5.2 Rights and Privileges

The right and the privileges of the local inhabitants, concerning the forest use is as per the Forest and Nature Conservation Act of Bhutan, 1995 and the National Forest Policy of Bhutan 2011. According to the Forest and Nature Conservation Act, grazing, collection of firewood, fodder and leaf mold for the domestic use is allowed either free or on royalty basis. Collection of firewood is permitted from only dead and fallen trees. Timber trees are issued for *bona fide* domestic use, after they have been marked by a Forestry Officials and royalty has been paid. Hunting wild animals is completely prohibited in the forest.

1.5.3 Grazing Rights

The local communities have the traditional rights for grazing their cattle in the forest within the forest management unit. There is no *Tsamdrog* as such within the KFMU at present. According to the Forest and Nature Conservation Act of 1995, there is a provision for regulating grazing in Government Reserved Forest.

1.5.4 Water Rights

Local people nearby the FMU have traditional rights to use water from rivers and perennial streams for domestic purpose, such as consumption, irrigation and other uses. Prondu Chhu, Kharpa Chhu and Khengzor Chhu are the main sources of water besides many small streams and creeks present within the KFMU. These three streams ultimately form the tributaries for Khalatsho River.

1.5.5 Historical Monuments and Monasteries

Dungkhar Goenpa which was built in the 15^{th} century in Khar Gewog is located within the FMU. A buffer of 100 m has been delineated to protect this important religious site.

1.5.6 Proximity to Protected Areas

The total area of the KFMU is 4,096.35 ha. The FMU area is bordered by Biological Corridor number 5 in the south, Khengzor stream in the east, a ridge between Dewathang and Choekhorling in the west, and Miktanglaga ridge in the north.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

The general terrain of KFMU ranges from moderate to steep landscape. The lower slopes are moderately gentle and the upper slope being steeper. The terrain is moderate in some of the compartments although most of the areas are steep and mountainous. The elevation of KFMU ranges from 300 m at the valley bottom to 2,300 m at the ridge top. The terrain is separated by many perennial streams, which flows into the main river of Khalatsho.

Major part of FMU falls within 40 to 80% slope class. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place.

2.2 Climate

2.2.1 Meteorological Station

The climate and meteorology information of Khengzor FMU is collected by the only meteorological station located in Pemagatshel Dzong premises. The data has been obtained from the Meteorology Division; Department of Hydro-met Services, Ministry of Economic Affairs, Thimphu.

2.2.2 Temperature

The yearly maximum and minimum temperature of Khengzor FMU from the year 2006-2017 is given in the following table and graph.

Table 2: Average Temperature (Degree Celsius)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Max. Temp	20.9	20.3	20.4	21.1	21.2	19.9	20.4	21	21	21.4	21.9	22
Min. Temp	12.4	11.6	11.4	11.8	12.1	10.3	11.2	11.6	11.8	12.9	13.2	13.1

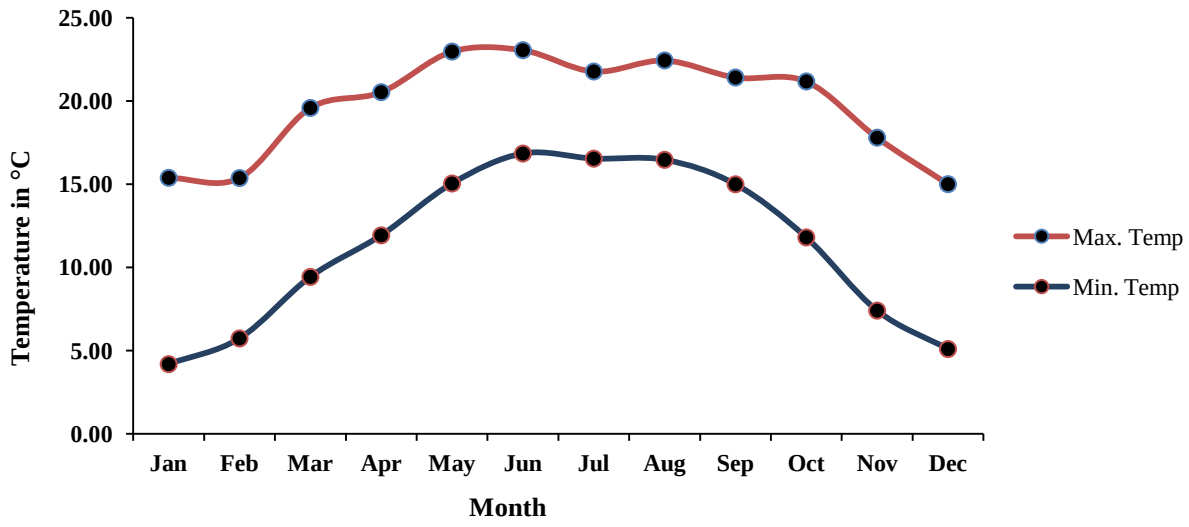


Figure 2: Graph showing Monthly Average Maximum and Minimum Temperature from 2006-2017

2.2.3 Precipitation

The precipitation of Khengzor FMU is expressed in the following graph from the year 2006-2017. During the monsoon, the rainfall can impact the commercial harvesting and transportation of timber to depot if the road is not maintained properly.

Table 3: Average Monthly Precipitation (in mm) from year 2006-2017

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Rainfall (mm)	0.3	0.84	1.78	3.94	4.25	10	11.69	8.48	7.02	2.29	0.25	0.04

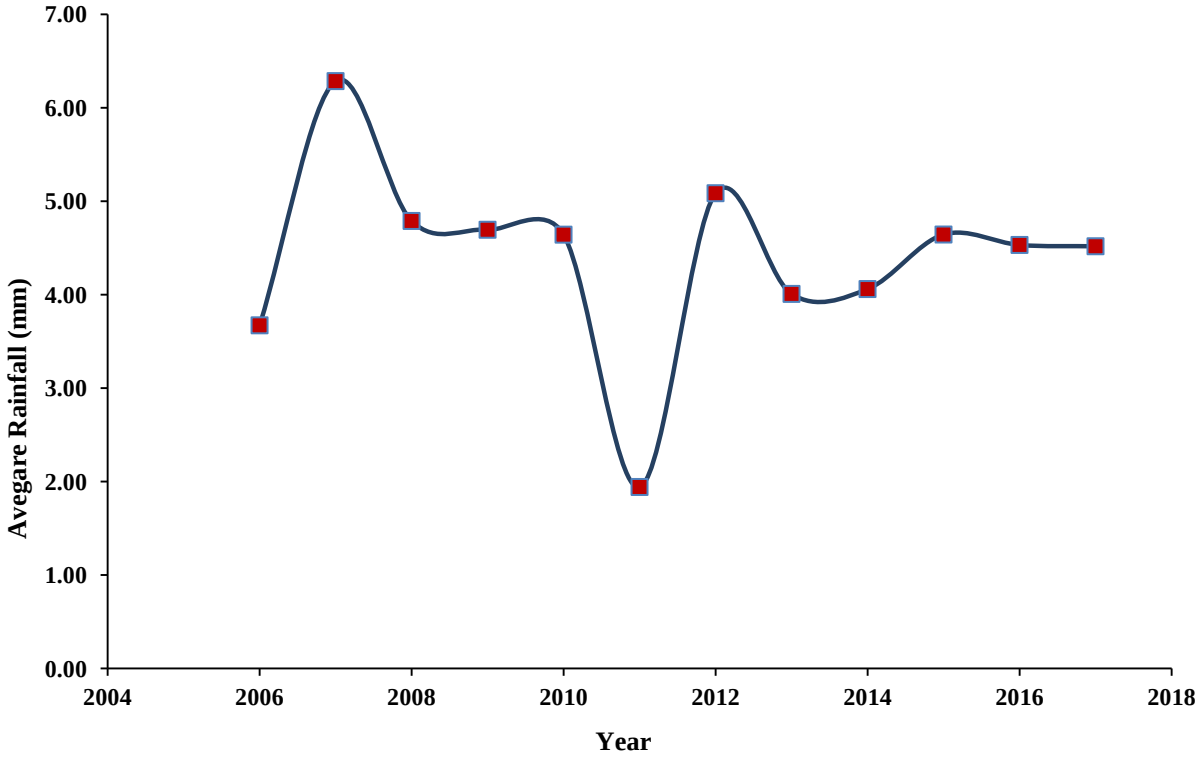


Figure 3: Graph Showing Average Annual Rainfall from 2006-2017

2.3 Geology and Soil

Major part of the FMU is covered by rock, stretching from bottom of the valley till top of the ridge. Hence, almost 50% of the FMU area is delineated as soil protection function. The soil is predominantly sandy loam and well drained in general.

2.4 Hydrology

There are three main streams within Khengzor FMU and no lakes. Khengzor Chhu, Kharpa Chhu and Prondu Chhu are the three main streams which ultimately joins the Khalatsho River. Beside these rivers, there are many perennial streams draining into the main river of Khalatsho.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

Khengzor FMU is located within the two Gewogs under Pemagatshel Dzongkhag. There is no settlement within the FMU area at present. However, Khalatsho village under Choekhorling Gewog is situated near the FMU boundary towards south. Likewise, Khengzor and Labar villages under Khar Gewog are located near FMU boundary towards northeast of the area. Khengzor and Labar village have their own community forest (CF) and the communities have been depending on CF for the timber and firewood till today. Certain provision to meet the rural timber demand for the local people may be kept from the FMU in case the timber requirement could not be met from the community forests.

3.2 Agriculture and Farming System

Main occupations of the people residing near KFMU are agricultural farming and livestock rearing. Potato is the main cash crop of Khengzor and Labar villages while ginger cultivation and Arica nut production is the main cash earning crops of Khalatsho village. However, the maize is the main staple food for all those three villages.

3.3 Traditional Use of Forest

People residing near KFMU have been dependent on the forest near the FMU since time immemorial. Timbers required for house construction, shingles, house repairs and various other purposes were extracted from the forest nearby FMU but there is no sign of timber being extracted from the FMU area. The provision for the rural timber supply to the nearby villages will be kept within KFMU and shall be supplied based on application from the designated areas.

3.4 Grazing

From the socio-economic survey and information from the Gewog RNR Livestock Office, it was found that there are 24 Jersey crossed, 15 Local and 3 Horses in Labar village, 30 Jersey crossed, 59 Local and 8 Horses in Khengzor village and 7 Jersey crossed, 15 Local and 4 Horses in Khalatsho village (Table 4). In order to reduce the grazing pressure on forest in future, introduction of improved varieties of livestock and awareness to the people may be looked upon by relevant agencies.

Table 4: Livestock Information

Village	Cow		Horse	
	Crossed	Native	Improved	Native
Labar	24	15	Nil	3
Khengzor	30	59	Nil	8
Khalatsho	7	15	Nil	4

(Gewog RNR Livestock Extension Office, 2017)

3.5 Wildlife

Wildlife survey was also carried out while carrying out the forest resource inventory. The survey was mainly carried out through direct and indirect sighting method. In the indirect sighting method, the scats, pugmarks, shredded antlers and territory markings were observed and recorded. The pugmarks of Tiger and small cats were observed during the transect walk. A herd of elephant, a Sloth Bear, the droppings of barking deer and Sambar were also sighted during the transect walk in the forest. During the socio-economic meeting, status of the wildlife was discussed with the local people. According to the local people the population of wildlife is more in KFMU area since the area is a thick and undisturbed forest. The different fauna present in Khengzor FMU as per the wildlife survey and information gathered from the local people is enlisted in Table 6 and Table 7.

3.6 Forest Fire

Until now, there is no record of forest fire incidence in the KFMU. Although, forest fire is not a regular phenomenon in broadleaved forest, proper monitoring and awareness to the local people should be carried out to certain extend.

3.7 Pest and Diseases

Pest and diseases in reality are always present in any type of forest. However, there is no record of any pest and disease that has caused major destruction in the forest.

3.8 Non-wood Forest Product

The main non-wood forest products present in the KFMU are bamboo, cane, daphne, and boulders and sand (Table 5). Growth of bamboo is found scattered in entire area. The non-wood forest products are not harvested at present moment; however, the FMU has high potential for such NWFP harvesting operations based on proper guidelines/management plans in future.

Table 5: NWFPs found in the area

Name of the NWFP	Provisional Uses
Bamboo	For making bamboo mats, fencing, construction of houses and livestock shed
Daphne	Paper making
Mushroom	For food
Rubus sp.	Fruits are consumed
Cane	Weaving baskets and shoots are consumed as food
Yula (Local)	Making Bangchung
Fern top	Consumed as food
Paris polyphylla (Satuwa)	Medicinal Value

3.9 Mineral Extraction

No record of mineral extraction from the FMU has been found.

4. ECOLOGY

4.1 Floral Association

Khengzor FMU is very rich in plant diversity. However, there are very few timber tree species in the area. The lower area, Khalatsho Block is dominated by tree species such as *Duabanga grandiflora*, *Bombax ceiba*, *Phoebe*, *Schima*, and *Ostodes*. The mid area, Pondure Block is dominated by *Quercus* tree species and *Carpinus*. Kharpadang Block is dominated by tree species such as *Morus*, *Terminalia*, *Exbucklendia*, and so on. While the top area of the FMU, Dungkhar Block is dominated by *Nyssa javonica*, *Exbucklendia*, *Castanopsis*, *Michelia*, and so on.

4.2 Fauna

The recent inventory shows the presence of variety of wildlife in the entire area. The following mammals and large birds have been recorded in the Khengzor FMU during the inventory:

Table 6: List of Mammal

Common Name	Scientific Name
Tiger	*Panthera tigris*
Asian Elephant	*Elephas maximus*
Gaur	*Bos gaurus*
Sloth Bear	*Melursus ursinus*
Sambar	*Rusa unicolor*

Barking deer	*Muntiacus muntjak*
Wild boar	*Sus scrofa*
Common Leopard	*Panthera pardus*
Gray Langur	*Presbytis entellus*
Assamese macaque	*Macaca assamenis*
Himalayan Serow	*Capricornis thar*
Hairy-footed Flying Squirrel	*Belomys pearsonii*
Himalayan Yellow-throated Marten	*Martes flavigula*

Table 7: List of Birds

Common Name	Scientific Name
Great Hornbill	*Buceros bicornis*
Lineated Barbet	*Megalaima lineata*
Great Barbet	*Megalaima Virens*
Blue-throated Barbet	*Megalaima asiatica*
Blue-eared Barbet	*Megalaima australis*
Golden-throated Barbet	*Megalaima franklinii*
Fire-tailed Sunbird	*Aethopyga ignicanda*
Plumbeous water Redstart	*Rhyacornis fuliginosus*
Crested Kingfisher	*Megaceryle lugubris*
Rufous-necked Hornbill	*Aceros nipalensis*
Himalayan Bulbul	*Pycnonotus leucogenys*
Hill partridge	*Arborophila torqueola*
Oriental Turtle Dove	*Streptopelia orientalis*
White-throated laughing thrush	*Garulax albogularis*
Common Hoopoe	*Upupa epops*
Black Drongo	*Dicrurus macrocercus*
Blue Whistling Thrush	*Myophonus caeruleus*
Long-tailed Broadbill	*Psarisornus dalhousiae*
Dusky Thrush	*Turdus eunomus*
Kalij pheasant	*Lophura leucomelanos*
Brown Bush-warbler	*Locustella luteoventris*
Large Hawk Cuckoo	*Hierococcyx sparverioides*
Oriental Cuckoo	*Cuculus optatus*
Barred Cuckoo Dove	*Macropygia unchall*
White-browed peculate	*Sasia ochracea*
Rufus-throated partridge	*Arborophila rufogularis*
Red-vented Bulbul	*Pycnonotus cafer*

5. SILVICULTURAL ASSESSMENT

5.1 Present Forest Types

Khengzor FMU consists of only broadleaf forest. The dominating tree species in the area are *Nyssa javonica*, *Exbucklendia* sp., *Phoebe* sp., *Terminalia* sp., *Quercu*s sp. and *Engelhardtia* sp. The maximum DBH observed was 190.2 cm while the minimum was 10 cm.

5.2 Plantations

There is no record of past plantation within the FMU. However, once the commercial harvesting operations commence and open areas are created, the need for artificial regeneration in the form of plantations will be inevitable. Moreover, as most of the broadleaved forest experience difficulty in getting natural regeneration, stocking of the forest through artificial regeneration would be necessary right after commercial harvesting operations are completed.

6. SOCIO-ECONOMICS

6.1 Common Source of Income

According to the information collected during the inventory and Socio-economic survey the main sources of income for the local communities nearby KFMU are agriculture and livestock rearing. Potato is the main cash crop of Khengzor and Labar villages while ginger cultivation and Arica nut production is the main cash earning crop of Khalatsho village. However, the maize is the main staple food for all those three villages.

7. CURRENT TIMBER DEMAND AND SUPPLY

The timber need for the rural communities residing nearby the KFMU is being met from their respective community forests except Khalatsho village. For this village they do not have community forest and the timber demand for construction and other uses could be met from the designated local use area of the FMU. The timber needs are mainly for rural house construction, renovation of rural house, cattle shed construction, fencing of farm lands and flag poles. When it comes to timber for commercial purposes, NRDCL is the sole agency who is going to harvest timber from the cable lines and ad-hoc activities for commercial supply.

8. ORGANIZATION AND ADMINISTRATION

8.1 Organization

Khengzor FMU falls within the jurisdiction of Pemagatshel Forest Division and is directly administered by CFO, Pemagatshel. A Unit In-charge will be identified to look after daily activities in Khengzor FMU. There will be several Foresters to assist him in the implementation of the management plan.

8.2 Health and Safety

Site specific Risk assessment seems necessary since most parts of the KFMU are in steep terrain. The major risks involved in the forestry operations are during:

a. Harvesting
b. Transportation

Following are the few recommendations to minimize hazards in the field:

- Ensure chain saws equipped with full functioning chain breaks
- Always ensure feller to keep two tree lengths apart while felling
- Deploy only trained power chain saw operators for felling operations
- Explain the dangers of falling timbers and overhead cable lines
- Stack timbers in the same direction and not to stack the logs too high
- Never approach or climb the log pile from the bottom of the slope
- Always dismantle a stack from the top rather than from the bottom.

It is recommended that NRDCL should initiate long term safety measures and ensure its improvement as we proceed.

8.3 Record Keeping

Maintenance of record in the FMU office is indispensable. Information will be useful for the future planning and management prescription purposes. The Unit Office shall maintain records of all the activities within the FMU as per the record-keeping format reflected in the Forest Management Code of Bhutan, 2004 and other guidelines issued by the Department.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Road

The construction of forest road will be mainly for extraction and transportation of commercial timber as well as rural timber from the FMU. The forest road construction will be carried out by NRDCL. The take off point of forest road falls just below the Khengzor Community Primary School (Map 11) and an approximately 10 kms of forest road will be constructed for this plan period.

9.2 Buildings

The Khengzor Forest Management Unit will be covered either from Gewog Range Office, Khar or the Divisional Forest Office, Pemagatshel at the initial phase but Division may have to come up with separate office structures for the Unit-In-charge and other supporting staff for smooth monitoring and implementation of management plan based on availability of budget. Similarly, the NRDCL also have to construct office structures for the staff for smooth functioning of the FMU.

9.3 Transport

Pemagatshel Forest Division is one of the new Divisions in the country and it is under developing stage in terms of structures, man power and equipments. Hence, no locomotive will be allotted separately for Unit In-charge. He/she may have to use his/her own vehicle to visit production areas and for other monitoring activities.

9.4 Equipment

The Divisional Forest Office, Pemagatshel does not have a sufficient amount of electronics and equipments and had to heir from FRMD during the resource inventory. However, the equipments are crucial for systematic collection of forest data and information for preparation of sound forest management strategies. Therefore, the Pemagatshel Division has to procure and distribute the following electronics and equipments for the KFMU:

- Laptop- 3
- Printer- 2
- Xerox Machine- 1
- Clinometers- 3
- Altimeter- 2
- Diameter tape- 4
- Measuring tape of various length- 5
- Compass- 3
- GPS Garmin- 4
- Walkie Talkie Set- 5
- Binocular- 2
- Digital Camera-1
- Tents- 5
- Knife- 5

PART 2: FUTURE MANAGEMENT

10. INTRODUCTION

The Constitution of Bhutan has the provision to maintain 60% of the total land as forest (Royal Government of Bhutan, 2008). This is reflected in the National Forest Policy, 2011 and also forms an important aspect of the developmental process of the country. This constitutional provision can be fulfilled by following scientific sustainable forest management practices which not only help us manage and utilize the forest, but also look into fulfilling the social, economic, ecological and cultural needs of present and future generations.

10.1 Forest Policy

Over the years, there has been increasing pressure on the environment and the natural resources, the alarming consequences of which are becoming evident in the increasing propositions. The National Forest Policy of Bhutan, 2011 consists of a long term goal, major policy objectives and specific statements to enable various aspects of forest production, use and management (Royal Government of Bhutan, 2011). It has five guiding principles i.e. equity and justice in terms of access, poverty alleviation through integrated approach, deregulation and devolution, integration of science and indigenous knowledge, and allowing import of logs and sawn timber (Department of Forests and Park Services, 2011).

According to the FNCA (1995) and FNCRR (2017), Management Plan needs to be prepared for all Protected Areas and for all forests where commercial logging is to be undertaken and needs to be approved before implementation (Department of Forests and Park Services, 2017). FNCA (1995) provides the legislative framework for the community participation in the forest management and streamline the preparation of supporting forest rules and regulations. The regulation lay out the best practices that apply nationwide. This plan has been prepared in line with the Act and the Forest and Nature Conservation Rules and Regulations of Bhutan.

10.2 Goals

To manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection.

10.3 Objectives

The objectives of Khengzor FMU are framed based on the different management circles identified to ease the implementation of the plan. The three management circles identified are Protection, Production and Non-production Management Circles. As different management circles are managed for different purposes, framing separate objectives can help manage, monitor and evaluate the areas with ease. However, there are instances where different management

circles share similar objectives. The objectives for management of the three management circles are as follows:

Protection Management Circle

- To conserve and enhance wildlife habitats and biodiversity
- To conserve and improve the health of the watershed
- To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people
- To prevent negative impacts due to forest resource use on religious sites and water quality.

Non-Production Management Circle

- To maintain and improve the forest condition
- To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people
- To ensure regulated grazing for livestock in the FMU
- To conserve the water catchment function.

Production Management Circle

- To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis
- To manage and harvest commercial timber on sustainable basis
- To protect the forest from illegal activities and grazing in regeneration areas
- To create employment opportunities for local people
- To maintain and improve health and safety measures during operation
- To conserve and enhance biodiversity within production areas.

10.4 Management Based on Forest Function

10.4.1 Introduction

Forest function mapping is the term used for grouping the different potential uses of the forest. The different forest potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. Forest function, in general, are not based only on subjective human demands, they are significantly and objectively limited by site condition of forest stand. For this reason, categorization of every forest stand into different forest function is mainly based on the dominant site, forest type, accessibility, slope, flora and fauna present. However, some forest function represents certain exception to this rule and these functions are designated on the basis of social importance (Forest Resources Development Division, 2004).

Forest function defines all the ecological, environmental and social function within the FMU, so as to balance the often diverging interest of commercial logging. Alongside it identifies areas of Production forest, Limited production forest and Protected Areas. It also provides the UIC with firsthand information on the location of different forest functions in order to enable him/her to specify the required management prescriptions and to control its implementation.

10.4.2 The main objectives of Forest Function Mapping are:

- To define different environmental and social functions of the forest and depict them on the map
- To identify Production, Non-production and Protection area within the FMU
- To provide a tool for the management planner for balancing the requirement of nature conservation, environment protection, social forestry, commercial timber production and also to provide spatial information required to compute the sustainable AAC (Forest Resource Development Division, 2004).
- To provide the Unit In-charge with information on the location of different forest function in order to specify the required management prescriptions on the ground and to control its implementation.

10.4.3 Function Groups

The functions used in this management plan are listed in table below:

Table 8: Different Forest Function used in the Plan

Soil Conservation	Water and Watershed Conservation	Nature Conservation	Social Function	Road Buffer
SP **Soil Protection**	**WRR** Riparian Reserve Protection	**NWP** Wildlife Protection	**SocRS** Religious Sites Protection	**RB** Road Buffer
SC **Soil Conservation**	**WLS** Local Water Supply Protection	**NWC** Wildlife Conservation	**SocL** Social (Local Use Only)	

10.4.4 Mapping Forest Functions

The forest function mapping was carried out to differentiate the forest area based on the function it provides. The mapping is carried out as per the criteria set for mapping based on the function groups. The details of criteria used to prepare forest function map for Khengzor FMU is given in Table 13. In this table, information for some criteria is not available or cannot be mapped at the

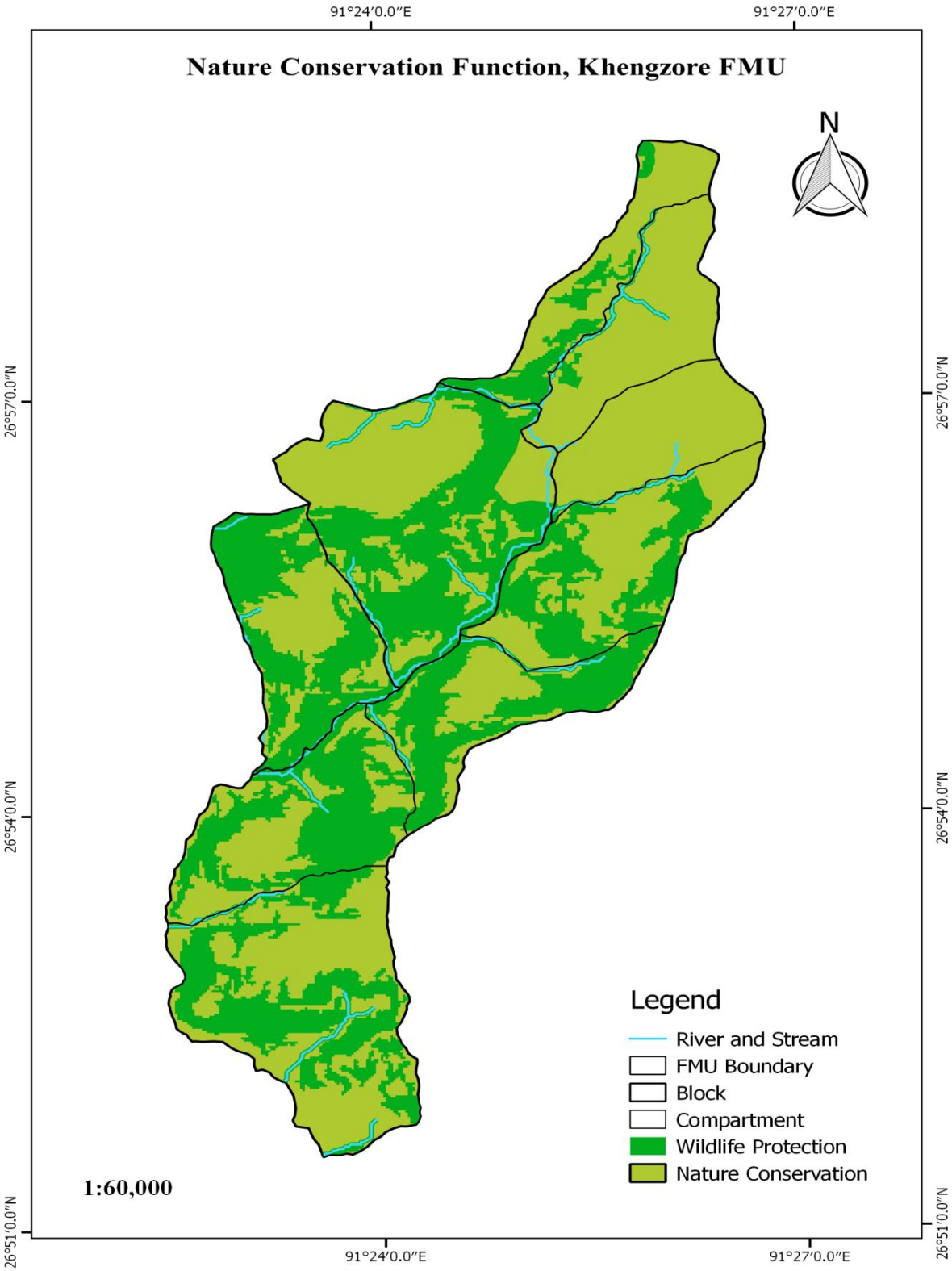
scale used for planning. These criteria are indicated in italics. When Operational Plans are prepared new detail is to be collected and these criteria should be implemented.

Table 9: Criteria for Mapping Forest Functions

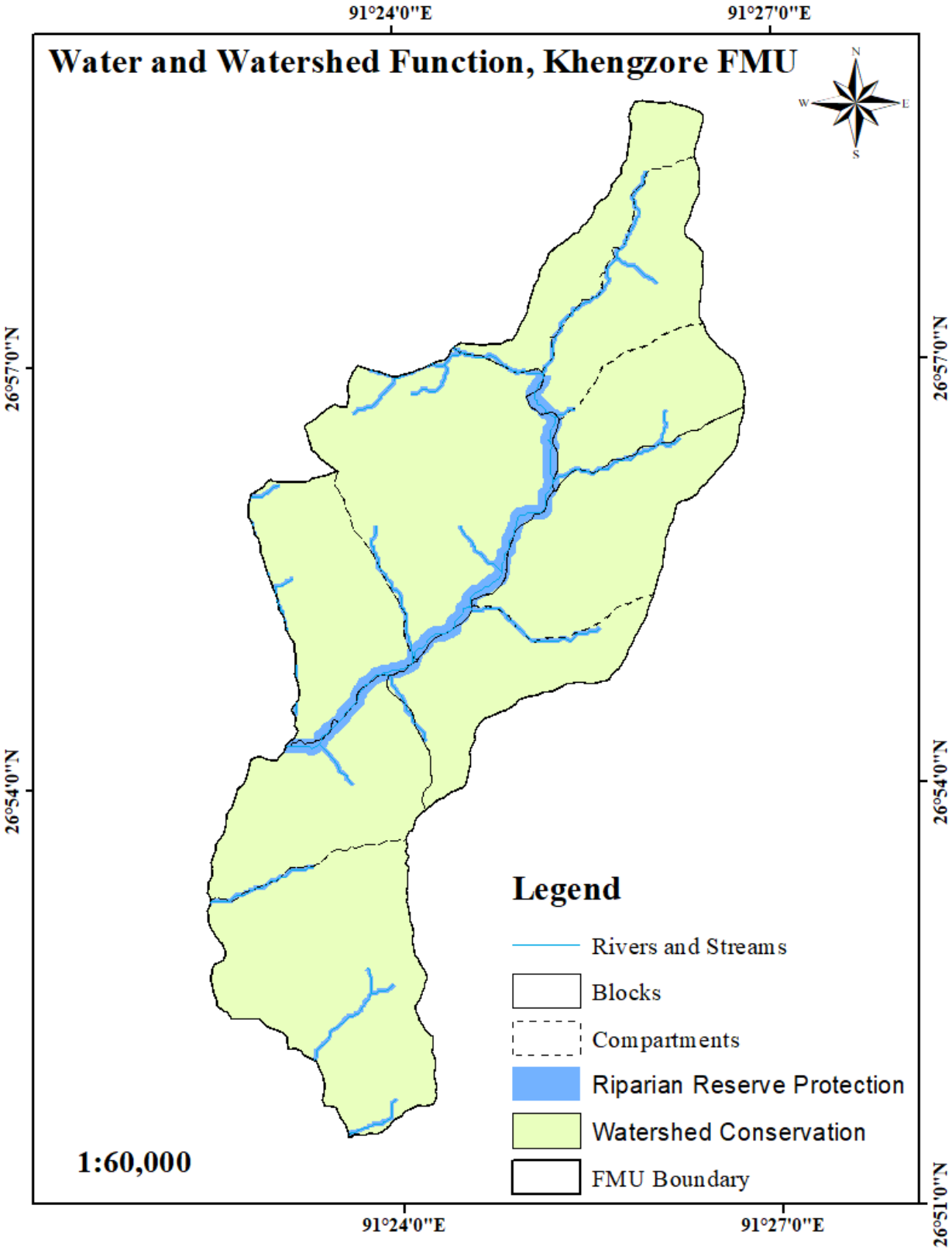
Function Group and Codes	Criteria for Mapping
Soil Conservation	**SP:** Very steep areas (slopes of greater than 100%), *areas with indication of slight to moderate erosion*. **SC:** Steep or sensitive areas (slopes of 76 - 100%)
Water and Watershed Conservation	**WSh:** Catchment areas of water courses, water retention areas. **WRR:** Areas within 30 m along all perennial streams, water logged areas, swamp etc. **WLS:** Upper catchment areas of streams serving as drinking water supply for settlement downstream.
Nature Conservation	**NWP:** Elephant and Gaur territory, *ecosystems of high conservation value*. **NWC:** Areas identified as biological corridors and all areas rich in wildlife, both in species and in number.
Social Function	**SocL:** Area close to or accessible to settlement or village, the areas traditionally used already, with definite boundaries. **SocRS:** Lhakhangs/ Goenpas, Gney and other religious sites.
Road Buffer	**RB:** 200 m uphill and 100 m downhill for motorable public road, 30 m uphill and 10 m downhill for unstable forest road.

(Forest Resources Development Division, 2004

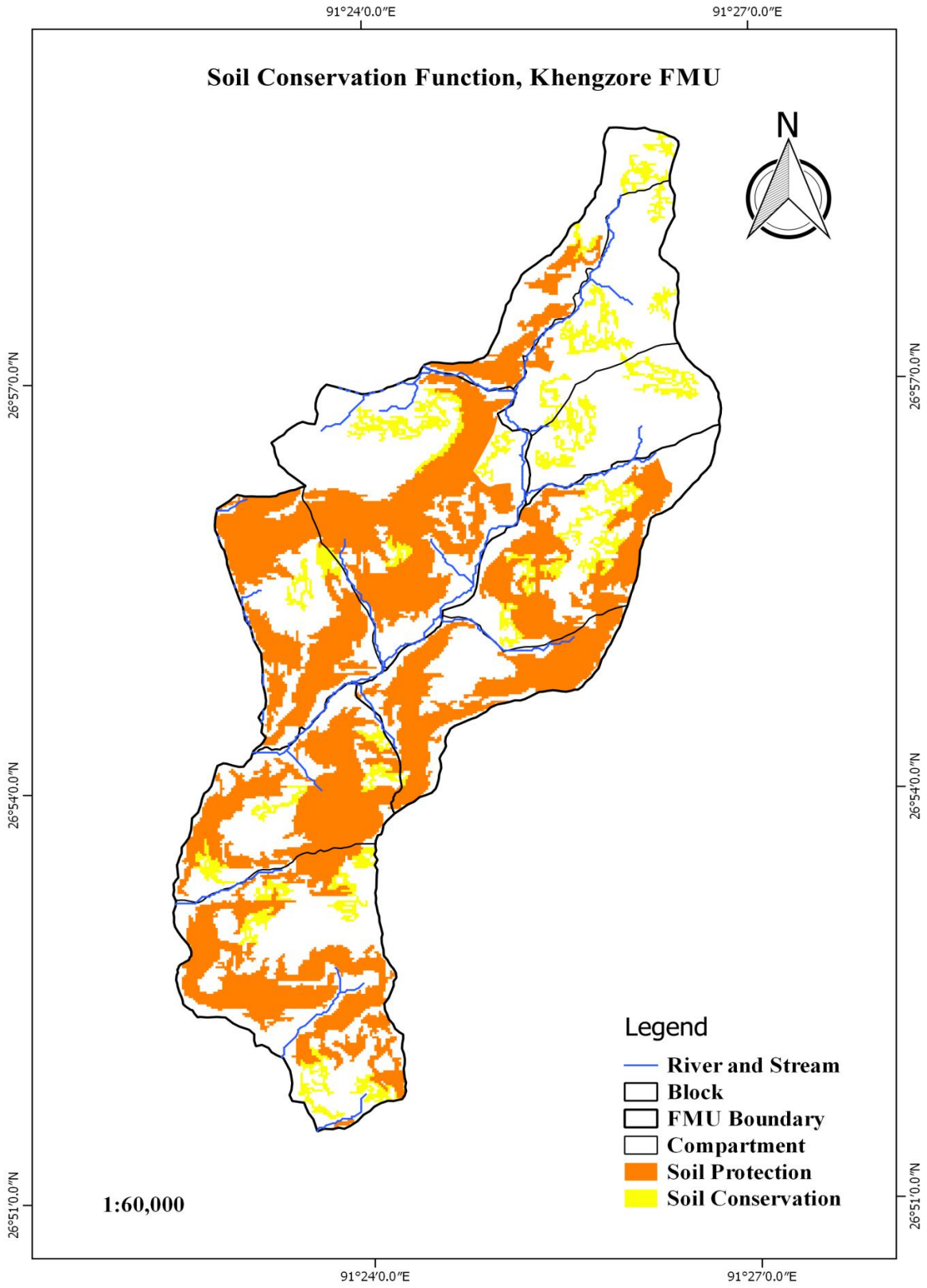
Map 3: Nature Conservation Function



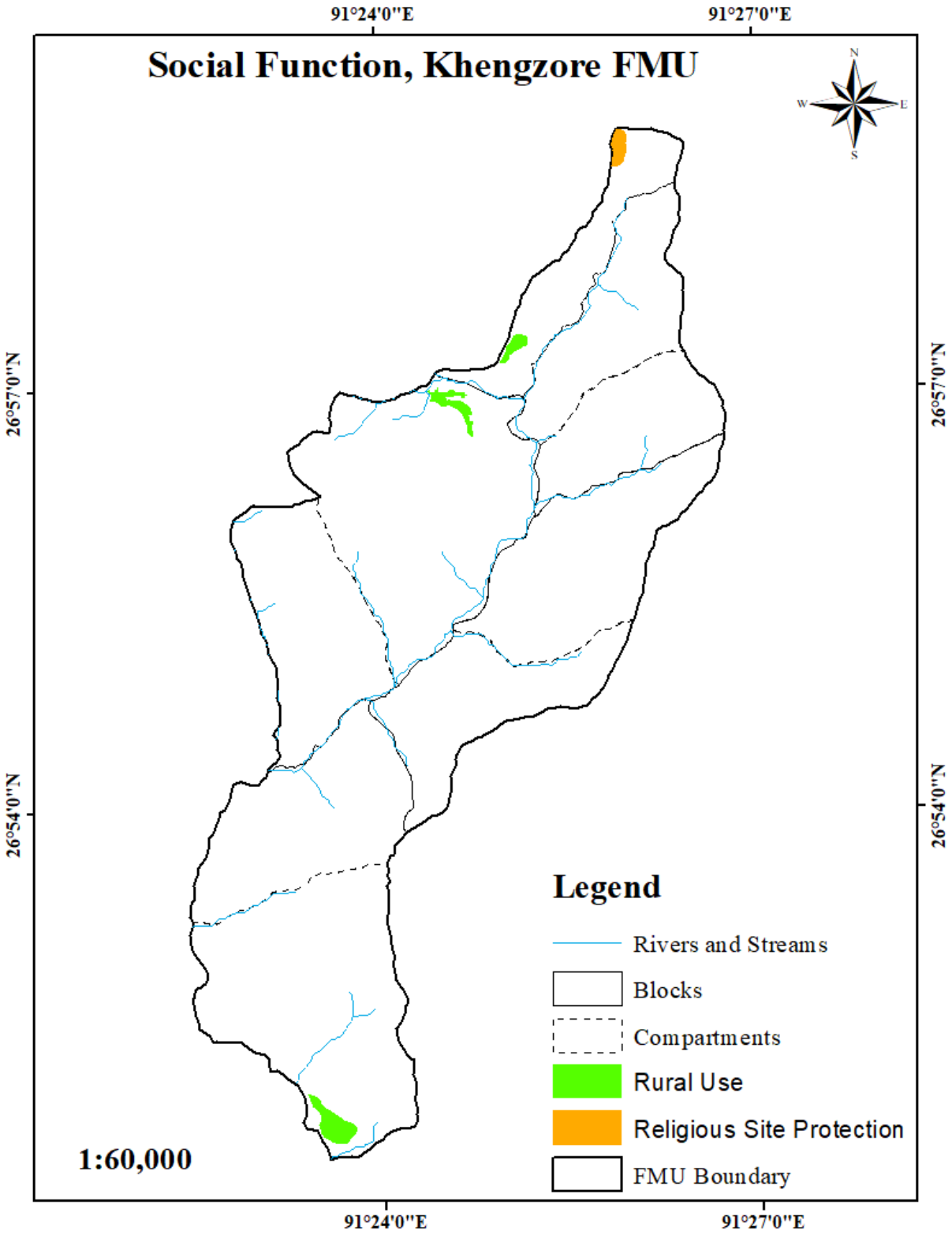
Map 4: Water and Watershed Conservation Function



Map 5: Soil Conservation Function



Map 6: Social Function



10.4.5 Restrictions of Forest Functions

The specific restriction to be applied to forest in the various function categories are summarized in table below:

Table 10: Forest Function Restrictions

Sl. No.	Code	Function	Restriction on Commercial Use	Restriction on Local Use
1	SP	Soil Protection	No commercial use	No tree felling, minimize human interference
2	WRR	Riparian Reserve Protection	No commercial use	Only collection of NWFP; no *tsamdrog*; no *sokshing*
3	RB	Road Buffer	No commercial use	No tree felling
4	NWP	Wildlife Protection	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife
5	WLS	Local Water Supply Protection	No commercial use	Low impact use only; no cattle grazing
6	SocRS	Religious Site Protection	No commercial use	Only uses which do not disturb the sanctity of the place
7	SocL	Social (Local Use Only)	No commercial use	No restriction
8	SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of rejuvenation periods	Low impact local use; no intensive cattle grazing
9	WSh	Watershed Conservation	No clear cutting; no conversion into plantation; minimize disturbance to understory vegetation	No intensive cattle grazing; low impact local use
10	NWC	Wildlife Conservation	No clear cutting; no conversion into plantation; leave snags; leave some undisturbed patches; minimize disturbance to understory vegetation (bamboo)	Low impact local use
11		Production	No restriction	No restriction

(Forest Resources Development Division, 2004)

11. QUANTITATIVE RESOURCE ASSESSMENT

11.1 Forest Management Inventory

Inventory Design of Khengzor Forest Management Unit

The forest management inventory of Khengzor FMU was conducted in 2017-2018 for the preparation of the first management plan. The standard FMU inventory technique was used, with data being collected for trees >10 cm DBH (OB). A total of 334 plots were laid over whole area of the FMU at a spacing of 350 m × 350 m, thus a plot representing an area of 12.25 ha. The inventory was designed with target sampling error of +/- 10% at 90 % confidence level using the coefficient variation of 85%.

The general objective of the inventory was to make available essential background information for preparation of Management Plan. The inventory was carried out to provide accurate overview of the growing stock and regeneration potential of the natural forest in the area, according to major forest types. Further, it was also intended to provide an overview of the general characteristics of the natural forest, indication of timber quantity and furnish essential data on tree height to generate local volume table for main species.

11.2 Forest Management Inventory Result

The data obtained from the forest management inventory was analyzed by the Inventory Section, FRMD using statistical software called 'R'. As per the forest management inventory of the FMU carried out in the year 2017-2018, the average standing volume per hectare was found to be 245.38 m^3/ha with a standard error of 10.705%. The average number of trees per hectare in the FMU was estimated at 286 with a standard error of 6.091%. The basal area per hectare was estimated to be around 28.8 m^2 with a standard error of 8.264%. The summary of the inventory results is shown in the table below:

Table 11: Summary of Inventory Results for overall FMU area

Result Type	Results	Standard Error	Margin of Error	Confidence Interval Low at 90%	Confidence Interval High at 90%
Total Area of FMU (ha)	4096.35	NA	NA	NA	NA
Number of Plots	334	NA	NA	NA	NA
Number of Trees per Hectare	286	6.091	17.425	268.637	303.488
Basal Area per Hectare (m^2)	28.8	8.264	2.380	26.426	31.188
Volume per Hectare (m^3)	245.38	10.705	26.269	219.111	271.650

11.3 Average Volume per hectare

The average volume per hectare is 219.11 m³. The number of trees in the lower diameter class is abundant; hence, it will replace the larger diameter class as they are being harvested down the line. The distribution mean volume per plot and number of tree distribution in different diameter class are given below:

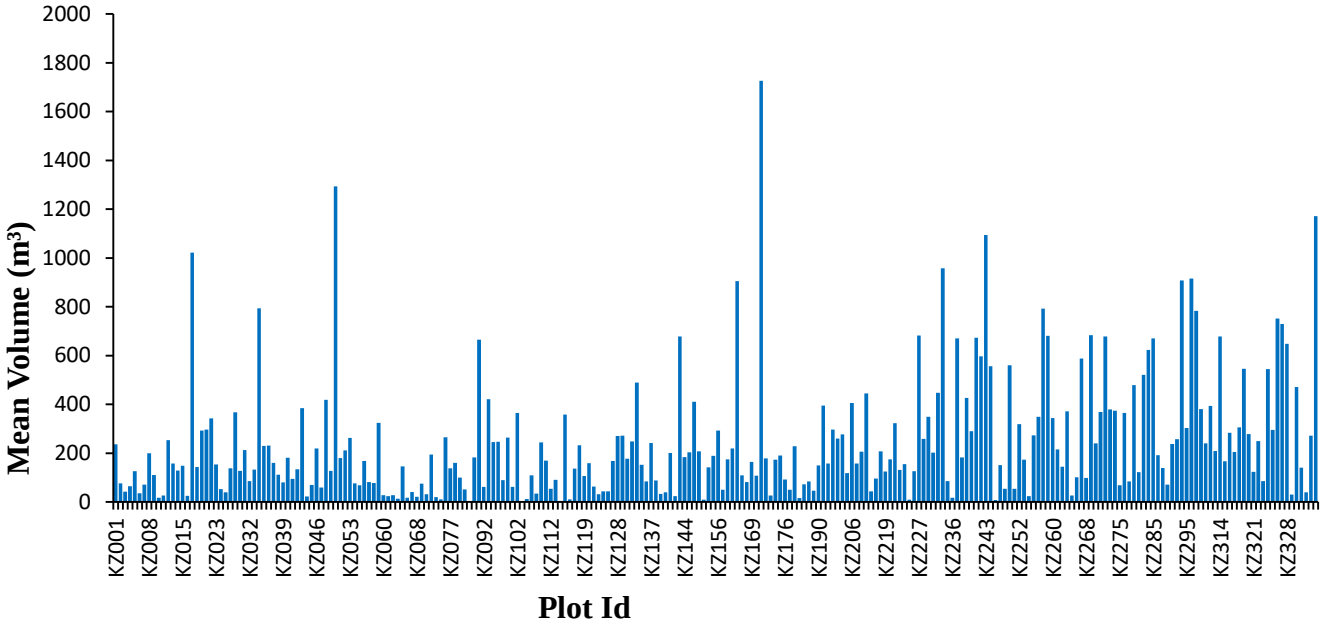


Figure 4: Graph showing the distribution of mean volume per plot

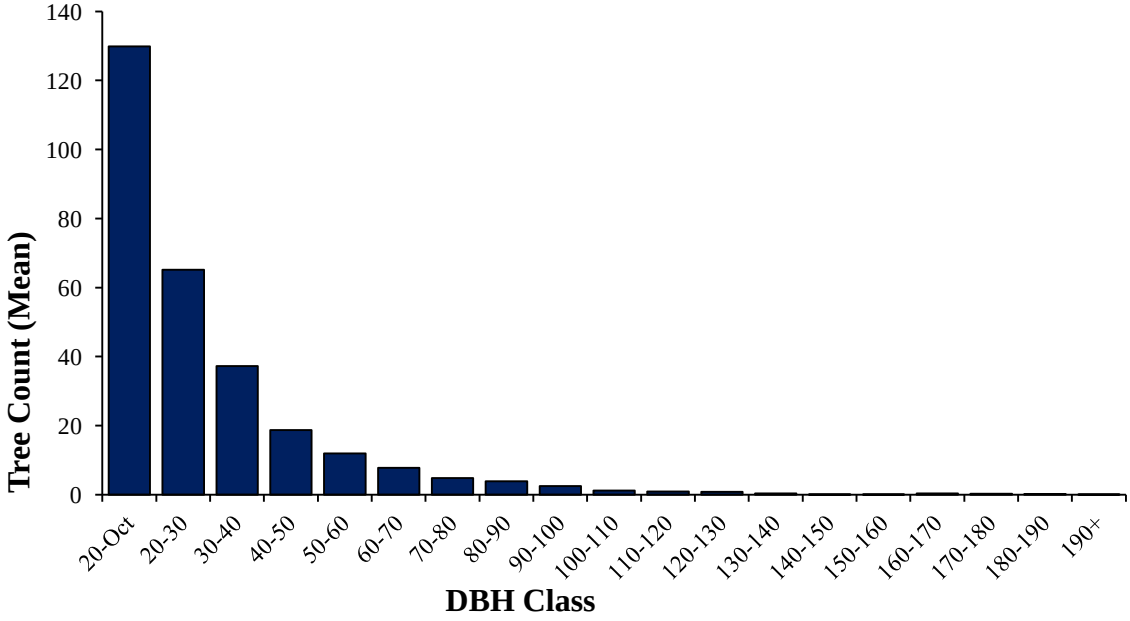


Figure 5: Graph showing the number of trees in different diameter class

12. AREA ORGANIZATION

12.1 Spatial Organization

The strategy for forest resource management begins with the formation of working circle and miscellaneous regulation. Therefore, the formation of working circle is an important step in planning process. However, there is only a broadleaf working circle for Khengzor FMU. The working circle is further divided into blocks and compartments. However, we could not further divide the working circle into sub-compartments due to very small FMU area. The blocks have been demarcated according to the natural features such as streams and ridges. The composition of the blocks and compartments are given in Table 12:

Table 12: Block and Compartments

Sl. No.	Blocks	Block Area (ha)	Compartments	Compartment Area (ha)
1	Dungkhar	867.09	Dungkhar I	249.55
			Dungkhar II	331.85
			Dungkhar III	285.69
2	Kharpadang	818.66	Kharpadang I	353.98
			Kharpadang II	464.68
3	Pondure	1218.38	Pondure I	424.35
			Pondure II	794.03
4	Khalatsho	1192.22	Khalatsho I	735.88
			Khalatsho II	456.34
	Total	**4096.35**		**4096.35**

Cable lines are usually aligned along the stable, well-stocked ridges and slopes and away from environmentally sensitive gullies and valley bottoms. According to the Forest Act, the felling of trees along the river banks, streams and in steep gullies is not permitted. The block boundary, as far as possible, follows permanent ridges and streams to a point where a spur easily recognizable on the ground leads to a ridge top. This will facilitate the recording of removals by cable lines and blocks (Rai, 2007).

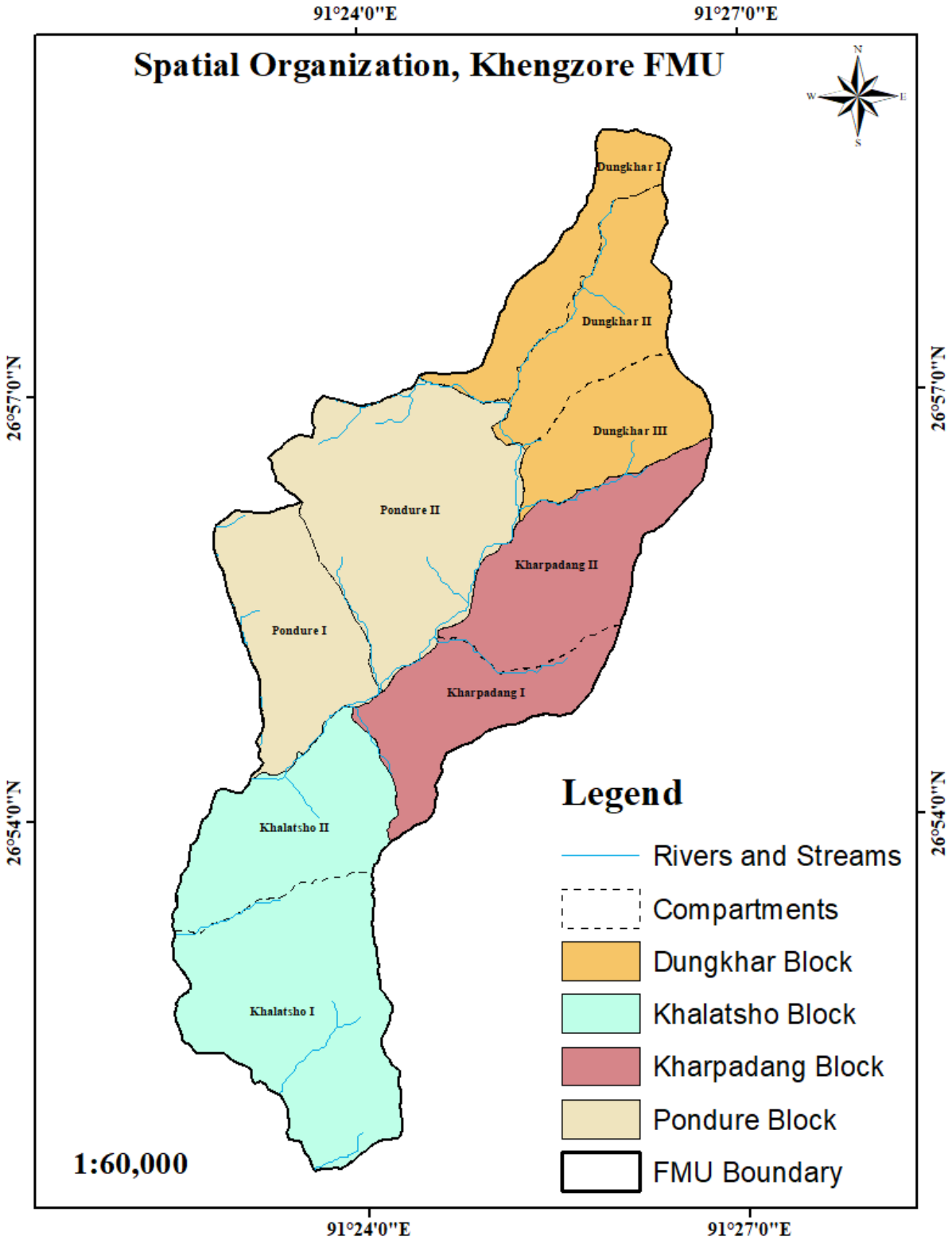
During the Forest Function Mapping, the production areas have been separated for local use and commercial use. In the FMU-level Management Committee meeting, it was agreed that demarcation of separate areas will be done, and production forests will be shared. However, preference will always be given to native inhabitants for rural timber and NWFPs.

12.2 Determining Operable Area

Forests are managed for multiple purposes. The roles of forest to people are immense. The multiple uses of forests are generally protective, source of food, climatic, productive, scientific, recreational, etc. But while managing a unit area of forest, all such purposes cannot be equally harmonized. One purpose has to take priority over the other. The area for commercial and rural forestry activities are those that are left after areas for other critical functions were identified and mapped out, using GIS and inventory information. The functions that take priority over commercial and rural forestry activities are:

- Soil protection areas (slopes greater than 100%)
- Soil conservation
- Agricultural uses
- Riparian buffers and zones
- Local water supply protection
- Biodiversity areas (wildlife conservation and protection)
- Religious site protection
- Road buffers.

Map 7: Spatial Organization of Khengzor FMU



12.3 Organization into Management Circles and Working Circles

Function mapping was used to delineate three broad management circles for Khengzor FMU. The three broad management circles for Khengzor FMU are Protection, Production and Non-production Management Circles.

Table 13: Area Statement for Management Circles and Working Circles

Management and Working Circles	Area (ha)
Protection Management Circle	
Soil Protection	1,574.48
Wildlife Protection	1,574.48
Riparian Reserve Protection	273.14
Religious Site Protection	8.65
Non-production Management Circle	
Shrubs	22.93
Agricultural Land/ Cultivated Land	0.11
Landslides	4.16
Production Management Circle	
Broadleaved Working Circle	2,275.30

12.4 Management Circles

12.4.1 Protection Management Circle

The Protection Management Circle is the sum of all protection functions; wildlife protection, soil protection, riparian reserve protection, and religious site protection. Commercial harvesting activities are strictly prohibited in this management circle. The total area under protection management circle is 1,793.85 ha. The removal of trees may be permitted in the Protection Management Circle to deal with outbreaks of pest and diseases. The outline of management objectives and options of the protection management circle are given below.

Table 14: Protection Management Circle

Management Objectives	Management Options	Responsibility
To conserve and enhance wildlife habitats and biodiversity	• Avoid disturbance • Promote research and habitat improvement activities	Territorial Division
To conserve and improve the health of the watershed	• Minimal intervention	All Parties
To meet the local demand for NWFPs on sustainable basis in order to improve socio-economic status of the people	• Regulate extraction of NWFP on sustainable basis • Carry out resource assessment	Territorial Division
To prevent negative impacts due to forest resource use on religious sites and water quality	• No interventions	All Parties

12.4.2 Non-production Management Circle

The Non-production Management Circle includes area where production is not economically feasible. It comprises of shrubs, landslides and agricultural lands. The total area under non-production management circle is about 27.20 ha.

Table 15: Non-production Management Circle

Management Objectives	Management Options	Responsibility
To maintain and improve the forest condition	• Silvicultural Operations • Regeneration	Territorial Division NRDCL
To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people	• Encourage people's participation in resource management and extraction • Promote community monitoring	Territorial Division
To ensure regulated grazing for livestock in the FMU	• Encourage high yielding livestock varieties • Fodder tree plantation • Involve local communities	Territorial Division and Local Government
To conserve the water catchment function	• Plantations • Keeping check on over exploitation of resources	Territorial Division, NRDCL and Local Government

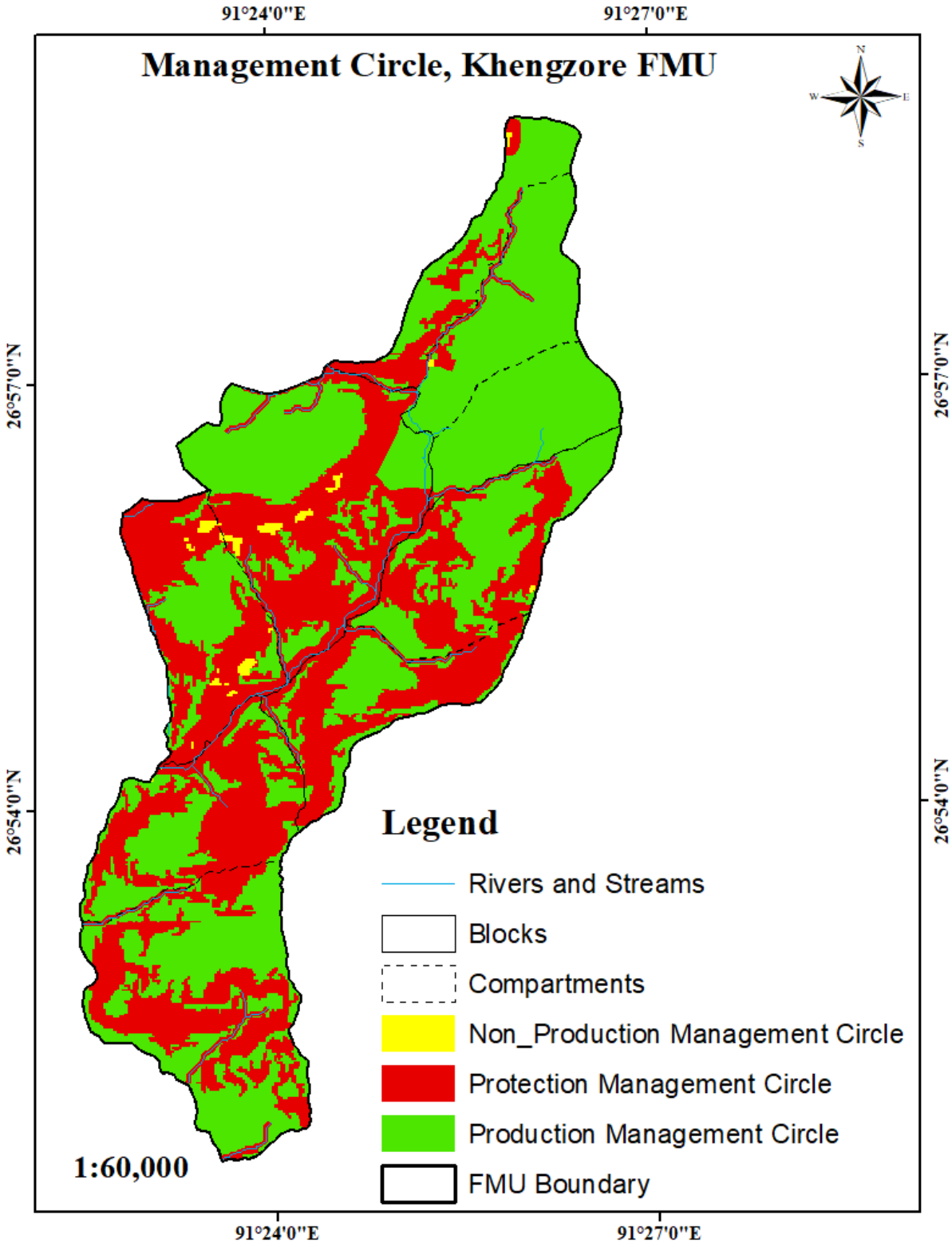
12.4.3 Production Management Circle

The Production Management Circle comprises of the area that has the potential for harvesting operations. It is the area left after delineation of protection and non-production management circles. This management circle comprises of areas which are well stocked with species which can be harvested on sustainable basis for both local and commercial uses. The total area under this management circle is 2,275.30 ha.

Table 16: Production Management Circle

Management Objectives	Management Options	Responsibility
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis	On the basis of single tree selection system from the identified local use area	Territorial Division
To manage and harvest commercial timber on sustainable basis	Patch-cut system	Territorial Division and NRDCL
To protect the forest from fire, illegal activities and grazing in regeneration areas	Surveillance and community monitoring Regulated grazing	Territorial Division and Local Government
To create local employment opportunities for local people	Involvement of local people in FMU activities	Territorial Division and NRDCL
To maintain and improve health and safety measures during operation	Enforce use of safety gears during harvesting work and road construction	NRDCL and Logging Contractors
To prevent negative impacts due to forest resource use on watershed functions and water quality	Minimal disturbance and plantation wherever required	Territorial Division and NRDCL
To conserve and enhance biodiversity within production areas	Monitoring and research activities	Territorial Division

Map 8: Management Circle under Khengzor FMU



12.4.4 Non-wood Management Circle (Overlapping)

In rural communities, non-wood forest produce forms a very important element to secure the livelihood of the people. It can also be an incentive for the local communities to conserve forests and take ownership of the resources for its sustainable management. The sustainable harvesting of NWFPs can help people generate income through selling these products in raw form as well as through value addition. However, it is important to introduce the scientific harvesting techniques and create awareness to the people on its harvest and marketing. This will contribute towards sustainable harvest of the available resources and sustain it for the future generations. Although, this management plan does not reflect detailed methods for harvesting of the NWFPs (except for bamboo harvesting), the Interim guidelines for harvesting and marketing of non-wood forest produce can be the basis to ensure its sustainability.

Viewing the contribution of NWFPs to uplift the living standard of the local people, the Non-wood Management Circle has been integrated in this management plan. It is designed as an overlapping management circle and the harvesting can be carried out as per the sustainable principles from all other management circles. The Territorial Division should monitor the collection and processing of the NWFPs from the FMU on regular basis to ensure its sustainability. As per the provisions of FNCRR, 2017, the communities should form NWFP Management Groups and by-laws should be developed accordingly for sustainable management and harvest of NWFPs. The groups should take full responsibility for managing the resources in close consultation with the Divisional Office.

Figure 6: Clump of Dendrocalamus sikkimensis

Bamboo

There are numbers of bamboo species found in the KFMU. The most important bamboo species found are *Dendrocalamus hamiltonii, Cinomonomum bambusa calosa, Dendrocalamus sikkimensis* (Figure 6), and *Neomicrocalamus andropogonifolius*.

The presence of *Cinomonomum bambusa calosa* is mostly concentrated in Pondure Block, *Dendrocalamus hamiltonii* and *Dendrocalamus sikkimensis* in Khalatsho Block, while *Neomicrocalamus andropogonifolius* is plenty in Kharpadang Block of KFMU. However, those bamboos are lying idle in the forest at present due to being far from the settlements. Only certain parts of Pondure Block are being visited by the

communities from Khengzor village and some cane shoots are collected occasionally. Otherwise, most of the NWFPs are left upon nature in the forest.

Economically, *Dendrocalamus hamiltonii* and *Dendrocalamus sikkimensis* are used to support in construction works besides weaving mat and fencing lattices. *Neomicrocalamus andropogonifolius* is used for making basket and decorative items. This species is not used for anything in this region, whereas it is widely used for making some decorative items in south central part of the country.

Management

Very little information on management technique of those bamboo species are known today. However, concerned technical experts might come up with some management techniques down the line.

General Harvesting Guidelines of Bamboos

Harvesting guidelines will differ with species. The following general guidelines may be applied:

- Immature culms less than 1 year old should not be cut.
- Immature culms of 1-2 years have very high water content and shrivel up when cut, which makes them useless for construction. Speed of development depends on the condition of the clumps and the position of the culm: If the clump is vigorous and the culm is in exposed position, it matures much sooner. The culms at the center of the poor clump mature more slowly (Haun et al.-1961 and Storey-1998, written in Bradshaw paper 2001).
- In a clump containing 12 culms or more, at least 6 mature culms over 1 year old should be retained, and in a clumps containing less than 4 mature culms over 1 year old, all mature should be retained during felling. Mature culms should be evenly distributed throughout the clump to provide mechanical support as well as nourishment (Gautam 1988).
- All culms older than 4 years should be removed.
- Culms should never become so overcrowded that they touch one another at the base. There must be sufficient space between them to allow movement of the cutting instrument (Sharma, 1988).
- The culms should not be cut lower than the first node above ground level, to ensure that the rhizome is not damaged and not higher than 30 cm (Gautam, 1988). Thinning the clumps reduces rhizome overcrowding and encourages the production of new culms in the center of the clump (Sharma, 1988).
- Damaged culms, debris and cut branches which may have become infested with shoot-boring moths (family: Pareuplexia) should be removed (Bahadur et al., 1980; Stapleton, 1985a) and burnt (Storey, 1988a), along with all dead and dry culms (Gautam, 1988).

- The culms should be severed by cutting round once with the blade of a patang (or any sharp knife) angled at 45 degrees to the stem, then again with it angled the opposite way to produce a wedge-shaped notch. This avoids splitting the culm (Storey, 1988b).

12.5 Management of Working Circles

The Production Management Circle consists of only broadleaf forest type (Map 9). The objectives, management options, responsibilities, monitoring and evaluation, and silvicultural system is given below (Table 17):

Map 9: Production Management Circle

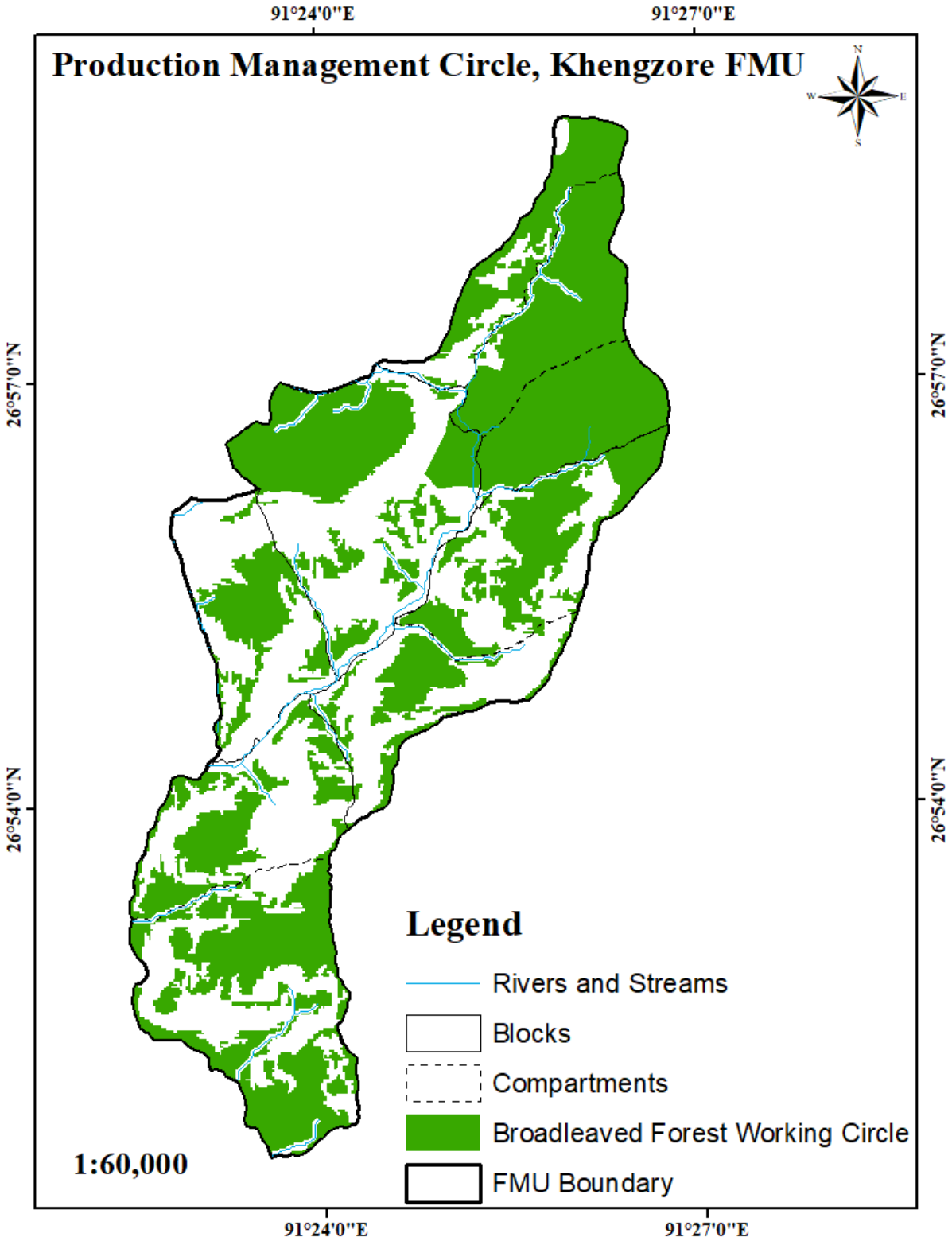


Table 17: Broadleaved Working Circle

WORKING CIRCLE: MIXED BROADLEAF				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To meet local requirements, as k priority, for timber, fuel wood and other forest produce on a sustainable basis	1. Consult with local community to ensure their needs for hardwood products (including lopping, etc.) are being met and resource is not diminished	1. Territorial	1. Territorial	***Patch-cut System*** The research finding has suggested that Patch Cut System is the appropriate silvicultural system apt for broadleaf forest. The patch will not exceed more than 0.25 ha and will be spaced in the interval of minimum 50 m. 4 m cable corridor will be maintained. Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL to maintain nursery at the site for artificial regeneration. Nursery to be stocked with local/native and commercial species.
To manage and harvest commercial timber on sustainable basis	1. Operate entire cable length 2. Ensure cable line layout allows interline logging 3. Use prescribed silviculture method and appropriate logging method 4. Encourage cleaning of entire cable lines	1. Territorial/ NRDCL 2. Territorial/ NRDCL 3. Territorial/ NRDCL 4. Territorial/ NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial	
To improve forest condition and other vegetation cover of the area	1. Minimal intervention	1. Territorial/ NRDCL	1. Territorial	
To create local employment opportunities for local people	1. Employ local people 2. Employ local contractor	1.NRDCL 2.NRDCL	1.NRDCL 2.NRDCL	
To protect the forest from grazing, fire and illegal activities	1. Control grazing, fire, illegal felling through	1. Territorial	1. Territorial	

	community participation			
To maintain biodiversity within the production area	1. Low impact silviculture systems	1. Territorial/ NRDCL	1. Territorial	
To conserve the water catchment functions	1. Minimal interventions 2. Abide by the buffers prescribed	1. Territorial/ NRDCL 2. NRDCL/ Territorial	1. Territorial 2. Territorial	

12.6 Implementing Working Circle Management

The Forest Function planning has been used in this plan to allocate land use among the forests in the FMU, so that strategic planning for sustainable yield can be carried out. The problem still remains to implement these prescriptions on the ground. Later sections indicate that this will be done through an Operational Planning process whereby more detailed information is collected through inventory and discussions with stakeholders, primarily local communities and NRDCL. However, even when this more detailed data is collected, the requirement remains to locate individual Forest Functions on the ground so that the prescriptions given can be implemented. Although, maps have been prepared indicating the boundaries of Forest Functions, the map indicating all Functions is quite complex. In addition, experience in the field indicates that the bases for all maps are derived, from the 1:50,000 topographic maps, which is often inaccurate and inappropriate for implementing Operational Plans.

Therefore, the Unit In-charge will have to use the provided maps to the best of their ability. Areas should be observed on the forest function maps prior to going to the field. Once in the field, visual observation within the operable areas should be able to provide the needed information. For example, stream buffer will occur in all the perennial streams and steep slopes should be measured and observed for soil protection or conservation. The forest function maps will be updated accordingly as per the field observations.

13. YIELD REGULATIONS AND HARVESTING

13.1 Determination of Annual Allowable Cut (AAC)

13.1.1 Introduction

Forest management based on the principle of sustainability ensures sustainable utilization of forest resources by present as well as future generations. The principle of sustained yield ensures the stability and continuous supply of raw materials to the industries and meets the local needs of the people. The concept of Sustained Yield allows harvesting of forest resources by which annual cut and other losses of timber do not exceed the average annual growth. It also assures continuity of harvest without harming the productivity of the soil. The calculation of sustained yield is expressed as AAC.

13.1.2 Increment Based AAC

In a perfectly structured normal forest, it should be possible to sustainably cut the annual increment each year. Some calculation methods rely heavily on increment. Unfortunately, data on increment is still limited for country as a whole. The forests are not perfectly structured, but have very varied natural growing stock. In the long term, increment should increase as over matured stands are replaced by younger stocks, but it will be many decades before this second growth is available for harvest. There is an over-matured growing stock and too little and unreliable increment data to be used in determining AAC. Therefore, increment based AAC is currently unsuitable for Bhutan.

13.1.3 The Most Appropriate AAC Method

Annual Allowable Cut can be calculated using a wide range of formulae but the most suitable formula used for the purpose of this management plan is the combination of area, rotational age and standing volume of species. The formula used for calculation of AAC for Khengzor FMU is given below:

$$AAC\ per\ Working\ Circle = \frac{Net\ Operable\ Area}{Rotation} \times Average\ Standing\ Volume\ per\ Ha$$

This method is applied for calculating total AAC.

13.1.4 Calculation of AAC for Khengzor FMU

Net Operable Area

The total operable area is identified through mapping using GIS technique. But it has been observed that in most of the FMUs, the total operable area cannot be always subjected to harvesting. Within the mapped area there can be small rocky terrain, water bodies and other conservation areas which often prevent harvesting operations. This occurs mainly when the cable

lines are being laid out. Beside this, Patch Cut System almost inevitably leads to some patches of mature timber being left in later phases due to the presence of new regeneration and the possibility of damage.

In such challenging terrains in Bhutan, exact geometric-shape patch layout is rarely possible. Due to the above inevitable fact, the past management plans practiced the method whereby around 20% of area from the gross operable area has been reduced to calculate the net operable area. However, this practice has led to inefficient use of production areas and has affected the sustainability of FMUs in the country. Therefore, this management plan does not prescribe the reduction in areas to calculate net production area as all areas which are inaccessible and inoperable are already mapped out as designated under protection working circle (Table 18). This prescription mandates the Unit In-charge and NRDCL to properly utilize the available production areas so that the area can be sustained for future harvesting operations. Any deviations from the prescribed cable line layout should be approved by the Department prior to implementation.

Table 18: Calculation of Net Production Area

Forest Types	Gross Operable Area (ha)	Calculation	Net Production Area (ha)
Broadleaved	2,275.30	In order to calculate the net production area, no area from the gross operable area has been reduced.	2,275.30
TOTAL	**2,275.30**		**2,275.30**

Rotation and Regeneration Period

The assumed rotation age for Broadleaved forest is 100 years. Consideration of establishment period while calculating rotation age is very crucial. Therefore, while calculating AAC for Khengzor FMU, 20 years of establishment period has been added to the rotation age of Broadleaf. As a result, the rotation age for Broadleaf is at 120 years. For Broadleaf forests, the regeneration period is rather very long and difficult too. Therefore, the assumed rotation lengths for the calculation of AAC in Khengzor FMU:

Broadleaf Working Circle= 100+20 Years= ***120 Years***

Average Standing Volume

The average standing volume is derived from forest inventory data statistically analyzed using "R". The sampling error and RME for each stratum is given below (Table 19). The forest management inventory of Khengzor FMU is designed based on the entire forest type and not

based on individual stratum. As KFMU has only one forest type, one average standing volume is obtained from the analyzed data. Hence, the average standing volume for KFMU is considered as 245.38 m^3/ha with a standard error of 10.705%. The reliable minimum estimate of standing volume thus obtained was 219.111 m^3/ha for the FMU.

AAC for Working Circle

The AAC for working circle is given in the following table (Table 19). The Khengzor FMU has only single strata therefore the AAC for entire FMU is as follows:

Table 19: AAC for the Working Circles (Standing volume)

Stratum	Net Operable Area (ha)	Rotation (Years)	RME standing volume (m^3/ha)	AAC (m^3/yr)	Clear-cut Equivalent
Broadleaf	2,275.30	120	219.111	4,154.53	18.96
TOTAL	**2,275.30**			**4,154.53**	**18.96**

Therefore, the total workable AAC for Khengzor is fixed at 4,100 m^3 in standing volume. It is permissible to vary the AAC area by plus or minus 10% in individual years, but the volume cut in each five year period must be no more than five times the AAC. The AAC prescribed is not solely to be met from the cable lines. The volume obtained from ad-hoc logging within the FMU should be accounted for.

Of the total AAC, only 10% has been allocated for rural use. Therefore, the commercial AAC allocated is 3,700 m^3 while rural AAC is 400 m^3 in KFMU.

13.2 Recording and Accounting for AAC

Annual Allowable Cut will be monitored through the records of tree marked (Tree Marking Register) for both commercial and local use. AAC has been calculated as gross volume and this is the measure that should be totaled on annual basis from the Tree Marking Register.

13.3 Allocation of AAC

The allocation of AAC has taken into account the needs of both rural people (living near Khengzor FMU) and commercial demands. The AAC for rural use has been allotted if incase the timber has to be issued to some other villages during the times of disaster and genuine needs. However, for now the villages adjacent to KFMU own their respective CFs from where they have been extracting timbers requirement till today.

Table 20: Allocation of AAC

Standing Volume (m^3)	Allotted to
400 m^3	Local Use- Allocated to local people based on eligibility
3,700 m^3	NRDCL- Allocated for meeting the timber demand in the market

13.4 Limits of harvesting area for commercial timbers in this plan period (1st Plan Period)

Table 21: Harvesting limits of commercial timber for the current plan period

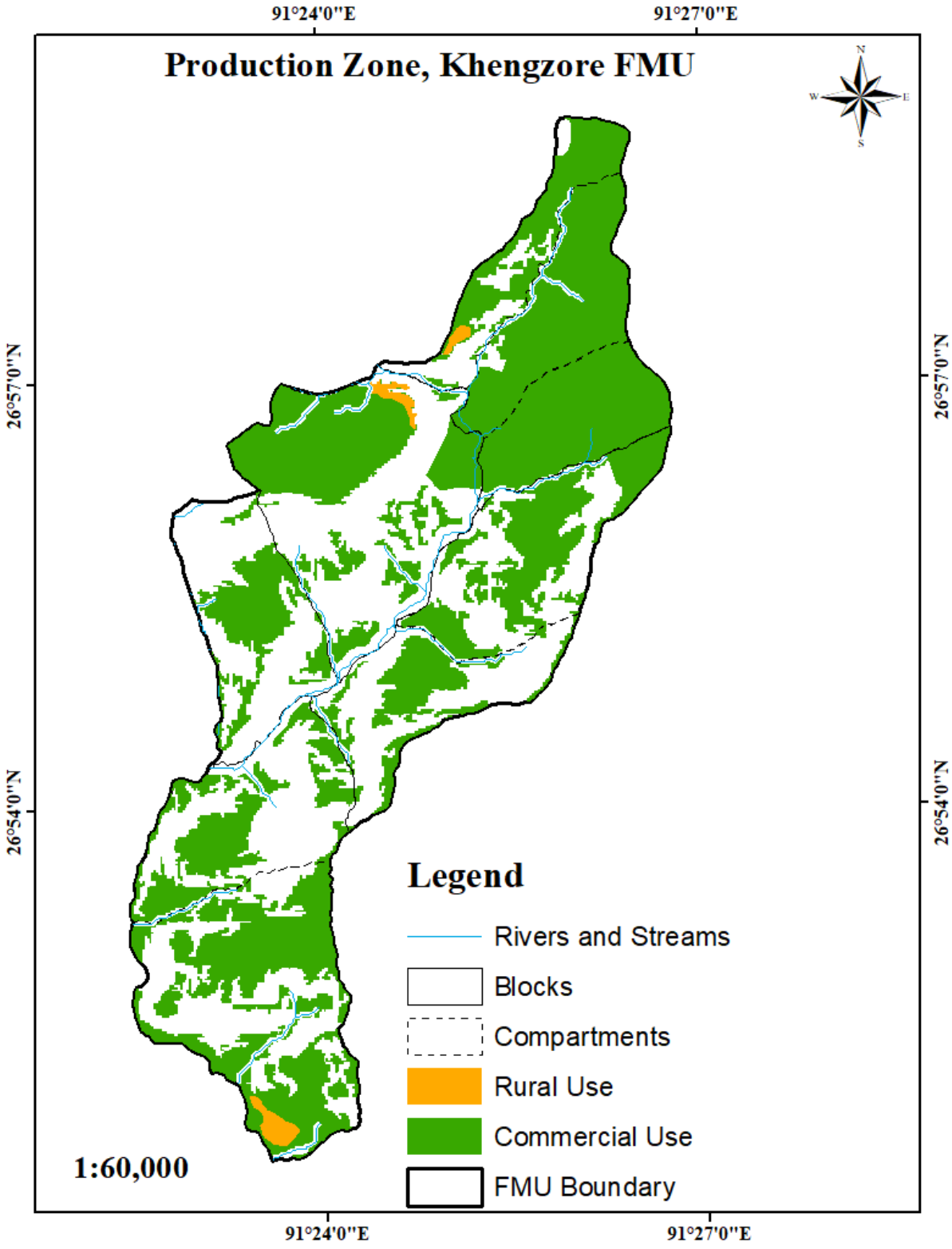
Blocks	Compartments	Compartment Area (ha)	Gross Operable Area (ha)	Net Production Area (ha)	1/3 of Net Production Area (ha)	Cumulative Net Production Area (ha)	Total Clear-Cut Equivalent for 10 Years
Dungkhar	Dungkhar I	249.55	163.68	163.68	54.56	54.56	
	Dungkhar II	331.85	307.12	307.12	102.37	156.93	
	Dungkhar III	285.69	280.86	280.86	93.62	250.55	
Kharpadang	Kharpadang I	353.98	125.55	125.55	41.85	292.40	
	Kharpadang II	464.68	258.09	258.09	86.03	378.43	189.60
Khalatsho	Khalatsho I	735.88	417.00	417.00	139.00	517.43	
	Khalatsho II	456.34	190.47	190.47	63.49	580.92	
Pondure	Pondure I	424.35	146.65	146.65	48.88	629.81	
	Pondure II	794.03	385.88	385.88	128.63	758.43	
Total		**4096.35**	**2275.30**	**2275.30**	**758.43**		

Total Commercial AAC = 3,700 m^3
Total Commercial AAC for 10 Years = 37,000 m^3
Total Clear-cut Equivalent for 1 Year = 18.96 ha
Total Clear-cut Equivalent for 10 Years = 189.60 ha

From the above (Table 21), total clear-cut equivalent for 10 years for the FMU will be met from the net production area of Dungkhar Block, Compartment I, II and III.

Therefore, the harvesting of commercial timbers by NRDCL must be limited till Dungkhar Block, Compartment I, II and III only for the current plan period and in no case the harvesting should be diverted to other compartments or carried out beyond Dungkhar Block unless approved by the Head of the Department.

Map 10: Production Zone



14. SILVICULTURAL SYSTEMS

14.1 Patch Cut System

For the Broadleaf Working Circle in the FMU, Patch Cut is the prescribed Silvicultural System. The particular Silvicultural System has been selected based on the ecosystem and natural regeneration system. Under the Patch Cut System, small openings will be created in the stand allowing light to reach the forest floor and creating conducive micro climate for seed germination and establishment of seedlings.

The patch will be opened along cable lines. The distance between cable lines will be not less than 75 m, and between patch along cable line not less than 50 m. The corridors should not exceed 4 m width. The length of the cable lines and number of openings along a cable lines must be determined by the availability of the stocks in a cable line. In the event of good stocks, the AAC or patch cut area equivalent of the FMU (whichever is achieved earlier) could be met even from a single cable line. In such instances, laying of subsequent cable lines must be restricted to next harvesting period only (Next OP).

The individual openings need not be uniform in shape or size and systematically located along cable lines. In most cases the openings will be irregular in shape and systematic location of patches will be almost impossible. Aspect, slope and silvicultural requirement would influence the actual size of the patch. An average maximum of 0.25 ha opening is recommended.

The signs of existing windfall, stands which are matured or diseased, and stands infested with mistletoes should be chosen as priority. In order not to lose the site protection effect of the surrounding trees it is necessary that the specified size for opening should be strictly adhered to. The tree should be felled towards the center of the group opening whenever possible to avoid damage to the unmarked trees. Terrain with steep slope and exposed South and South-West aspects should be avoided, or the opening should be smaller to match with the terrain and site conditions or the selection system should be applied.

In areas where opening cannot be created under Patch Cut System (in between two cable lines) such areas should be operated under Single Tree Selection System. However, care should be taken that spatial distribution of the trees are strictly followed and should match with openings created under Patch Cut System.

The Patch Cut System has the following advantages:

- Regeneration in the patch under even-aged condition gives better stem form.
- Creates less of a visual and environmental impact in forested areas.

- Larger openings in comparison to that under single tree selection system permit the establishment of intolerant species.
- Harvesting is more concentrated, so the logging cost is lower.
- Harvesting in patch lower damages to residual stands.
- Intermediate cuts may be made less frequently.
- Aesthetically and environmentally more acceptable than clear cutting system.

15. FOREST PROTECTION

15.1 Fire

The forest fire is not been a major threat in the KFMU and have no record of occurrence in the past few years. However, it is always safe to keep the forest under vigilance. The Unit In-charge and the Production In-charge of NRDCL will need to foster forest fire protection programs at regular interval in consultation with the local communities and other stakeholders involved with the activities of FMU.

15.2 Pest and Disease Management

Till date, there is no record of any pest and diseases outbreak in Khengzor FMU. However, there can be chances of pest and diseases outbreak in the future. Therefore, periodic monitoring of the forests to check any outbreak of pest and diseases will be done. In order to detect and report any outbreak of pest and diseases, the FMU staff will conduct regular inspection to enable the initiation of earliest possible remedial and preventive measures. Report should be submitted to the CFO, Pemagatshel and to the Department as well.

The following are the control measures suggested:

- Regular periodic survey of the forest and removal of deformed trees.
- Regular survey of regenerated areas and burning of infected plants after slashing and debarking.
- Education extension program to the workers in the forest so as to report symptoms of the pest and diseases.

The source of seedlings to be planted in the FMU will need to be monitored for pest and diseases before really planting away in the field. The infected seedlings should not be supplied, instead destroy by burning at the nursery itself.

15.3 Grazing

It is observed during the general inventory that only certain pockets from Khalatsho and Pondure Blocks of FMU are being visited by the cattle. These days, local communities are being encouraged by the Livestock Sector to go with the improved stall feeding. Hence, the cattle population in the locality is expected to reduce in the coming years. Grazing shall be prohibited if they pose negative impact on regeneration/plantation in the FMU area.

16. ENVIRONMENTAL STATEMENT

All developmental proposals in Bhutan have to fulfill certain environmental criteria as per the provision of the Environmental Assessment Act, 2000. The Chapter III, Section 18 of the Environmental Assessment Act necessitates obtaining environmental clearance prior to the commencement of the proposed developmental activity. To carry out any forestry activities, the National Environment Commission Secretariat has developed Regulation for Environmental Clearance of Projects in 2002, the procedures of which the applicant should meet. This section of the plan provides all necessary information required for environmental clearance which includes the perceived threats of the proposed project to the environment and necessary mitigation measures to minimize the impacts resulting from the planned activities. This section, altogether, meets the requirement of the Act to be fulfilled by the applicant concerned.

16.1 Project Description

16.1.1 Introduction

Khengzor Forest Management Unit will be incepted from 2019 with the Department's aspiration to establish one FMU in each Dzongkhag to cater to the timber needs of the people of Bhutan on sustainable basis.

The harvesting from Khengzor FMU will be based on the principle of sustainability to meet the timber for commercial as well as *bona fide* rural requirements.

Khengzor FMU has total area of 4,096.35 ha and out of which only 2,275.30 ha of forest will be subjected to harvesting operations. The broad objective of this project is to harvest the over matured and matured trees to improve the forest stands and also to make timber available in the market along with generation of revenue for the government. To enable transportation of logs from the forest, a total of approximately 10 kms of road shall be constructed during this plan period of 10 years.

16.1.2 Objectives

- To improve the forest stand of Khengzor
- To ensure sustainable supply of timber, fuel wood and non-wood forest produces
- To support developmental activities through the construction of forest road

16.1.3 Project Location and Area

The Khengzor Forest Management Unit is located in Pemagatshel Dzongkhag covering two Gewogs. Its boundary stretches from Khalatsho village of Choekhorling Gewog till the ridge top

of Khengzor village under Khar Gewog. The Forest Management Unit falls within 91˚23′42.98″ to 91˚25′55.18″ East and 26˚51′36.02″ to 26˚58′46.74″ North. The total area of Khengzor FMU is 4,096.35 ha. The entire area will not be subjected to harvesting. Only about 2,275.30 ha of the area will be subjected to timber harvesting in a scientific and sustained manner. Rest of the area is categorized under various protection and non-production zones.

16.1.4 Benefits

Khengzor FMU area was not subjected to commercial operations in the past and thus it has lots of matured stands. These over matured stands can be harvested so that it creates space for regeneration to establish. This would not only benefit in terms of generating revenues but also help improve the forest conditions. The FMU activities can also contribute towards providing employment opportunities to the local communities. Local people can be involved as unskilled labour during maintenance of road, construction of forest road, extraction of timber and transportation. This will help uplift the livelihood of the people residing near by the Forest Management Unit. The proposed road will benefit the settlements near the FMU in extracting rural timber from the local use area. The FMU road will also help people extract rural timber for their house construction and renovation purposes.

The harvesting of matured trees as per the prescription of the plan will allow the extraction on sustainable basis and also contribute towards government revenues. Managed forest will definitely ensure future sustainability of the resources.

16.2 Forest Management Unit: Planning and Zoning

All the Management Plans will have to be prepared based on Forest Management Code of Bhutan, 2004. Very comprehensive and consultative land use planning has to be carried out while preparing the Forest Management Plan. The process is briefly outlined below:

The FMU resource inventory was carried out in 2017-2018 by Inventory team consisting of members from Pemagatshel Forest Division and FRMD Inventory Mobile team to provide the information about tree stocking, regeneration, timber volumes, site characteristics, wildlife presence and understory species. Consultation with the community was carried out to map out local use areas, drinking water sources and places of religious importance.

Forests zoning is based on above data collected, using the forest function mapping prescribed in the Forest Management Code of Bhutan. The KFMU has only one Working Circle and it is divided into Blocks and Compartments. The protection areas such as soil protection, wild life protection, rivers and streams buffer protection, etc. are excluded from the net operable area.

The silvicultural system to be implemented is Patch Cut System for Broadleaf Working Circle. No clear cutting will be permitted and all the trees will be harvested using the skyline cable crane. The opening of the patch size shall not exceed 0.25 ha depending upon the stand composition and condition. The distance between the cable lines will be not less than 75 m and distance between the patches will be not less than 50 m.

16.3 Harvesting and Extraction

Fixed volume of timber expressed as Annual Allowable Cut (AAC) is prescribed in this Management Plan. The AAC prescribed is 4,100 m^3 in Standing Volume per year. This means that the maximum volume that can be harvested from Khengzor FMU will not exceed 4,100 m^3 per year. Out of 4,100 m^3, 3700 m^3 will be allotted to NRDCL for commercial harvesting and 400 m^3 will be allotted for rural use.

However, mitigating measures will be employed during harvesting and extraction to minimize potential negative environmental impacts. Cable cranes would be used for harvesting operation and no manual logging would be permitted in the laid cable lines. Power chain saws would be used in place of the axe to reduce waste. The harvesting prescription and silvicultural treatment will be taken care and described in detail in the Management Plan.

16.4 Road Construction

For the extraction of timber from the production site, it is necessary to construct all season road to transport the logs and firewood to the timber depot. The physical assessment for the road construction in Khengzor FMU was carried out by the team comprising of Planner and Engineer from NRDCL, Unit staffs both from NRDCL and Pemagatshel Territorial Division. Takeoff point of forest road will be from Khengzor villange road. During the assessment, it has been identified just below the Khengzor Community Primary School (Map 11) which ultimately will enter Dungkhar Block, Compartment I, II and III (approximately 10 Km).

The forest road construction in Khengzor FMU is aimed at minimum negative environmental impacts. The proposed road has been aligned in such a way that none of the drinking water sources and settlement is affected. For stream crossings, culverts, side drains and hume pipe have been designed to minimize the pollution of the stream. The takeoff point of the road and the alignment has been agreed by the general public of Khengzor village during the consultation meeting held at Khengzor village on November 23, 2018.

During road construction, the NRDCL engineers will supervise and no deviation from the proposed road alignment should take place. As general rules, excavators will be deployed. Bulldozers shall not be permitted for use. Road Standards recommended by FRMD and the general principles and practices to be followed during forest road construction as identified by

NEC Forestry Sectorial Guidelines will be followed. These will ensure that the road construction within the FMU will meet the recommendations and also ensure that any erosion or other negative impacts will be minimized or eliminated. Complete Road Standard is given in annexure 2.

16.5 Regeneration and Post Harvesting Treatments

As the forest type in KFMU is broadleaved, it is prescribed in the Management Plan that harvesting will be immediately followed by artificial regeneration (plantation) before the area is being invaded by undesirable species. The artificial planting will be carried out with immediate fencing. 1,600 seedlings per hectare should be planted. Thereafter, weeding and tending operations should be carried out every year till the regeneration gets established. Regeneration is considered successful only if >80% of 1600 seedlings planted gets established. Therefore, establishment of a forest nursery of principal species by NRDCL is recommended in this Plan period. Besides, regular maintenance of the plantation will be done by NRDCL. CFO, Pemagatshel Forest Division shall monitor establishment of regeneration in harvested areas at the end of every year. If the survival percentage is lower than the above prescribed number, immediate beating up will be carried out with the same local species. The established regeneration should be evenly distributed in the operated area and not concentrated in one particular place. Fencing could be removed once the regeneration gets established.

16.6 Existing Environment

16.6.1 Topography and Geology

The general terrain of KFMU ranges from moderate to steep landscape. The lower slopes are moderately gentle and the upper slope being steeper. The terrain is moderate in some of the compartments however; most of the compartments are steep and mountainous. Rocky outcrops are present in all the Blocks. The altitudinal range of the FMU ranges from 448 m to 2142 m above sea level. There are many streams flowing in and out of the FMU area but Kharpa Chhu passes through the middle of the FMU area.

Almost 50% of the KFMU falls above 45 to 100% slope class. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as Soil Conservation where limited activities can take place.

16.6.2 Hydrology

Within Khengzor FMU, there are three main streams and a river. These three main streams are Kharpa Chhu, Prondu Chhu and Khengzor Chhu which ultimately joins the main river of

Khalatsho. Kharpa Chhu runs through the middle of the entire FMU area, while Khengzor Chhu boarders the FMU from the east. These streams and River are not used at the present. However, the communities might use it later as the time passes by.

16.6.3 Air Quality and Noise

The quality of air within the FMU is very good as there is no pollution at all. However, the village approach road to Khalatsho village from Choekhorling Gewog Centre might impact the quality of air when the under construction road reaches the village. Otherwise, there is no air and noise pollution in the FMU at the present.

16.6.4 Plant, Animal Species and Habitat

Khengzor FMU has good floral as well as faunal diversity, due to its altitudinal variation, aspects and different forest composition. Several species of mammal and bird were recorded during the general FMU inventory.

16.6.5 Scenic Qualities

The area has no popular sites developed as such. However, the area is beautified by the several numbers of waterfalls from the rugged ridge top and the diverse of fish species in the streams and river. Also the beauty is added to the nature by the presence of calls of diverse birds.

16.6.6 Cultural Significant Sites

The historic Dungkhar Goenpa falls within the boundary of the FMU. The Goenpa attracts a lot of tourist and pilgrims. However, due to lack of quality tourist products and services in this region, we do not receive many tourists as western part of Bhutan.

16.7 Assessment of Impacts and Mitigating Measures

16.7.1 Impact on Water

Pollution

The FMU has a number of perennial streams. While carrying out the planned activities in the FMU, there are higher chances of polluting the water bodies within the FMU with garbage by workers engaged in road constructions and harvesting operations. Some harmful pollutants might include oil spills from vehicles and machineries.

Drying up of water source

Khengzor FMU forms the source of water for Khalatsho River and we have seen that the same river at the downstream in Summan Kata, India has been used for irrigating the paddy field. Any

disturbance in the area by human intervention will adversely affect the water downstream, increasing the probability of the streams and water sources drying up. Therefore, it is essential to acknowledge the impact it has on the surrounding vegetation and address appropriate mitigation measures. Proper harvesting of timber as per the prescription of the management plan needs to be prioritized in order to minimize the impact of harvesting operations on water sources.

Mitigations

A buffer of 30 m on both sides of the perennial streams has to be maintained. Similarly, a buffer of 100 m on both the sides of river shall be maintained. The coupe will be laid in such a way that they are located away from the streams and rivers. Proper pit latrines and garbage disposal should be in place and the camp sites are at least 100 m away from the main streams. Every concerned individuals/agencies/organizations/institutions are fully responsible for managing their waste materials properly.

During the road construction, NRDCL site engineer will monitor the construction activities. Moreover, the bulldozer will be replaced by excavator in order to avoid the blockage of river and streams from wind throw. Owing to the plenty of streams in the FMU, forest road will pass through streams and river sources hence to mitigate the impacts, 30 m and 100 m buffer respectively shall be kept to prevent damage to the water source.

Major part of the FMU is covered by rock, stretching from bottom of the valley till top of the ridge. Hence, the KFMU is almost 50% under soil protection management. The soil is predominantly sandy loam and well drained in general.

16.7.2 Impact on Forest Resources

As the timber harvesting operation is the main activity in the FMU, it is evident that there will be impact on forest resources. Although, prescribed silvicultural systems are encouraged during harvesting operations, it will result in reduction of the forest cover within the FMU. The opening of corridors and patches during the harvesting operation might open the area for grazing with less regeneration of principle timber species. This could result in exposing the site to various environmental and climatic conditions and thus affect the ecological processes in place. In certain forest type, openings can lead to increased undergrowth and hence regeneration of commercial native species will be affected.

Employment of untrained personnel during harvesting operations might lead to wastage of resources while felling trees such as increased number of splitting, breaking and other sorts of felling damages. Excessive collection of NWFPs may also lead to unsustainable harvesting of such resources in the future.

Mitigations

The management plan for the FMU is prepared for a period of ten years. The harvesting will not exceed the prescribed AAC, nor will the size of the opening be larger than that prescribed in the management plan. If the natural regeneration fails to establish then the area will be planted with local principle timber species. However, natural regeneration is preferred over artificial regeneration considering its ecological as well as economic importance. The introduction of exotic species will not be allowed. For proper planning, implementation and monitoring of activities in the Forest Management Unit, a full time dedicated staff for the FMU will be required from both DoFPS and NRDCL. Only trained power chain saw operators will be allowed to carry out the felling and harvesting operations to reduce the felling damage within the FMU.

16.7.3 Impacts on the Faunal Diversity

Habitat fragmentation and disturbance to wildlife is one of the major threats as a result of operation in the FMU. Activities such as road construction and timber extraction will cause disturbance in the wildlife habitat and thereby increasing the chances of reduction in wildlife population. Construction of roads will also affect the movement of animals from one niche to another. Harvesting operations will adversely impact the prey base and may create imbalance in the food chain.

Mitigations

Certain areas within the FMU have been designated as wildlife protection areas while the remaining areas are designated as nature conservation areas. No harvesting operations will be allowed in area designated as wildlife protection function. As all forest areas are not subjected to harvesting operations, enough areas have been kept for free movement of wild animals. Sufficient number of snag trees and fruit bearing trees will be retained to provide enough food for survival and reproduction of wild animals. Moreover, as biological corridors number five is also located near the Forest Management Unit, these areas would enable movement of wildlife from one area to another.

For the conservation of wildlife, clear felling of large stretch of forest will be avoided so that sufficient forest is retained for forage, shelter and cover. In operated areas, if natural regeneration fails to establish, artificial regeneration by native trees will be undertaken and subsequently fenced to avoid grazing by domestic as well as wild animals. Regular monitoring and patrolling of the forest area will be carried out in order to minimize poaching and other illegal activities within the FMU.

16.7.4 Impacts on Ecology (Flora)

One of the possible impacts of harvesting operations within the FMU is the change in forest composition. There are higher possibilities of the harvested areas being invaded by non-native species of plants if proper monitoring of the area from time to time is not carried out.

Mitigations

In order to retain the original forest composition in the harvested areas, the operation should follow the prescriptions strictly. Opening along the cable lines should be maintained as per the prescribed silvicultural systems so that it creates conducive environment for desired species to regenerate. Larger openings will be avoided in order to avoid its colonization by unwanted species. To ensure adequate regeneration of desired species, mother trees will be retained in sufficient numbers as a source of seed. Forest roads have to be aligned in such a way that it does not pass through sensitive and critical areas. Proper monitoring should be ensured while constructing new forest roads.

16.8 Monitoring and Evaluation

The Management Plan, which is for the period of ten years, will be prepared by Divisional Forest Office, Pemagatshel. It will be approved by the Minister, Ministry of Agriculture and Forests. The Plan will be implemented by CFO, Pemagatshel Forest Division, who will be engaging NRDCL for harvesting timber. Annual Operational Plans will be prepared by Pemagatshel Forest Division in consultation with the stakeholders, based on the Management Plan. The Operational Plan will be approved by the Head of the Department. Annual monitoring will be carried out by Pemagatshel Forest Division (CFO and Unit In-charge). A report will be submitted to FRMD, DoFPS, Ministry of Agriculture and Forests, Thimphu, based on the annual monitoring forms. FRMD will also monitor the implementation of the activities. Mid-term evaluation will be done during the last quarter of the fifth year of the plan period and final evaluation during the last quarter of the ninth year of the plan period.

Table 22: Checklist of Environmental Parameters for Forestry Projects

	Adverse Environmental Impact	**Preliminary Evaluation**			
		No Significant Effect	**Small Effect**	**Moderate Effect**	**Major Effect**
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Sitting					
1. Watershed Areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			

d) water quality	d) loss of downstream beneficial uses	*			
2. Relation to other dedicated land uses					
a) conservation areas	a) impaired ecological and recreational opportunities	*			
b) economic ventures	b) possible economic loss	*			
3. Traditional forest uses	3. Impaired beneficial uses	*			
4. Rehabilitation	4. Social Problems	*			
5. Relation to regional/national forestry plans	5. Possible conflicts with established management policies	*			
6. Critical environmental areas	6. Downstream economic losses				
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
7. Precious ecology	7. Loss of ecological values	*			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Operations and maintenance	2. Diminished project efficiency and objectives if lack of funds			*	
3. Data based for decision making		*			
4. Road network design					
a) erosion	a) downstream	*			

	economic losses				
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
5. Design of logging activities	5. Unnecessary damage to residual stand			*	
6. Critical environmental areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
7. Precious ecology	7. Loss of ecological values	*			
C. Considerations Regarding Project Operations					
1. Road Construction					
a) erosion	a) downstream economic losses		*		
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
2. Felling					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and	*			

	flood flows				
d) water quality	d) loss of downstream beneficial uses	*			
3. Log conveyance and allocation					
a) erosion	a) downstream economic losses	*			
b) siltation	b) increased runoff	*			
c) hydrology	c) impede navigation	*			
d) water quality	d) less than optimum economic benefits		*		
4. Logging in riparian zones	4. Degradation of waterways/fisheries	**N.A**			
5. Socio-economic		*			
a) employment opportunities		*			
b) loss of traditional forest use	b) economic and cultural losses		*		
D. Considerations Regarding Post-Project Activities					
1. Rehabilitation and conservation		*			
2. Road shutdown		*			
II. REFORESTATION/AFFORESTATION					
A. Considerations Regarding Project Siting					
1. History of forest abuse	1. Negation of project goals if not effectively controlled			*	
2. Relation to other dedicated land uses					
a) conservation areas		*			
b) economic ventures	b) Interference with more profitable ventures	*			
c) regional/national forestry plans		*			
3. Rehabilitation	3. Social Problems	*			
4. Siting in degraded forest	4. Possible unnecessary loss of	*			

	ecological values				
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Selection of tree species	2. Diminished project objectives	*			
3. Precious ecology					
a) wildlife		*			
b) fisheries		*			
c) plants		*			
d) soil and water		*			
4. Allocation of benefits to locals		*			
a) employment opportunities		*			
b) training		*			
c) non-wood products		*			
5. Operation and maintenance	5. Diminished project efficiency and objectives if lack of funds			*	
6. Data base for decision making		*			
7. Project financing and reservoirs		*			
8. Appropriate technology	8. Diminished project objectives if inappropriate	*			
9. Relation to other dedicated land uses	9. Potential social and economic conflicts	*			
a) extensive land use modification		*			
10. Road network design	10. Increased erosion	*			
11. Use of grasslands		*			
C. Considerations Regarding Project Operations					

1. Commercial logging	1. Same as in Commercial Logging A and B	*			
2. Reduced water supplies	2. Socioeconomic losses	*			
3. Chemical and fertilizers	3. Impaired fisheries and aquatic systems	*			
4. First-year operations	4. Increased erosion due to soil disturbance		*		
5. Soil conservation benefits					
a) erosion			*		
b) sedimentation		*			
c) soil capacity		*			
d) soil surface moisture		*			
e) soil nutrients		*			
6. Socio-economic benefits		*			
a) employment opportunities		*			
b) fuel-wood		*			
c) enhanced fisheries		*			
d) enhanced recreational/tourism		*			
7. Water resources benefits		*			
a) minimized overland flows		*			
b) reduced flood peaks		*			
c) water quality		*			

17. FINANCIAL AND ECONOMIC APPRAISAL

Table 23: Assumption used for Financial Forecast

Assumptions	Figures
m^3 to cft	35.31
Recovery Volume (%)	40% (Broadleaf)
Road Construction (Nu/Km)	37,80,600
Length of proposed new road (km)	10
Road maintenance (Nu/km/yr)	15,000
Distance to Depot (km)	10
Cable craning (Nu/cft)	14.69
Rural allotment (m^3)	400
Regeneration maintenance (cable line) (Nu/ha)	3,500
Artificial Plantation (ha)	63.2
Plantation cost (as per plantation norms and standard, SFED)	50,000

Table 24: Financial Forecast

Financial Forecast- Khengzor Forest Management Unit																
	AAC (m^3)	Rec. Volume	Nu/ cft	Nu/m^3	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	10 Years
					Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Total (Nu)
Revenue: NRDCL															
Timber- Commercial	3,700	1,480	147	5,207.17	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	7,706,605.24	77,066,052.36
Timber- Rural	400														
Total Revenue NRDCL					**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**7,706,605.24**	**77,066,052.36**
Costs: NRDCL															
Bridge Construction															-
Road Construction		37,806,000			3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	3,780,600	37,806,000.00
Road Maintenance		15000/km				30,000.00	45,000.00	60,000.00	75,000.00	90,000.00	105,000.00	120,000.00	135,000.00	150,000.00	810,000.00
Marking Cost			0.08	2.82	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	10,434.00	104,340.00
Inventory Costs					50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	500,000.00
Felling and Cross-cutting			4	141.24	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	522,588.00	5,225,880.00
Debarking			0.5	17.7	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	65,490.00	654,900.00
Cable Craning			14.7	519	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	1,920,300.00	19,203,000.00
Transportation to Depot			11.7	296.6	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	438,968.00	4,389,680.00
Stand Tending (Spacing etc.)															-
Coupe Regeneration															-
Regeneration Maintenance		3,500/ cable line			17,500.00	35,000.00	52,500.00	70,000.00	87,500.00	105,000.00	122,500.00	140,000.00	157,500.00	175,000.00	962,500.00
Creation of Plantation		50,000/ha				50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	450,000.00
Plantation Maintenance		8,000/ha					8,000.00	16,000.00	24,000.00	32,000.00	40,000.00	48,000.00	56,000.00	64,000.00	288,000.00
Total Costs NRDCL					**6,805,880.00**	**6,903,380.00**	**6,943,880.00**	**6,984,380.00**	**7,024,880.00**	**7,065,380.00**	**7,105,880.00**	**7,146,380.00**	**7,186,880.00**	**7,227,380.00**	**70,394,300.00**
Total Revenue less Total Costs NRDCL					**900,725.24**	**803,225.24**	**762,725.24**	**722,225.24**	**681,725.24**	**641,225.24**	**600,725.24**	**560,225.24**	**519,725.24**	**479,225.24**	**6,671,752.36**
Royalty															
Royalty- Commercial			15	529.65	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	783,882.00	7,838,820.00
Royalty- Rural															
Total Royalty NRDCL					**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**783,882.00**	**7,838,820.00**
Revenue less Royalties NRDCL															
Timber- Commercial					6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	6,922,723.24	69,227,232.36
Timber-Rural															
Total Revenue less Royalty NRDCL					**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**6,922,723.24**	**69,227,232.36**
Total Revenue less Royalty Less Costs					**116,843.24**	**19,343.24**	**(21,156.76)**	**(61,656.76)**	**(102,156.76)**	**(142,656.76)**	**(183,156.76)**	**(223,656.76)**	**(264,156.76)**	**(304,656.76)**	**(1,167,067.64)**

Table 25: Financial Forecast Summary (For this plan period)

Financial Summary for the Plan Period	
Particulars	**Amount (Nu.)**
Total Revenue NRDCL	77,066,052.36
Total Cost NRDCL	70,394,300.00
Total Royalty NRDCL	7,838,820.00
Total Revenue less Royalty less Costs NRDCL	1,167,067.64

18. RESEARCH

Research programs will be in collaboration with UWICER. The Division and Unit staff can also collaborate as and when required. The prioritized areas for research are mentioned below:

- Determination of Annual Allowable harvest of NWFPs in the FMU
- Coexistence of Great and Rufus Necked Hornbill
- Impact of commercial harvesting on wildlife population
- Timber recovery rate for particular FMU
- Forest composition change overtime due to commercial harvesting
- Habitat mapping of Elephant and Gaur
- Human-wildlife conflict
- Determination of local volume table

PART 3: IMPLEMENTATION OF THE PLAN

19. IMPLEMENTING AGENCY

The Department of Forests and Park Services is assigned with the responsibility of protection and management of forest resources in Bhutan. In the field, the territorial division is mandated by the Department to discharge the responsibility of implementing and monitoring all the activities prescribed in the plan. The Chief Forestry Officer, Pemagatshel Forest Division will be responsible for implementation of this Management Plan. The Chief Forestry Officer, will be assisted by the Unit In-charge and other staffs of the Forest Management Unit.

19.1 Cutting Cycle

For sustainability of the forest resources in the FMU, the cable line spacing must be properly laid to enable subsequent passes in the future. A minimum of 75 m needs to be kept in between the cable lines so that two passes can be enabled in the future. Broadleaf Working Circle has a rotation period of 100 years with additional 20 years regeneration establishment period, which means that the two cable lines that will be implemented in the future are occurring at year 41 and year 81. The original line will therefore, be harvested in year 121 (Figure 7). This gives sufficient time to the adjacent area to regenerate and also prevents the area from large opening.

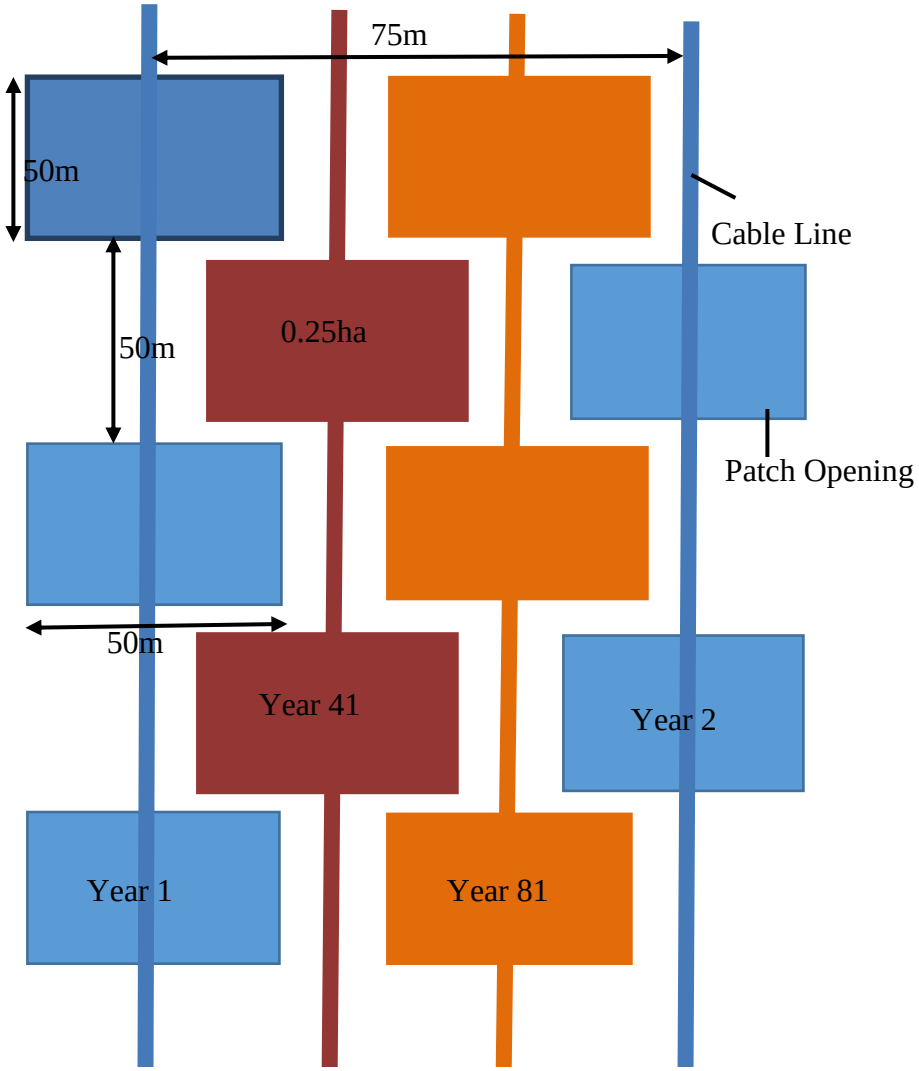


Figure 7: Layout for Pacth-Cut system

The rough terrains of Bhutan possess challenge while laying cable lines in the field. Therefore, the layout in the field must be aligned to suit the terrain and to the best possible, guidelines must be followed.

The Broadleaved working circle will be worked under Patch-cut System. The patch will not exceed more than 0.25 ha and will be spaced in the interval of minimum 50 m. 4 m cable corridor will be maintained. Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL should maintain nursery at the site for artificial regeneration. Nursery should be well stocked with local and commercial species for replantation.

19.2 Annual Coupe

For the selection of annual coupe, accessibility, slope, stand condition and other environmental conditions should be considered. The annual coupe will follow the required spacing designed as per the prescribed silvicultural system of the working circle.

Coupes must fulfill the following conditions:

- The Unit In-charge, in consultation with the NRDCL counterpart, will determine the location and extend of the cable lines in the compartment to be harvested annually. All prescription and restriction laid down in the plan must be considered and adhered to completely.
- The cable lines must be laid to the full length if the area is operable in order to avoid unnecessary loss of production area. This practice will also help cut down the expenditure for road construction.
- The Unit In-charge will arrange to mark the trees as per the approved annual Operational Plan.
- Cable line layout will be based on safety, stand composition, environment and cost consideration. This will be done in consultation with the Unit In-charge.
- The cable lines may cross slopes greater than 100% but extraction is not allowed.

19.3 Tree Marking Guidelines

- Groups of matured and over-matured trees are selected systematically according to the opening size given in the plan.
- Trees within stream buffer stripes and on slopes greater than 100% must not be marked.
- The direction of the tree lean and topography has to be taken into account to prevent large tree being felled on nearby advanced growth.
- Some dead, dying, malformed or damaged (snags, scars. conk, etc.) and fruiting trees will be retained in between patches, and in the interline spaces, to safeguard the niches or habitats for the flora and fauna, but not in the harvested patch themselves, where there is risk of wind throw and danger to person working underneath.
- Diseased trees (pest and disease) will be removed to protect the quality of the remaining stand.

- All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered.
- The trees selected will be marked with the authorized marking hammer close to ground level by Unit Staff, and diameter measurements, along with estimated total tree height and tree species, will be entered in the Marking register.
- The volume of each tree will be estimated using an appropriate Volume Table. The standing volume marked will be recorded in the Marking Register. Log volume at the NRDCL Depot will be recorded.

19.4 Harvesting

To reduce the negative impact to the forest and environment due to extraction, the hauling method for transporting logs from the coupe to road will be done by skyline crane system. This system will allow logs to be kept above the forest floor during extraction and will enable logs to be taken across sensitive ecological sites, gullies and riparian filter buffer zones. Cutting trees 10cm above the ground level will be strictly followed to avoid the wastage. To maintain the sanitation and hygiene of the forest, the cut over debris must be disposed off and if possible burn in a proper place avoiding forest fire. The skyline cable system has the following advantages:

- Minimizes soil disturbance and initiation of soil erosion.
- Maximizes work safety (if used correctly according to the manufacturer's directions and according to the safety practices in the Code of Logging Practice).
- Avoid damage to residual reserve stands.
- Avoid disruption to wildlife corridors in the valley bottoms.
- Minimizes noise and dust pollution on any adjacent farmland and villages.
- Eliminates the need for log extraction tracks and feeder road construction.

Harvesting in the Working Circle is to be carried out in accordance with the following prescriptions:

- The layout of the cable lines should be planned and undertaken well in advance of the harvesting operations after the logging coupe has been demarcated. Suitable log landing site should be identified and incorporated into the forest road design.
- Care should be taken to avoid lines in and along gullies and other protected areas, but lines may cross these at an angle. Trees to be felled will be enumerated and marked in time so as not to delay harvesting operations.
- The cable corridor shall not exceed the prescribed width stated in the Silvicultural System for the working circle.
- Trees will be felled, de-limbed, crosscut, extracted on the cable, loaded and hauled to the log depot. Only chain saws and hand saws will be permitted in felling operations. Trees will be felled, where possible, into natural openings, into harvested openings or in a

direction that will not damage residual stands. Damage to soil should be minimized at all times.

- The use of axes is discouraged except in fuel wood splitting.
- All infected trees, if any, will be debarked as soon as they are felled to avoid the spread of bark beetles.
- All logs will be measured and recorded in the Log Yard Register. This should be kept up-to-date and made available to inspecting officers as required. A copy of the list of log/timber entered in the Log yard Register will be submitted to concern CFO every month. This information will be used for royalty calculation and issuance of removal permits. Logs will be transported by private haulage contractors and all deliveries will be made to designated depots and/or sawmills.
- Records of all trees marked and issued for local use or for conversion within the forest, by blocks and compartments will be maintained by the Unit staff and furnished monthly to the concern CFO.
- The CFO and the Regional Manager, NRDCL will co-operate and co-ordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands.
- Fuel wood will be collected from harvesting residues. It is important that all lops and tops for fuel wood are collected along entire cable lines, not just the easily accessible areas. It is desirable that the trees to be used as fuel wood are extracted with the cable line and fuel wood conversion occurs at the designated log landing areas.

19.5 Reforestation of Harvested Sites

Natural regeneration is the preferred method of reforestation in the harvested areas of the FMU. Natural regeneration is the ecologically and economically viable method to ensure sustainable development of forest resources. Therefore, it is crucial that natural regeneration is given preference over artificial regeneration. It is essential that the harvested areas are effectively regenerated as soon as the harvesting operations are completed. However, the natural regeneration is not a promising in case of broadleaf forest. Therefore, restocking by means of artificial regeneration through plantation must be carried out by NRDCL right after the harvesting operation. It might be evident in some FMUs that the natural regeneration is either very poor or prove to be a complete failure because of site conditions, over grazing, prolonged disturbance due to prolonged harvesting operations and overgrowth of weeds and other invasive plant species. These problems must be considered, analyzed and eliminated to successfully regenerate the operated areas.

It is prescribed that periodic tending activities such as weeding, brushing and fencing are carried out to chances the regeneration establishment in the FMU. Such interventions will help to ensure higher survival percentage of the forest crops. In case of natural regeneration failure, NRDCL

should have a reserve of seedlings of locally viable species which can be done through establishment of forest nurseries. Care should be taken to plant commercially viable local species in the FMU to ensure sustainable harvest in the future. In areas where plantations are carried out, regular maintenance should be done for higher survival percentage. The maintenance of plantation should be carried out as per the Norms for Plantation and Nursery, 2016 and the concern CFO must monitor and evaluate the plantations on annual basis.

The NRDCL in consultation with the Unit In-charge should keep adequate budget provisions in the Operational Plan to carry out plantation creation and maintenance works. This is because the plantation has to be carried out right after the harvesting in the broadleaf forest.

19.6 Sequence of Operations Relating to the Annual Coupe

The sequence of operation relating to the annual coupe is given in the following table:

Table 26: Sequence of Operations Relating to the Annual Coupe

Operation Description	Timing (months) (- before felling; + after felling)
Unit In-charge describes regarding the location and size of annual coupe in accordance with the Biennial Operation Plan	-12
NRDCL and FMU In-charge prepares an estimate of human, material, equipment and financial resources required.	-10
Unit In-charge finalizes the annual coupe size, demarcates the coupe and instructs NRDCL to carry out pre-logging planning	-6
NRDCL prepares cable line layout and alignment plan, proposed log depot and log landing points and submits these to Unit In-charge for approval	-3
Unit In-charge marks the carriage corridor trees and the trees to be felled in the first sub-coupe	-2
NRDCL manually fells trees that are in the way of the skyline installation and installs the skyline and cable crane	-1
NRDCL commences systematic harvesting and extraction operation according to the approved sequence in the Biennial Operation Plan	0
NRDCL/Contractor completes harvesting and extraction	When completed
The Unit In-charge will inspect the coupe when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	When works completed
DoFPS assess success of natural regeneration	As per Guidelines
NRDCL completes post harvesting operation	As per the instruction by UIC

19.7 Road Construction

Despite the negative impact of forest road on forest and environment, still forms an essential part of managed forest land, both for timber extraction and to provide for forest management and monitoring. Road construction in the FMU requires extra precautions to achieve environmental best practice. The necessity during the forest road construction is to avoid steep and fragile areas, to provide a proper drainage system, especially for safe discharge of run-off water during the monsoon, with enough culverts, and cross drains, to have an efficient draining compacted road surface.

Through detailed field survey and consultation with the concerned stakeholders, it was decided that a total of 10 kms of forest road will be constructed in the Dungkhar Block during this plan period from 2019-2028. The proposed take off point of the road will be from Khengzor village road just below the Khengzor Community Primary School. The forest road should be maintained on annual basis by NRDCL in order to facilitate safe transportation of logs to depot.

ROAD STANDARD

A set of road standards has been developed by Forest Engineers of TFDP. These road standards, were developed in the East, address policies that are required throughout Bhutan. These standards will be adopted for Khengzor FMU and NRDCL road engineers must follow these standards, given in annexure 2, during designing and estimating, and provide supervision during construction to ensure that the standards are met. Road design in Khengzor FMU should follow the recommended road profile given in Figure 10 to avoid excessive water pooling leading to uneven road surfaces that inhibit access during monsoon season. Improper drainage may lead to landslide.

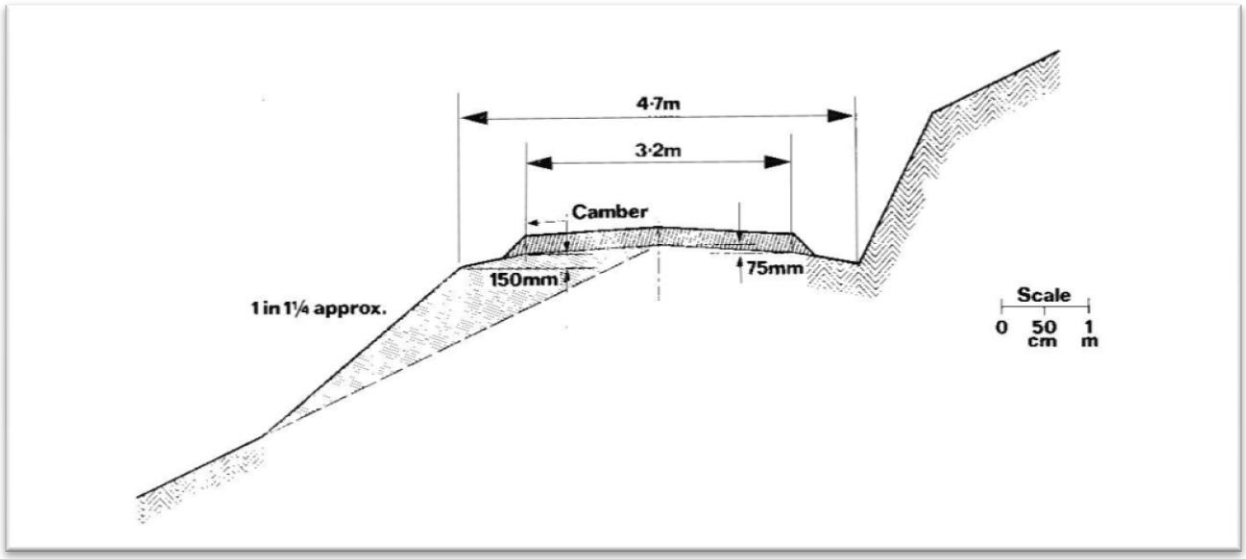
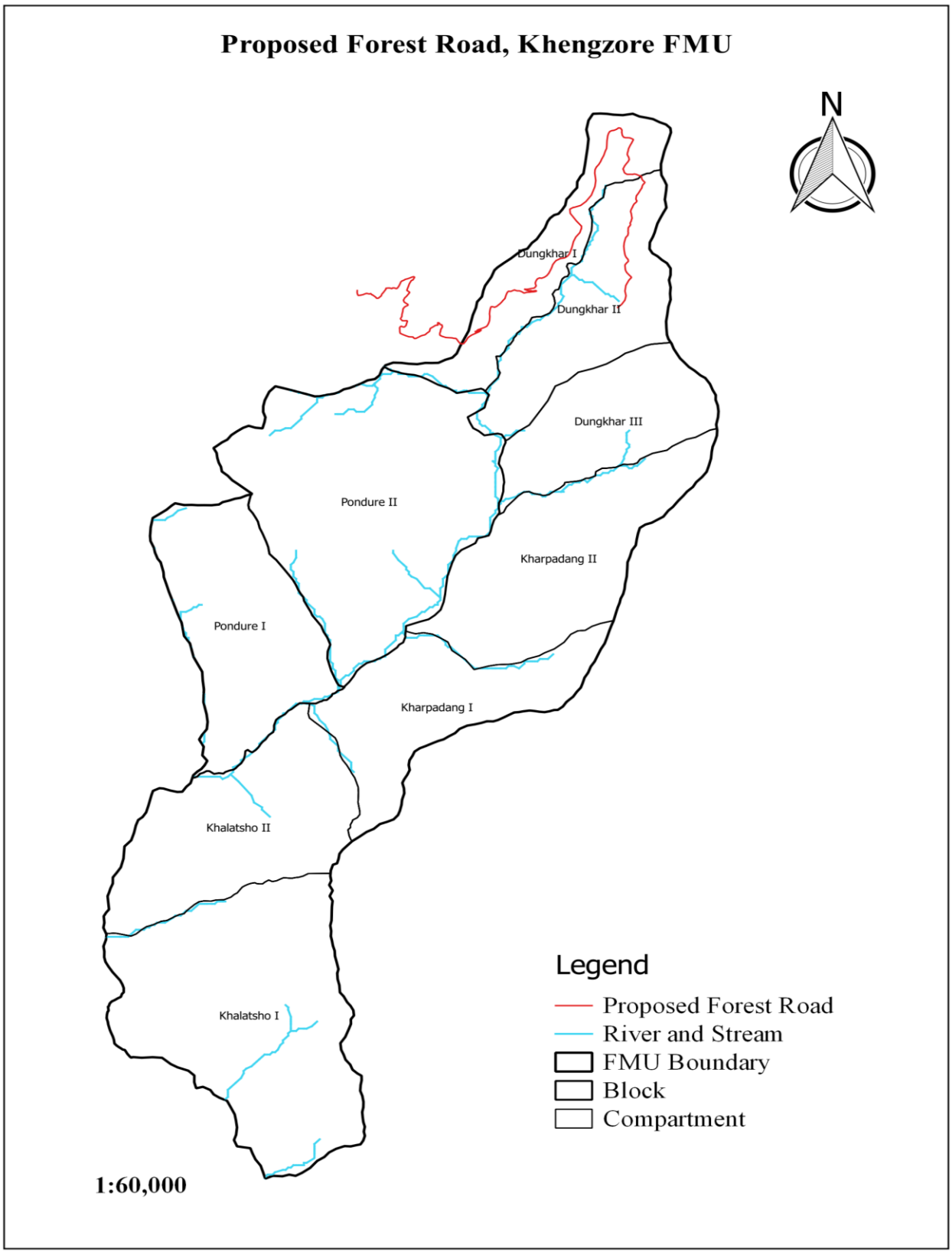


Figure 8: Recommended Road Profile

Map 11: Proposed FMU Road



20. PLANNING

20.1 Operational Plan

For facilitating the timely implementation of the Management Plan, a Biennial Operational Plan will be prepared by the CFO, Pemagtashel and the Unit In-charge. Guidelines for the preparation of the Operational Plan have been prepared by FRMD (2002) and a copy of each is available to all Territorial Divisions. The guidelines have been updated and will continue to be so. The Operational Plan is also the tool used to provide for changes that cannot be foreseen or allowed for in the FMU Plan, such as insect and disease outbreaks, severe fire, etc. If and when these occur, the current Operational Plan should be immediately reviewed and the areas or methods of operation modified to deal most effectively with possible changes in the sustainable level of harvest.

The Operational Plan will be prepared in consultation with all the agencies and parties who will be using the forest. Inclusion of a consultation process with local communities in the preparation of the plan is particularly important so that potential issues concerning communities in the forthcoming operational areas are worked through before the plan is implemented.

The Operational Plan is meant to be a rolling one, i.e., Operational Plan is prepared annually but the plan period is for two year. Therefore, activities for the second year of the plan are carried forward into the first year of the next plan (Table 27). This has important implication on budgeting (since will then be possible to estimate well in advance of the start of the financial planning year) and for participatory process since these can be carried out a year before the start of activity. The primary aim in preparing the Operational Plan is to determine and co-ordinate the timely input of resources.

Table 27: Concept of Rolling Plan

Year 1	**2**	**3**	**4**	**5**	**6**	**……**
Detailed	Outline	Detailed	Outline	Detailed	Outline	Etc
	Detailed	Outline	Detailed	Outline	Detailed	Outline

The process for preparing and implementing the Operational Plan is given in the Table 28.

Table 28: Preparation and Implementation of Operational Plan

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
1. Approved FMP				
2. PRAs with local Stakeholders	To prepare participatory plan for fire management, grazing control and rural timber	Participatory plan for grazing management and rural timber harvesting (to be incorporated within the OP)	DoFPS/FMU In-charge	First step is to enter into discussion with stakeholders and their representatives
	To involve relevant stakeholders in planning for activities which have a direct impact in their "interest"			Use PRA technique to prepare the plan
				Plan cost are included in the OP
3. Operational inventory	To assess the resource availability for the planned harvesting area	Site-level inventory data for the operational area to be harvested	FMU In-charge/ NRDCL	For the areas proposed for harvesting during the next two years
	Calculation of the harvestable volume	Precise estimate of volume to be removed during the coming year		May be combine with harvesting plan and cable line survey
4. Harvesting plan and cable line survey	To plan for harvesting and extraction activities	Agreed extraction and road plan	NRDCL	Within the selected identified harvestable area for the year
5. Preparation of Operational Plan	To prepare a plan for implementation during the next two years (involving	Approved operational plan with budget	FMU In-charge with stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in

	stakeholders for some activities)			the FMP
	To formalize local institutional responsibility for planned activities (e.g. grazing management, rural timber distribution)	Identified responsibilities for each planned activities Calculate cost for each planned activities		Each activity with identified responsibility for implementation, estimated cost, and site-specific location
6. FMU annual report presented to the FMU-level Management Committee	To review process and identify and address any implementation problems	FMU Annual report endorsed by FMU-level Management Committee	FMU Manager presents to the FMU-level Management Committee	During FMU-level Management Committee meeting
	To identify any future actions necessary based on issues arising			Implementation problems need to be addressed before endorsing the new OP
7. OP review by FMU-level Management Committee and endorsed	For the FMU-level Management Committee to endorse the OP (prior to approval by DoFPS)	OP endorsed by FMU-level Management Committee	FMU Manager presents to the FMU Level Management Committee	During FMU Level Management Committee meeting
	To endorse expenditure estimates for the coming financial year			
8. NRDCL financial commitment within OP agreed	To ensure that NRDCL is committed to funding the agreed activities in the OP	Budget estimates for the OP endorsed by NRDCL and FMU-level Management Committee	FMU-level Management Committee	Meeting needs to take place by November to ensure that budget requirements can be included in

				the NRDCL APO for the next financial year
9. OP approved by Director, DoFPS	To approve OP for implementation	Approved plan and budget	Approved by FRMD and Director, DoFPS	OP approved linked with sanctioned budget for all planned activities
10. OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuel wood, etc.	According to responsibilities identified in the OP e.g. FMU In-charge, NRDCL, etc.	Each activity with specific responsibility and budget
11. Monitoring of activities	To assess the level of achievement for planned activities	Information for FMU annual report	FMU In-charge	DoFPS responsibility is to monitor the implementation of activities carried out by NRDCL
				Monitoring cost need to appear in the OP
12. DoFPS, Unit In-charge prepares FMU annual report	To report progress against planned activities	FMU annual report	FMU In-charge	Prepared annually
	To highlight any problems being encountered in implementation			Progress is reported against each FMP objective and the associated activities
13. Prepare the next years' OP (step 2-5)	To prepare the next OP taking into account progress over the past year	Operational Plan	FMU In-charge	OP may alter in response to FMU management committee suggestions and recommendations

20.2 Mid-term Evaluation of FMP

Based on the information collected by the annual monitoring and from other sources, the Chief Forestry Officer, FRMD, will ensure that the plan is evaluated at the interval of five years after the implementation. The results of mid-term review should be discussed with the FMU-level Management Committee.

20.3 FMU-level Management Committee

The FMU-level Management Committee will be established to ensure smooth implementation of the management plan. The committee will be chaired by CFO, Pemagatshel.
The committee shall consist of the following members:

- Chief Forestry Officer, Pemagatshel (Chairman)
- Regional Manager, Mongar Region, NRDCL
- Unit In-charge, Khengzor FMU
- Production In-Charge, NRDCL, Khengzor FMU
- Gup/Mangmi, Khar and Choekhorling Gewog
- Tshogpa, Khengzor, Khar, Khalatsho and Choekhorling
- FRMD Representative (if possible)

The Terms of Reference for the FMU-level Management Committee are:
During FMU Management Plan Preparation:

- To support the interest of identified stakeholder groups during the planning process for Forest Management Plan preparation.
- To agree FMU forest management objectives for different parts of the forest based on national priority and specific local condition and needs.
- To consult (along with FRMD) with specific groups of stakeholders likely to be significantly affected by proposed activities such as road construction and timber harvesting ensuring that their interest are effectively accommodated in the final plan.
- To review and endorse the draft Forest Management Plan before it is presented to the Department and Ministry for final approval.

During the Operational Planning, Implementation and Monitoring:

- To represent the interests of identified stakeholders group during planning and review of activities under Operational Plans.
- To review achievements during the past year (based on annual report submitted by the FMU Unit In-charge) and advice and act on any issue identified.
- To make recommendation for changes in the proposed Operational Plan for the coming year based on previous years' experience and on the need to achieve the agreed objectives in the forest management plan.

- To review and endorse the draft Operational Plan before submission to the Department for approval.
- To participate in the 5-year mid-term review of forest management plan.
- To hold any additional meetings as and when required in response to specific issue arising from Forest Management Plan and Operational Plan.

20.4 Staff

The Chief Forestry Officer, Pemagatshel is the overall controlling Officer of the area. The controlling and management of Khengzor FMU will be looked after by the FMU In-charge. They will be under the administrative control of the Chief Forestry Officer, Divisional Forest Office, Pemagatshel. The Chief Forestry Officer is the direct representative of the DoFPS in the field and as such he is solely responsible for all forestry activities, both technical and administrative within his jurisdiction.

20.4.1 Responsibility

For the smooth monitoring and implementation of the plan in the FMU, following staff will be required (Table 29). It is also being recommended by the Organizational Development Exercise by Royal Civil Service Commission.

Table 29: Staff requirement in the FMU

Sl. No.	Designation	Numbers
1	Unit In-charge (Sr. Range Officer/ Forestry Officer)	1
2	Forest Ranger II/ Sr. Forester/ Forester	4

The Unit In-charge under the guidance of Chief Forestry Officer will be directly responsible for the day-to-day implementation of the plan. The Unit In-charge will keep records of all the works, supervise and initiate other silvicultural activities as envisaged in this plan. Unit In-charge will be responsible to report to the Chief Forestry Officer, Pemagatshel.

Forest Ranger II will be responsible for carrying out operational inventory, help to prepare the operational plan, supervise road construction and maintenance and keep the track of regeneration of the harvested areas. Forest Ranger II will also be responsible for supervising the tree marking and felling, timber extraction, transport of logs to depot and reporting the coupe clearance. He will be responsible for marking of thinning, fire prevention and monitoring pest/diseases outbreak. The Foresters will be assigned to help the Unit In-charge and the Forest Ranger.

20.5 Buildings

Khengzor FMU is the only one coming up in the Dzongkhag today and it does not have separate office in the initial phase. Moreover, the office structure of the Division itself is under construction. However, the Divisional Forest Office, Pemagatshel may have to construct a separate office for the Khengzor FMU Unit In-Charge and supporting staff for smooth monitoring and implementation of the management plan. NRDCL will also have to construct the office for the Unit Manager and supporting staff.

20.6 Vehicles and Equipment

As it is in the initial phase, the KFMU does not have any equipment at present. In order to ensure proper implementation of this plan, the Unit must be equipped with the following equipments and instruments:

- Laptop- 3
- Printer- 2
- Xerox Machine- 1
- Clinometer- 3
- Altimeter- 2
- Diameter tape- 4
- Measuring tape- 5
- Two wheeler- 1 number
- Hypsometer- 2 numbers
- Compass- 3
- GPS Garmin- 4
- Walkie Talkie Sets-5
- Binocular- 2
- Digital Camera- 1
- Tents- 5
- Crown densitometer- 2 numbers
- Bark gauge- 2 numbers

21. MONITORING AND EVALUATION

The primary focus of the Royal Government of Bhutan's forest policy is to ensure conservation of the environment and, only thereafter, to allow the derivation of economic benefits (such as commercial timber production) from the forest.

To ensure that this policy is being carried out in the management of FMUs, a two stage verification process is necessary. The first stage checks that on-ground activities are being carried out as planned in the short term, the second checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs on year to year basis) is the term used for first stage and evaluation (checking achievements against objectives over five year periods) is the second stage.

Standard forms for monitoring and evaluation were prepared and are available from the Forest Management Code of Bhutan. The forms for monitoring were subdivided into Physical,

Financial and Environmental sections that contained an exhaustive set of questions and the forms for evaluation were also sub-divided into Evaluation form A and Evaluation form B.

21.1 Monitoring

Monitoring is the continuous/periodic review undertaken by management at every level of implementation of an activity to ensure that input deliveries, work schedules, targeted output and other required actions are proceeding according to the plan. The CFO, Pemagatshel will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD.

21.2 Evaluation

Evaluation is the examination of whether objectives are being achieved. In the context to FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress towards fulfilling objectives (Incoll 1999). Evaluation should be carried out at the intervals of five year, based on the information collected by annual monitoring.

The Head, FRMD will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information. Copies of necessary forms can be collected from FRMD. Corrective actions, if necessary, may require changes to a range of inputs or to implementation methodology. The evaluation will be carried out by staffs that are independent of the field implementation activities. The evaluation team will be appointed by the Department of Forests and Park Services.

22. CONSTRAINTS AND RISKS

Constraint of forest conservation and management planning are:

- Lack of locomotives for field staffs, leading to an inability of the staff to supervise any management activities in the FMU on time.
- No regular training for field staffs on preparation of operational plans and other related surveys.
- Inadequately trained Unit staffs to carry out cable line profiling.
- Insufficient technical staff in the FMU.
- Financial feasibility for commercial extraction by NRDCL.
- Lack of research.

23. DEVIATION FROM PLAN PRESCRIPTIONS

The annual harvested area should be managed to allow for unforeseen situation. For these and other *bona fide* reasons, the annual coupe may vary up to +/- 10%. However, the total volume harvested over successive five-year period must be no more than five times the AAC volume.

Unforeseen circumstances may warrant deviation from the Plan prescription. In such an event, the CFO, Pemagatshel must obtain prior written approval from the Director, DoFPS. Any such request for plan deviation(s) must be fully justified and such approved deviation(s) entered into the Management Plan during its next scheduled revision. The NEC Secretariat must be informed of the plan deviations approved by the Head of the Department if any.

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ANNEXURE 1: Compartment Description and Prescriptions

Block: Dungkhar, Compartment I
Altitude: 1300m - 2200 m
Aspect: SE, SW
Terrain: 15º - 65º
Protection: 84.76 ha
Non-production: 1.11 ha
Production: 163.68 ha
Total Area: 249.55 ha

Block: Dungkhar, Compartment II
Altitude: 1100 m - 2300 m
Aspect: SW, NW
Terrain: 16º - 59º
Protection: 23.97 ha
Non-production: 0.76 ha
Production: 307.12 ha
Total Area: 331.85 ha

Block: Dungkhar, Compartment III
Altitude: 1000 m - 2200 m
Aspect: SW, SE
Terrain: 17º - 62º
Protection: 4.83 ha
Non-production: 0.00 ha
Production: 280.86 ha
Total Area: 285.69 ha

Forest Description
The Block has over matured *Nyssa javonica*, *Exbucklendia* and *Michelia* trees. The girth of these trees is harvestable.

Prescription for Future Management
The commercial harvesting can be carried out in this compartment during the first plan period and rural allotments can also be made from this area to the people of Khengzor and Labar Village.

Block: Pondure, Compartment I
Altitude: 600 m - 1900 m
Aspect: NE, SW, NW

Terrain: 16º - 67º
Protection: 266.90 ha
Non-production: 10.80 ha
Production: 146.65 ha
Total Area: 424.35 ha

Block: Pondure, Compartment II
Altitude: 700 m - 2000 m
Aspect: NE, SE, SW, NW
Terrain: 16º - 70º
Protection: 396.54 ha
Non-production: 11.61 ha
Production: 385.88 ha
Total Area: 794.03 ha

Forest Description
This block consists of two compartments with major inaccessible areas. It is more of steep area with scattered stands. The area is more or less dominated by *Quercus* species.

Prescription for Future Management
Commercial harvesting can take place in this block as well but then with very minimum volume due to steep terrain of the area.

Block: Kharpadang, Compartment I
Altitude: 700 m - 1900 m
Aspect: NW, NE, SW
Terrain: 18º - 67º
Protection: 228.43 ha
Non-production: 0.00 ha
Production: 125.55 ha
Total Area: 353.98 ha

Block: Kharpadang, Compartment II
Altitude: 800 m - 2000 m
Aspect: SW, NW
Terrain: 16º - 61º
Protection: 205.93 ha
Non-production: 0.66 ha
Production: 258.09 ha
Total Area: 464.68 ha

Forest Description

This block is also divided into two compartments. It is dominated by timber tree species such as *Terminalia*, *Schima*, *Morus*, *Altingia*, etc. It also consists of more than three species of Bamboos and diverse of wildlife are observed in the area during general resource inventory.

Prescription for Future Management

Major commercial harvesting can be carried out from this block due to availability of diverse timber tree species. We could hardly observe the regeneration of timber tree species in the block during the inventory. Hence, artificial regeneration has to be established immediately after harvesting in the block.

Block: Khalatsho, Compartment I

Altitude: 300 m - 1600 m
Aspect: NE, SW, NW
Terrain: 15º - 59º
Protection: 318.88 ha
Non-production: 0.00 ha
Production: 417.00 ha
Total Area: 735.88 ha

Block: Khalatsho, Compartment II

Altitude: 500 m - 1600 m
Aspect: NE, SW, NW
Terrain: 17º - 64º
Protection: 265.50 ha
Non-production: 0.37 ha
Production: 190.47 ha
Total Area: 456.34 ha

Forest Description

This block also has two compartments. It consists of more of non-timber tree species with much open and inaccessible area. Few timber tree species are found over the ridges while the gullies are being used as grazing ground by Elephant and Gaur. This block is nearer to Khalatsho village and Biological Corridor number 5.

Prescription for Future Management

Commercial harvesting is feasible in this block as well. However, timber tree species are situated over the steep ridges which would hinder the extraction process.

ANNEXURE 2: Road Standards

The road standards developed in the east by TFDP will be implemented for design, drainage and construction of all forest roads in Khengzor FMU.

Road Design

- Road lengths and density should be minimized, consistent with access requirements to reduce environmental impacts and enhance access economics.
- Where possible, locate roads in areas with low side slopes. The maximum side slopes allowed in all areas, except rock, is 100%.
- Roads must be constructed in such a way that no earth works or soil spill into water courses or watercourse buffer areas. Care should also be taken to ensure that no earth works or soil is allowed to spill onto agricultural land, near houses or main roads.
- Roads should be planned in such a way that the cut and fill are balanced to minimize transport of construction materials.
- Roads should not be constructed in steep and unstable areas where there is the possibility of landslide. A thorough survey of any area suspected of being unstable should be undertaken prior to construction.
- Roads should be kept as narrow as possible to reduce damage to the environment and to reduce costs.
- Where possible, box cuts should be avoided, however they are acceptable for short distances (up to 300m), if they reduce the length of the road, reduce environmental damage and are properly drained.
- Minimum radius formed by curves or corners should be 15m and should where possible fit the topography of the land.
- Roads should be located on elevated areas, where possible, to minimize side cutting, width of clearing and drainage problems.
- Side cutting should be carried out leaving a stepped batter, each step no more than 3m in vertical height and no more than 100% gradient with a 1.5m horizontal step.
- Convex road surface should be maintained at all times with the center line 30cm higher than the edges.
- Stabilize and re-vegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.
- Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon seasons.

Drainage

- Road planning should ensure that roads are located in such a way as to minimize stream river crossings and avoid areas which are prone to floods during monsoon.
- In areas where side slopes of 70% or greater extend for a distance of 100m or more above the proposed road catch drains should be constructed to divert surface water into culverts. Side drains or table drains should be at least 40cm deep and 65cm wide and should drain into culverts of sufficient size and frequency.
- All culverts must have stone or concrete aprons at their exit points to prevent erosion by water. These aprons should be of suitable width and design to prevent any erosion, taking place and should extend down the slope for at least the length of the spill. They should divert the water back into the stream if the water came from a stream.
- Culverts of appropriate diameter (not less than 30cm) should be placed at regular intervals along the road. The following table gives the minimum spacing required according to road gradient. Should the roadside drain be composed of erodible material then the distance between the culverts must be reduced by 50%.

Road Gradient (%)	Distance Between Culverts (m)
4	110
5-8	90
9-10	80
11-15	60

- Culverts should be laid at 2 to 5% gradient across the road to enable water to flow but should not exceed 6% as damage from erosion will result. Culverts pipes (Hume pipe) should be buried a minimum of 700mm below the surface of the road.
- In areas of high seasonal rainfall, catch drains should be constructed above the road to collect surface runoff and prevent it from reaching the road.
- Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50m before a watercourse.
- Sumps or silt traps should be places in drains every 50m in erodible soils and must be cleaned regularly.

Road Construction

- All timbers above 30 cm diameter must be felled and removed from the road alignment, the remaining timber should be cut and burnt (no organic material should be used as fill).
- Primary excavation should be done in such a manner as to remove the topsoil and place it on the downward slope of the road. This will allow vegetation to regenerate and stabilize the slopes.
- Where side slopes of 70% or more extend more than 100 m downhill no side casting of spoil should be allowed. In this situation end haul methods must be used.

- Forest roads should only be constructed on stable soil types where there is no possibility of slippage.
- All road construction on side slopes of over 50% or difficult terrain, such as boulder fields, must be carried out using excavators.
- Batter and fill slopes should not exceed 100%.
- Where road construction is carried out on side slopes of over 90% rock or concrete wall should be built to support both batter and fill (this is not required in solid rocks).
- On side slopes of over 70% all of the load carrying surface of the road must be built on stable ground. The road should not be supported by fill.
- The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distances of up to 300 m if this substantially reduces road length. Following this incline, a minimum distance of 100 m of grades of 10% or less must be maintained.
- The favorable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300 m will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 m or more.

ANNEXURE 3: Tree Marking Guidelines

Marking Guidelines for Patch Cut System

The Patch Cut System aims to secure natural regeneration by imitating nature in the creation of small opening in the forest stand; thus allowing light to reach the forest floor and creating favorable microclimatic condition for seed germination and seedling establishment. It is important to avoid damage to the remaining stand by selecting only trees that will fall into the opening and ensuring that accurate felling is carried out.

- Small patches spaced at specified interval will be harvested removing all tress over 10cm DBH.
- The patch will be located along extraction lines.
- The distance between the extraction lines will be no less than 75 m.
- The distance between the patch, along the extraction lines, will be less than 60 m.
- The shape of the harvested patch can be irregular, according to the site and terrain conditions.
- Existing opening in the stand having already established regeneration should be used as a nucleus for marking the patches.
- Signs of existing wind fall in the stand should form the basis of the opening. In such a case, opening boundaries should correspond to changes in soil moisture that is often the cause of the windfall.
- Wind firm trees must surround the selection patches. This could be achieved by leaving intermediate height trees along the edge of the opening.
- The trees will be marked for harvesting along the extraction corridors.
- The extraction corridors must be as narrow as possible; no wider than 4m in the broadleaf stands.
- The maximum size of the patches will be on an average less than 0.15ha depending on the sites characteristics and stand condition.
- Diseased, dead and malformed tress will be marked on the priority basis and should be used as a nucleus for creating a patch.
- Boundaries of patch should, where possible corresponds to change in slope. A patch opening should not end in the middle of a steep slope since tree will slide into the remaining stand during logging.
- Care must be taken in choosing the boundary of the patch opening. Trees, which can be expected to fall into the opening, should be marked while trees leaning out of the proposed opening must be left standing so as to minimize damage to the remaining stand.
- Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Spacing and stand Density Regulation

The spacing of trees should be roughly 2 m and the resulting stand density, approximately 2,500 trees/ha. Preferentially maintain admixed species, unless damaged or malformed. Mean maximum diameters of solitary blue pines provide guidance for optimal size dependent stand density considering a 25% deduction of mean maximum crown dimensions for optimal spacing in closed stands. Trees in closed stands will not develop the crown dimensions of free growing (solitary) trees and at the same time individual tree growth and stand growth have to be optimized. A too severe reduction of stem density (increase of spacing for optimized growth of individual trees) would result in lower standing volume per hectare.

Selection of Plus Trees

Once the stand reaches crown closure at the beginning of pole stage (at top heights of 12-15 m), differentiation between trees in terms of performance and quality will start to become clearly visible in case initial spacing has been carried out. Trees forming part of the stand at time of the final cut (plus trees) have to be selected and marked during this time. A change or supplementary marking of plus trees at a later stage are not possible.

The number of plus trees depends on the target diameter during the final harvest. Considering crown dimensions with a target DBH of 50 cm at rotation period of 100-130 years, selection of 200 plus trees per hectare resulting in a spacing of 7 m between plus trees is recommended. In case the target production for the stand is 40 cm DBH at final harvest, optimal spacing is 6-6.5 m resulting in 260 stems per hectare (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

In case of doubt, stability should have priority before quality. In locations where suitable trees are lacking, no plus tree should be selected. While carrying out thinning operations, special care should be given to plus trees in order to protect them from damage. In case initial spacing has not been carried out, stands reaching pole stage are densely stocked and differentiation between trees in terms of vitality and quality is not clearly visible. Marking of plus trees at this stage is not meaningful. Therefore, a series of low-intensity thinning entries should be completed before trees are differentiated enough in terms of stability and quality criteria so that selection of plus trees can be carried out (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

- For each plus tree, mark the one or two (maximum three) strongest competitors for removal in order to provide it enough growing space. Ideally, the total volume removed should be around 25% corresponding to moderate thinning intensity.
- Paint plus trees with yellow band to signalize their importance and for ease of marking in subsequent entries. Trees with such a yellow band should be protected throughout the stand development as they represent the final crop.

- The remaining stand may optionally be thinned, but this is not an essential requirement. In case of thinning the remaining stand, concentrate on removal of malformed and diseased trees.
- In case the favored tree (plus tree or other) has a crown ratio below half or an asymmetric crown, remove maximum one competitor in order not to jeopardize stability.
- Remove trees affected by dwarf mistletoe on a top priority basis.
- The stems of forked trees belong to the same vegetative individual and have to be treated together- if you remove one, you have to remove both.
- Remove malformed trees and trees with other diseases than dwarf mistletoe.
- Marking should not result in creation of gaps in the canopy.
- Focus on maintaining a well-structured stand.
- Focus on promoting a mixed-species stand.
- Do not blaze trees in the remaining stand. Blazing wounds weaken the trees and provide entry point for pathogens, devaluating the most valuable first log of the tree.
- Remove wolf trees (large emergent trees remaining from an earlier cohort) in a priority basis and do not consider their volume within the target of 25% volume removal.
- Do not worry about having to induce regeneration in the course of thinning.
- Thinning is primarily about stand improvement and is not a regeneration cut (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

Marking for Rural Uses

- It is necessary that the marking for rural use, whether for timber or fuel wood, should be done under standard Silvicultural system.
- Firewood marking when necessary should be done under Single Tree Selection System from local use area only.
- Flag posts, fence posts and poles demand should be met by marking for thinning in the pole crop high density stands thereby subjecting the stands to Silvicultural thinning.

ANNEXURE 4: Administrative Approval for establishment of KFMU

དཔལ་ལྡན་འབྲུག་གཞུང་།
Royal Government of Bhutan
རྫོང་ཁག་བདག་སྐྱོང་ ཤན་དགའ་ཚལ།
District Administration
Pema Gatshel

PG/DPU-29/2018-19/ 5784

Match 06, 2019

Administrative Approval

The Dzongkhag Administration is pleased to accord Administrative Approval for the establishment of Khengzore Forest Management Unit under Khar Gewog.

This is issued with reference to the request submitted vide letter no.PG/RMS-32/2018-19/680 dated March 6, 2019 by Offtg Chief Forestry Officer, Divisional Forest Office, Pema Gatshel.

(Phuntsho)
Dzongdag

Copy:

1. Chief Forestry Officer, Divisional Forest Office, Pema Gatshel for necessary action.
2. Gup, Gewog Administration, Khar for information.
3. Office copy

Phone # +975-471133. Fax # +975-471142

ANNEXURE 5: Social Clearance for establishment of KFMU (Khar Gewog)

དཔལ་ལྡན་འབྲུག་གཞུང་།
རྡེད་བོག་གདུགས་སྐྱོང་། མཁར། པདྨ་དགའ་ཚལ།
ROYAL GOVERNMENT OF BHUTAN
GEWOG ADMINISTRATION, KHAR, PEMA GATSHEL

ཡིག་ཨང་། གེ་ཁི/བདག་སྐྱོང་། (০৫) ২০১৫-১৫/ 3873 སྤྱི་ཟླ: ১৭/০৩/২০১৫

ནགས་ཚལ་གཅོད་འཇིན་འགོད་རོགས་མཛོད་གཡུག

ནགས་ཚལ་དང་ཐྲིང་ཀཱ་ཞུས་ཀྱི་གལས་ཁུངས། མངའ་སྡེ་ནགས་ཚལ་ཡིག་ཚང་།

པདྨ་དགའ་ཚལ།

ཟུར་དེན: **ཁེངས་རྫོང་ནགས་ཚལ་འཇིན་སྐྱོང་སྡེ་ཁག་གི་དོན་ལུ་ ཉོག་ཡཁད་ཞེད་ཡཁ་ཁྱེད།**

ཁེངས་རྫོང་ནགས་ཚལ་འཇིན་སྐྱོང་སྡེ་ཁག་ གཞི་བཙུགས་འབད་ཞིའི་དོན་ལུ་ ཉེ་འདབས་ཀྱི་ མི་སེར་ཚུ་དང་ ས་ཁི་ངང་གཏུགས་གིས་ ཉོག་ཡཁད་ཀྱི་ རིམ་པ་ཅུ་ གང་ཡང་མེད་པ་ལས་འཁེན་ ཞེད་བོག་གདུགས་སྐྱོང་གིས་ ཁ་ཐུག་ལས་ཡང་ ནགས་ཚལ་འཇིན་སྐྱོང་སྡེ་ཁག་ གཞི་བཙུགས་འབད་ཞིའི་དོན་ལུ་ རྒྱབ་སྐྱོར་སྤེལ་ཏཱ་ཞིན་ལས།

ལྷུན་སྐྱོབ Gup
Khar Gewog
རྡོ་རྗེ། Pemagatshel

འཕྲི།

༡) ཡིག་སྐྱོང་ནང་།

☎ Mobile no. +97517631572 (Gup), +97517841785, +97577841785, +97517691140 (GAO), +97577691990 (Mangmi), +97517961582 (Gaydrung)
☎ e-mail id: npelden@pemagatshel.gov.bt

Public Consultation Meeting on Khengzore FMU

Pema Gatshel Forest Division

Venue: Khengzore Primary School, Khar Geog, Pema Gatshel

6th January, 2018

Sl. No.	Name	Designation	Place	Signature
1	Ugyen Wangchuk	CFO	Division	
2	Ngagay Dorji	Grp	Khengzore	
3	Ugyen Dorji	Sr. FR	Division	
4	Ugyen Tenzin	Sr. FR	"	
5	Singye Namgay	Driver	Khengzore	
6	Pema Dorji	Forest Ranger	Khengzore	
7				
8		"	"	
9		"	"	
10		"	"	
11		"	"	
12			"	
13				
14			"	
15		"	"	
16		"	"	
17		"	"	
18		"	"	
19		"	"	
20		"	"	
21		"	"	
22		"	"	
23		"	"	
24		"	"	
25		"	"	

Sl. No.	Name	Designation	Place	Signature
༢༨	[illegible]		[illegible]	
༢༩	[illegible]	[illegible]	''	
༣༠	[illegible]	''	''	
༣༡	[illegible]	''	''	
༣༢	[illegible]	''	''	
༣༣	[illegible]	''	[illegible]	
༣༤	[illegible]	''	''	
༣༥	[illegible]	''	''	
༣༦	[illegible]	[illegible]	''	
༣༧	[illegible]	''	''	
༣༨	[illegible]	''	''	
༣༩	[illegible]	''	''	
༤༠	[illegible]	[illegible]	''	
༤༡	[illegible]	[illegible]	[illegible]	
༤༢	[illegible]	[illegible]	''	
༤༣	[illegible]	''	''	
༤༤	[illegible]			
༤༥	[illegible]			
༤༦	[illegible]		Phad.	
༤༧	[illegible]			
༤༨	[illegible]			
༤༩	[illegible]			
༥༠	[illegible]			
༥༡	[illegible]			
༥༢	[illegible]		Shingngri	
༥༣	[illegible]		Shinangri	Tshering
༥༤	[illegible]			
༥༥	[illegible]		Duwang	
༥༦	[illegible]			

Sl. No.	Name	Designation	Place	Signature
५५	ཀུན་བཟང་དབང་མོ།	ཚ	སྐྱིད་ཁང	
५६	ཐབས་པ་རྡོ་རྗེ།			
५७	ཀུན་ཐུ་གཞན་ཕྲིན།			
५८०	ཀུན་ཐུ་སྐྱོབ་མ།			
६१	དྲྭ་མོ།			
६२	ཀུན་བཟང་མོ།			
६३	ཀུན་ཐུ་གཞན་ཕྲིན།			
६४	ཀུན་དུས་ཕྲིན།			
६५	ཡིད་ཀྱིས་དྲྭ་མོ།			
६६	ཀ་ཤ་དྲྭ་མོ།			
६७	དུས་ཀརྨམས།			
६८	ཡོན་པ་གཞན་ཕྲིན།			६८.
६९	ཀུན་དུས་ཀུན་ལྡན།		Chinari	
७०	ཀུན་ཐུ་དྲྭ་མོ།		Shinari	
७१	ཀུན་ཀྱི།			
७२	ཀུན་བཟང་ཀུན་ཀརྨམས།			
७३	བཤེས་གནེན་བཟང་སྐྱོབ་མ།			
७४	ཤུགས་ཀྱབ་ནུ་མ།			
७५	ཀུན་ཀྱི།			
७६	རབ་ཏུ་གཞན་ཕྲིན།			
७७	ཀ་ཤ་བཟང་མོ།		phadi	
७८	རབ་ཏུ་ནུ་ཕྲིན།		~~[illegible]~~	
७९	ཀུན་བཟང་བཟང་མོ།		[illegible]	
८०	རིགས་ཆེད་བཟང་མོ།			
८१	ཀུན་ཐུ་བཟང་མོ།		Shinangri	
८२	ཀུན་སྐྱོབ་མ།			
८३	ཉིམ་ཐུ་ཆ།			
८४	ཡེ་ཤེ་ཐུ་ཐུ།		zorchung	
८५	ཀུ་ཀུབ་དཔལ་མོ།		Du Neeng	
८६	ཀུ་ཀུབ་ཀྱི།			

Sl. No.	Name	Designation	Place	Signature
८५	[illegible]			
८८				
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१०५			Trebar	
१०६				
१०७				
१०८				
१०९				
११०			Duwang	
१११				
११२				
११३				
११४				
११५				
११६				

Sl. No.	Name	Designation	Place	Signature
११७	[illegible]		Phadi	
११८	[illegible]			
११९	[illegible]			
१२०	[illegible]			
१२१	[illegible]		[illegible]	
१२२	[illegible]		Bargonpa	
१२३	[illegible]			
१२४	[illegible]		[illegible]	
१२५	[illegible]		[illegible]	
१२६	[illegible]		[illegible]	
१२७	[illegible]		[illegible]	
१२८	[illegible]		[illegible]	
१२९	[illegible]			
१३०	[illegible]			
१३१	[illegible]			
१३२	[illegible]			
१३३	[illegible]			
१३४	[illegible]		Tsebar	
१३५	[illegible]			
१३६	[illegible]		[illegible]	
१३७	[illegible]		[illegible]	
१३८	[illegible]	Gup	Khenangri	
१३९	[illegible]	Tshogpa	Khenangri	
१४०	[illegible]			
१४१	[illegible]		Naktseri	
१४२	[illegible]			
१४३	[illegible]			
१४४	[illegible]			

ANNEXURE 6: Social Clearance for establishment of KFMU (Choekhorling Gewog)

ROYAL GOVERNMENT OF BHUTAN
GEWOG ADMINISTRATION
CHOEKHORLING, NGANGLAM
NGANGLAM-PEMAGATSHEL
EASTERN-BHUTAN

ཡིག་ཚང་ སེ་གོ་ཇི/ཚེ་དྲི་ཚེས-২৩/২০১৯/ 2976 སྤྱི་ཚེས་ ১২-০২-২০১৯ ལྷག

ཁ་ཤེས་བཞད་མེད་པའི་ཡིག་འཕྲིན

༡ ཁེངས་རོང་ནགས་ཚལ་འཛིན་སྐྱོང་སྡེ་ཚན་གྱི་ ནགས་ཚལ་སྡེཕུན་ཅོགཁྲི་བཙུགས་འབད་ནི་དོན་ལུ་ མི་སེང་ཚུ་ལས་ཨོགས་མེད་པའི་ཡིག་ལེན་སྟེ་ ཨོགས་བཞད་གང་ཡང་མེད་པ་ལས་བརྟེན་ ཤེད་འོག་གི་ཉེར་ལས་ཡིང་ ཨོགས་བཞད་མེད་པའི་རོགས་ལྷལྷ་ཞིན།

ཀུན་ཁྱེམས་རྫོང
Gup
Choekhorling Gewog
Nganglam

Gup – 17755741 GAO – 17653337 Mangmi – 17515970 Gedrung - 17492298

Public Consultation Meeting on Khengzore FMU

Pema Gatshel Forest Division

Venue: **Pema Gatshel**

6th January, 2018

Sl. No.	Name	Designation	Place	Signature
1.	Kinzang Dorji	Farmer	Chestbeating	
2.	Yoenten	"	"	
3.	Tshuroku	"	"	
4.	Zepa Thinley	"		
5.	Khandu	"		
6.	Tashi Tobgay (son of Khandu Zangmo)	Teacher		
7.	Namkha Gyaltshen	Farmer		
8.	Dubala	"		
9.	Tenzin Dorji	"		
10.	Zangpo 'A'	"		
11.	Sangay Pelzang	"		
12.	Norbu Wangdi	"		
13.	Ugyen Zangpo	"		
14	Chona Lhamo	"		
15	Deperi	"		
16	Damtshe Lhamo	"		
17	Bumzang Lhamo	"		
18	Ningay Zangmo	"		
19	Sangay Lhamo	"		
20	Kelzang Lhamo	"		
21	Jangchuck Wangmo (wangdi)	"		
22	Jangchuck Tenzin	"		
23	Phuntsho Chodon	"		
24	Kinzang Chedon	"		
25	Tshejay	"		
26	Rigzangmo	"		
27	Sumcho Wangmo (D.o. Deki)	"		
28	Lhatu (Son of Wangchuck)	Student		
29	Sangay Yeazer (son of Jamtsho)	"		
30	Tshomo	Farmer		

Public Consultation Meeting on Khengzore FMU

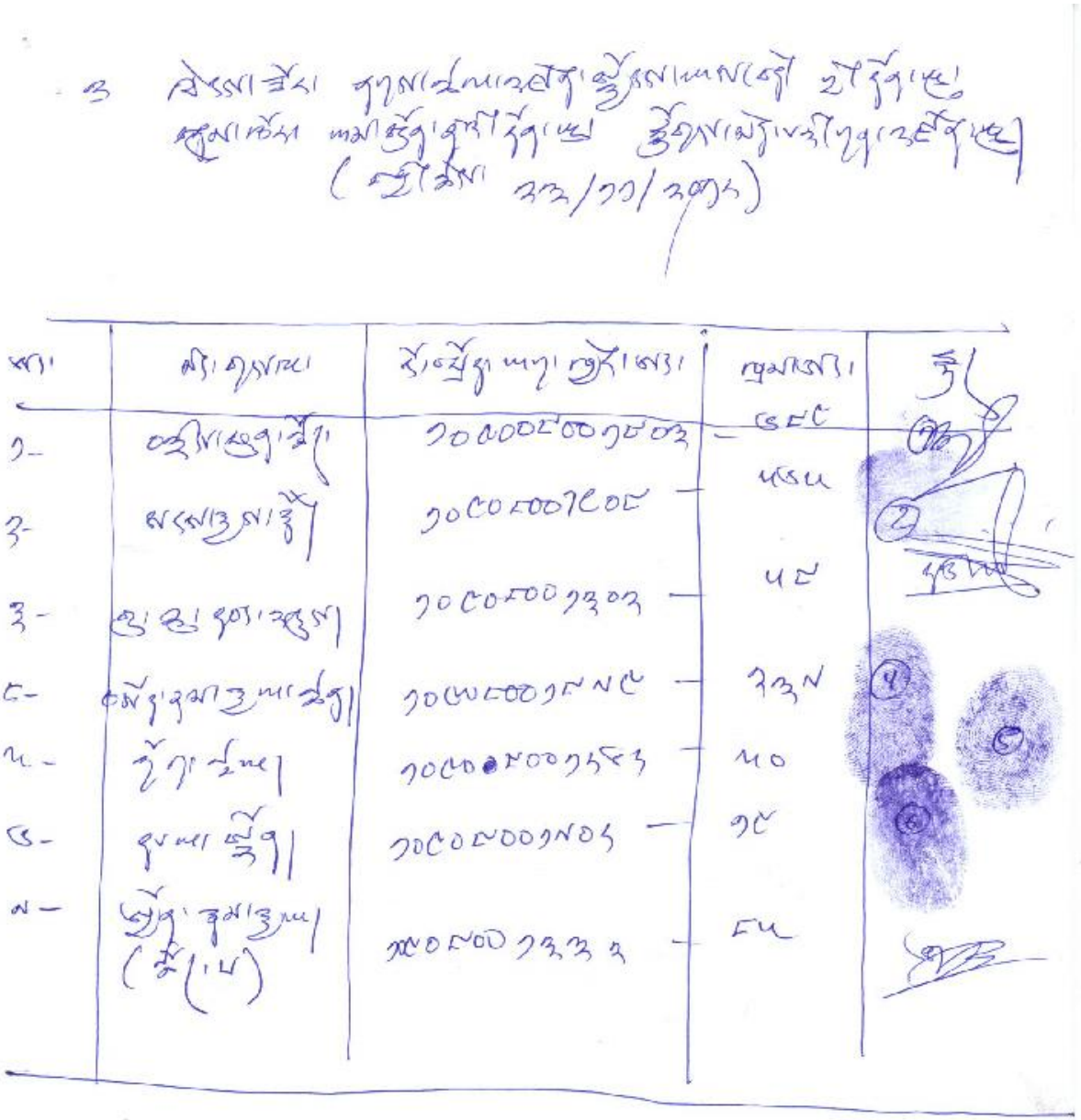
Pema Gatshel Forest Division

Venue: **Pema Gatshel**

6th January, 2018

Sl. No.	Name	Designation	Place	Signature
31	Doko Lhamo	Farmer		
32	Yangki	"		
33	Pelmo	"		
34	Chokhor Zangmo	"		
35	Migmar Wangmo	"		
36	Domi	"		
37	Leki Dema	"		
38	Dorji Kerab (Son of Sonam Wangchuck)	Survice		
39	Jamyang Tshöltrim (Son of Tashi Zangpo)	"		
40	Tashi Dendup (Son of Pema Dorji)	"		
41	Kandon	farmer		
42	Tshering Chogom	"		
43	Sangay Chazom	"		
44	Sangay Lhadon	"		
45	Tsheye Lhamo	"		
46	Karma Thinley (S.O. Yongba'Z)	Student		
47	Karma Tashi (S.O. Yaktong)	"		
48	Jigme Tobgay (Representive of Kelgang)	"		
49	Jagay Phuntsho (R-of-Wama Dema)	"		
50.	Kunzang Rabten	Tshogpa	Chookchoong	
51	Sangay Chophel	Tshogpa	Yarjeykoong	
52.	Jigme Nidup	Mangmi		
53.	Tsheltrim Dorji	Gup		
54.	B. B. Mongar	R.O	Chookchoong	
55.	Pema Dorji	R.O	Nyunglam	
56	Pema Renzin	R.O	Nyunglam	

ANNEXURE 7: Social Clearance for Road and Bridge Construction



ANNEXURE 8: Environmental Impact Assessment Report of Proposed Forest Road

ENVIRONMENTAL IMPACT ASSESSMENT REPORT ON CONSTRUCTION OF FOREST ROAD AT KHENGZOR FMU, PEMAGATSHEL DZONGKHAG

1 Name of the applicant : Natural Resources Development Corporation Ltd.

2 Name of project : Construction of forest road

3 Present mailing address : Chief Executive Officer, NRDCL Thimphu, P.O. Box no. 192, Tel. no. 326749, EPABX no. 00975-02-323834/323868. Fax no. 00975-02-325585. Email: info@nrdcl.bt

4 Name of environmental focal person : Mr. Nidup Dorji, Junior Engineer, Forest Resources Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: nidupdorji@nrdcl.bt

5 Project objectives : Timber harvesting & afforestation of harvested areas

6 Relevence to overall planning : Preparation of Forest Management Plan

7. Funding and costs : Funded by NRDCL, Thimphu

: Nu. 37,806,000.00

8 Project description

8.1 Project location : 26° 57' 38.3"N, 91° 24' 16.4" E to 26° 57' 30.35" N, 91° 26' 04.26" E

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 10000	Pemagatshel	Khar		Khengzor

8.2 Category of road :Forest Road

8.3 Road specification :

Table 2. Road Specification/Quantities

Item	Unit	Specification/Quantities
Right of way clearing	m	10.00
Formation Width	m	5.00
Pavement Width including edging	m	3.50
Pavement material (Edging, soling & agttes)	cum	10,500.00
Volume of excavated material		
a) Excavation in soil all type	cum	15,183.90
b) Excavation in rock all type	cum	23,067.96
Average road gradient	%	±7
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	NIL
V-shaped side drain diamensions		
In soil (horizontal x vertical)	cm	40CM X 30 Cm
In rock (horizontal x vertical)	cm	30 CM X 20 CM
Total length of v-shaped drain	m	9,945.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

8.4 Excavated Materials : The excavated material will be managed and disposed off safely at designated locations through the use of excavator and tipper trucks or hydraulic tractors.

8.5 Explosives : Approximate quantity of explosive to be used is as under:

Page 1

Sl. No	Particulars	Quantity	
1	Safety fuse	1205 coils	(Approx)
2	detonator	2105Nos.	(Approx)
3	D-chord	1701 m	(Approx)
4	Jelatine	2701 kgs	(Approx)

Control single shot blasting technique will be adopted with the engagement of a trained & certified blaster.

9 Alternatives : NIL

10 Public Consultation : Public consultation meeting conducted

11 Project site Physical Environmental details

11.1 Topography and Geology

Table 3: Topography and observations along the road

Chainage(Km 0+000)		distance (m)	Side slope %	Observation on geology & possible problem	Method of slope & terrain stabilization Above & Below road
From	To				
0 + 000	0 + 10000	10,000.00	10 -120	Not foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		10,000.00			

11.2 Water Course Crossings

Table 4: Details of water courses that will require crossing along the proposed road

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0+000 + 0+577	N A	Hume pipe culvert	NIL	None	None	None
0+577+ 0+825	N A	Hume pipe culvert	NIL	None	None	None
0+825 + 0+856	NA	Hume pipe culvert	NIL	None	None	None
0+856 + 0+947	NA	Hume pipe culvert	NIL	None	None	None
0+947 + 1+199	NA	Hume pipe culvert	NIL	None	None	None
1+199 + 1+427	NA	Hume pipe culvert	NIL	None	None	None
1+427 + 1+550	NA	Hume pipe culvert	NIL	None	None	None
1+550 + 1+737	NA	Hume pipe culvert	NIL	None	None	None
1+737 + 1+849	NA	Hume pipe culvert	NIL	None	None	None
1+849 + 2+202	NA	Hume pipe culvert	NIL	None	None	None
2+202 + 2+269	NA	Hume pipe culvert	NIL	None	None	None

2+269 + 2+714	NA	Hume pipe culvert	NIL	None	None	None
2+714 + 3+080	NA	Hume pipe culvert	NIL	None	None	None
3+080 + 3+509	NA	Hume pipe culvert	NIL	None	None	None
3+509 + 4+202	NA	Hume pipe culvert	NIL	None	None	None
4+202 + 4+375	NA	Hume pipe culvert	NIL	None	None	None
4+375 + 6+310	NA	Hume pipe culvert	NIL	None	None	None
6+310 + 6+980	NA	Hume pipe culvert	NIL	None	None	None
6+980 + 7+640	NA	Hume pipe culvert	NIL	None	None	None
7+640 + 7+910	NA	Hume pipe culvert	NIL	None	None	None
7+910+8+318	NA	Hume pipe culvert	NIL	None	None	None
8+318+8+560	NA	Hume pipe culvert	NIL	None	None	None
8+560+8+670	NA	Hume pipe culvert	NIL	None	None	None
8+670+8+940	NA	Hume pipe culvert	NIL	None	None	None
8+940+9+180	NA	Hume pipe culvert	NIL	None	None	None
9+180+9+380	NA	Hume pipe culvert	NIL	None	None	None
9+380+9+760	NA	Hume pipe culvert	NIL	None	None	None
9+760+10+000	NA	Hume pipe culvert	NIL	None	None	None

12 Project Site Ecological Description

12.1 Land Use/Vegetation

Table 5: Land use and forest clearance required for road construction

Chainage from take off		Land use	Area (M^2)	Tenure	Affected House hold no
From	To				
0 + 000	10 +000	Mixed Hard Wood	100,000.00	10 years	2

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	hip	Remarks
Labour camp	Mixed Hard Wood	2000 per annum	Govt. reserve forest	Till project completes
Others	None	None	None	None

12.2. Protected area : The protected areas such as Soil protection, local water supply protection, Reparian protection, Wild life protection etc. shall be indentified where no commercial activities shall be allowed.

13 Project social environment

13.1. Population

Table 7: Project Beneficiaries. Households with possible access <2km either side of the road

Dzongkhag	Gewog	Households (No)
Pemagatshel	Khar	80

Source of information: as per attached No Objection letter of the Gup, Khar Geog

Loss of Houses, Services, Infrastructure and Cultural Heritage Sites

Type of loss	NOS	Description of disturbance
Service	NIL	NIL
House	NIL	NIL
Infrastructure	NIL	NIL
Cultural sites	NIL	NIL
Heritage	NIL	NIL

13.3 Aesthetics

No aesthetic distrubance is foreseen however, grass seeding & other bio-engineering technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

Type of negative impact	Mitigation measures	Estimated metigation costs
Blockage of water canal	Cleaning & maintenance	Nu. 10,000.00 (Lumpsum)
House	NIL	NIL
Infrastructure	NIL	NIL

14.1. Monitoring Program

Monitoring of the construction works shall be done by Site supervisor, Khengzor Unit, NRDCL, including time to time monitoring by the Unit Manager, Khengzor Unit under Zhonggar Regional Office, Mongar. The Regional Manager, Zhonggar Regional Office, NRDCL Mongar, shall also carry out the frequent monitoring. Also the Engineer from Forest Resource Division, NRDCL HO, shall carry out the monitoring of the construction works as & when required.

Ngawang Dorji
Jr. Engineer
Forest Resouce Division,HO,NRDCL

ENIVIRONMENTAL MANAGEMENT PLAN

Sl. No	Activity	Potential Negative Environment Impact	Mitigation Measures	Public participation & coordination	Socio- Economic & cultural considerations	Budgeting	Supervision	Monitoring
1	Stone Quarry Operation	• Landscape instability • Dust pollution • Aesthetics • Damage to vegetation	• Careful sitting & investigation • Proper operation • rehabilitation	• DoFPS • Dzongkhag administration and locals	• Consider local resource demand	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
2	Soil Disposal	• Disruption of local hydrology • Landslide • Damage to vegetation	• Use of excavator • Balanced cut & fill • Deposit excess material in designated dump sites • Bioengineer exposed slopes	• Technical person knowing bioengineering	• Considering local water supply if any	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
3	Slope stability	• Slope failure • Clog side drain	• Bioengineer slopes and protect from grazing • Erect retaining structure	• Technical person knowing bioengineering	• Consider local land use and grazing	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
4	Drainage	• Surface run off along road • Siltation of water down stream • Slope failure • Water seepage	• Design structure to accommodate discharge • Adequacy of culverts / drains • Regular clearing of clogged culverts	• Involve locals	• Consider local drinking water supply and irrigation channels	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
5	Work camp location, operation and closure, restriction on workers (sanitation, fuel wood collection poaching etc)0	• Conflict with locals • Garbage, oil and grease pollution • Damage to the vegetation and wildlife	• Proper setting • Provide sanitary facilities • Restoration • Provide fuel to workers	• DoFPS • Local people • Awareness of labors	• Consider local culture, expropriate-on &compensatio n compensate, if required	• Incorporated in the budget	• Unit manager • Site supervisor	• Unit Manager • Regional Manager • External team
6	Explosive & toxic waste management	• Fire & explosion hazard • Ground and surface water pollution	• Do not store near surface water • Use plastic sheeting under hazardous material • Collect waste properly and dispose of safely	• Contact ministry of Home and Culture Affair in case of hazard or needing material innihilation	• Consider local drinking water sources	• Included in budget	• Unit manager • Site supervisor	• Regional Manager • Engineer NRDCL • External team
7	Water management	• Sedimentation of surface particle • Slope failure • Creation of new gullies • Water seepage	• Build check dams • Tap excess water by catch drains and dispose of natural gullies	• Involve locals when deciding about discharge location • Geog administration	• Irrigation channel and drinking water supplies need considerate – on	• Additional water management and other permanent structures included	• Unit manager • Site supervisor	• Regional Manager • Engineer NRDCL • External team

ANNEXURE 9: Record Keeping Forms

Compartment Record Sheet

Block: …….

Compartment: …….

Sub-compartment: ……..

Year	Harvesting		Tending		Planting		Others	Remarks
	Area (ha)	Volume (m^3)	Area (ha)	Volume (m^3)	Area (ha)	Species		
2019								
2020								
2021								
2022								
2023								
2024								
2025								
2026								
2027								
2028								

Rural Allotment

Block:……
Compartment:…….
Sub-compartment:……..

MC	WC	Date	Name & Address	Permit No.	TMB No.	Particulars			Volume (m^3)			Comments
						Species	Product Types	Amount	Marked	Recovered	Firewood	

Commercial Allotment

Block: …….
Compartment: ……
Sub-compartment: ……

MC	WC	Year of Activity	Commercial Activities					Volume (m^3)				Other Activities	TMB No.	Comments (Include detailed description of cable line location in relation to mappable features)
			Cable Lines			Groups/ Patches/ Other		Marked		Extracted (NRDCL)	Firewood (lops/ tops)			
			Line No.	Length (m)	Azimuth	Total No.	Total Area (ha)	No. of Trees	Vol.					

Stand Tending and Regeneration[8]

Block:……..
Compartment: …….
Sub-compartment: ……

MC	WC	Cable Line No.	Year	Stand Tending		Regeneration						Comments or Other Activities
				Activity	Area (ha)	Natural/ Plantation	Species	Year Surveyed	Area (ha)	Survey Results (stems/ha/ survival percent)	Resurvey ?	

[8] *Used for brushing, planting, weeding, and spacing or ground preparation activity*