དཔལ་ལྡན་འབྲུག་གཞུང་། སོ་ནམ་དང་ནགས་ཚལ་ལྷན་ཐག་ནགས་ཚལ་དང་སྐྱོང་ཁག་ཞབས་ཏོག་ལས་ཁུངས། སྤུ་རོ་ མངའ་སྡེ་ནགས་ཚལ་སྡེ་ཚན་ ཡིག་ཚང་།

ROYAL GOVERNMENT OF BHUTAN
DEPARTMENT OF FORESTS AND PARK SERVICES
OFFICE OF THE CHIEF FORESTRY OFFICER
PARO FOREST DIVISION

FOREST MANAGEMENT PLAN
FOR
LONCHU FOREST MANAGEMENT UNIT

PARO DZONGKHAG

(1st January 2020-31st December 2029)

Plan Prepared by:

Ugyen Tshering, Sr. Forestry Officer, Paro Forest Division.
Tashi Norbu Waiba, Sr. Forestry Officer, FRMD.
Lhab Tshering, Forestry Officer, FRMD

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from **1st January 2020 to 31st December 2029**

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of Forest Management Plan for Lonchu Forest Management Unit has been delegated to Territorial Divisions by the Department of Forests and Park Services, Ministry of Agriculture and Forests, Royal Government of Bhutan, vide No. FRMD/MPS/1(e)/2014-2015/701 dated December 1, 2014.

PROVISION FOR REVISIONS AND CHANGES

This Forest Management Plan may be revised during the plan period when it is in effect if major changes occur in the Forest Management Unit or if new information becomes available that may have significant implication on the effective implementation of the plan sustainably, the Director of DoFPS has the authority to revise and approve the plan with directives to the division concerned.

APPROVAL

This plan was examined by a wide section of user groups, clients and organizations. The proposed plan has been reviewed by FRMD of the DoFPS. The final version of the Plan was furthered reviewed and technically cleared by the Technical Advisory Committee of the DoFPS. It was then recommended for approval by the Director, Department of Forest and Park Services (DoFPS) and the Secretary, Ministry of Agriculture and Forests to the Minister, Ministry of Agriculture and Forests for his approval for implementation.

Submitted for approval:

Chief Forestry Officer
Forest Resources Management Division
Department of Forests and Park Services

Recommended for approval:

.....
Director
Department of Forests and Park Services

Recommended for Approval:

.....
Secretary
Ministry of Agriculture and Forests

APPROVED

Honourable Minister
Ministry of Agriculture and Forests
Date.....05/11/2015

Environmental Clearance

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

NECS/EACD/Dzo-Haa/3753/2019/ 2139 **October 17, 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 the second phase of **Lonchu Forest Management Unit (LFMU)** measuring an area of **6039.54 hactres** with Annual Allowable Cut (AAC) Fixed at **6440.13 m^3** (Six Thousand Four Hundred Forty Meter cube) and covering the plan period from 2020 till 2030; and construction of **10 Km forest road** within the FMU at Sama Gewog under Haa 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 6440.13m^3 (Six Thousand Four Hundred Forty Meter cube) per annum only;
4. ensure that no extraction of timber is carried out at the critical watershed and wetland;
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. restore the damage to water pipelines supplying water to local community by the construction of the forest road;
8. avoid disturbances and damage to the internal drainage system by the construction of the forest road;
9. ensure that restoration works are carried out as per the management plant submitted to NECS;
10. 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
11. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address.

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

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
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 onlyat the pre-identifiedapproved dumpsite; and
2. put appropriate measures for management ofsurface 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.

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 **October 17, 2019 until October 16, 2024 for** the operation and management of the second phase of Lonchu Forest Management Unit with total area of 6039.54 hactres, Annual Allowable Cut (AAC) Fixed at 6440.13 m^3 (Six Thousand Four Hundred Forty Meter cube) and covering the plan period from 2020 till 2030; and construction of 10 Km forest road within the FMU at Sama Gewog, Haa Dzongkhag only.

(Phento Tshering)
DIRECTOR

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

Acknowledgement

Territorial Division Office, Paro, would like to extend special thanks to the GEF-LDCF project on '*Enhancing Sustainability and Climate Resilience of Forest and Agricultural Landscape and Community Livelihoods*' for financial support to prepare this Sustainable Forest Management plan for not only timber production, but also for conservation and protection of biodiversity within FMU for vital ecosystem services.

The author would like to thank the DoFPs, particularly Mr. Arun Rai, Deputy Chief Forestry Office and Mr. Dawa Zangpo, Senior Forestry Officer, and Mr. Tashi Norbu Waiba, Senior Forestry Officer of FRMD for reviewing the plan and providing valuable comments and feedback during preparation of this management plan.

I would like to sincerely extend thanks to Mr. Kaka Tshering, Chief Forestry Officer of Territorial Division Office, Paro, for his administrative support and valuable advices while preparing this plan.

I would like thank Dzongkhag Administration, Haa and Local Government, Sama, Haa, and local community people for their support and valuable comments and feedbacks to address concerns and interests of local communities in this management plan.

Special thanks also go to the staff of Lon chhu FMU and NRDCL for their constant support and assistance in the field through entire planning process.

This management plan was possible because of support and valuable comments from many readers and immense gratitude are extended to all who supported in the process to bring this management plan for Lon chhu FMU.

Abbreviations

AAC	Annual Allowable Cut
CFO	Chief Forestry Officer
DoFPS	Department of Forest and Park Services
NRDCL	Natural Forest Resources Development Corporation Ltd.
FMU	Forest Management Unit
FRMD	Forest Resources Management Division
GEF	Global Environment Facility
GIS	Geographic Information System
ha	hectare
UIC	Unit In-Charge
JKSNR	Jigme Khesar Strict Nature Reserve
km	kilometer
LDCF	Least Developed Countries Fund
MoAF	Ministry of Agriculture and Forests
msl	meters above sea level
NEC	National Environment Commission
RGoB	Royal Government of Bhutan
TD	Territorial Division
WC	Working Circle

EXECUTIVE SUMMARY

This is the second Forest Management Plan for Lon Chhu FMU . The overall structure of this management plan is as per the Forest Management Planning guidelines of Forest Management Code of Bhutan, 2004. It consists of three parts:

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

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

- Lon Chhu FMU is located in the western part of the country, under the administrative block of Haa District. The FMU falls within longitude of 89^{o} 08' 52'' to 89^{o} 17' 21'' East and latitude of 27^{o} 14' 48'' to 27^{o} 23' 03'' North. Lon *Chhu river* passes through middle of the FMU. Selela FMU lies toward the west of Lon Chhu FMU and is separated by a ridge which forms a common boundary between Lon Chhu and Selela FMU.

- The total area of the FMU is 12664.49 ha. There are no other management regimes within the FMU.

- In total, there are two households with total population of 17 within the FMU. The FMU falls within the administrative boundary of Sama gewog, Haa Dzongkhag. Animal Husbandry and Agricultural farming are the main livelihood activities of people living nearby FMU.

- The general terrain of FMU ranges from moderate to steep landscape. The elevation of FMU ranges from 2600 m at the valley bottom to 4600 m at the ridge top from m.s.l. The average monthly rainfall is approximately 809.6 mm. Precipitation in the form of snowfall occurs in the winter.

- There are broadly three types of forest within the FMU. The main forest type comprises mixed conifer, fir and blue pin. Blue pine growth is eminent at the lower altitudes either in pure stand or mixed with other species like *Quercus semicarpefolia*, *Populas ciliate*, *Betula utalis*, *Picea spinulosa*, and *Tsuga dumosa*. Mixed conifer forest mostly comprises of *Picea spinulosa* and *Tsuga dumosa* at the lower altitude. At the higher altitude, Spruce and Hemlock is mixed with other species like *Taxus baccata,* Juniper species, *Cupressus sps*, *Rhododendron sps*, *Larix graffithiana* and other species. The fir forest is seen at upper portion of the FMU and this forest favour dense under storey where abundant growth of Rhodendron species and other shrubs are usually seen.

- The AAC of the last Management Plan was set at 67,00 m^3. Out of the total AAC for FMU, 5000 m^3 was allocated for commercial use and 1700 m^3 for local use. The total commercial timber harvested for the last ten years (2010 to 2019) was 34,240.66 m^3 and rural timber extracted is 8,210.74 m^3 in standing volume. The AAC in past plan period has remained within the prescribed AAC for the FMU.

- The forest road network of FMU has benefitted not only Sama gewog and Haa Dzongkhag in general, it has also benefited people outside Haa Dzongkag and Nation at large to transport timbers of special sizes.

PART 2: FUTURE MANAGEMENT

- ***The overall goal of this management plan is to manage the Forest Resources within Lon Chhu FMU on a multiple use, sustained yield basis for the production of timber, fuel wood& non-wood forest products, conservation of watershed, wildlife and environment.***

- To facilitate the planning, implementation and recording of activities, FMU is divided into blocks and compartments. There are four Blocks viz Marpjerry, Rosha, Haa-nga and Sokono, which are further divided into compartments.

- FMU has been divided into four Management Circles, which allows different areas to be managed and evaluated separately, and increases the ease of management and implementation. The Management Circles has been identified, using forest function mapping and they are **Protection**, **Production** and **Non-Production Management Circle.** The objectives for each Management Circles have been identified and the Production Management Circles have been further divided into Working Circles so that the objectives tailored to the type of stand being harvested and managed. The objectives for each Management Circles have been listed in a logical framework along with the Management Options and responsibility for easy reference by implementers and monitoring agency.

- The total area for Protection Management Circle is about 6114.91 ha, Production Management Circle of 6032.12 ha and Non-Production Management Circle with 518.81 ha.

- The Production Management Circle has been further grouped into Working Circle as Fir Working Circle, Mixed Conifer Working Circle and Blue Pine Working Circles based on Land Use Land Cover, 2016.

- The prescribed Silvicultural System for the commercial harvesting is Group Selection System. Group 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 groups and laying out annual coupes are given in detail in the Plan. For Local/Rural use, Single Tree Selection System is prescribed.

- The total AAC for this management plan is fixed at 6300 m^3 in standing form of which 5300 m^3 standing volume or 30.25 ha clear cut equivalent, whichever is achieved earlier, for commercial use and 1000 m^3 for rural/local use.

- About 10 km forest road construction within FMU is proposed during this plan period to extract timber from FMU on sustainable approach.

Allocation of AAC

Standing Volume (m^3 or ha/year)	Allotted to
1000 m^3	Local Use: to meet rural house construction timber.
5300 m^3 or 30.25 ha	NRDCL: to meet commercial timber demand in the market.

- In collaboration with NRDCL, the Divisional Forest Office, Paro carried out detailed EIA for FMU. Using a series of environmental criteria outlined in the Environment Assessment Act, 2000 and adopted by the National Environment Commission, the recommended guidelines have examined to ensure that the practice within FMU meets the requirement. The environment statement includes the effects of previous activities within the FMU along with recommended mitigation measures for future actions.

- A ten-year financial forecast has been prepared for the FMU summarizing the total costs, revenue and royalties for NRDCL and 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

- CFO, Territorial Division Office, Paro, will be responsible for the implementation of this management plan, assisted by the Planner, Unit In-charge and other unit staff.

- FRMD, DoFPS, will be responsible for providing technical support and evaluation of FMUs as per timing prescribed in the Forest Management Code of Bhutan.

- A rolling biennial Operational Plan will be prepared by the CFO and Unit In-charge in consultation with NRDCL to facilitate timely implementation of this management plan. NRDCL will be responsible for execution of FMU activities as per the prescriptions of this management plan.

- Mid-term and Final evaluation should takes place within the prescribed timing and completed as per management code.

- The FMU must have adequate technical capability and appropriate institutional set-up to implement this forest management plan.

- FMU Level Management Committee shall be chaired by the CFO, Paro, to assist in objective setting and ensuring the smooth implementation of the plan. The committee comprises of the stakeholders of the FMU and each member has equal say in recommendation for management and implementation of the FMU. Plan activities to achieve the FMU objectives will be discussed in the FMU Level Management Committee.

- Unforeseen circumstances may warrant deviation from plan prescriptions and in such an event, the CFO, Paro, must obtain prior written approval from the Head of the Department. The reasons for the deviation must be fully justified by the CFO in writing and such approved deviations updated into the Management Plan during the next scheduled planning period and plan revision.

	Action required by FMU plan	Responsibility
1	**Implementation and Review**	
1	CFO Paro will be responsible for the implementation of this Management Plan, assisted by the Unit In-charge and staff.	CFO Paro
2	The FMU Management Committee chaired by CFO Paro will be maintained to ensure the smooth implementation of the Management Plan.	CFO Paro
	Monitoring and Evaluation	
1	CFO Paro will ensure that the monitoring is carried out on regular basis and in accordance to FMCB and guidelines issued by FRMD. The Forest Management Committee at Division level will be responsible for review and address any technical issues which can be address at Division level.	CFO, Paro
2	Head, RMD, will ensure annual monitoring of FMU is carried out and provide advices and recommendations to CFO, Paro for implementation.	Head, FRMD
3	Head,FRMD, will ensure that mid-term and final evaluation will be executed by FRMD as per deadline outlined in the FMCB. Policy and technical regulations will be provided by FRMD to CFO, Paro.	Head, FRMD
	Operation Planning (OP)	
1	A Biennial OP will be prepared by CFO, Paro, and FMU In-Charge (IC) to facilitate the timely implementation of this Management Plan. NRDCL will commit financial and endorse OP by the FMU Level Management Committee. The OP should be completed and submitted to FRMD as per deadline outlined in the FMCB.	CFO Paro FMU IC
2	FMU IC will identify harvesting area based on production area prescribed by management plan and conduct operational inventory using GIS and GPS. FMU IC will determine the number of location and extend	FMU IC, NRDCL PIC

	of cable lines in the compartment to be harvested annually based on average standing volume per hectare from operational inventory and NRDCL will lead cable line survey for operational plan.	
3	Objective for each Management Circle will be met with the implementation of specific activities.	FMU IC
4	Silviculture system for each Working Circle will be adhered to, following cutting cycle guidelines to ensure sustainability.	FMU IC
5	The harvesting Plan set out for each Working Circle will be followed unless pests and diseases arise.	FMU IC, NRDCL RM
6	CFO Paro and the Regional Manager, NRDCL will co-operate and co-ordinate to ensure that the logging operation and the log outturn are conducted smoothly and in accordance with local and other demands.	CFO Paro , NRDCL RM
7	The FMU IC will ensure that natural regeneration is surveyed as per regeneration guidelines and implement corrective actions as per guidelines.	FMU IC
8	CFO, Paro, will evaluate plantation and recommend corrective actions as per plan prescriptions to NRDCL.	CFO Paro, NRDCL RM
9	Road survey, design and construction will be carried out by NRDCL. NRDCL road engineers must follow the standards, given in Annex 4, during designing and estimating and provide supervision during construction to ensure that the environment standards are met.	NRDCL RM
	Forest Protection (Pests and diseases)	
1	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
2	FMU IC will seek approval from DoFPS through CFO for sanitation operation of trees/stands affected by forest prests and diseases.	FMU IC, CFO Paro
3	FMU IC and CFO Paro will maintain detail records of outbreak of forest pests and diseases and apprise DoFPS through CFO for record and inferences for corrective measures	FMU IC, CFO paro
	Participatory Forest Management	
1	Records of all tree marked with geo-coordinates by Blocks and Compartments for rural/local use will be maintained by the Unit staff and furnished monthly to CFO Paro	FMU IC
2	Grazing will be minimized in the Protection Management Circle and grazing will be encouraged in the Non-Production Management Circle.	FMU IC
3	The views of stakeholder groups will be incorporated into the operational plans through the inclusion of stakeholder representatives on the FMU level Management Committee.	CFO Paro
4	Local communities have priority in use of forest products from the area set aside for Local use (Forest Function Socl).	FMU IC

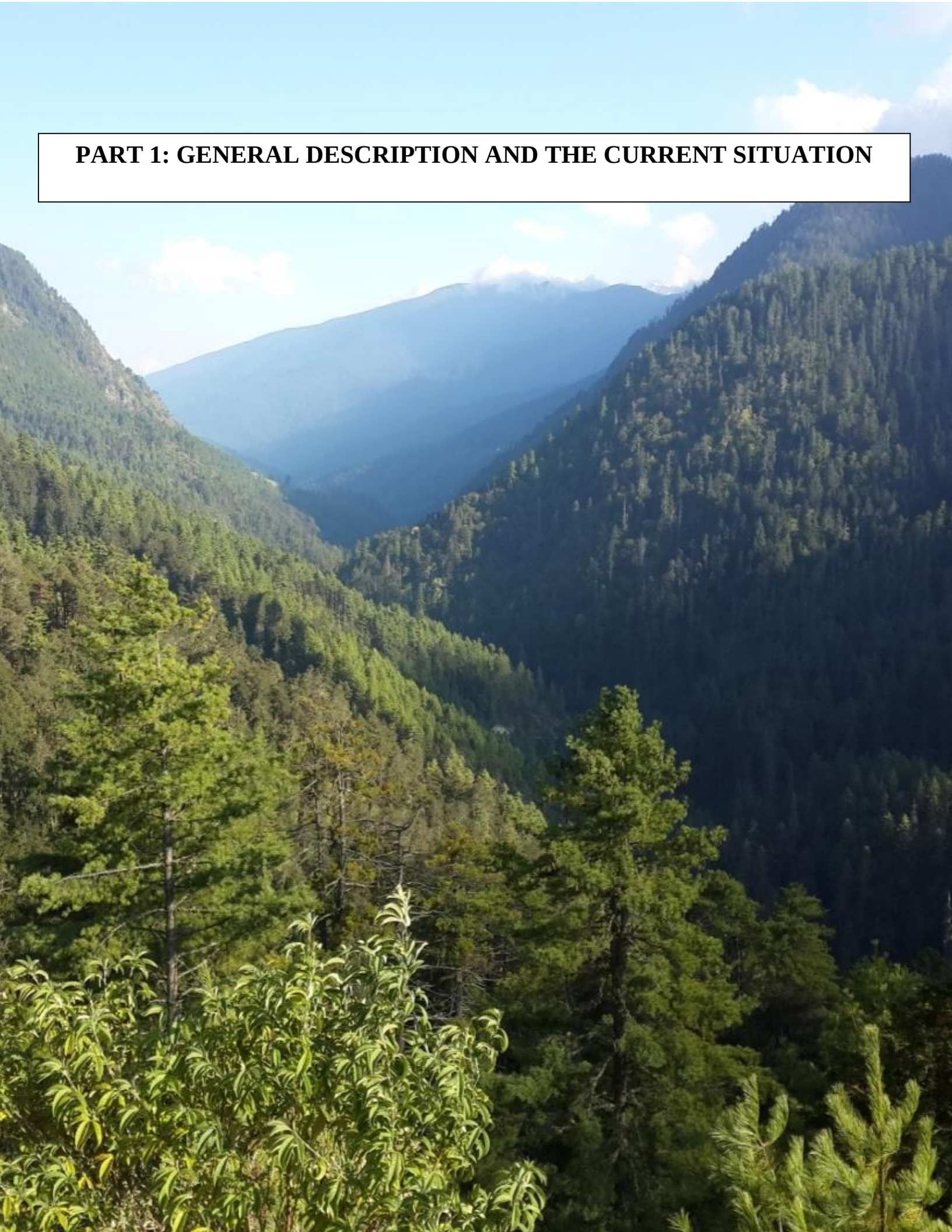
TABLE OF CONTENT

List of Tables

List of Figures

List of Maps

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION



PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location

The Lon Chhu FMU falls under the Haa Dzongkhag and lies within the longitude of 89º 08' 52'' to 89º 17' 21'' East and latitude of 27º 14' 48'' to 27º 23' 03'' North. The entire FMU is situated within the Sama gewog of Haa Dzongkhag and FMU is under the management jurisdiction of Paro Territorial Division. The river so called Lon *Chhu* nearly divides the FMU into two equal halves. The Selela FMU lies toward southeast of FMU. Towards west, the FMU shares part of boundary with the JKSNR.

1.2 Historical Background

The first scientific forest management plan for FMU was implemented from 1 January 2010 to 31 December 2019. The total AAC for the FMU was 6,700 m^3 in standing form of which 5,000 m^3 was prescribed for commercial use, 700 for local use and 1,000 m^3 for rural cum commercial. The gross operable area was 3,848.8 ha of which 2,957.10 ha was prescribed as net production area for the plan period after reduction of certain percents for each forest type under commercial use.

1.3 Area Statement

Table 1. 1 Land Use Land Cover of Lon chhu FMU

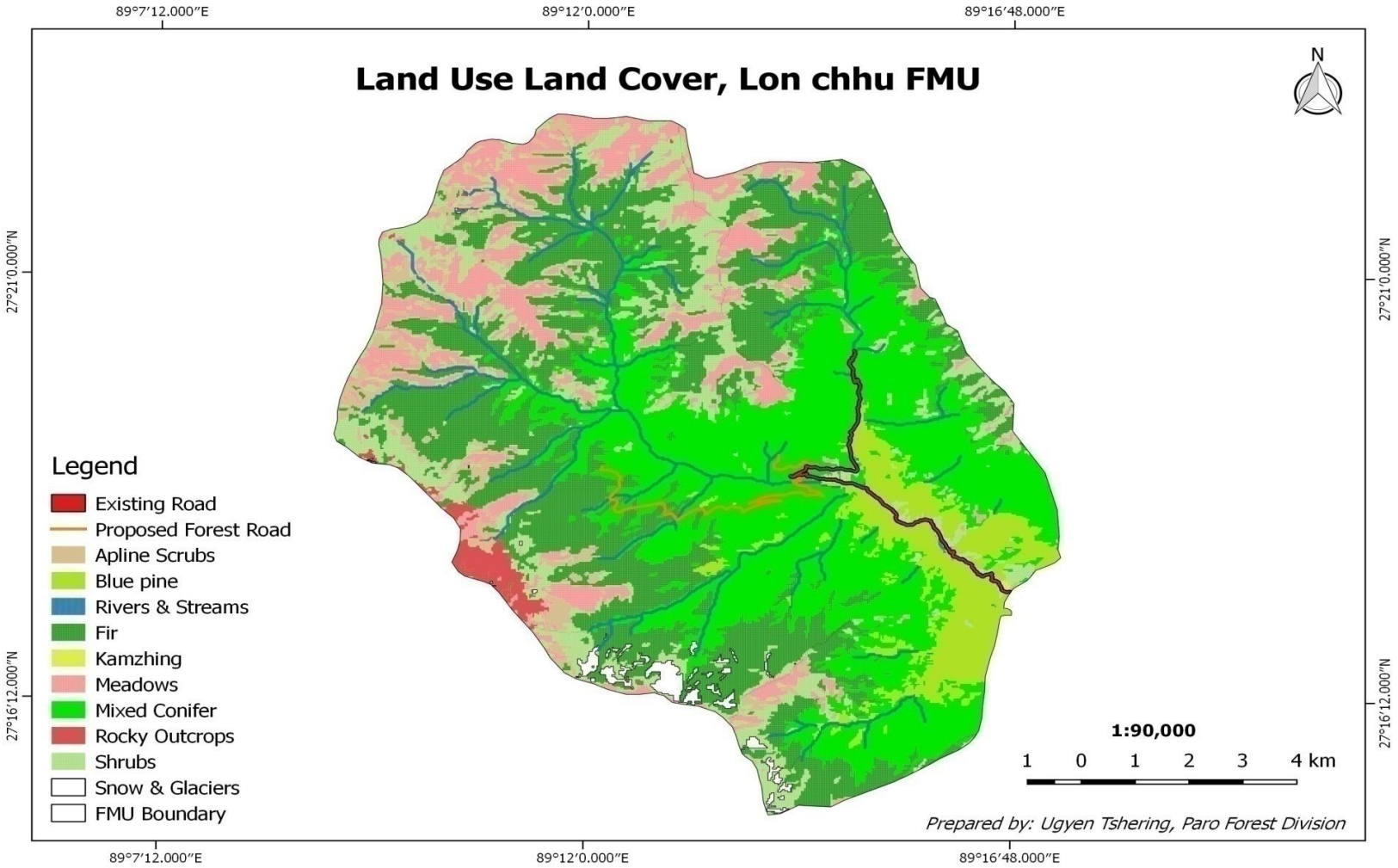
Class	Sub-Class	Category	Area (ha)	Area (%)
Forests	Conifer Forests (FC)	Fir Forest	3709.918	29.29
		Mixed Conifer Forest	4266.647	33.69
		Blue pine Forest	870.1461	6.87
Shrubs			1683.552	13.29
Meadows			1393.136	11.00
Cultivated Agriculture Land	*Kamzhing*		3.238294	0.03
Alpine Scrubs			442.3775	3.49
Rocky Outcrops			150.401	1.19
Snow and Glacier			145.0743	1.15
Total			**12664.49**	**100**

Reference: Land Use Land Cover, 2016 (through QGIS 3.0.0 with GRASS 7.4.0)

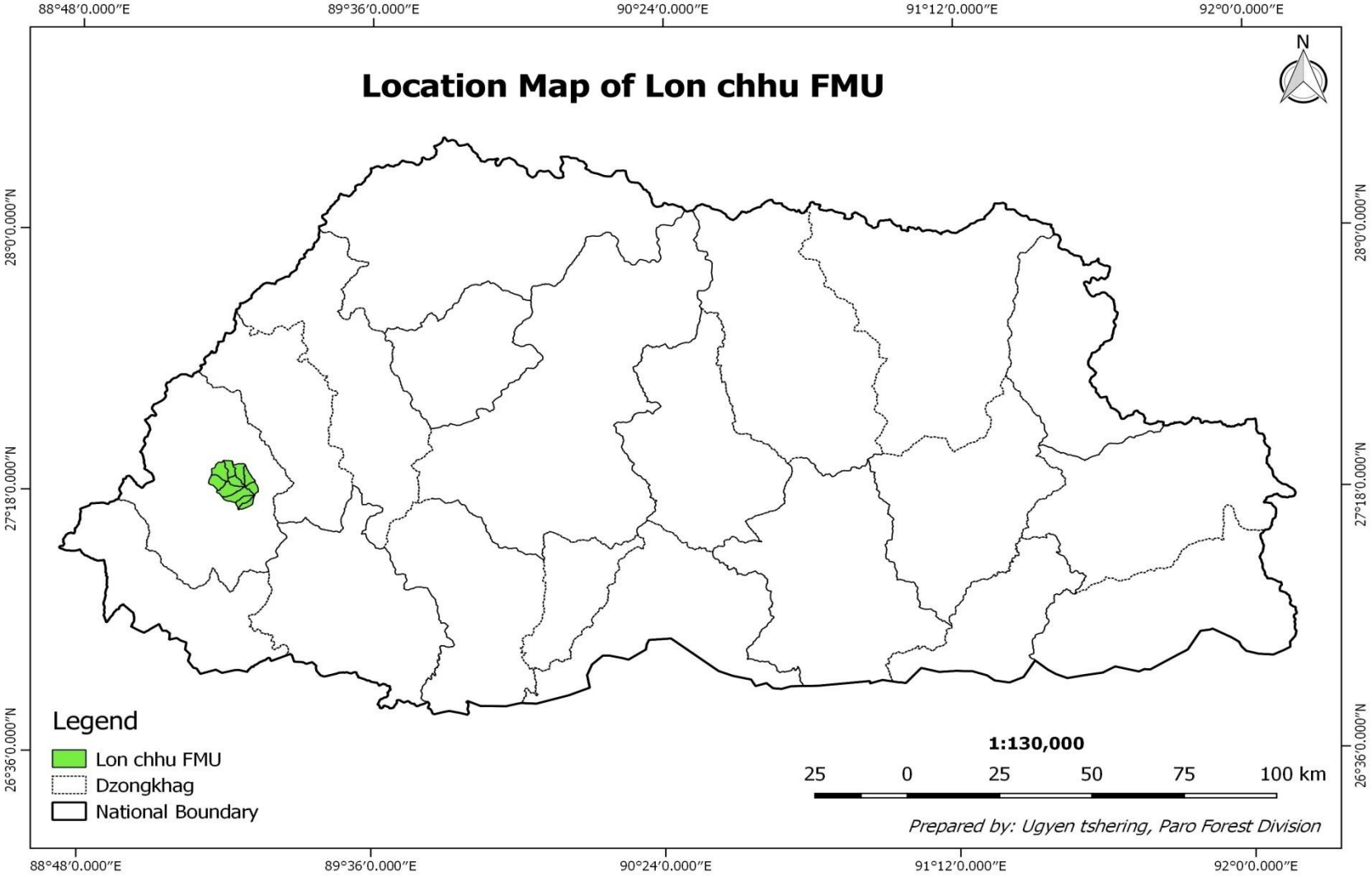
1.4 Forest Condition

The altitude of FMU ranges from 2600 m to 4600 m amsl. The major forest types found within the FMU are Blue pine forest, Fir forest and Mixed conifer forest. The mixed conifer forest comprises species like Spruce (*Picea spinulosa*), Hemlock (*Tsuga dumosa*), Blue pine (*Pinux wallichaina*) Juniper (*Juniperus recurva*), Larix (*Larix griffithii*) and some broadleaf species like Poplar (*Populus ciliate*), Maple (*Acer campbellii*), *Rhododendron sp.*, Oak (*Quercus sp.*), etc. As per land use land cover, 2016, the forest within FMU is dominated by mixed conifer forest with 33.69% followed by fir forest with 29.29 % and blue pine forest with 6.87 % cover.

Map 1. 1 Land Use Land Cover of Lon chhu FMU



Map 1. 2 Location Map of Lon chhu FMU



1.5 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act 1995, defines forest as "any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable rights of uses and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as *Tsamdo* (Grazing land) or *Sokshing* (woodlot for collection of leaf litter)". All such areas are considered as Government Reserved Forest and the entire area of FMU falls under this category of Government Reserved Forest except for small part of land classified as cultivation (Kamzhing) which is private.

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 (FNCA) of 1995 and the National Forest Policy of 2011. According to the FNCA, 1995, 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 only from dead and fallen trees. Timber trees are issued for bona fide domestic use, after they have been marked by a Forestry Officer 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 FMU. The forest in FMU faces the grazing pressure more during the summer months than during the winter months. Most cow herder in and around FMU moves down to south during the months of winter to escape from the severe winter taking their domestic animals along with them and return back to FMU during the months of summer. However, few local who does not migrate to south and instead lets their cattle and horses graze in and around FMU throughout the year.

1.5.4 Water Rights

Local population within the FMU has traditional rights to use water from rivers and perennial streams for domestic purpose such as consumption, irrigation and other uses. Lon *Chhu* is the main river, which flows through the FMU.

1.5.5 Historical Monuments and Monasteries

There are no historical monuments and monasteries inside the FMU. People only use one to two trees at Rosha block to worship every year and in this management plan, the area was identified as religious sites and provided buffer of 100 meter radius around those trees for protection, and no forestry operation will take place within the plan period. This area was prescribed under the protection management circle.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

The general terrain of Lon Chhu FMU is from moderate to steep landscape.
The lower and uppermost portion of FMU has the moderate steepness and the middle portion is highly steep. The terrain in some compartment is moderate but in most of the compartments steep and rocky outcrops are very prominent.

About 46.13% of the FMU falls within slope classes of $>10^0$ to 25^0 and remaining 53.87% of the FMU has slope greater than 25^0.

Beside major portion of FMU being steep, the uppermost portion of the FMU is devoid of any tree stand; those areas are either blank or bear alpine grass and most of the time those areas remain under the snow coverage.

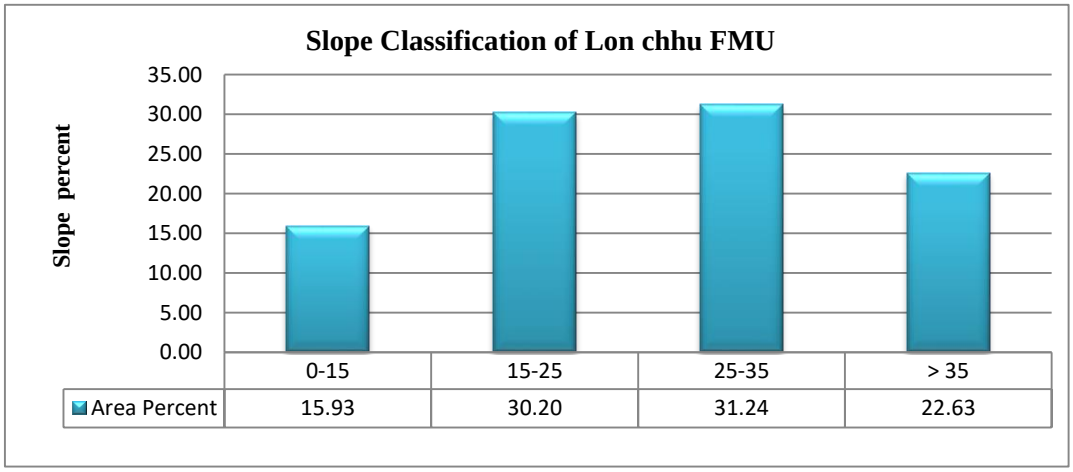
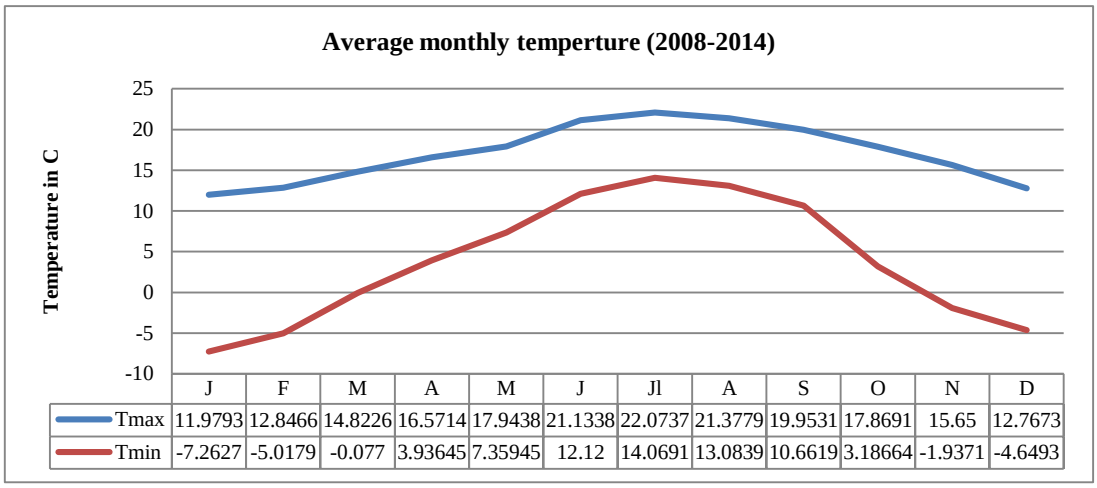


Figure 1. 1 Slope classes of Lon chhu FMU

The elevation of Lon Chhu ranges from 2600m amslat the valley bottom to 4600m amsl at the ridge top. The whole of FMU is nearly divided into two equal halves by Lon Chhu.

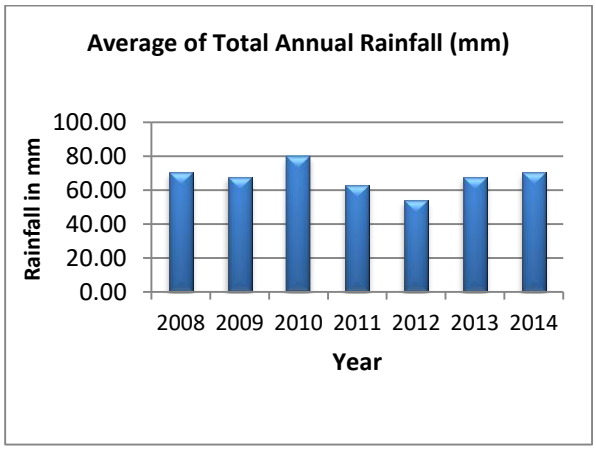
2.2 Climate

There is no meteorological station at Lon chhu. The data has been obtained from the National Center for Hydrology & Meteorology, Thimphu.



	J	F	M	A	M	J	Jl	A	S	O	N	D
Tmax	11.9793	12.8466	14.8226	16.5714	17.9438	21.1338	22.0737	21.3779	19.9531	17.8691	15.65	12.7673
Tmin	-7.2627	-5.0179	-0.077	3.93645	7.35945	12.12	14.0691	13.0839	10.6619	3.18664	-1.9371	-4.6493

Figure 1. 2 Average monthly maximum and minimum temperature



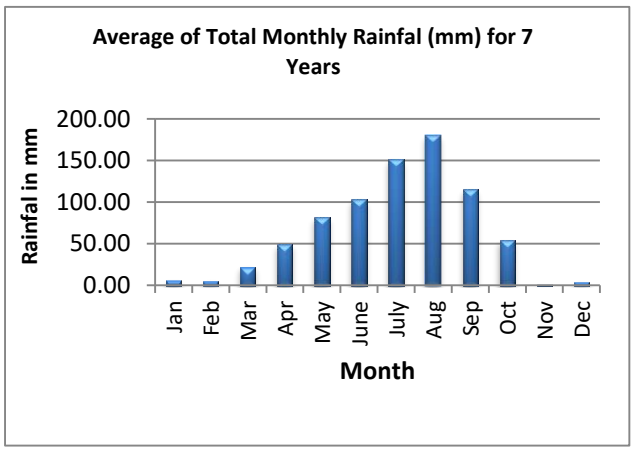


Figure 1. 3 Average total annual (2008-2014) and monthly rainfall

2.3 Geology and Soil

The rock of FMU is of Paro formation. This formation is characterized by mica-schist, quartzite-schist, calc-silicate, graphite schist, marble etc.

2.4 Hydrology

The main river, which flows within the FMU is Lon *Chhu*, This Lon *Chhu* is a tributary of Haa *Chhu*. Beside this Lon *Chhu*, there are numerous fleeting streams ultimately draining into Lon *Chhu*.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

The main villages that are present around the FMU are Langpa, Lhakhangchen, Nobgang and Mendona. Only two households of Nobgang village fall within the FMU. The figures represent for the year 2018 as per rapid socio-economic survey.

Table 1.1 Population/Demography profile of main villages

Hamlet	Total No.of Population	Sex		Age group			
		Male	Female	<6	7 to 14	15-64	>64
Nobgang	172	96	76	10	21	118	23
Langpa	103	62	41	5	13	80	5
Lhakhangchen	17	12	5	0	5	12	0
Mendona	19	7	12	3	1	14	1
Total	311	177	134	18	40	224	29
in % of total		57	43	6	13	72	9

3.2 Farming and Agriculture

The people of these villages are mostly engaged in subsistence farming. Almost all the household own dry land and grow their agricultural product. The agricultural products from their field are used for family consumption and whatever surplus is left, they sell for earning little money. The agricultural crops that the people usually grow in their field are potato, peas, cabbage, green leaves (sag), etc. Among the cereals, two different kinds of wheat are cultivated.

Table 1. 1 Agriculture land holding

Village	Land (Acre per person)	Land (Acre per Household)
Nobgang	0.5	5.0
Langpa	0.7	35.7
Lhakhangchen	0.5	4.1
Mendona	0.8	0.7

Land type	Acres	Land (Ac per person
Dryland	128.44	3.06
Orchard	16.85	0.40
Kitchen Garden	4.75	0.11
Pasture	16.85	0.40
Owned & operated	80	
Ac per households	1.9	
Ac per person	0.26	

Besides agricultural farming, all most all the household also engaged in livestock rearing. Cattle and yaks are usually reared for dairy products and horse for transportation.

3.3 Traditional use of Forest

Ever since people have settled around the FMU, people have been using the forest for their livelihood. People use the forest for various purposes and some of the notable uses are timber, firewood, water, grazing, leaf litter, farm implements, fencing materials, collection of medicinal plants, etc for their own uses. This practice of forest use has been carried out from the time immemorial and the same practice will continue in the future too from FMU by local communities.

3.4 Grazing

The information about number of cattle and grazing were obtained from rapid socio-economic survey. There were about 173 livestock population of which 70 were local and

103 were improved breed over last one year. The total number of months of grazing in the FMU over last one year was 217 days and people will still use FMU as grazing field.

There is a practice of migratory grazing. Starting from the month of October, people from these villages migrates down to the warmer place especially to Samtse taking along their livestock and returns back only during the month of April and May. The grazing pressure within the FMU is low during the months of winter as compared to other seasons. Despite major population of the cattle accounted by migratory cattle, the cumulative effect on forest regeneration as a result of selective browsing both by resident and migratory cattle can lead to severe impairment of regeneration capacity of the forest in the long term. Future management prescriptions and options should take into account the dynamic and the appropriate regulation of cattle grazing in the forest.

Table 1. 2 Number of livestock owned by villages

Village	Cows		Bulls		Horse		Sheep		Poultry	
	Local	Imp	Local	Imp	Local	Imp	Local	Imp	Local	Imp
Nobgang	23	42	14	7	0	0	0	0	0	0
Langpa	13	33	8	7	4	0	1	0	1	0
Lhakhangchen	2	6	3	0	0	0	0	0	0	0
Mendona	1	7	0	1	0	0	0	0	0	0

Imp-Improved

Table 1. 3 Number of grazing months by cattle inside FMU

Village	No.of cattle	No.of grazing months	Status on stock (Available/Not available)	Plan to continue in future (Yes/No)
Nobgang	64	136	Available	Yes
Langpa	28	59	Available	Yes
Lhakhangchen	4	22	Available	Yes
Mendona	0	0		

3.5 Forest Fires

Forest fire is very unpredictable and fire is one of the main factors of forest degradation. Though forest fire is one of the management tools, it has negative effect on the ecology of the forest to greater extent. Bhutan being mountainous with steep and rugged landscape, the negative effect of the fire is more common. The cause of forest fire can be both natural and manmade.

Most forest fires in the country are human induced, commonly from burning of agricultural debris, careless smokers, road workers, electricity short-circuits from transmission lines and children playing with matchsticks.

In the country like Bhutan where major portion of the population depends on agricultural farming, burning of debris in the field is a regular routine for the farmers and forest fire spreading from such burning is very common.

In Lon chhu FMU, there was one incidence of forest fire in 2018 at Haa-nga III and has damage about 0.8 ha forest. However, NRDCL has planted same area in 2018 with native tree species. Although incidence of forest fire is very less in FMU during first plan period, precaution is needed in the future since conifer forest is the dominant forest type for the FMU.

3.6 Pest and Diseases

During the first plan period, there was outbreak of spruce bark beetles in the year 2016, 2017 and 2018 and has affected 2386 number of trees that was equivalent to 8989.83 m^3 in standing form. Further, along with sanitation of affected trees, 609 numbers of standing trees (equivalent to 1165.02 m^3 standing form), which falls along the cable corridor for removal of affected trees, were also felled from the FMU. From field observations, roots of affected trees were found to be infested by *Armillari amellea*, root rot. In most of the infested stands, mortality of trees was observed in the patch form and this could be because of root-to-root contact of the fungus. To our understanding, stands would have infested by bark beetles after weakening the trees with damage to the root system by root rot. The other probable causes of beetle outbreak could be because of poor management and harvesting practices.

With incidents of outbreak of spruce bark beetle over past years, there are every chances of pest and diseases outbreak at any time during this plan period. Therefore, the periodic monitoring of the forest to detect any outbreak of pest and diseases should be conducted by FMU and NRDCL. Immediate reports should be made to the CFO and seek approval for immediate sanitation from head of the Department.

3.7 Non-wood Forest Product

No detailed study and assessment on availability of non-wood forest product within FMU has been carried out. As per the record maintained by FMU over last ten years, harvesting of non-wood forest products for commercial level has not taken place. Even during the transect walk and forest management inventory, there was no commercial potential of such products within the FMU. However, if people wish to extract such products for commerce purpose from FMU, CFO and Unit In-Charge should carry out detailed resources assessment and apprise the DoFPS for allotment.

4. ECOLOGY

4.1 Floral Association

The altitude of FMU ranges from 2600 m to 4600 m amsl and vegetation is dominated by conifer forest. The forest type for FMU has been grouped into Blue pine, Mixed conifer and Fir forest as per land use land cover, 2016.

Blue pine growth is eminent at the lower altitudes either in pure stand or mixed with other species like *Quercus semicarpefolia*, *Populas ciliate*, *Betula utalis*, *Picea spinulosa*, and *Tsuga dumosa*.

Mixed conifer forest mostly comprises of *Picea spinulosa* and *Tsuga dumosa* at the lower altitude. At the higher altitude, Spruce and Hemlock are mixed with other species like

Taxus baccata, Juniper species, *Cupressus sps*, *Rhododendron sps*, *Larix graffithiana* and other species.

The fir forest is seen at upper portion of the FMU and this forest favour dense under storey where abundant growth of Rhodendronsps and other shrubs are usually seen.

Uppercanopy: Spruce (*Picea spinulosa*), Hemlock (*Tsuga dumosa*), Fir (*Abies densa*), Blue pine (*Pinus wallichiana*)

Middle canopy: Juniper (*Juniperus recurva*), Rhododendron sps, Oak (*Quercu s*semecarpifolia), *Acer cambellii*, *Betula alnoides*, *Populus ciliate*, and other species

Shrubs: *Rosa laevigata*, *berberis sps*, etc.

Ground cover: *Aconitum sps, Thalictrum foliolosum, Potentilla sps, Eleagnus parviflora, viola sp, Senecio sp, Aster albescense, Rubus sp, Rumex hastatus, Causiniat homsonii, Gerenium wallichianum* and lot other

4.2 Fauna

During stock inventory, wildlife was also recorded during the first management plan period in 2005 and in 2017 as well. During the transect walk in the FMU, some of the animals and birds were directly spotted and many data regarding wildlife was recorded through indirect signs. Some of the animals and birds found in the are listed below.

Table 1. 4 Wild animals of Lon Chhu FMU

Common Name	Scientific name
Himalayan Black Beer	*Selenarctosthibetanus*
Sambar deer	*Cervus unicolor*
Barking deer	*Muntiacusmuntjak*
Wild boar	*Sus scrofa*
Wild dog	*Cuon alpines*
Leopard	*Pantherapardus*
Wolf	*Canis lupus*
Musk deer	*MosChhuschrysogaster*
Jungle cat	*Felischaus*
Himalayan yellow throated marten	*Martesflavigula*
Three stripped palm squirrel	*Funambuluspalmarum*
Pine marten	*Martesmartes*

Table 1. 5 Birds found in Lon Chhu FMU

Common Name	Scientific Name
Monal Pheasant	*Lophophorusimpejanus*
Blood Pheasant	*Ithaginiscruentus*
Spotted Nutcracker	*Nucifragacaryocatactes*

Yellow-billed Blue Magpie	*Urocissaflavirostris*
Kalij pheasant	*Lophuraleucophaeus*
Large billed crow	*Corvusmacrorhynchos*
Yellow-billed chough	*Phyrrocoraxgraculus*
Green backed Tits	*Parusmonticolus*
Blue-fronted Redstart	*Phoenicurus frontalis*
Blue-whistling Thrush	*Myophonuscaeruleus*
Grey-sided Bush Warbler	*Cettiabrunnifrons*
White throated laughing Thrush	*Garrulaxalbogularis*
White tailed nuthatch	*Sittahimalayensis*
White capped redstart	*Chairmarrornisleucocephalus*
Plumbeous redstart	*Rhyacornisfuliginosa*
Alpine swift	*Apus mulba*
Hoopoe	*Upapaepops*

5. SOCIO-ECONOMICS

5.1 Common Source of Income

Villages around the FMU depend on subsistence farming. Majority of the local communities are farmers and have individual land holding of 0.26 acre per person. They also practice horticulture to a lesser extent. Potato is one of the main cash crops grown by the communities. Cereal crops like bitter and sweet buckwheat, wheat and barley are also grown. The communities also grow vegetables like cabbage, peas, beans, radish, mustard, etc.

The main source of income over last one year was from agriculture products followed by vegetables and then off-farm labour.

Table 1. 6 Source of income

Rank	Income Source	Amount earned in million (Ngultrum)			
		Nobgang	Langpa	Lhakhangchen	Mendona
1	Crops (Wheat))	0.02	0.01	0.00	-
2	Vegetables (Potato & Chilli)	0.54	0.23	0.05	0.06
3	Fruits (apple)	0.02	0.02	-	-
4	Livestock products (Cheese & butter)	1.66	0.59	0.08	0.06
5	Craftsmanship(specify)	-	-	-	-
6	On-farm labour (specify)	0.04	-	0.02	-
7	Off-farm labour (specify)	0.49	0.18	-	0.05
8	Forestry products (cane, mushroom,wood etc.)	-	0.03	0.01	-
9	Wholesale trade	-	-	-	-
10	Retail trade	-	-	-	-
11	Remittances	-	0.01	0.01	-
12	Others (specify)	-	-	-	-

6. TIMBER DEMAND AND SUPPLY

For commercial timber use, the total AAC prescribed during the plan period was 50,000 m^3 in standing form. The total timber harvested from FMU over period of previous management plan period was 34240.66 m^3, which is about 68% against prescribed AAC.

The total AAC over 10 years period for local use was 17,000 m^3 in standing form. However, timber extraction by Haa gewogs and people outside of Haa Dzongkhag was 8210.74 m^3, which is about 48% against the prescribed AAC. The highest timber allotted from FMU was for people of Sama gewog. FMU also catered timber resource to people of Paro &Thimphu. Timber demand was highest in the year 2014, 2015 and 2016 being highest during plan period. On an average, the annual timber demand for rural use from FMU was about 821 m^3 in the plan period.

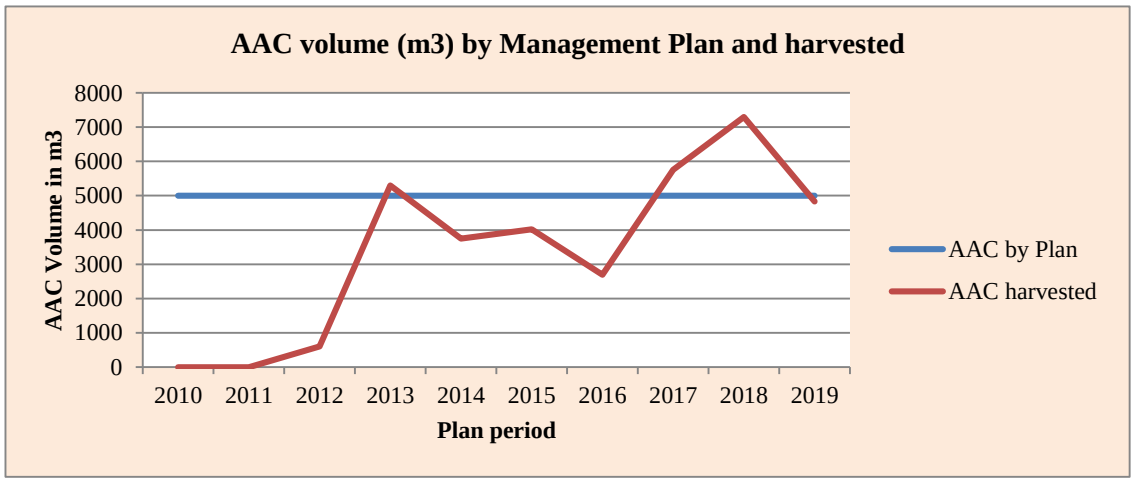


Figure 1.5 Commercial timber demand and supply over period of previous FMP.

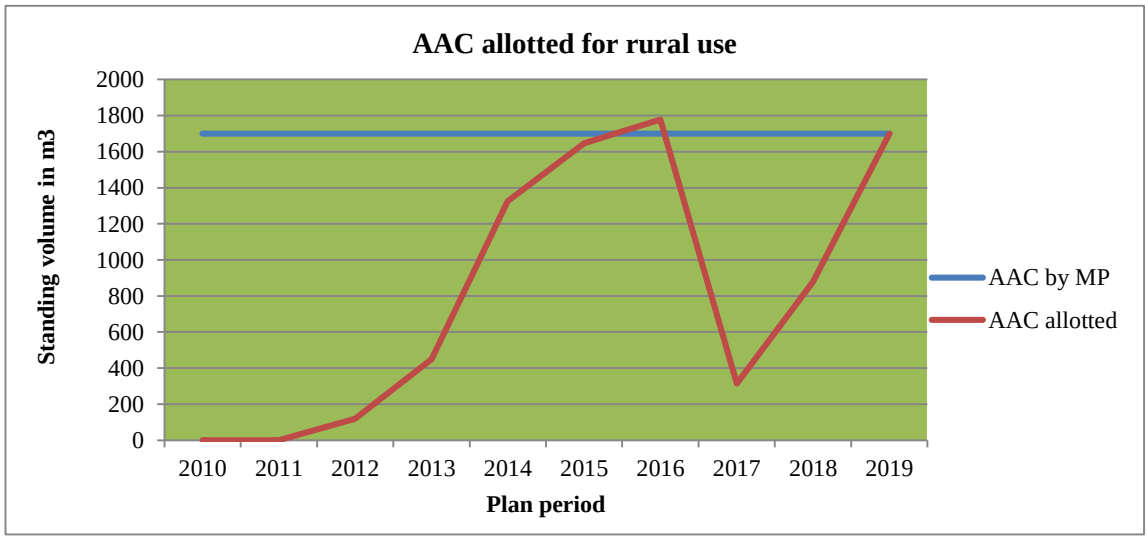


Figure 1. 4 Timber demand and supply from FMU in past plan period for rural use

7. SILVICULTURAL ASSESSMENT

Forest Types

The main forest types of FMU are:

Blue pine
Blue pine is mostly found in the lower valley. It occurs both in pure and mixed with Spruce, Hemlock and Oak. At the bottom most of the valley this Blue pine is mixed with Poplar and with Oak but as we ascend it is observed that Blue pine is mixed with Spruce and Hemlock.

Mixed Conifer
Mixed conifer is found in the upper valley. This forest type is dominated by Spruce and Hemlock. At the lower altitude Spruce and Hemlock is mixed with Oak and at the higher altitude, they are mixed with Juniper, Larch, Maple and Birch.

Fir
Fir forest in Lon Chhu FMU is confined to the uppermost ridges and occurs mostly as pure stand. In few places this forest is mixed with Birch and the dense canopy provide environment for luxuriant understorey for *Rhododendronsps*. and other shrubs. Most of the Fir at the higher elevation is over matured in the state of die back.

Table 1. 7 Area covered by different Forest Type and Percentage of FMU covered

Forest Type	Area (ha)	% of Forest	% of FMU area covered
Fir	3709.94	41.94	29.29
Mixed Conifer	4266.72	48.23	33.69
Blue Pine	870.16	9.84	6.87
	8846.82	100	69.86

8. ORGANIZATION AND ADMINISTRATION

8.1 Organization

The FMU is under the management jurisdiction of Territorial Division Office, Paro. The Territorial Division Office, Paro, is the Government agency responsible for implementing and monitoring the management plan. All activities within the FMU should be administered by the CFO, Paro.

8.2 Health and Safety

At present, health and safety measures are poor and sometime altogether absent. Site-specific risk assessment seems necessary if not generic risk assessment. The major risk involved in the forestry operation is during the harvesting and transportation of timbers.

Actions should be initiated with little or no expenditure to ensure health and safety of the field staff and forest workers.

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

- Ensure chain saw equipped with full functioning chain breaks
- Always ensure feller to keep two tree lengths apart while felling
- Explain the danger of falling timbers and overhead cable lines
- Stack timbers in the same direction and stack not 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

8.3 Record Keeping

Poorer record keeping system was observed for FMU during the past plan period. Required records were not maintained and kept as per Forest Management Code of Bhutan, 2004. Office records were messy and incomplete for many activities of FMU. In this plan period, FMU should maintain and retained complete information for every activity of FMU as per management code. Prescribed recording forms of Code and FRMD should be used properly and strengthen record keeping system for FMU.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Roads

About 12.6 km forest road was constructed during the previous plan period. In this plan period, NRDCL shall construct 1.50 km forest road at Haa-nga III and 8.50 km from Haa-nga III to Rosha I. The total length of the road needed to be constructed during this plan period is about 10 km.

10. EVALUATION OF PREVIOUS PLAN (2010-2019)

It is mandatory to review the previous plan to identify areas that are in need of management interventions. This review will comment on the objectives that were set for the last plan period and look at the situation in the field concerning harvesting, roads and regeneration. The last management plan by Arun Rai (2010 -2019) and Operational Plans are some of the documents available and this review was based on those documents and observations made during field visits.

10.1 Review of Goals and Objectives

Forest management plan for FMU was written to manage the environment, wildlife, soil, water and timber. This plan tries to tie together all the aspect of sustainable utilization of forests resources, involving stakeholders and the local people in the FMU. A brief review of the Goals and Objectives of the last management plan, to define where activities have been focused are documented below;

Goal:

To protect the environment and at the same time provide sustainable supply of all forest produce to meet the needs of the local people.

The broad goal to manage on a multiple use and sustained yield basis was not achieved. This goal is usually considered as the long-term objective of management. It should be met in the long run.

Objectives:

To protect forest from encroachment, fire, grazing and other illegal activities to conserve and enhance wildlife habitats and biodiversity. This objective has been prescribed under the protection management circle.

Form field records maintained by FMU and field observations, there is no evidence of encroachment into FMU area. In the plan period, FMU has protected 2948.2 ha as habitat for musk deer habitat, 2411.02 ha as soil protection, about 68.04 ha as local water supply protection and riparian reserve of 1694.7 ha. All these areas were under total protection in previous plan period. There was only two incidence of forest fire within 5 ha in 2013 and 0.8 ha in 2016 at Haa-nga III. However, damage by fire in 2013 was minimal and have now restored with growth of vegetation and tree seedlings. For fire burnt area in 2016, NRDCL has brought 0.8 ha under plantation in 2018.

To ensure sustained supply of timber, fuel wood and non-wood forest products from FMU. This objective has been prescribed to achieve through production management circle.

The AAC of the last management plan have been set at 6700 m^3. As per the data compiled from the Operational Plans of FMU, the volume harvested for the last five years comes to 11540.77 m^3 (Standing volume) while five times the allocated AAC is 33,500.00 m^3. Hence, indicating that the extraction has not exceeded the prescribed AAC.

10.2 Review of Harvesting Activities

The harvesting is done with a fixed skyline and gravity cable system. This has helped to reduce the impact on soil and other environmental impact. Because of skyline system, impact from road construction was reduced. In the previous plan period, outbreak of spruce bark beetle has damaged spruce and blue pine trees in FMU and about 10154.85 m^3 standing volume has been removed from FMU.

10.3 Review of Road Building Activities

In previous plan period, about 12.6 km of forest road was constructed in the FMU. The road network has benefiting the local people residing both within and outside the FMU. NRDCL should keep annual budget provision for proper maintenance of forest road to keep road in good condition for transportation of timbers and management of FMU in this plan period.

PART 2: FUTURE MANAGEMENT

PART 2: THE FUTURE MANAGEMENT

11. INTRODUCTION

The Royal Government of Bhutan (RGoB) is committed to the principles and practice of sustainable forest management and to achieve such management, sound policies along with comprehensive approach, appropriate legislative and governance framework is important. The national forest policy, 2011, envisaged sustainable management of Bhutan's forest resources and biodiversity and the RGoB has adapted a firm national policy requiring the preparation and implementation of scientific management plans to produce a wide range of social, economic and environmental goods and services and fulfil social, economic, ecological and cultural needs of the present and future generations. It is important to understand our forest resource dynamics from what has already occurred and useful to take a look at what is likely to occur in near future. The constitution of the kingdom of Bhutan mandated to retain at least 60% of the country under forest cover for all times to come.

11.1 Forest Policy

1. One of the policy measures of the National Forest Policy of 2011 is to have forest management plans for all GRF land focusing on sustainable supply of forest products or ecosystem services. Several principles have been considered while framing the National Forest Policy and some of these are equity and justice in terms of access, optimal utilization, conservation of forest resources and its ecosystem services.

2. Contribution of forest products and services for poverty reduction through integrated approach.

3. Deregulation and devolution through people centred forest management practices and decision making.

4. Application of good science and indigenous knowledge through integrated research and development in all aspects of forest planning and management.

5. Allowing imports of logs and sawn timber to enhance availability of timber materials within the country while export of round logs and sawn timber shall not be allowed to encourage value-addition.

11.2 Goal

The overall Goal of the Lon chhu Forest Management Plan is to manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood, non-wood forest products, and conservation of watersheds, wildlife and environment.

In order to support this long term goal, FRMD will have to assess every thematic elements of Sustainable Forest Management (SFM). The elements includes extent of forest resources, biological diversity, forest health and vitality, productive and protective functions of forest resources, socio-economic functions and legal, policy and institutional framework through monitoring and evaluation framework for FMUs. The Territorial

Division Office, Paro, will have to process for evaluation of FMU to the DoFPS through FRMD.

11.3 Objectives

The objectives of the Lon chhu FMU have been divided under the Management Circles and Working Circles set up for the ease of implementation. Three Management Circles have been identified; **Protection**, **Production** and **Non-Production** including **Non Wood Forest produce (overlapping)** with all other Management Circles. The objectives are listed below. This allows different areas to be managed and evaluated separately. Some of the same objectives may occur under different Management Circles.

Protection Management Circle

- To conserve the water catchment functions by keeping buffer zones and not harvesting timber;
- To protect the forest from fire and illegal activities through involvement of local people;
- To allow low-impact collection of Non-Wood Forest Products through some regulations;
- To conserve and protect wildlife habitats and biodiversity by not interfering any human interventions while managing FMU;
- To raise awareness on biodiversity and the natural forest to local communities and stakeholders;
- To respect the sanctity of religious places and to protect historical sites through FMU management.

Non-Production Management Circle

- To manage and regulate grazing for livestock through involvement of local communities;
- To conserve and protect biological diversity by regulating function maps of FMU;
- To conserve the water catchment areas by keeping buffer zone and not harvesting timber;
- To maintain the forest condition by following the plan prescriptions of management plan;
- To meet the local demand for NWFPs on sustainable basis.

Production Management Circle

- To meet local requirement, as a priority, for timber, fuelwood and other forest products on a sustainable basis;
- To manage the FMU for commercial timber production on a sustainable basis;
- To enhance and improve forest condition and productivity to meet national needs;
- To create local employment opportunities through forestry activities;
- To protect the forest from pest and diseases, fire, illegal activities and from grazing in regenerating areas.

In order to utilize and manage the forest resources and forest land sustainably to fulfil social, economic, ecological, cultural and spirituous needs of the present and future generations, the Royal Government of Bhutan has set a firm forest policy of maintaining at least 60% of the country's land under the forest cover for perpetuity.

11.4 Management based on Forest Function

11.4.1 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 individual forest stand. For this reason, categorization of every forest stand into different forest function is mainly based on the dominant site, forest type, accessibility, slopes, flora and fauna present. However, some forest function represents a certain exception to this rule and these functions are designated on the basis of social or certain group importance.

Forest Management Code of Bhutan,2004, describe that forest function defines for all the forest area within the FMU ecological, environmental and social functions and as such serves to balance the often diverging interest of commercial logging, local forest use and nature conservation. For effective management of forest it is essential to map all the different forest functions. Forest function map provides the information on the total commercial operable area identifies which areas have to be reserved for local use and provides the management planner and the implementer with information on management restrictions for particular areas.

The main objectives of forest function planning for this management plan are:

- To define, for a particular area (FMU), different environmental and social functions of the forest and depict them on the map
- To identify production, non-production and protection forest
- To provide a tool for a management planner for balancing the requirement of nature conservation, environment protection, social forestry and commercial timber production and also to provide spatial information required to compute the sustainable AAC.
- To provide the FMU 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 their implementation.

11.4.2 Function Groups

The functions used in this management plan are listed in the table below. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.

Table 2. 1 Difference Forest Function used in the plan

Code	Function Group (Bold) and Functions
S	Soil Conservation Functions
SC	Soil Conservation
SP	Soil Protection
W	Water and Watershed Conservation Functions
WRR	Riparian Reserve Protection
WLS	Local Water Supply Protection
N	Nature Conservation Functions
NWP	Wildlife Protection
Soc	Social Function Functions
SocL	Social (Local Use Only)
RB	Road Buffer

11.4.3 Mapping Forest Functions

The criteria used to prepare forest function map for Lon Chhu FMU is given in the table 10.2 below. In this table, the 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 2. 2 Criteria for mapping Forest Functions

Function Group and Codes	Criteria for Mapping
Soil Conservation	**SP:** very steep areas (slopes above 45^{o}), areas unstable and sites prone to landslides and areas with indications of severe erosion. **SC:** steep areas (slopes of 25-45^{o}), areas with indication of slight to moderate erosion; exposed sites (ridges, etc.)
Water and Watershed Conservation	**WRR:** areas within 30 m of the bank or edge of any river, streams, water course and water source. **WLS:** upper catchment areas of streams serving as drinking and irrigation water supply for settlement downstream.
Nature Conservation	**WNP:** alpine areas, ecosystem of high conservation value.
Social Function	**SocL:** area close to or accessible to settlement or village, the areas traditionally used by the local population.
Road Buffer	**RB:** 30 m uphill and 10m downhill for forest road.

11.4.4 Restriction of Forest Functions

The specific restrictions to be applied to forest in various categories are summarized in table 10.3. These restrictions should be applied in conjunction with the objectives set for each Management Circle.

Table 2. 3 Forest Function Restrictions

Code	Function	Restriction on Commercial Use	Restriction on Local use
SP	Soil Protection	No commercial use	No tree felling, minimize human interference
WRR	Riparian Reserve Protection	No commercial use	Only collection of NWFP; no *tsamdo*; no *sokshing*
RB	Road Buffer	No commercial use	No tree felling
NWP	Wildlife Protection	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife
WLS	Local Water Supply Protection	No commercial and Local use	Low impact use only; no cattle grazing
SocRS	Religious Site Protection	No commercial use	Only use which do not disturb sanctity of place
SocL	Social (Local Use Only)	No commercial use	No restriction
SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of rejuvenation periods	Low impact local use; no intensive cattle grazing
WSh	Watershed Conservation	No clear cutting; no conversion into plantation; ,minimize disturbance to understorey vegetation	No intensive cattle grazing; low impact local use

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

Forest management inventory for the second plan period was carried out from 16 November 2017 to 20 January 2018. The standard FMU inventory technique was used with data being collected for the trees >10 cm DBH (OB) from circular plot of 12.62 regeneration from 3.57 m radius. The data obtained from the forest management inventory was analyzed using statistical software called 'R'. A total of 299 plots were laid at 650 m x 650 m throughout the FMU area. The inventory was designed with target sampling error of +/- 10 % and the coefficient level of 95 %.

The general objective of the inventory was to provide essential background information for preparation of Lon Chhu Forest Management Plan. More especially the objectives of inventory were:

- To provide relatively accurate overview of the growing stock and regeneration potential of natural forest in the area, according to major forest types;

- To give an overview of the general site characteristic of the natural forest, in terms of soil, non-green vegetation and the use by local population;
- To provide an indication of timber quality in different forest type
- To furnish essential data on tree height to enable construction of local volume table for main species

12.2 Forest Management Inventory Result

The summary of the inventory results is shown in the table below

Table 2. 4 Summary of Inventory Results for overall FMU area

Parameters	Results	SE %*	Reliable Minimum Estimates (RME)
Total Inventory Area (ha)	12567.92	NA	NA
Number of Plots	299	NA	NA
Total Number of Trees	1820695	13.50	1574913.26
Number of Trees per Hectares	172.29		149.03
Total Basal Area(m^2)	208768	15.95	175477.7204
Basal Area (m^2) per Hectares	19.76		16.61
Total Growing Stock (m^3)	2248610	17.69	1850914.85
Volume(m^3) per Hectares	212.78		175.15

*SE= sampling error (95% confidence level)

13. AREA ORGANIZATION

13.1 Spatial Organization

The working circle was divided into blocks and compartments. The blocks and compartments have been demarcated according to prominent natural drainage, terrain/ridges, etc. to facilitate field staff on identification of boundaries and extent of area for management purposes. Lon chhu FMU has been divided into four blocks: Marpjerry, Rosha, Haa-Nga and Sokono blocks.

Table 2. 5 Block, Compartment and Sub-compartment with their corresponding areas

Block	Compartment	Area (ha)	Total Area (ha)
Marpjerry	I	613.94	3078.93
	II	794.48	
	III	1670.51	
Rosha	I	1673.34	3003.75
	II	1330.41	
Haa-nga	I	1684.42	3593.97
	II	1027.14	
	III	882.41	
Sokono	I	780.66	2987.84
	II	932.35	

	III	1274.83	

13.2 Determining Operable Area

For optimal utilization of available areas, Lon chhu FMU will be managed for multiple purposes. For this, the FMU areas were, in the planning process, formed into different working circles using GIS application.

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 preference over commercial and rural use areas are as follows:

- Soil protection areas (slope greater than 100%)
- Soil conservation
- Agricultural land
- Riparian buffers
- Local water supply protection
- Biodiversity areas (wildlife protection)
- Road buffer

13.3 Organization into Management Circles and WorkingCircles

For Lon chhu FMU, function mapping was used to delineate three different broad Management Circles. The three broad Management Circles for Lon Chhu FMU are Protection, Production and Non-production Management Circles.

Table 2. 6 Area statement for Management Circles and Working Circles

Management and Working Circles	Area (ha)
Protection Management Circles	
Soil Protection	1192.55
Wildlife Protection (musk deer habitat)	3067.84
Local Water Supply Protection	1168.99
Riparian Reserve	621.24
Forest road buffer	47.11
Water Chanel	13.47
Religious site	3.71
Non-Production Management Circle	
Private/Cultivated Land	3.24
Non-forest	515.57
Production Management Circle	
Fir Working Circle	2561.76
Mixed Conifer Working Circle	2910.09
Blue Pine Working Circle	560.28

13.3.1 Protection Management Circle

The protection working circle is the sum of all protection functions; wildlife protection, soil protection, riparian reserve protection, religious sites and local water supply protection. The area of total protection management with legal and management restriction is about 6114.91 ha for the plan period. In this working circle, no commercial activities can take place. However, removal of trees shall be considered in the following cases upon technical recommendations from the DoFPS.

i. Epidemic out-break and
ii. On silviculture reasons.

Brief outline of the management objectives and options of the protection management circle are given below

Table 2. 7 Protection Management Circle

Management Objectives	Management Options	Responsibility
To conserve and enhance wildlife habitats and biodiversity	Avoid disturbance Promote research	All parties Territorial
To conserve the water catchments functions and watershed value of the FMU	Minimal intervention	All parties
To meet local needs for NWFPs on sustainable basis	Resource assessment Regulate harvesting on sustainable basis	Territorial Territorial
To protect forest form grazing, fire and illegal activities	Involve local people in implementing conservatives measures	Territorial
To raise awareness of the important biodiversity areas	Public meeting Research	Territorial Territorial
To respect the sanctity of religious places	Non-intervention	All parties

13.3.2 Non-Production Management Circle

The non-production management circle includes areas where production is not economical or feasible and such areas comprise non-forest areas and settlements. The total area under non-production management circle is about 518.81 ha.

Table 2. 8 Non-Production Management Circle

Management Objectives	Management Options	Responsibility
To meet local needs for collection of NWFPs	Promote Community Monitoring	TD
To maintain and improve the forest condition	Regenerate Silviculture operation	NRDCL/ TD
To manage grazing for livestock	Fodder tree plantation and local involvement	TD/ Dzongkhag Livestock / Local Government

Environmental conservation	Environmental concern are to be taken into consideration while activities are implemented	NRDCL/ TD

13.3.3 Production Management Circle

This production management circle consist those areas more stable with potential timber production forest areas, which can be used for timber harvest for commercial and local use from FMU over the plan period. Such area comprises those areas that are left after identifying the critical functions using the GIS technique. The total net production management area within this plan period is 6032.12 ha**.**

Table 2. 9 Production Management Circle

Management Objectives	Management Options	Responsibility
To meet local need for timber and other forest produce on sustainable basis	Priority must be given to local people	TD
Manage commercial timber production on sustainable basis	Scientific and systematic harvesting	NRDCL/ TD
Enhance and improve forest condition and productivity	Suitable silvicultural operation Plant degraded area	NRDCL/ TD
Create employment	Involve local people	NRDCL/ TD
Maintain Biodiversity within production area	Field visit Research	TD

13.3.4 Non-Wood Forest Products Management Circle (Overlapping)

Over the last ten years of management period, use of NWFPs from the FMU indicates not that prominent. Based on field visit and during management inventory, availability of NWFPs within the FMU was not found in abundant whereby local people could harvest and manage for economic purposes. However, use of available NWFPs from FMU for local use would continue. Since no detail study and assessment of NWFPs within FMU was done so far, AAC calculation for the plan period is not available. However, in case demand for NWFPs from FMU arises during plan period, Lon chhu FMU should carry out detail resources assessment and then only allocate to sustain available resources for perpetuity. Further, FMU should follow available guidelines and framework for resources extraction from the FMU.

The Management Circle shall overlap with all other Management Circles, including Protection, Non-Production and Production Management Circles, which constitutes the entire FMU area. The overall objective of this management circle is to manage the NWFPs in Lon Chhu on sustainable basis, and monitor the impact of collection.

13.4 Management of Production Working Circle

The working circles have been created on the consideration of stands requiring similar silvicultural treatment. For this plan period, the production management circle has been divided into three regular working circles and the working modality of each working circles differs. The three working circles are:

Fir Working Circle
Mixed Conifer Working Circle
Blue pine Working Circle

The objectives, management options, responsibilities, monitoring and evaluation and silvicultural systems specific to each working circle is given in the following table:

Table 2. 10 Mixed Conifer Working Circle

WORKING CIRCLE: MIXED CONIFER				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural systems**
To meet local requirement as a priority, for timber, fuel wood and other forest products on a sustainable basis	Controlled marking of trees	Territorial	Territorial	**Group Selection System** Due to the lack of research into the light requirements needed for regeneration, the coupe sizes are a guideline that must be followed unless new information on silvicultural system is obtained. Cable lines will be laid to their full capacity. Cable corridors will be no more than 4m wide.Group opening will not exceed 0.15ha.The distance between the cable lines will not less than 60m and between groups along cable line will not less than 50m. All merchantable trees >10cm DBH (OB) will be felled. Dead, dying, malformed and diseased tree will be felled by priority. Opening can be irregular shapes and should be based on terrain features and stand condition. However, size of the opening should be not more than 0.15 ha. Damage to residual tree must be minimized
To manage the commercial timber production on sustainable basis	Use appropriate logging and Silviculture method Ensure cable-line lay out allows inter line logging Operate entire cable line Encourage cleaning of entire cable lines	Territorial/ NRDCL Territorial/ NRDCL Territorial/ NRDCL NRDCL	Territorial Territorial Territorial Territorial	
To enhance and improve forest condition and productivity	Ensure that all barren and past harvested areas are restock with suitable native species Use appropriate logging and silvicultural method Monitor on the attack of pest and disease Involve local communities	NRDCL/ Territorial NRDCL/ Territorial Territorial NRDCL/ Territorial	Territorial Territorial Territorial NRDCL	
To protect the forest from overgrazing, fire and other illegal activities	Control over grazing, fire and other illegal activities through participation and dialogue and acceptable fencing	Territorial	Territorial	
To create local employment	Employ local people Employ local contractor	NRDCL/ Territorial NRDCL	NRDCL NRDCL	
To maintain biodiversity within the production area	Low impact Silviculture system	Territorial/ NRDCL	Territorial	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Territorial/NRDCL NRDCL/Territorial	Territorial Territorial	
To protect the forest form fire, illegal activities and form grazing in regeneration areas	Control grazing, fire, poaching and illegal felling with local community participation	Territorial	Territorial	

All objectives will be evaluated annually by the FMU Level Management Committee.
Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term and final review.

Table 2. 11 Fir Working Circle

Working Circle: Fir				
Management Objectives	**Management Options**	**Responsibilities**	**Monitoring**	**Silvicultural Systems**
To meet local requirement, as a priority, for timber, fuel wood and other forest products on a sustainable basis	Controlled marking of tree and proper monitoring	Territorial	Territorial	**Group Selection System** Due to the lack of research into the light requirements needed for regeneration, the coupe sizes are a guideline that must be followed unless new information on silvicultural system is obtained. Cable lines will be laid to their full capacity. Cable corridors will be no more than 4 m wide. In case of understory conditions with bamboo/large rhododendron understory, the opening size should be 0.1 ha, while with herbaceous/moss understory with no major competitors, the opening size should be 0.25 ha. The distance between the cable lines will not less than 60 m and between groups along cable line will not less than 50 m. All merchantable trees >10 cm DBH will be felled. Dead, dying, malformed and diseased tree will be felled by priority. Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized.
To manage the commercial timber production on sustainable basis	Operate entire length of cable line Ensure cable-line layout allows interline logging Use prescribed logging and silviculture methods Ensure cleaning of entire cable lines	Territorial/ NRDCL Territorial/ NRDCL Territorial/ NRDCL Territorial/ NRDCL	Territorial Territorial Territorial Territorial	
To enhance and improve forest productivity	Ensure that barren and past harvested areas are restock sufficiently with desired species composition Plantation with protection Harvest all Fir (Dieback) areas to ensure the next rotation has less rot using full cable line lengths Work with local communities for planting/restocking activities Use stand tending techniques Create 44 favourable conditions for regeneration and growth	NRDCL/Territorial NRDCL Territorial/NRDCL NRDCL/Territorial NRDCL/Territorial NRDCL	Regeneration Survey Territorial Territorial Territorial Territorial Territorial	
To create the local employment opportunities	Employ local people Employ local contractor	NRDCL NRDCL	NRDCL NRDCL	
To maintain biodiversity within the production area	Low impact Silviculture systems	Territorial/ NRDCL	Territorial	
To protect the forest from fire, illegal activities and from grazing in regeneration areas.	Control grazing, fire, poaching and illegal felling with local community participation	Territorial	Territorial	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Territorial NRDCL/Territorial	Territorial	

All objectives will be evaluated annually by the FMU Level Management Committee.

Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term review

WORKING CIRCLE: BLUE PINE				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural systems**
To meet local requirements, as a priority, for timber, fuel wood and other forest products on a sustainable basis	Controlled marking of trees Systematic thinning	Territorial Territorial	Territorial Territorial	***Thinning/single tree selection*** The young Blue pine stands will be worked under thinning/selection in rural blocks. Marking trees will depend on the number of stem per hector, age or size class and spatial distribution. Pole crop stand should have a target of 400 trees/ha (5m spacing). The spacing can decrease or increase with size class. Dead, dying, malformed and diseased trees will be thinned on priority basis. ***Seed Tree System*** For cable harvesting, felling areas of 1000m x 30m can be logged, leaving 20-25 trees/ha as a seed source. Harvesting line must not run directly downhill. Lines must be 90m apart to allow 2 interlines operation. On exposed or sensitive sites harvesting must leave 40-50 trees/ha & all understory vegetation. Seed tree must of good form, not over matured & representative of existing stand. In mixed stand equal distribution of seed tree must be left.
To manage the commercial timber production on sustainable basis	Encourage use of small diameter wood Promote commercial harvesting	NRDCL NRDCL/Territorial	NRDCL Territorial	
To enhance and improve forest productivity	Mark trees for rural use as planned thinning exercise NRDCL to commercially thin stand Use appropriate logging and silvicultural methods Restock logged or barren areas Create favorable condition for regeneration and growth Involve local communities for planting and restocking activities Use stand tending techniques, such as bush clearing and spacing Harvest all areas regardless of financial return	Territorial NRDCL Territorial/ NRDCL NRDCL NRDCL/ Territorial NRDCL/ Territorial NRDCL NRDCL/Territorial	Territorial Territorial Territorial Regeneration Surveys Territorial Territorial Territorial	
To maintain biodiversity within the production area	Low impact Silviculture system	Territorial/ NRDCL	Territorial	
To create local employment opportunities	Employ local contractor Provide proper training Employ local people	NRDCL NRDCL/Territorial NRDCL	NRDCL Territorial NRDCL	
To protect the forest from over grazing, fire and illegal activities	Control overgrazing, poaching, prevent fire and illegal activities with local community participation	Territorial	Territorial	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulations	Territorial NRDCL/Territorial	Territorial Territorial	

Table 2. 12 Blue Pine Working Circle

All objectives will be evaluated annually by the FMU Level Management Committee.
Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term review

13.5 Implementing Management Working Circle

The Forest Function planning concept has been used in this plan to allocate land use among the forest in the FMU, so that strategic planning for sustainable yield can be carried out. The problem remains to implement these prescriptions on the ground. Later sections indicate that this will be done through an operational planning process whereby information that is more detailed collected through inventory and discussions with stakeholders, local communities and NRDCL. However, even when this more detailed data is collected, the requirement remains to locate individual Forest Function on the ground so that the prescription and the objectives can be implemented. However, function maps have been prepared indicating the boundaries of the Forest Functions to facilitate FMU while overseeing implementation of management plan.

Therefore, the Unit In-charge will have to use shape files of FMG using GIS and Google Earth besides maps to the best of his/her ability. Areas should be observed using various means 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.

14. YIELD REGULATION AND HARVESTING

14.1 Determining of AAC

14.1.1 Introduction

Principle of Sustainability is an accepted norm in Forest management and forms the core principle of organized forestry. The concept has evolved from the basic consideration that the later generation may derive from the forest that at least as much of the benefits as the present generations. The principle of sustained yield ensures the stability and continuous supply of raw materials to the industries and meets the social and domestic needs of the people.

Sustained Yield management allows harvesting of forest resources in a way by which annual cut and other losses of timber do not exceed the average annual growth and assures continuity of harvest, indefinitely, without impairment of the productivity of the soil. Calculation of Sustained Yield is expressed as Annual Allowable Cut (AAC).

14.1.2 Increment based AAC

In theory, with a prefect 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 growth rate is still limited for Lon Chhu FMU and Bhutan in general, and it will be some time before valuable data from permanent plots are available. In addition, Bhutan forest are not perfectly structured, but have very varied natural growing stock, some of which (particularly Fir zone) is actually in negative increment at present as the rate of decay exceeds new growth. In the long term, increment should increase as over mature stands are replaced by younger stocks, but it will be many decades before this second growth is available for harvest. In the mean time there is an over-mature growing

stock and too little and unreliable increment data to use in determining AAC, therefore increment based AAC's are currently unsuitable for Bhutan

14.1.3 The Most Appropriate AAC Method

A wide range of formulae and calculation approaches are available and advantages and disadvantages can be argued for each. Whilst it is difficult to define a clear best method for the country, there is a strong believe for standardization around a fairly simple and robust single methodology. The method which is used for the calculation of AAC in Lon Chhu FMU is based on combination of area, volume and rotational age of species.

The following method is used for calculating the AAC:

$$\text{AAC per Working Circle} = \frac{\text{Net operable area}}{\text{Rotation}} \times \text{Average standing Vol. / Ha}$$

This calculation is performed for each working circle, providing AAC per working circle. These are summed together to provide the total AAC.

14.1.4 The Calculation of AAC for Lon Chhu FMU

Net Operable Area

The total operable area was identified using QGIS 3.0.0 with GRASS 7.4.0. All areas having a slope > 45^{o} has been classified as Soil Protection, which accounts about 1309.37 ha. In addition prescribed buffer areas for rivers and streams, forest road and irrigation channel have also been included within the Protection Management Circle. Further those production forest areas which are not likely to be harvested for timber production during this owning to its remoteness mostly located at the top of the ridges have also been excluded from the Gross Operable Area. In the previous plan, about 23% of the gross areas have been reduced to come out with the final net operable area. However, in this plan period, no such reduction was made as all areas which are inaccessible and inoperable are already mapped out and designated under Protection Management circle during function mapping.

Table 2. 13 Calculation of Net Production Area

Forest Types	Gross Operable Area	Net Operable area
Fir	2561.757	2561.757
Mixed Conifer	2910.087	2910.087
Blue pine	560.277	560.277
Total	**6032.121**	**6032.121**

*Therefore, the total Gross Operable/ Net operable Area for Lon chu FMU for this plan period is **6032.121 ha.***

Rotation and Regeneration Period

In this management plan period, the assumed rotation length for mixed conifer working circle is 140 years. With importance of considering regeneration period while calculating rotation length, 20 years of regeneration period has been added to the rotation age of mixed conifer forest. For fir working circle, the assumed rotation length is 160 years and added 20 years as regeneration period. The assumed rotation length for Blue pine, which grows at relatively lower altitude, is 110 years and regeneration period of 10 years has been added. Therefore, the assumed rotation lengths for the calculation of AAC in Lon Chhu FMU are:

Fir working circle:	160+20 years
Mixed Conifer working circle:	140+20 years
Blue pine working circle:	110+10 years

Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analyzed using "R". The RME for each stratum is given below (table 2.14). The forest management inventory of Lon chhuFMU is designed based on the forest type of the entire FMU and not based on individual stratum. Therefore, the average standing volume obtained from the analyzed data is kept the same irrespective of the stratum. Therefore, the average standing volume for all the strata is considered as 212.78 m^3/ha with a standard error of 17.69 %. The reliable minimum estimate of standing volume thus obtained was 175.15 m^3/ha for all stratum.

AAC for each Working Circle

Table 2. 14 The AAC for each working circle, based on the above is:

Strata	Gross Operable Area (ha)	Rotation (Years)	RME standing volume (m3/ha)	AAC (m3/Yr)	Clear Cut Equivalent (ha)
A. Commercial Use					
Fir	2429.02	180	175.15	2363.57	13.49
Mixed Conifer	2396.65	160	175.15	2623.58	14.98
Blue Pine	280.57	120	175.15	409.52	2.34
	5106.24			**5396.67**	30.81
B.Rural Use					
Fir	132.74	180	175.15	129.16	
Mixed Conifer	513.44	160	175.15	562.06	
Blue Pine	279.70	120	175.15	408.25	
	925.88			**1099.47**	
TOTAL	**6032.12**			**6496.14**	

The total AAC for Lon Chhu FMU comes to **6496.14 m^3** in standing form from the production area of 6032.12 ha.

14.2 Recording and Accounting for AAC

AAC for FMU has been calculated on the basis of the whole production area and the expected rotation. Thus, all material that comes out of the Production Working Circle, not just the volumes that come from group selection system and cable corridor, must be included in the removal that is compared with the AAC. This includes timber cut for rural use, timber from normal cable lines, sanitation of pests and disease infested trees, ad hoc removal, wind-thrown & uprooted trees, road construction, etc. It is also crucial that all material felled but not removed in included in the 'actual cut'.

AAC will be monitored through the records of tree marked (Tree Marking Register) for both commercial and local use in all the working circles. AAC has been calculated as gross volume and this is the measure that should be totalled on annual basis from the Tree Marked Register.

14.3 Allocation of AAC

Allocation of AAC has taken into account the need of rural people (living within and around FMU) while providing NRDCL with commercial timber and accounting for the needs of other organizations within the country.

AAC (m^3/year or ha/year)	Allotted to
1000 (standing volume)	Local Use: local villagers and general public for rural house construction.
5300 (standing volume) or **30.25** ha clear cut area	NRDCL: to meet the commercial timber demand in the market.

14.4 Distribution of the cut

Although AAC has been calculated by Working Circles, during implementation of the plan, it should be noted that the distribution of cut will be considered as the entire FMU and not as individual working circle. If the operable area for a particular area falls completely under one working circle, the sum total of AAC for that year will be removed from this working circle. Therefore, AAC for each stratum is mentioned purely for calculation purpose and not to be accounted as individual cut for each working circle. The tentative number of cable lines to be harvested annually should be mentioned in the Annual Operational Plan.

Further, calculation of AAC is based on AREA and VOLUME. To this, AAC should also be regulated either through volume or through clear-cut area equivalent for each year. In this plan period, the total permissible clear-cut area per year for FMU is 30.25 ha, meaning area cut through cable corridors, group openings, road construction, sanitation operation, etc should not surpass more than 30.25 ha per year. If AAC achieved through clear-cut area is equivalent to 30.25 ha and even if there are remaining normal cable lines, FMU should immediately stop harvesting timber from cable lines. Remaining cable lines should be earmarked for next operational year.

15. SILVICULTURAL SYSTEM

15.1 Group Selection System

For the Mixed Conifer Working Circle and Fir Working Circle in the FMU, Group Selection is the prescribed Silvicultural System. The particular Silvicultural System has been selected based on the ecosystem and natural regeneration system. Under the Group Selection System small opening 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 opening will be no longer than one and half tree length in the Hemlock, Spruce and Fir Stand.

Working Pattern

The groups will be open along cable lines. The distance between cable lines will be not less than 60 meters, and between groups along cable line not less than 50 meters. The corridors should not exceed four meter widths. The effective area within the limit of standard cable length is 6 hectares (1000 m x 60 m), less the area of the corridor 0.40 hectares (1000 m x 4 m), thus the one-third removal would be equivalent to (1.87 ha.) which is the area available for opening groups. Thus, it would be possible to open up about 9 to 10 groups along the standard cable lines, if the average tree height is taken about 35 m and further the diameter of any opening will not exceed 50 m.

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 groups will be almost impossible. Aspect, slope and silvicultural requirement would influence the actual size of the groups. An average of 0.15 ha opening is recommended. However, group opening in fir working circle will not exceed 0.1 ha if the understory conditions is with bamboo/large rhododendron understory and 0.25 ha is the understory conditions is herbaceous/moss understory, no major competitors.

Group openings should be created in already opened up/barren/blank areas and opening area of 0.15 ha for mixed conifer and 0.1 ha for fir if the understory conditions is with bamboo/large rhododendron understory and 0.25 ha if understory conditions is herbaceous/moss understory, no major competitors should be calculated for clear felled area in the operational plan.

The tree should be felled towards the centre 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 Group Selection 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 Group Selection System.

The Group Selection System has the following advantages:

- Regeneration in the small groups under even-aged condition gives better stem form;
- 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 group lower damages to residual stands;
- Intermediate cuts may be made less frequently;
- Aesthetically and environmentally more acceptable than clear cutting system.

Considering average cable length of 1000 m, about 14 cable lines can be tentatively harvested annually from the production area by NRDCL from FMU.

Stratum	AAC	Volume	Clear cut area equivalent	Clear cut equivalent area of one-cable line	Number of cable lines
Fir	2363.57	175.15	13.49	2.27	6
Mixed Conifer	2623.58	175.15	14.98	2.27	7
Blue pine	409.52	175.15	2.34	2.27	1
Total			**30.81**		**14**

However, in the field, the length of cable lines may varies based on the landscape and extent of production areas within the identified harvesting area. Therefore, the number of cable lines will also vary as per the length of the cable line. Therefore, the Unit in-Charge should ensure that required number of cable lines is surveyed to achieve prescribed standing volume for commercial use and accordingly survey cable lines for the operational year. There may not be linkage between calculations of cable lines and prescribed AAC for commercial use. For instance, for commercial AAC of 5300 m^3 with standing volume of 175.15 m^3/ha and clear-cut area of 30.25 ha in this plan period and as per calculation of cable lines, it comes to 14 lines per year. However, prescribed standing volume for commercial use may or may not meet from these worked out cable lines.

Whatever the calculation may be, the annual harvesting should not be more than 5300 m^3 standing volume.

15.2 Seed Tree System

Blue pine working circle in FMU will be worked under the silvicultural system of Tree Seed system if in case identified harvesting area is pure blue pine stratum. Seed Tree is the silvicultural system that involves retaining a number of trees to supply seed for regeneration after rest of the trees being harvested. Blue pine regenerates easily when light is ample and ground vegetation is sparse. However, it is important to note that this Seed Tree system is not suitable on steep and exposed south and southwest sites; rather group selection system should be preferred on such condition.

Working Pattern

For cable line harvesting, the felling area of 1000 x 30 m can be logged, if the felling is confined only to Blue pine stand stratum with the retention of about 20-25 trees/ha that are

phenotypically superior. Harvesting lines must not run directly downhill. Lines must be 90 m apart, allowing two interline operations. Dead, dying, malformed and diseased tree will be cut on priority basis. On exposed or sensitive site harvesting must leave 40 to 50 trees/ha. The distance between the seed bearers should not be more than one-crown length as weeds and/or regeneration of unwanted species can easily colonize it.

Seed Tree System has the following advantages

- Compare with artificial sowing, the seed from seed trees is gradually released over the time and this can increase the probability of seed being on the ground when the desired germination conditions occur;
- The expense of collecting and sowing of seed is avoided where there is suitable on-site seed;
- The local gene pool is more closely reproduced, leading to better adaptation to the site;
- Harvesting is more concentrated, so logging cost is reduced;
- Aesthetically and environmentally more acceptable than clear cutting.

15.3 Coupe Clearance

Territorial Division and Lon chhu FMU should follow the following procedure for issuance of coupe clearance for execution of timber extraction from planned cable lines in this plan period. The following procedure was recommended by FRMD on issuance of coupe clearance certificate in FMUs vide No.FRMD/MPS/2(1)2018-2019/708 dated 17/01/2019.

1. The concern Territorial Division through Unit office must issue coupe clearances to NRDCL prior to execution of timber extraction works from planned cable lines. The operation of cable lines by NRDCL must commence only upon obtaining the coupe clearance issued by the division.
2. Coupe clearance for the 1st cable line to be issued prior to installation of cable cranes. Further the cable crane in the 1stline will be removed only upon complete extraction of lops and tops from the cable corridor and are brought to the landing site.
3. Coupe clearance for the 2nd cable line to be issued while 1st cable line is still under Operation so as to enable marking of trees and installation of cable crane in the end cable line.
4. Coupe clearance for the 3rd line to be issued only after lops and tops extracted from 1st cable line is completely disposed from the landing site. The same procedure must be followed for the operation of following consecutive lines.

16. FOREST PROTECTION

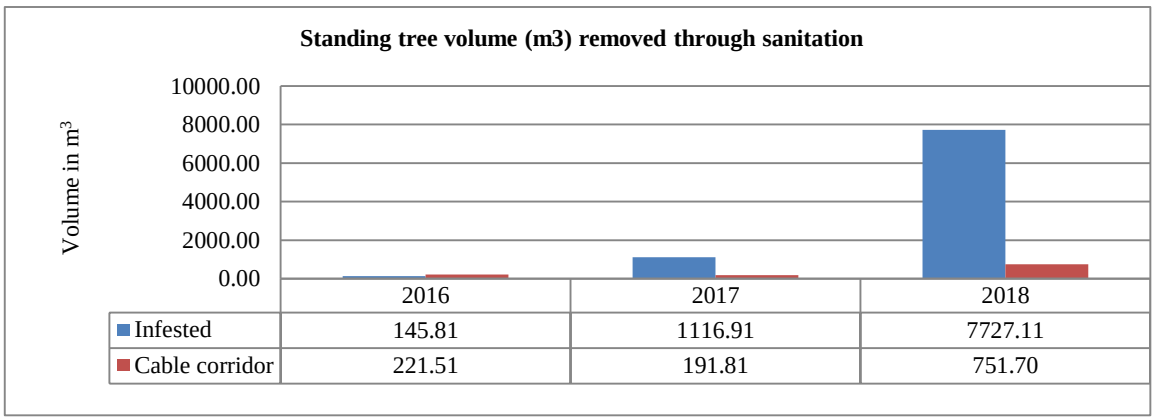
16.1 Fire

In first plan period, there was two incidences of fire outbreak at Haa-nga III in 2013 damaging approximately 1 ha area, and another incident in 2016 at Haa-nga III damaging 0.8 ha. The cause of fire was man-mad. Most area of Lon Chhu Forest Management Unit is conifer and there is high risk of fire outbreak if proper preventive measure is not taken.

The needles and resin of the conifer trees makes the fuel, which will enhance the outbreak of forest fire especially during the dry seasons of winter.

Therefore, the Unit In-charge and the Production In-charge of NRDCL will need to review forest fire protection programs at regular interval in close consultation with the local communities and forest workers in the FMU. The danger of forest fire outbreak

Figure 2. 1 Standing volume removed through spruce bark beetle infestation



	2016	2017	2018
Infested	145.81	1116.91	7727.11
Cable corridor	221.51	191.81	751.70

from the burning of field debris should be well informed to the local people, as it is the common practiced followed by the local people. When the local people are going to burn their property, the information must reach to territorial staff so that monitoring can be taken.

16.2 Pest and Diseases Management

During first plan, there was outbreak of spruce bark beetles in 2016, 2017 and 2018 and has damaged 2386 number of trees that was equivalent to 8989.83 m^3 in standing form.

Further, along with sanitation of affected trees, 609 numbers of standing trees (equivalent to 1165.02 m^3 standing form) were also felled, which falls along the cable corridor used for removal of affected trees from FMU. During field visit and observations conducted, roots of infested trees were found infested by *Armillari amellea*, root rot.

In most of the infested stands, mortality of trees was observed in the patch form and this could be because of root-to-root contact of the fungus. To our understanding, stands would have infested by bark beetles after weakening the trees with damage to the root system by root rot. The other probable causes of beetle outbreak could be because of poor management and harvesting practices.

With incidents of outbreak of spruce bark beetle over past years, there are every chances of pest and diseases outbreak at any time during this plan period. Therefore, the periodic monitoring of the forest to detect any outbreak of pest and diseases should be conducted by FMU and NRDCL. Immediate reports should be made to the concern CFO and seek approval for immediate sanitation from head of the Department.

16.3 Grazing

In line with the multiple-use of the forest and traditional rights of grazing within the FMU, grazing will be allowed to continue in some part of the Unit.

However, grazing will be excluded from Protection functions and light grazing will be permitted in Conservation functions. Grazing in planted areas along the cable corridors and any other areas where plantation has been taken up by NRDCL should be avoided. In this plan period, FMU should focus more on educating people regarding impact of grazing and and their participation in managing FMU and other ecosystem services. FMU should collaborate with the livestock sector of the Dzongkhag or gewogs to strategise an appropriate methods and approaches to avoid impact on natural regeneration and plantation within FMU during plan period. More importantly, a participatory approach to secure the cooperation of local villagers in keeping their cattle out of environmentally sensitive areas and away from regeneration coupes will be adopted with high priority.

NRDCL should provide adequate support with available local materials to support and protect planted seedlings until its establishment. Regular maintenance should carried out as per maintenance schedule reflected in the annual operational plan to prevent damage of seedlings from grazing.

17. ENVIRONMENTAL IMPACT ASSESSMENT

The Environment Act, 2000 requires that all developmental proposals in Bhutan meet a series of environmental criteria. The chapter III, section 18 of the act provides lists of five general requirements that must be fulfilled by any applicant requesting for the environmental clearance. To ease the applicant applying for environmental clearance and to ease the implementation, National Environmental Commission has also developed various Sectoral Environmental Guidelines. Application for Environmental Clearance Guideline for Forestry Activities specifies the detail criteria to be met by any applicant to carry out the forestry activity. It is assumed in this chapter that if the Sectoral Guidelines are met, the requirement of the Act will also be met.

This section of Lon chhu Forest Management Unit Plan provides information how the forestry activity will be carried out and controlled so that the proposed activity meets the requirements of the Act.

17.1 Project Description

17.1.1 Introduction

The demand for timber is continuously increasing in the domestic market. Nevertheless, the supply of the timber is more or less remaining the same, thus the price of the timber was escalating very high until the Natural Resources Pricing Committee fixed the price of log and sawn timber in the market. The reason behind fixing the price of timber is to make the timber affordable to the citizens of Bhutan. The Lon chhu FMU has been identified as potential forest area, which can cater the demand for timber if the principle of sustainability is strictly followed.

17.1.2 Objectives

- To maintain and improve the present vegetation cover to protect the environment, soil and water conservation and as well as biodiversity;
- To ensure sustain supply of timber, construction poles and posts, fuel wood and other non-wood forest products for local supply through regulated harvesting and collection;
- To strengthen the awareness of the communities within the Forest Management Unit to participate in forest protection and conservation;
- To ensure that multiple use of forest does not result in unacceptable level of ecological and environmental disturbances;
- To generate local employment opportunities in the forest based activities;
- To regulate grazing to maintain the ecology and natural regeneration potential of forest;
- To promote local research, demonstration, aesthetic and educational values of the natural forest ecosystem.

17.1.3 Project Location and Area

The Lon chhu FMU falls under Haa Dzongkhag and lies within the longitude of 89^{o} 08' 52'' to 89^{o} 17' 21'' East and latitude of 27^{o} 14' 48'' to 27^{o} 23' 03'' North. The entire FMU is situated within the Sama gewog of Haa Dzongkhag and FMU is under the management jurisdiction of Territorial Division Office, Paro.

The total area of Lon chhu FMU is 12664.49 ha. However, the whole area will be not subjected to timber harvesting, only about 6032.12 ha of area will be subjected to timber harvesting in scientific and sustainable manner in this plan period. Rest of the area is categorized under Protection and Non-Production Working Circles.

17.1.4 Benefits

The forest management inventory results indicated that timber species trees within some mixed conifer and fir stand of Lon chhu FMU have attained harvestable size and some stands are matured and annual increment growth will be not significant. Removing matured stands would create space for regeneration and help to improve the forest condition. Regeneration is always a problem in the natural forest due to limited space and light, grazing pressure from the domestic animals and competition from unwanted species that dominates over the principle commercial species. Therefore, timber harvest with application of scientific approach will improve forest structure and condition to suit natural regeneration for restock and other ecosystem services.

Forest road have benefited rural communities of Sama and other gewogs to transport their rural house construction timbers and firewood mechanically. It is also anticipated that additional forest road would be benefiting the people of Sama, Katsho, Esu and Bji and outside these gewogs. Road accessibility would also benefit forest management and protection during outbreak of wild fire and forest pests and diseases during plan period.

Establishment of forest management unit would create job opportunities to local residents of Sama gewog; the priority will be given to the local residents for forestry activities involving in the project. The overall benefit would be that the Lon chhu FMU would be

managed on the principle of sustainability. The over matured timber, which otherwise would rot in the forest, would be brought to the market to earn revenue for the government and at the same time improve the forest stand and ecosystem services from forest of FMU.

17.2 Forest Management Unit Planning and Zoning

All the management planning has to be based Part 2, section 2.03 of the 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:

Potential production forest area was identified using QGIS Desktop 3.0.0 with GRASS 7.4.0, Land Use Land Cover, 2016 and existing national data like Digital Elevation Model (DEM), drainage, road networks, protected area system, etc. Application of GIS was then followed by the ground reconnaissance of selected area in conjunction with the local community consultation to ascertain potential conflicts between forestry use and existing local use. These consultations included local communities, local government, and other stakeholders like Jigme Khesar Strict Nature Reserve (JKSNR), NRDCL and Lon chhu FMU. A forest resource inventory was carried out to provide the information about tree stocking, regeneration, timber volumes, sites characteristics, wildlife presence and under storey species.

Forest zoning is based on above data collected, using the forest function mapping prescribed in the Forest Management Code of Bhutan. The area is divided into different forest type so called working circle and they are further divided into blocks and compartments. The protection area such as soil protection, local water supply catchment areas, wildlife protection, rivers and streams buffer, etc. was also excluded from net operable area.

The silvicultural system to be implemented is Group Selection System for Fir and Mixed Conifer forest and Seed Tree System for Blue pine forest. No clear cutting will be allowed. All the trees will be harvested using the skyline cable crane system to avoid negative impact on surrounding environment. The opening of the group size can vary from 0.1 to 0.25 ha in fir zone and to 0.15 ha in mixed conifer forest depending upon the stand composition, condition and understory cover. The distance between the cable lines will be no less than 60 meter and distance between the groups will be no less than 50 meter in mixed conifer forest.

17.3 Harvesting and Extraction

Fixed volume of timber so called “Annual Allowable Cut or AAC” is prescribed in this management plan. The annual allowable cut prescribed in this management plan is 6300 m^3in volume. From this total AAC, 5300 m^3 will be allotted to NRDCL for commercial use and 1000 m^3 for rural use. Considering the terrain condition and forest composition and structure, timber will be extracted using the skyline cable crane system. Skidding and rolling of timber from commercial production zone is strictly prohibited.

FMU will start timber extraction from Haa-nga III and then from from Rosha I. However, FMU shall remove timbers from pests and diseases first and then only harvest timbers from the normal cable lines after construction of forest road.

17.4 Road Construction and Maintenance

In previous plan period, NRDCL was allowed to use existing Barlam Zam – Norgang farm road since 4.190 km road was already constructed up to formation level by Haa Dzongkhag as farm road for the community. NRDCL had then used farm road and continued with construction of 12.6 km forest road into FMU during previous plan period.

For this plan period, road network was discussed in the public consultation meeting held at Sama gewog on 8 March 2019 involving all the FMU level committee members of FMU and representatives of local people and officials from local government of Sama gewog. Physical assessment for the road construction in FMU was then carried out by the team comprising of engineer from NRDCL, staff from Rinpung Region, NRDCL and planner with other officials from NRDCL and FMU.

Construction of forest road in FMU during this plan period is aimed at minimum negative environmental impacts. During the construction of forest road, NRDCL engineer will supervise and monitor to ensure no deviation from the proposed road alignment take place. Road Standards recommended by FRDD and the general principles and practices of the forest road construction as identified by NEC Forestry Sectoral Guidelines will be followed. These will ensure that the road construction in Lon Chhu FMU will meet the recommendations and ensure that any erosion or other negative impacts will be minimized or eliminated. Complete Road Standard is given in annex 4.

17.5 Regeneration and Post Harvesting Treatments

The natural regeneration in harvested areas of previous management is very poor. Therefore, in this plan period, FMU and NRDCL will give priority for success of regeneration through assessment and plantation starting from first year of the plan period.

It is prescribed in the management plan that harvesting will be followed by the natural regeneration. However, if the natural regeneration fails then the regeneration will be supplemented by artificial planting of the principle local species. The series of operation after harvesting is prescribed in the management plan in details. Regular maintenance of the plantation will be done by NRDCL and CFO shall evaluate the regeneration or plantation as per existing guidelines for FMUs. If the plantation survival percentage is lower than 80 %, immediate beating up operation will be carried out with same local species by NRDCL. Reforestation, afforestation, nursery and plantation for FMU by NRDCL will be based on Norma and Standards for Nursery and Plantation of the DoFPS.

17.6 Existing Environment

17.6.1 Topography and Geology

The general terrain of FMU ranges from moderate to steep landscape. At a glance whole of the FMU area bears the steep landscape but in reality the lower and uppermost portion of FMU has the gentle slope. The terrain in some compartment is gentle but in most of the

compartments, steep and rocky outcrops are very prominent. The total area of FMU is 12664.49 ha and the net production area is only 6032.12 ha. About 1192.55 ha of the total area are delineated as soil protection (slope above 100%).

The uppermost portion of the FMU is devoid of any tree stand; those areas are either blank or bear alpine grass and most of the time remains under the snow coverage.

Elevation of FMU ranges from 2600 m above sea level at the valley bottom to 4600 m above sea level at the ridge top. The rock of is of Paro formation. This formation is characterized by mica-schist, quartzite-schist, calc-silicate, graphite schist, marble etc.

17.6.2 Hydrology

The main river which flows within this FMU is Lon *Chhu*, thus, from this river the name of the FMU was derived. This Lon *Chhu* is a tributary of Haa*Chhu* and ultimately drains into the Haa*Chhu*. Beside this Lon *Chhu* there are numerous fleeting streams draining into Lon *Chhu*.The whole FMU is nearly divided into two equal halves by Lon *Chhu*.

17.6.3 Air Quality and Noise

There are neither developmental works nor there is any interference from the tourism. The forest of FMU has only been used by local residents of villages around FMU and only noise is from the cattle grazing in the forest.

17.6.4 Plant, Animal Species and Habitat

Multi-resource inventory was carried out by FRMD inventory crew and Territorial Division Office, Paro. During the inventory, crew noted various signs and sighting of the animals and corresponding data collected via commonly identifiable signs (footprints, scats, actual sighting, browsing and other ground disturbances signs) includes animal like barking deer, Sambar deer, goral, wild boar, Himalayan black beer and occasionally musk deer. Since the data did not indicate the number of different species in the particular area, the measure of density population of different species at this planning stage may not be possible.

The plant species diversity is great in FMU due to the altitudinal range and aspects. No threatened plant species has been recorded within the net production area.

17.6.5 Scenic Qualities

The area has no unique scenario in particular to complements it scenic beauty.

17.6.6 Cultural Significant Sites

There are no historical monuments and monasteries within the FMU.

17.7 Assessment of Impacts and Mitigating Measures

17.7.1 Impact on water

Pollution

Labourer engaged for road construction and harvesting operation might pollute the rivers and streams through garbage disposal and sewage. The other pollutant might come from the oil spills from machineries and vehicles.

Drying up of water source

Water source originate from the forested area. Though the proposed construction road doesn't pass through the drinking water source but during the construction phases, damage to the surrounding vegetation is inevitable. Thus harvesting operation and opening of forest might have small impact on water source.

Mitigations

A buffer of 30 meters on either side of rivers and streams were delineated and prescribed as riparian protection zone and the total area delineated for this protection is 621.24 ha. About 1168.99 ha have been delineated as local water supply protection for drinking and irrigation purpose of villages around the FMU. Further, about 1192.55 ha has been delineated as soil protection, 47.11 ha as forest road buffer and about 13.47 ha as buffer for protection of water channel.

Proper pit latrines and garbage disposal will be in place and the campsite will be at least 100 m away from the main streams.

During the road construction, NRDCL's site engineer will monitor the construction activities. NRDCL will take extra precaution to avoid any damage to water pipes and irrigation structures. For damage of such infrastructure, NRDCL will be sole responsible to replace and maintain damaged structures.

17.7.2 Impact on forest resources

The silvicultural system prescribed in this management plan is the Group Selection System for Mixed Conifer and Fir Working Circles and Tree Seed System for Blue pine Working Circle. The opening of corridors and groups during the harvesting operation might result into grazing ground with no regeneration of principle timber species. This could result in reducing the total forest cover within the Forest Management Unit. More opening means more area for under growth, which in turn might results into more grazing ground for the cattle for round the year.

Due to short-term gains, the implementers might go for choosing best tree and leaving behind the dead, diseased and dying tree species.

Implementer might go in the easy accessible areas only and start logging only in that areas while the whole idea of opening the forest management unit is to manage the forest on sustainable basis.

Improper harvesting techniques by untrained personnel would result into damage of surrounding trees that may not require felling. It would also result in more waste of timber resource.

Mitigations
The management plan for the whole area for a period of ten years is prepared before the harvesting operations take place. Harvesting will not exceed the prescribed allowable annual cut in the management plan. The size of the opening will not be in any cases larger than as prescribed in the management plan. If the natural regeneration fails to establish, the area will be planted with local principle tree species by NRDCL. The introduction of exotic species will not be allowed.

For proper planning, implementation and monitoring of the Forest Management Unit activities, a full set of staff for the unit would required both by DoFPS and NRDCL. CFO, Paro, will be responsible to depute adequate staff to function FMU effectively. The wet and marshy area should be avoided during the road alignment to minimize the impact on the ecology.

The Unit-in-Charge should monitor community activities outside Production Working Circle to ensure that they are not locally concentrated to the extent that they affect biodiversity, water quality and soil stability.

17.7.3 Impacts on the faunal diversity
Wildlife is very important component in the forest ecology. Due to the construction of road and harvesting operation, there might be loss of wildlife habitat and thereby by reducing wildlife population in the area.

Mitigations
The species composition and forest type is similar throughout the Forest Management Unit. The protected and non-harvested area would provide sufficient space, cover for movement and food resources. NRDCL and FMU will retain hollow and fruiting trees from feeling. Snag trees will be retained within the production areas for ecological benefits.

The Lon chhu FMU will carry out periodic anti-poaching activity through patrolling and field visit at musk deer habitats to curb illegal poaching. The habitat used by musk deer within the FMU has been delineated as wildlife protection zone, which is about 3067.84 ha. FMU will also educate forest workers and local community on importance of biodiversity conservation and their important role to protect and preserve existing biodiversity. Community people and forest workers will also be made aware on rules and regulations related to wildlife protection during the plan period by FMU.

17.7.4 Impacts related to Ecology (Flora)
The most anticipated impact on ecology is the change of present forest composition from over matured stand to normal stand especially within the operated areas in the long run.

Mitigations
While harvesting timbers from the forest, sound phenotype mother seed trees will be retained by FMU and NRDCL. Apart from the sound phenotype mother seed trees, some of those over matured individuals that will not yield any good timber will also be retained for the purpose of eco-friendly and to serve as relics and shelters for niche biodiversity.

Forest road will be aligned by NRDCL and ensure that it does not pass through any of the critical area where the disturbance could be more. In many of the critical areas that might damage the surrounding, NRDCL will provide hump pipes, culverts and wooden bridges where necessary and appropriate.

17.8 Monitoring and Evaluation

The Management plan, which is for the period of ten years, will be prepared by Territorial Division Office, Paro and facilitated by FRMD, DoFPS. It will be approved by the Minister, Ministry of Agriculture and Forests. The plan will be implemented by NRDCL under the supervision of Chief Forestry Officer, Territorial Division, Paro. Annual Operational Plans will be prepared by Territorial Division, Paro, in consultation with the stakeholders, based on the management plan. The OP will be approved by the Head of the Department. Annual monitoring will be carried out by Territorial Division (CFO and Unit In-charge). A report will be submitted to FRMD, Department of Forest and Park Services, based on the annual monitoring forms. FRMD will also monitor the implementation of the activities.

There will be two evaluations of FMU: mid-term evaluation at last quarter of the fifth year and final evaluation at the last quarter of the ninth year by the independent of staff implementation. An evaluation team will be constituted by the head of the Department. CFO will apprise the Department for evaluation and evaluate the FMU as per terms of reference.

Table 2. 15 Checklist of Environmental parameters for forestry projects

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Siting					
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. Rehabitation	4. Social problems	✓			
5. Relation to regional/ national forestry plans	5. Possible conflicts with established management policies	✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
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 base 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	NA			
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) soil compaction	*b) increased runoff*	✓			
c) log floatation	*c) impede navigation*	N.A.			
d) allocation	*d) less than optimum economic benefits*	N.A.			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
4. Logging in riparian zones	4. Degradation of waterways/fisheries	N.A.			
5. Socio-economics					
a) employment opportunities		✓			
b) loss of traditional forest use	*b) economic and cultural losses*	✓			
D. Considerations Regarding Post-Project Activities					
1. Rehabilitation and conservation		NA			
2. Road shutdown		NA			
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. Rehabitation	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	*a) social conflict if local people not significantly involved*	✓			
b) training		✓			
c) non-wood products		✓			
5. Operations and maintenance	5. Diminished project efficiency and objectives if lack of funds		✓		
6. Data base for decision making		✓			
7. Project financing and reservoirs		NA			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
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. Consideration Regarding Project Operations					
1. Commercial logging	1. Same as in Commercial Logging A and B	✓			
2. Reduced water supplies	2. Socioeconomic losses	✓			
3. Chemicals and fertilizers	3. Impaired fisheries and aquatic systems	NA			
4. First-year operations	4. Increased erosion due to soil disturbance	NA			
5. Soil conservation benefits					
a) erosion		✓			
b) sedimentation		✓			
c) soil capacity		✓			
d) soil surface moisture		✓			
e) soil nutrients		✓			
6. Socioeconomic benefits					
a) employment opportunities			✓		
b) fuel-wood			✓		
c) enhanced fisheries		✓			
d) enhanced recreation/ tourism		✓			
7. Water resources benefits					
a) minimized overland flows		✓			
b) reduced flood peaks		✓			
c) water quality			✓		

Source: Forestry Sectoral Guidelines, NEC (1999)

18. FINANCIAL AND ECONOMIC APPRAISAL

Ten-year financial forecast and economical appraisal has been drawn for FMU. This is intended to identify the revenue to NRDCL and Treasury (via royalty) and the cost and royalty paid by NRDCL. Overhead costs to NRDCL are not included. Some of the figures are estimates based on the assumptions listed and the information made available to the planner. The assumptions for the forecast are listed in table 2.16.

A summary of the forecast is presented in table 2. 17 and forecast itself in table 2.18.

Table 2.16 *Assumption used for financial forecast*

Assumptions	Figures
GENERAL	
Recovery volume (%)	60 % logs & 40 % lops & tops
Length of proposed new road (km)	10
Length of existing road (km)	15.2
Distance to Depot (km)	10
Hectors of existing plantations in the FMU (ha)	7.11
ROAD & BRIDGES	
i. Road survey (Nu/km)	6450
ii. Road construction (Nu/km)	2,200,000
iii. Road maintenance (Nu/km)	14,000
TIMBER HARVESTING	
i. Marking costs (Nu/cft)	0.08
ii. Felling & crosscutting (Nu/cft)	4.3
iii. Debarking (Nu/cft)	1.5
iv. Cable craning (Nu/cft)	6.9
v. Transportation to Depot (Nu/cft)	8.5
REFORESTATION	
i. Plantation creation -2 ha/year (Nu/ha)	45,000
ii.Plantation maintenance (Nu/ha)	9,225
MACHINERIES/EQUIPMENT & INFRASTRUCTURE	
i. Fuel & maintenance cost (Nu/year)	850,000
ii. Maintenance of infrastructure (Nu/year)	50,000
HUMAN RESOURCES (NRDCL)	
i. Total Pay and Allowance (Nu/year)	780,000
ii. Total Daily and Travel Allowance (Nu/year)	220,000
iii. HR capacity development (Nu/year) or Nu for plan period	100,000
MISCELLANEOUS COST, if any (Nu/year)	**150,000**

Table 2. 17 Financial ForecastSummary (for this plan period)

Category	Amount (Nu)
Total Revenue for NRDCL	178288719
Total Costs for NRDCL	78148306
Total Royalty for NRDCL	577020
Total Revenue-Total Costs-Total Royalty	99563393

19. RESEARCH

Research programs will be collaborated with National Research Center. The FMU Level Management Committee for Lon ChhuFMU will discuss, during the yearly meeting and decide what research is deemed necessary in the FMU for coming year.

Some possibilities for research include:

- Post impact assessment of logging activities on flora and fauna
- Natural regeneration and light requirement
- Economic benefits from logging activities
- Growth rate of native timber species through tree ring science

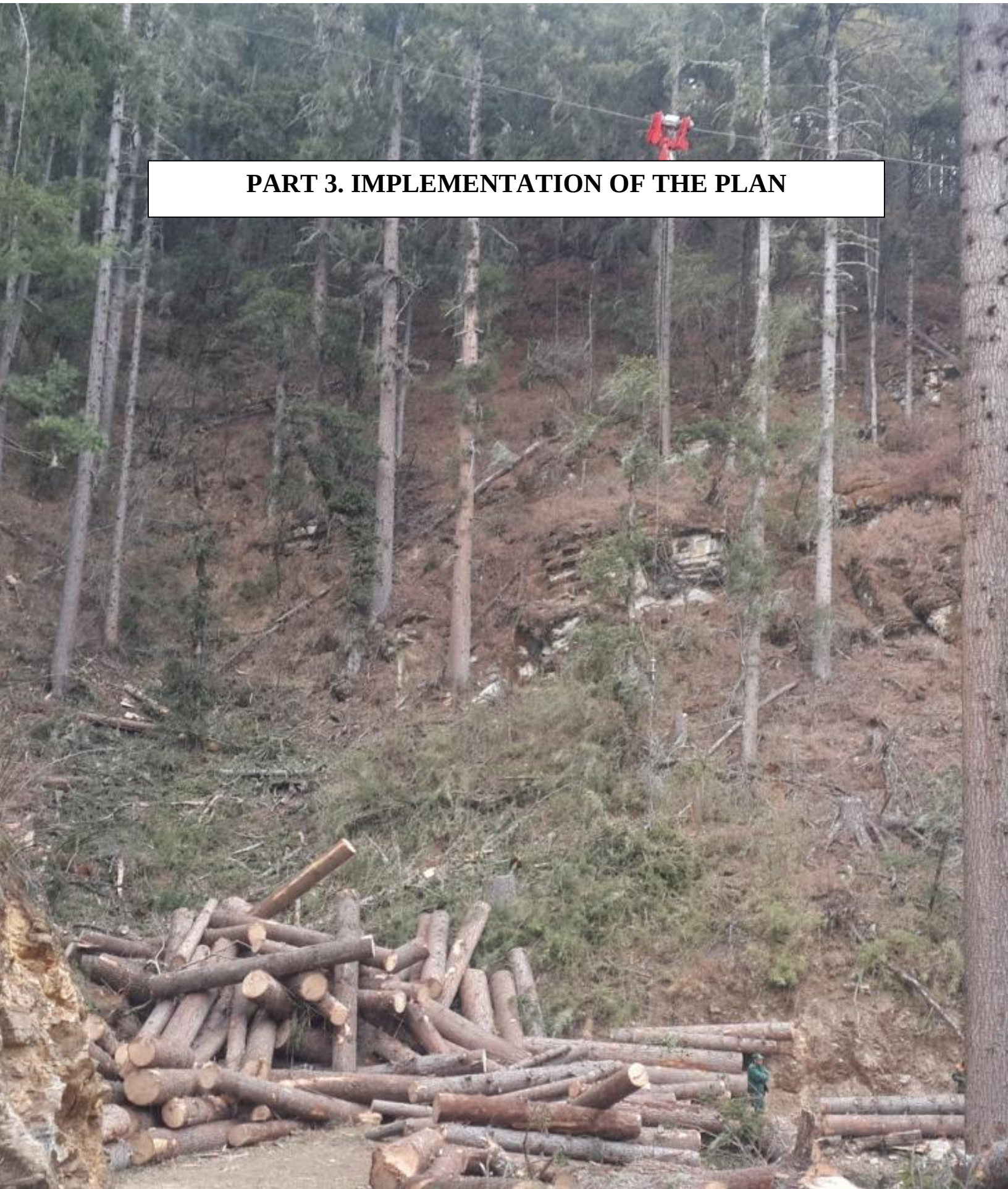
Table 2. 18 10 year financial forecast for Lon Chhu FMU

	AAC (m3)	Existing rate			Plan period										10 Years
		Rec.Vol (m3)	Nu/cft	Nu/m3	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total (Nu)
Revenue: NRDCL															
Timber-Commercial															
Class A	280.57	168.342	160.91	5681.7321	956474	956474	956474	956474	956474	956474	956474	956474	956474	956474	9564741
Class B	4825.67	2895.402	157.0	5543.3169	16050131	16050131	16050131	16050131	16050131	16050131	16050131	16050131	16050131	16050131	160501308
Total Revenue: NRDCL					17006605	17006605	17006605	17006605	17006605	17006605	17006605	17006605	17006605	17006605	170066050
Cost: NRDCL															
Road survey				6450	6450	6450	6450	6450	6450	6450	6450	6450	6450	6450	64500
Road construction	10	km			2200000	2200000	2200000	2200000	2200000	2200000	2200000	2200000	2200000	2200000	22000000
Road maintenance															
Farm road	5.5	km		24300	133650	133650	133650	133650	133650	133650	133650	133650	133650	133650	1336500
Forest road	9.7	km		14000	135800	149800	163800	177800	191800	205800	219800	233800	247800	261800	1988000
Marking cost			0.08	2.82	14424	14424	14424	14424	14424	14424	14424	14424	14424	14424	144241
Felling & crosscutting cost			4.3	151.833	775296	775296	775296	775296	775296	775296	775296	775296	775296	775296	7752957
Debarking			1.5	52.965	270452	270452	270452	270452	270452	270452	270452	270452	270452	270452	2704520
Cable craning			6.9	243.639	746448	746448	746448	746448	746448	746448	746448	746448	746448	746448	7464475
Transportation to depot			8.5	300.135	919537	919537	919537	919537	919537	919537	919537	919537	919537	919537	9195368
Creation of plantation	ha/year	2		45000	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000	900000
Plantation maintenance	7.11	ha		9225	65589.75	84039.75	102489.8	120939.8	139389.8	157839.8	176289.8	194739.8	213189.8	1515779	2770286.873
Fuel & maintenance cost	Nu/year	850000			850000	850000	850000	850000	850000	850000	850000	850000	850000	850000	8500000
Maintenance of infrastructure	Nu/year	50000			50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	500000
Pay & allowance	Nu/year	780000			780000	780000	780000	780000	780000	780000	780000	780000	780000	780000	7800000
Total TA/DA	Nu/year	220000		220000	220000	220000	220000	220000	220000	220000	220000	220000	220000	220000	2200000
Miscellaneous cost	Nu/year	150000			150000	150000	150000	150000	150000	150000	150000	150000	150000	150000	1500000
Total Cost: NRDCL					7407646	7440096	7472546	7504996	7537446	7569896	7602346	7634796	7667246	8983835	76820849
Royalty-commercial															
60% of Class A	168.34	Nu/m3		18	3030	3030	3030	3030	3030	3030	3030	3030	3030	3030	30302
60% of Class B	2895.40	Nu/m3		11	31849	31849	31849	31849	31849	31849	31849	31849	31849	31849	318494
40%	2141.95	Nu/m3		10	21420	21420	21420	21420	21420	21420	21420	21420	21420	21420	214195
					56299	56299	56299	56299	56299	56299	56299	56299	56299	56299	562991

Total Revenue : (Revenue less Cost less Royalty): NRDCL	9542660	9510210	9477760	9445310	9412860	9380410	9347960	9315510	9283060	7966471	92682210

Note: NRPC rate (Nu/cft) Logs for 2017

PART 3. IMPLEMENTATION OF THE PLAN



PART 3: IMPLEMENTATION OF THE PLAN

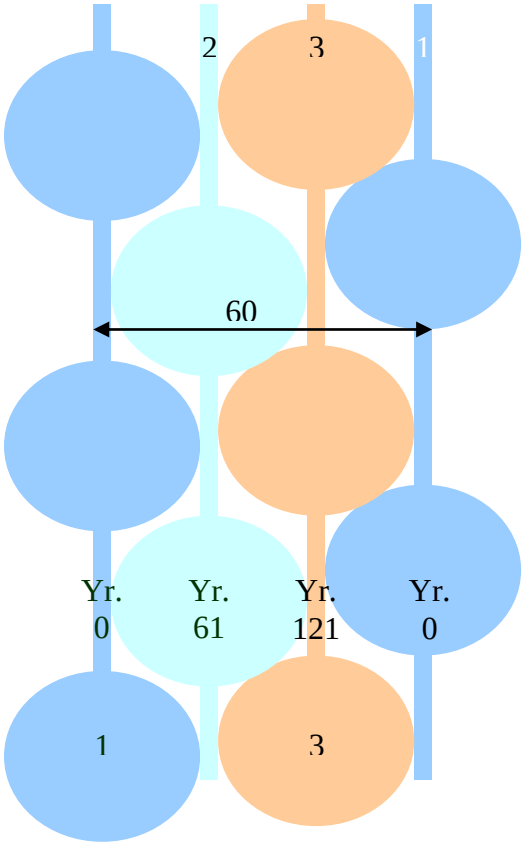
20. IMPLEMENTATION AGENCY

The Department of Forest and Park Services is charged with the responsibility of protection and management of the forest resources in Bhutan. The above-mentioned agency will discharge this responsibility through the territorial division. The CFO, Paro Territorial Division will be responsible for the implementation and monitoring of this Management Plan, assisted by the Unit In-charge and other support staff.

20.1 Cutting Cycle

For the sustainable harvesting of the forest resources, the cable line spacing must be properly laid so as to enable the subsequent passes in the future. To enable the two passes in the future, a minimum distance of 60 m needs to be kept in between the cable lines. Mixed Conifer Working Circle has a rotation period of 160 years with an additional 20 years regeneration period, which means that the two cable lines that will be implemented in the future are occurring at year 61 and year 121. This is diagrammatically represented in the figure 19.1. The original line will therefore be harvested in year 180. This gives the adjacent area time to regenerate and also prevents the area from being open largely.

The same method of cable line layout could be applied to the Fir Working Circle except that size of the group opening will be no more than 0.1ha.



Problem of laying cable line is inevitable in the field due to the unavoidable rough terrain. The layout in the field must be tailored to suit the terrain and to the best possible guidelines must be followed.

The Blue pine Working Circle, which will be worked under Seed Tree System, requires 90m spacing between initial cable lines. Thus, the two interlines in the future will be harvested at year 40 and 80, with original line being harvested at year 120.

Figure 3. 1Layout for Group Selection System

20.2 Annual Coupe

The Unit In-charge will determine the location and extend of cable lines in the compartment to be harvested annually, in consultation with NRDCL staff. All prescription and restriction laid down in the plan must be considered and adhered completely. NRDCL will obtain Coupe Clearance Certificate in writing from FMU to start marking felling. The Unit In-charge will arrange to mark along the cable corridor and openings and allot to NRDCL for felling.

The cable lines may traverse slopes greater than 100%, but extraction is not allowed. This means there should not be any group openings in those areas having slope greater than 100 %.

The FMU should consider the following point while identifying annual harvesting areas.

For operational inventory, it is safe to select an area about 4 times as large as the prescribed AAC. In this plan, the AAC is set at 30.25 ha. Use Land Use Land Cover (LULC) 2016 for area statement. If operational inventory area is represented by more than one stratum, it has to be corrected for the size of each stratum to obtain standing volume per hectare of the identified harvesting area. For this, CFO and Unit In-Charge should refer operational inventory guideline by Paul Laumans (May, 1994).

20.3 Tree Marking Rules

Groups of mature and over-mature are selected systematically according to the group 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 groups, and in the interline spaces, to safeguard flora and fauna niches or habitats, but not in the harvested group themselves, where there is risk of wind throw and danger to personnel working underneath. Diseased trees (bark beetle, mistletoe) 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.

20.4 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 hygienic condition of the forest, the cutover 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 each 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 Blue pine and Spruce, 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.

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.

20.5 Reforestation of Harvested Sites

For sustainable development of the forest resources, it is necessary that the forest crop continue with natural regeneration. It is crucially important that harvested areas are effectively regenerated as soon as possible after harvesting. In Lon Chhu FMU natural regeneration will be given preference over artificial regeneration, but if natural regeneration fails either enrichment or complete stocking by planting must be carried out. It is observed that in many FMUs, reforestation has not been successful and in some cases, it has been a total failure. It is highly imperative that the harvested areas are regenerated successfully and adequate time and resources be invested in this program to ensure better seedling survival rates, if the FMUs are to be managed on a sustainable basis. The future yield and continuity of operation is entirely dependent on the success of the reforestation program in the FMU.

The limiting factors that can encounter during natural regeneration process are; grazing pressure, protracted harvesting periods, weeds and brush growth. These problems must be considered, analyzed and eliminated to acquire a successful regeneration in the harvested areas of the FMU. It is recommended in this plan period to adopt more tending activities, such as weeding, brushing and fencing, so that regeneration has a chance to establish. This would also reduce the cost of reforestation as clearing and replanting a failed area would cost much more than the initial tending for natural regeneration.

If possible, NRDCL must raise nurseries for the local viable species in advance to supply the planting stock for subsequent plantation. The harvested area shall be planted with commercially viable local species. Regular maintenance of the plantation must be done to ensure the survival percentage of the plants. The concern CFO shall evaluate the plantation at the end of three years and if the survival percentage is lower than 80%, immediate beating up must be carried out with the same species.

Although a monitoring process has been adopted in FRMD it is recommended that regeneration surveys be conducted at the end of every three years, until the regeneration has reached a height that will ensure its survival. If the second survey (6^{th} year) indicates poor stocking, remedial action must be taken in the following planting season.The Unit In-

charge will ensure that stocking of natural regeneration is first monitored within three years following completion of the harvesting operation.

Enrichment planting, if necessary, will be carried out by NRDCL. Fencing and other necessary action to protect regeneration will also be carried out by NRDCL, in consultation with FMU In-charge and the FMU Level Management Committee.

20.6 Sequence of Operations related to the Annual Coupe

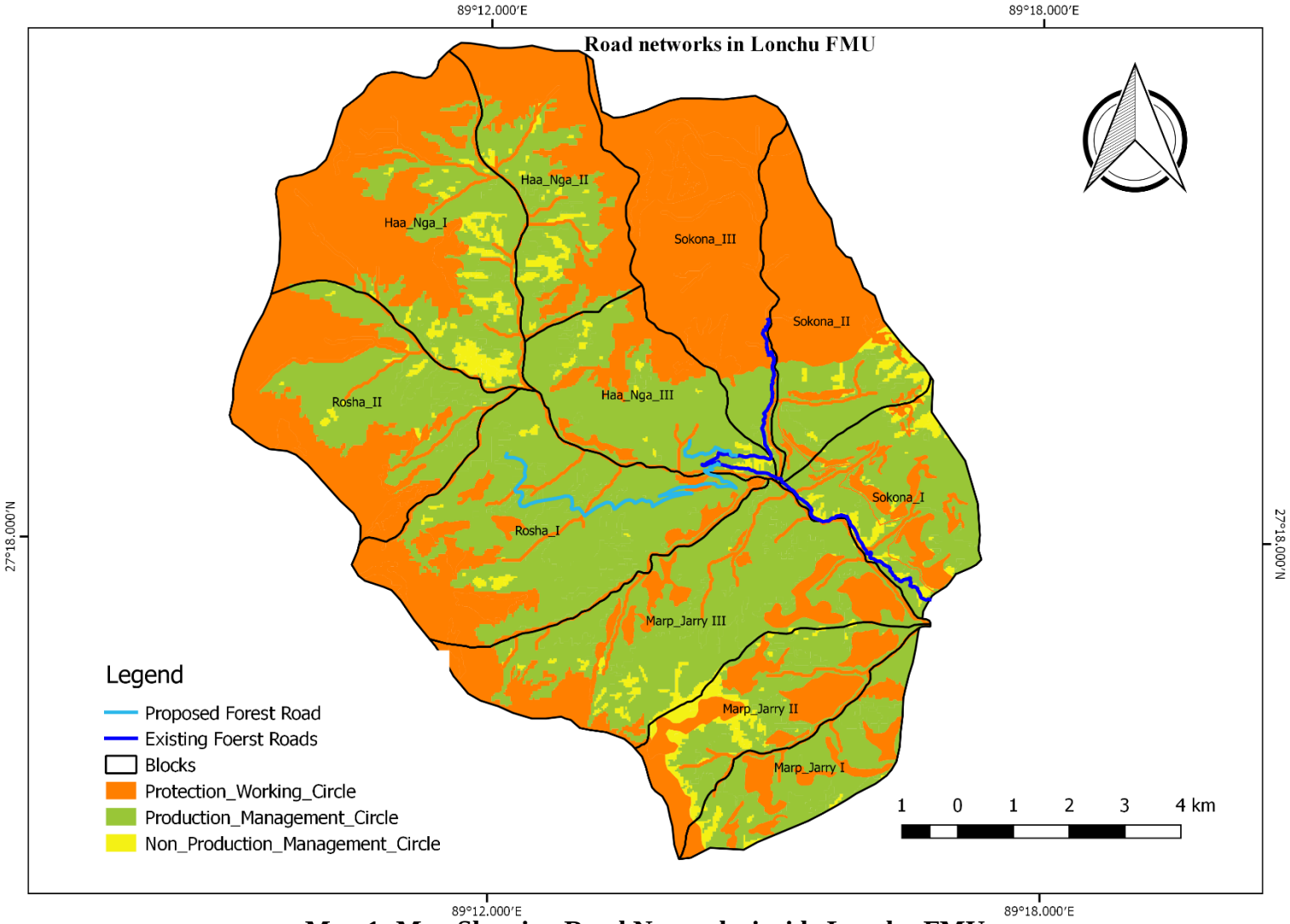
The operations relating to operating to annual coupe should follow the sequence given in following table

Table 3. 1 Sequence of Operation relating to Annual Coupe

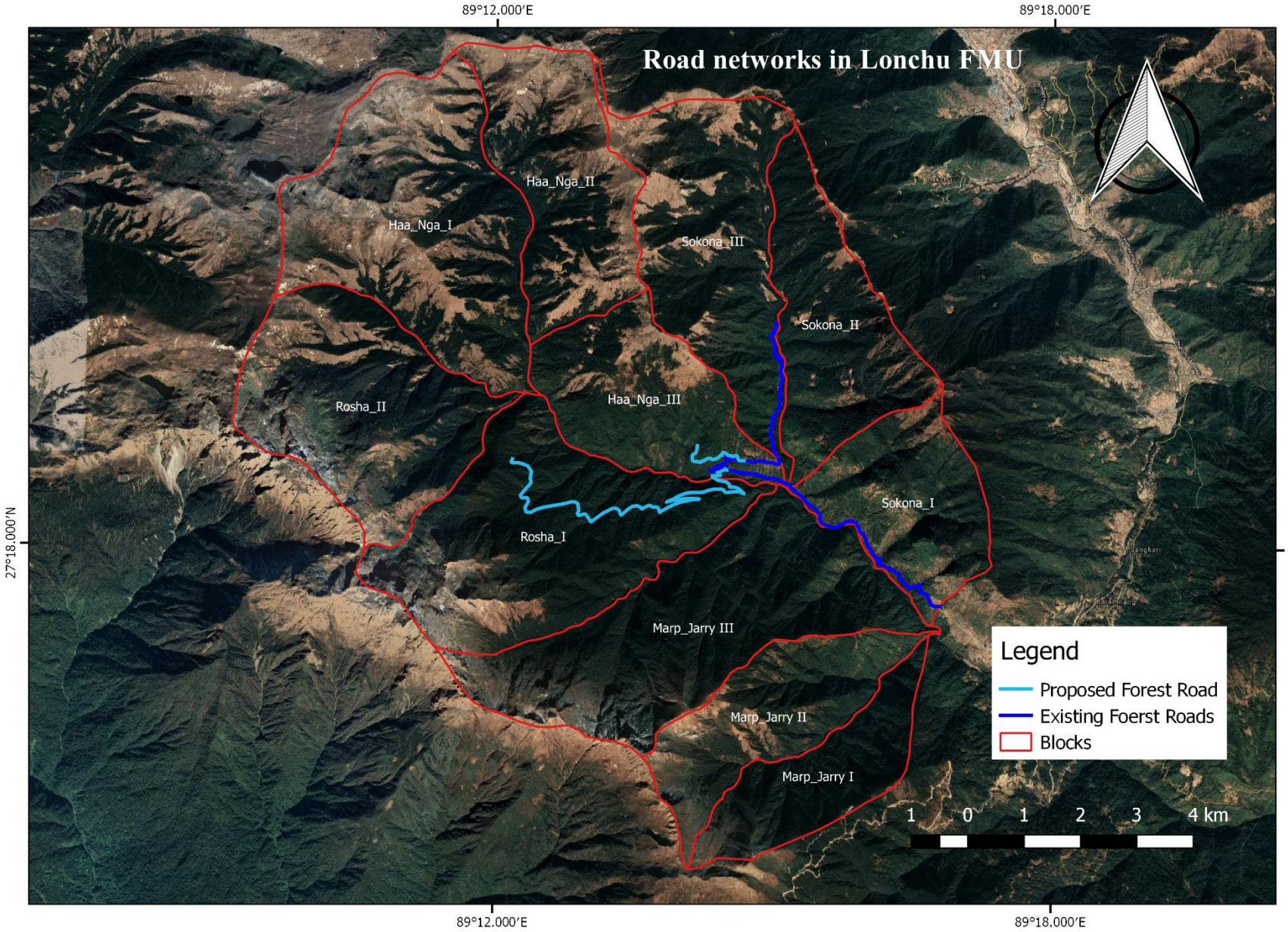
Operation Description	Timing (months) (-before felling; + after felling)
Unit In-charge decides regarding the location and size of annual coupe in accordance with the Biennial Operation Plan	-12
NRDCL and FMU In-charge prepares an estimate of human, material, equipments and financial resources required.	-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 tress 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 coups when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	When works completed
DoFPS asses success of natural regeneration	As per Guidelines
NRDCL completes post harvesting operation	As per Unit In-charge instruction

20.7 Road Construction

Despite the negative impact of forest road on forest and environment, still forms an essential part of managed forest estate, both for timber extraction and to facilitate forest management and monitoring programs. 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 .In this plan period, NRDCL will construct forest road of 10 km at Haa-nga and Rosha block.



Map 1: Map Showing Road Networks inside Lonchu FMU


Road networks in Lonchu FMU
89°12.000'E
89°18.000'E
27°18.000'N
Haa_Nga_II
Haa_Nga_I
Sokona_III
Sokona_II
Rosha_II
Haa_Nga_III
Sokona_I
Rosha_I
Marp_Jarry III
Marp_Jarry II
Marp_Jarry I
Legend
Proposed Forest Road
Existing Foerst Roads
Blocks
1 0 1 2 3 4 km

Road Standards

A set of road standards has been developed by Forest Engineers of TFDP. These road standards, although developed in the East, address policies that are required thorough out Bhutan. These standards will be adopted for Lon Chhu FMU and NRDCL road engineers must follow these standards, given in annex 4, during designing and estimating and provide supervision during construction to ensure that the standards are met.

Road design in Lon Chhu FMU should follow the recommended road profile given in the Figure 3.2 to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may lead to landslide.

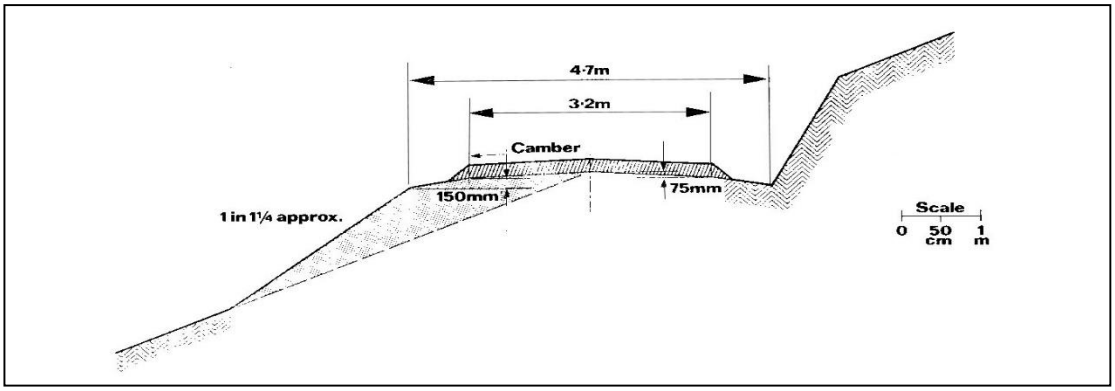


Figure 3. 2 Recommended Road Profile

21. PLANNING

21.1 Operational Plan

For facilitating the timely implementation of the Management Plan, Operational Plan will be prepared by the CFO, Territorial Division, Paro and the Unit In-Charge. Guidelines for preparation of Operational Plan are given in the FMCB (2004) and a copy of each is available at FRMD.

The Operational Plan is also the tool used to provide changes that cannot be foreseen. Such as insect and disease outbreaks, severe fire, developments, etc would happen within the FMU for the interest of nation or local communities. When such unplanned changes are inevitable and happen inside FMU, the current Operational Plan should immediately address methods of operation modified to deal most effectively with possible changes in a sustainable level of harvest.

The Operational Plan is meant to be a rolling one, i.e., Operation Plans are 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. This has important implication of 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 Operation Plan is to determine and co-ordinate the timely input of resources.

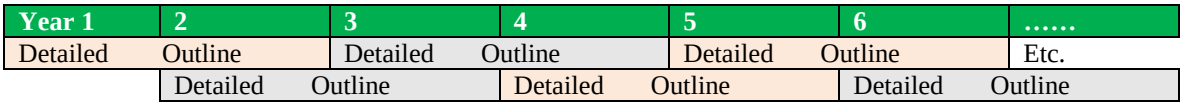


Figure 3. 3 Concept of Rolling Plan

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 before the plan is implemented.

The process for preparing and implementing the Operational Plan is given in the table 3.2.

Table 3. 2 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 To involve relevant stakeholders in planning for activities which have a direct impact in their "interest"	Participatory plan for fire management, grazing management and rural timber harvesting (to be incorporated within the OP)	DoFPs FMU In-charge	First step is to enter into discuss with stakeholders and their representatives 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 Calculation of the harvestable volume	Site-level inventory data for the operational area to be harvested Precise estimate of volume to be removed during the coming year	FMU In-charge NRDCL	For the areas proposed for harvesting during the next two years 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 roading 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 stakeholders for some activities) To formalize local institutional responsibility for planed activities (e.g. grazing, fire management , rural timber distribution)	Approved operational plan with budget Identified responsibilities for each planned activities Calculate cost for each planned activities	FMU In-charge with stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in the FMP Each activity with identified responsibility for implementation, estimated cost, and site-specific location
6. FMU annual report presented to the FMULevel Management Committee	To review progress and identify and address any implementation problems To identify any future actions necessary based on issues arising	FMU Annual report endorsed by FMU Level Management Committee	FMU in-charge presents to the FMU Level Management Committee	During FMU Level Management Committee annual meeting 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	During FMU Level Management Committee annual meeting

	To endorse expenditure estimates for the coming financial year		Management Committee	

Activity (Planning Step)	Objective	Output	Responsibility (lead)	Comments
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 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 FRDD and Director, DoFPS	OP approved linked with sanctioned budget for all planned activities
10. OP implementation by NRDCL	To carry out planed activities	Harvested timber; protected area; roads; fuel wood etc	According to responsibilities identified in the OP e.g. FMU In-charge , NRDCL, DzFOetc	Each activity with specific responsibility and budget
11. Monitoring of activities	To assess the level of achievement of planned activities	Information for FMU annual report	FMU In-charge	DoFPS responsibility is to monitor the implementation of activities carried 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 To highlight any problems being encountered in implementation	FMU Annual report	FMU In-charge	Prepared annually Progress is reported against each FMP objective and the associated activities
13. Prepare the next year's 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

21.2 FMU Level Management Committee

For the smooth implementation of the plan, the FMU-Level Management Committee has been established. The Committee will consist the following members:

- CFO, Paro Territorial Division, Chairman
- FRMD Representative
- FMU In-charge, Lon chhu FMU
- Regional Manager, Rinpung Region, NRDCL
- Gup, Sama Gewog, Paro
- JKSNR Representative
- Production in-charge NRDCL, Haa
- Key Village Elders

Terms of Reference for the FMU Level Management Committee:

A. During FMP preparation;

- To represent the interests of identified stakeholder groups during the planning process for FMP preparation;

- To discuss and agree on FMU forest management objectives for different parts of the forest (zones and working circles), based on national priorities and combined with specific local conditions and local 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 and ensure that their interests are effectively accommodated in the final version of the management plan;

- To review and endorse the draft forest management plan before it is presented to the DoFPS, submitted to NEC and Ministry of Agriculture and Forests for final approval.

B. During operational planning, implementation and monitoring

- To represent the interests of all the identified stakeholder groups during annual planning and review of activities under Operational plans;

- To review achievements during the previous year (based on an FMU annual report submitted by the FMU In-charge) and advice and act on any issues identified in this report;

- To make recommendations for changes to the proposed OP for the coming year based on the previous years' experience and on the need to achieve the agreed objectives in the FMP;

- To endorse activities, priorities and funding arrangements within the draft OP before submission to the DoFPS;

- To hold any additional meetings as required in response to specific issues arising from FMP and OP implementation;

- To participate in the mid-term (5-year) and final (10-year) evaluation of the FMP.

This will require minimum one annual meeting of the FMU-Level Management Committee during each year of FMP implementation with the possibility of further meetings to address any urgent matters arising. Meetings need to be timed to ensure consistency with the annual planning cycle and financial year.

21.3 Staff

The CFO, Paro, is the overall controlling officer of the area. The controlling and management of the Lon Chhu FMU will be looked after by the FMU In-charge. They will be under the administrative control of the CFO, Paro. The CFO is the direct representative of DoFPS in the field and as such he is solely responsible for all forestry activities, both technical and administrative within his jurisdiction.

21.3.1 Responsibility

For the smooth monitoring and implementation of the plan in the FMU, following staff will be required;

Unit In-charge	1
Deputy Ranger	1
Forest Guard	4

The UIC under the guidance of CFO 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 CFO, Territorial Division Office, Paro.

Deputy Ranger 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. Deputy Ranger 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 also be responsible for marking of thinning, fire and pest activities. The forest guards will be assigned to help the deputy ranger.

21.4 Buildings

A unit office for the UIC and his/her subordinate staff will have to be constructed by the Territorial Division, Paro. NRDCL will also have to build an office for the Range manager and his/her subordinate staff to stationed unit staff in the field.

21.5 Vehicles and equipment

For the smooth functioning and implementation of the Lon Chhu FMU management plan, following equipment will be very necessary for FMU during the plan period.

Table 3. 3 Vehicles and Equipments required

Items	Quantity	Items	Quantity
Motor cycle	2 nos.	Walkie-talkie	6 nos.
Computer (desk top)	2 sets	Hypsometer	3 nos.
Laptop	1 set	Binocular	3 nos.
Suunto clinometers	1 nos.	GPS	5 nos.
Suunto Compass	2 nos.	Digital Camera	1 no.
Diameter tapes	5 nos.	Printer	2 nos.
Distance measuring tape	4 nos.	Scanner With Photocopy	2 nos.
Camera trap	5 nos.		

22. 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 FMU, 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, and the second stage checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs on a year to year basis) is the term used for the first stage and evaluation (checking achievements against objectives over five year periods) is the second stage.

The Third Forestry Development Project (TFDP), working closely with the FRMD developed a new monitoring and evaluation process in 1999, for use on FMUs in Bhutan. Different forms were developed on different time scales; **Monitoring Form A** for the annual monitoring process, **Evaluation Form A** for the five year evaluation, **and Evaluation Form B** for the once only Evaluation. The field data collection forms used, consists of **Physical and Financial Forms 1-3, Environmental Forms 4-11** and the **Physical, Financial and Environmental Summary Form.**

The necessary Monitoring and Evaluation Forms is available in the FMCB.

22.1 Monitoring

Monitoring is the examination of whether inputs, activities and outputs are successfully supplied according to the planned schedule. The CFO, Paro, will ensure that monitoring is carried out on an annual basis as per the guidelines issued by FRMD. In the context of FMU implementation, *inputs* includes machinery availability and staff skills and availability, while *outputs* include OP completion, road construction, production of forest produce, and the like.

It is essential that monitoring forms are recorded regularly by FMU and are handed to CFO for review. The plan must be monitored to obtain the best practice of forest management.

22.1.1 Record Keeping

Record keeping and reporting is one of the important tools in this management plan of FMU for sustainability and it has to be maintained throughout the plan period. It is essential that all records of activities and operations within the FMU be maintained so that analysis and investigation of past management can be carried out. Record keeping is the backbone of future management decisions and the importance must be stressed by CFO and FMU in-charge.

FMU should keep detail records of the FMU activities by blocks and compartments, commercial and rural, planned and *ad hoc* separately in the data base of FMU by not only following all the recording forms recommended in the FMCB, but also by maintaining additional data and information. Records related to forestry activities should be updated until end of the plan period and produce a copy for office record. Data collection must also focus on people-not on trees alone since we need to improve our understanding of the people who live in and around forests to measure the importance of forests on social aspects. This would ensure recording and maintaining correct and consistent annual records of FMUs and facilitate mid-term and final evaluation of FMU.

The guidelines to complete and fill in the forms; one for Rural Allotment, one for Commercial Allotment and one for Stand Tending and Regeneration activities are available in FMCB, 2004 or in Territorial Divisions, Paro, and FMU office.

22.1.2 Reporting

FMU In-Charge should keep FMU records in the standard format recommended in the FMCB and any format circulated by the Territorial Division and the DoFPS and follow the timeframe for the submission of required information. Any amendments of record through validation should be apprised to CFO, Paro for similar correction and update.

FMU should be able to furnish any kind of data or record to CFO and to the DoFPS at any time and data maintained in any form should be consistent to each other. Required records for mid-term and final evaluation should be made readily available to the evaluation team.

22.2 Evaluation & Compliance

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

The Head, FRMD and CFO, Paro, 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 obtained from the Territorial Division, Paro, or from FRMD. However, the detailed forms are there in the FMCB for evaluation.

Staff that are independent of field activities will carry out the evaluation. The evaluation team will be constituted by the Head, DoFPS (minimum five members). The team composition for evaluation of BFMU would comprise of the following members from:

FRMD (leading agency)
Policy and Planning Division, MoAF
CFO, Territorial Division (not from same Division)
NRDCL Regional Manager (not from same Division)
RNR-RDC Forestry
Local Government

22.2.1 Mid-Term Evaluation

The Mid-Term Evaluation of FMU will take place during the last quarter **(April-June) of the fifth year (2024)** of the FMP period. Team will evaluate implementation of FMU activities based on the required forms and field observation. Observations with suggested recommendations will be provided to FMU and Territorial Division Office, Paro, for implementation.

CFO and UIC will implement the recommendations and advices of the evaluation team and submit compliance report. Recommendations would be in achievable in shortterm and longterm. However, the Department will provide sufficient time to implementers to implement the recommendations based on their nature of issues and time required.

The findings of mid-term evaluation should be communicated to the FMU Level Management Committee during their annual meeting by the CFO, Paro.Develop action plan based on the recommendations and address by proposing in the cycle of fiscal year of the Government and then into the operational plan. CFO should submit compliance report to the Department for perusal and record.

22.2.2 Final Evaluation

Final evaluation is to take place during the last quarter **(April-June) of the ninth year (2028)** of the FMP period. The evaluation team will evaluate FMU activities and specify corrective actions, if necessary, and who should carry out.

FMU and NRDCL will implement recommendations and submit compliance report to the Department through Division. The Territorial Division Office, Paro, and NRDCL will be given sufficient time for implementation based on the nature of issues and recommendations. The final evaluation should directly inform the preparation of the FMP for the subsequent 10 year period.

CFO should communicate findings and recommendations of the evaluation to the FMU Level Management Committee during their annual meeting. Develop action plan and address by proposing in the operational plan. The CFO should submit compliance report

to the Department of Forests and Park Services for perusal and record. The recommendations of the evaluation should be incorporated in the next planning period.

23. CONSTRAINTS AND RISKS

The possible risk and constraints in smooth implementation of the management plan are:

- Inadequate funds for forest management
- Uncertainty of natural regeneration, due to excessive grazing and undergrowth competition
- Lack of research information
- Lack of skilled and trained forest workers
- Lack of sufficient support to UIC
- Poor coordination between field and office staff and between involved parties

Forest Management Plan relates to multiple uses of forest resources. Increasing benefits of one type may impair or damage others. For instance, timber management may lead to underproduction of non-wood forest products and degradation of bio-diversity. For effective assessment, not only the production function, demand and price structure of each product need to be understood, but also the relationship and conflicts of resource use should be fully comprehended.

24. DEVIATIONS FROM PLAN PRESCRIPTION

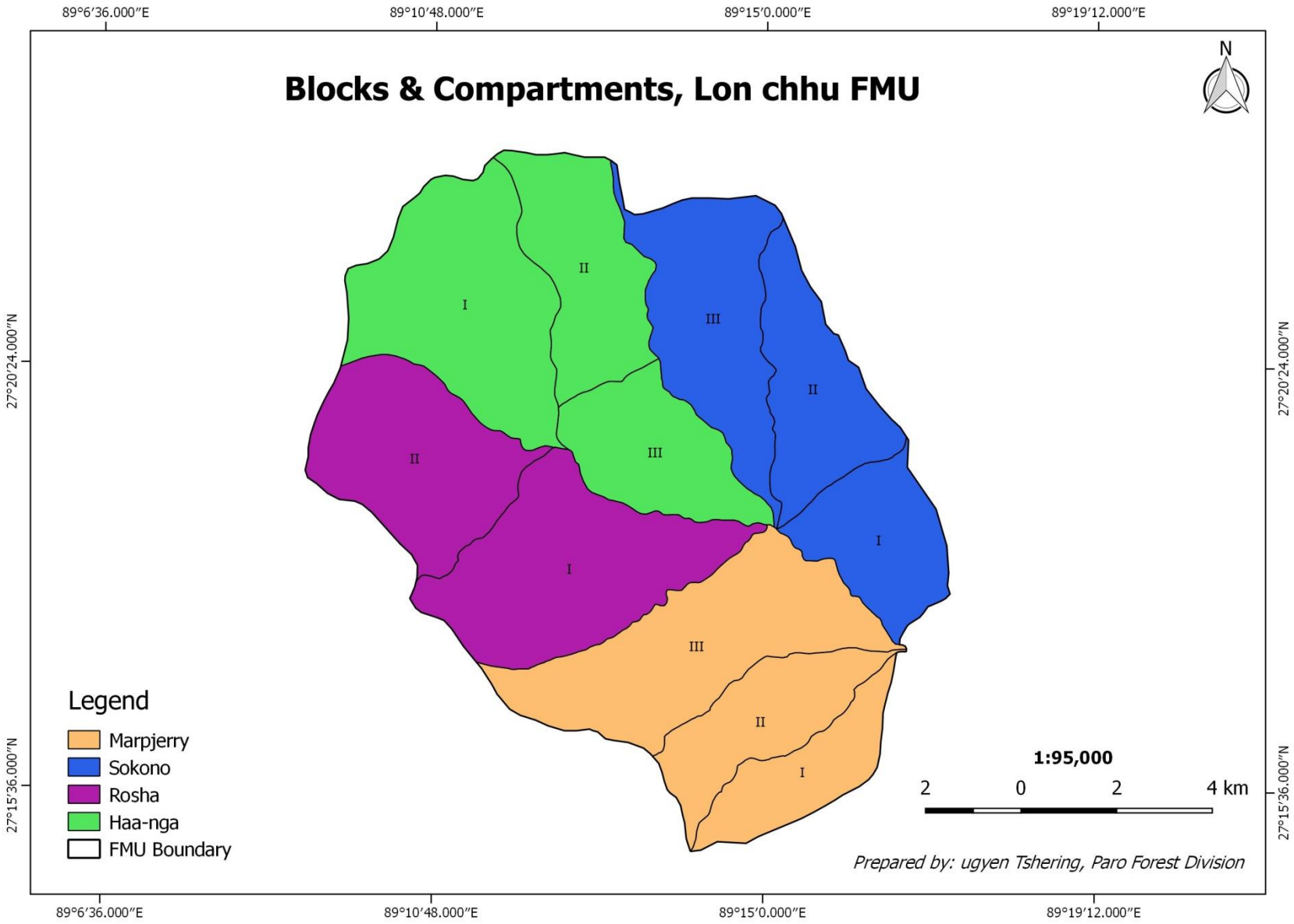
The annual harvested AAC should be made to allow for unforeseen situations. For these and other bono fide reasons, the annual AAC may vary +/- 10%. However, the total volume harvested over successive five-year period must be no more than five times the ACC volume.

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

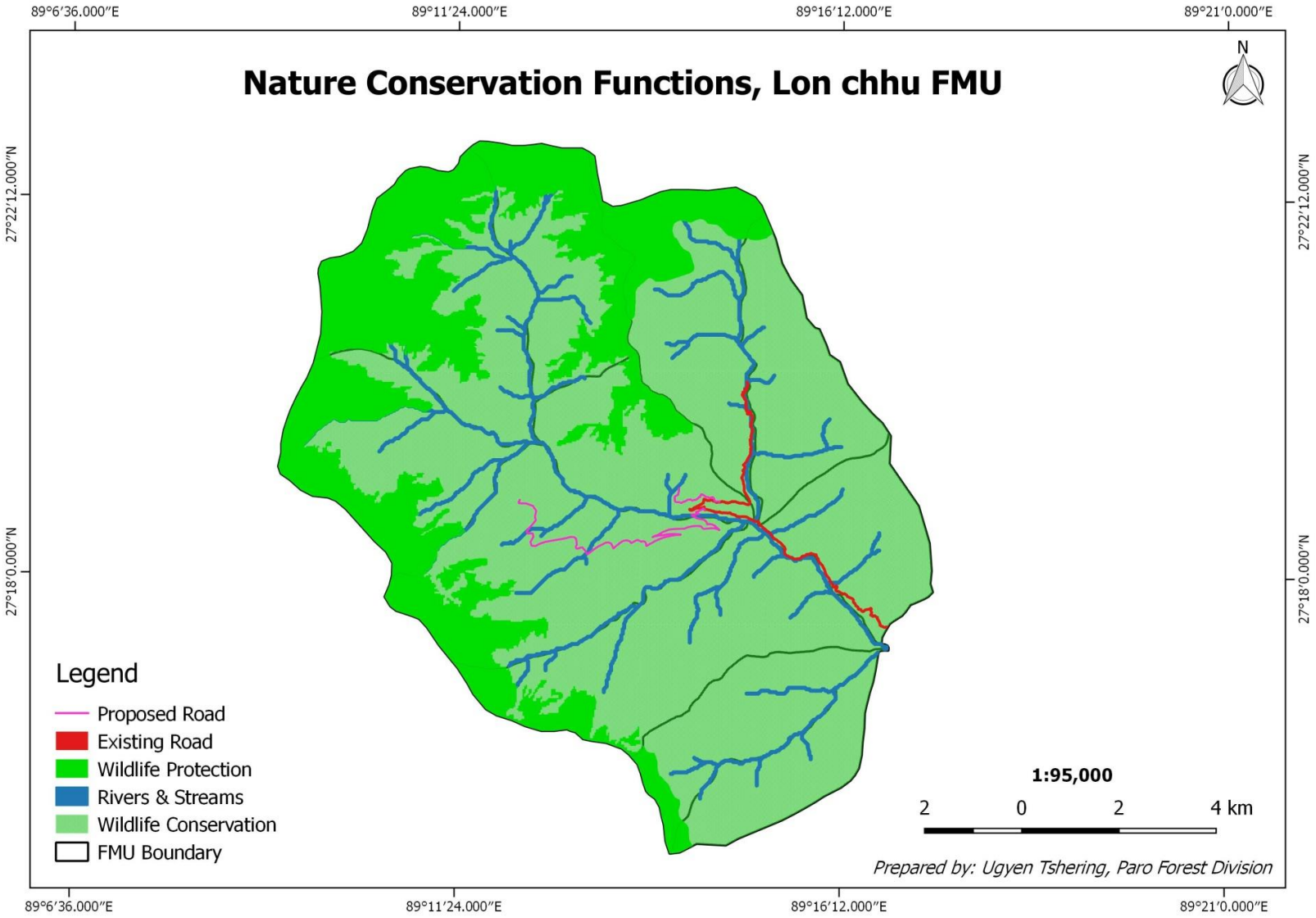
25. REFERENCES

NEC (1999). Bhutan Environment Assessment Sectoral Guidelines
DoFPS, MoAF (2004). Forest Management Code of Bhutan.
RGoB, MoAF (1995). Forest and Nature Conservation Act of Bhutan, 1995. Thimphu
RGoB, MoAF (2011). National Forest Policy of Bhutan.
NEC (2000). Environmental Assessment Act.
RGoB (2011). The Water Act of Bhutan.

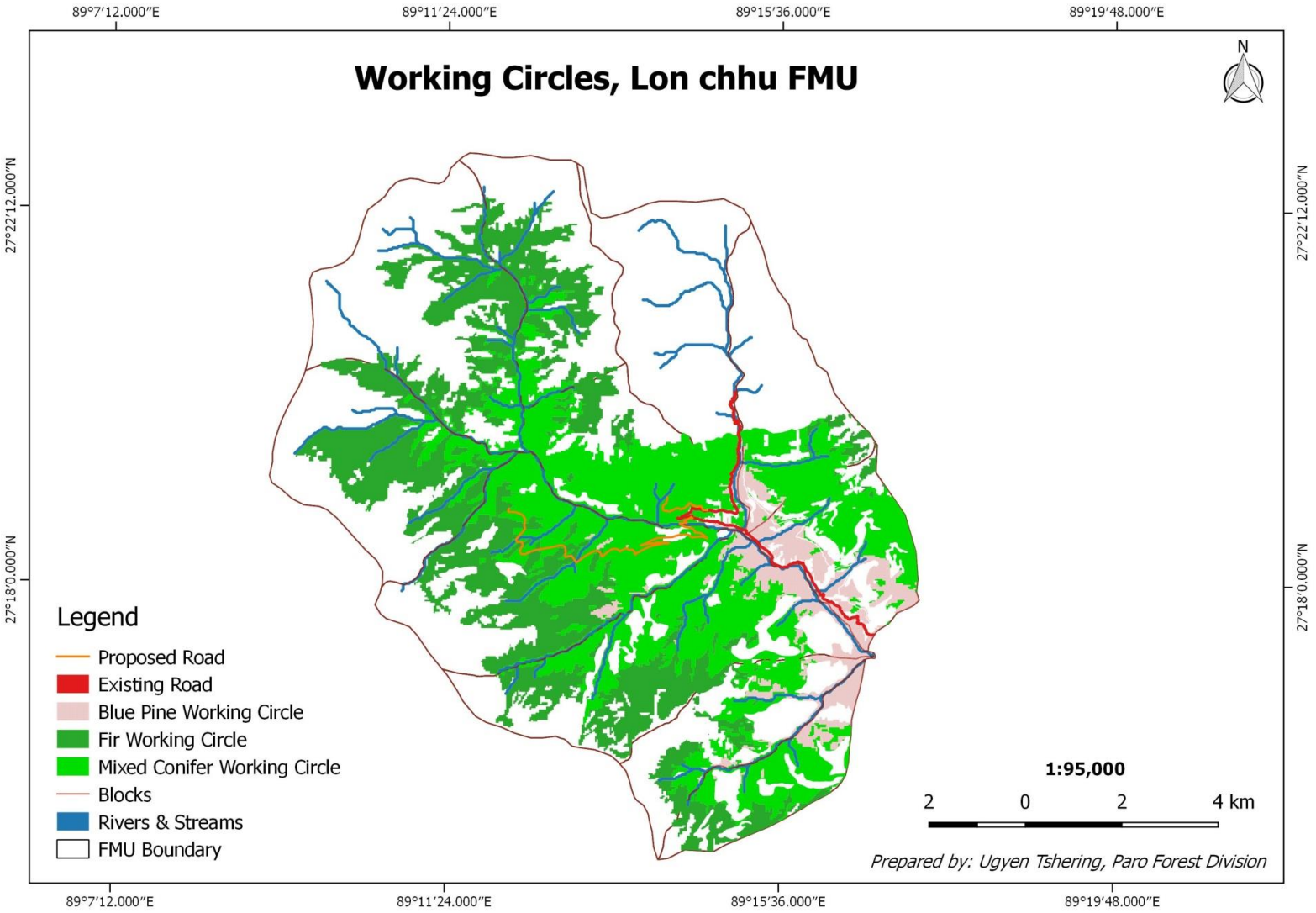
Map 1. 3 Block and Compartments of FMU



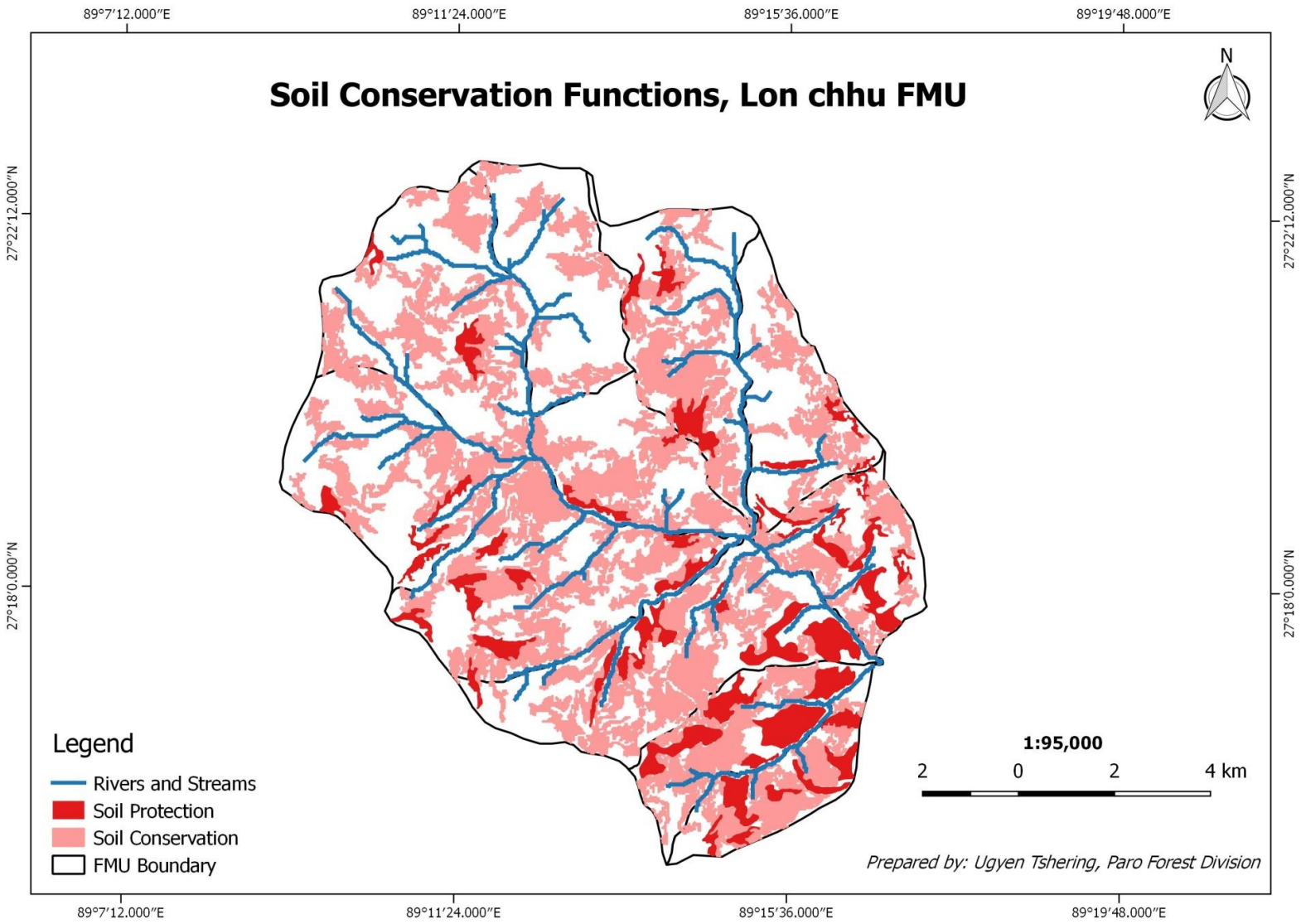
Map 1. 4 Nature Conservation Functions



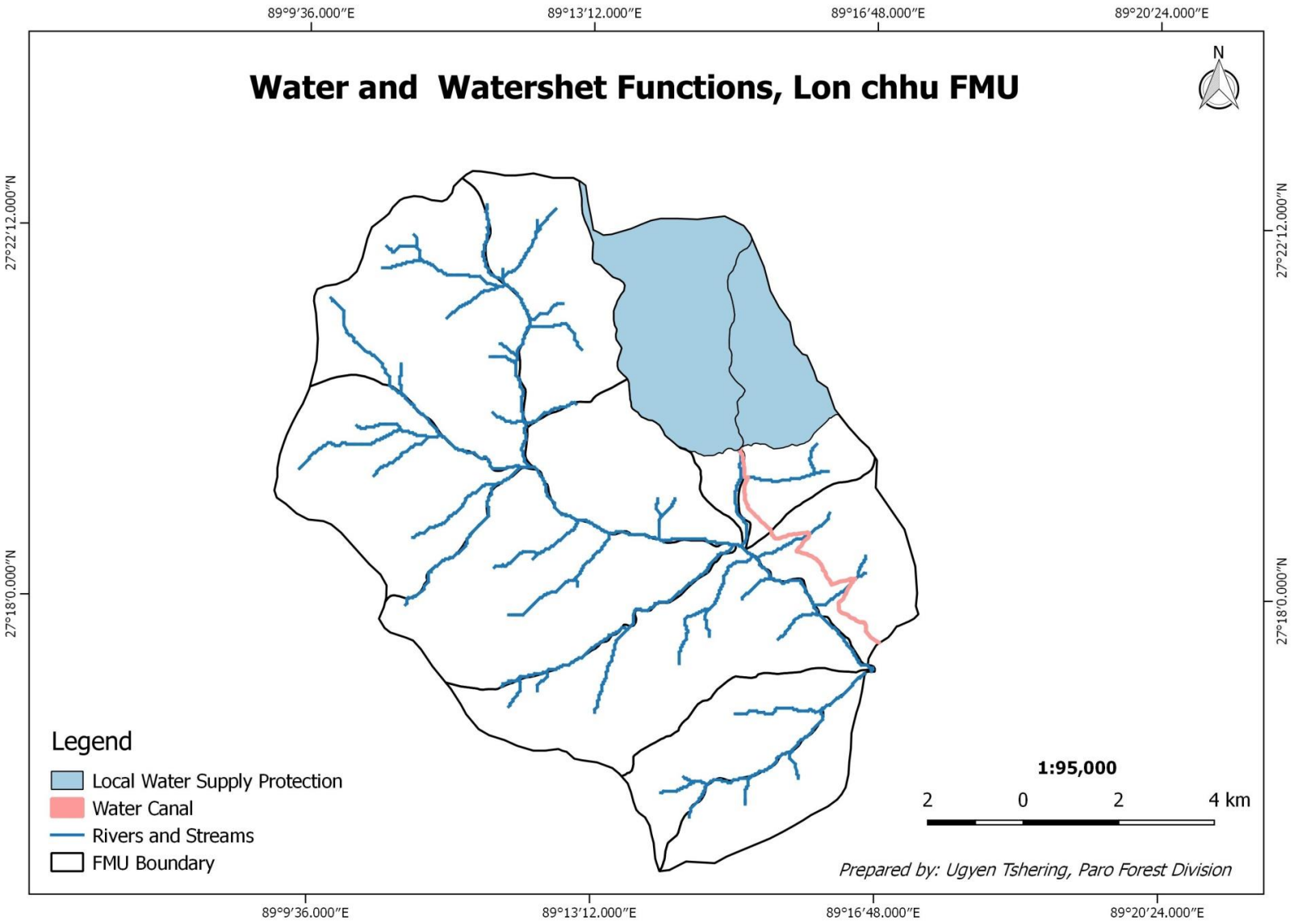
Map 1. 5 Production Working Circles



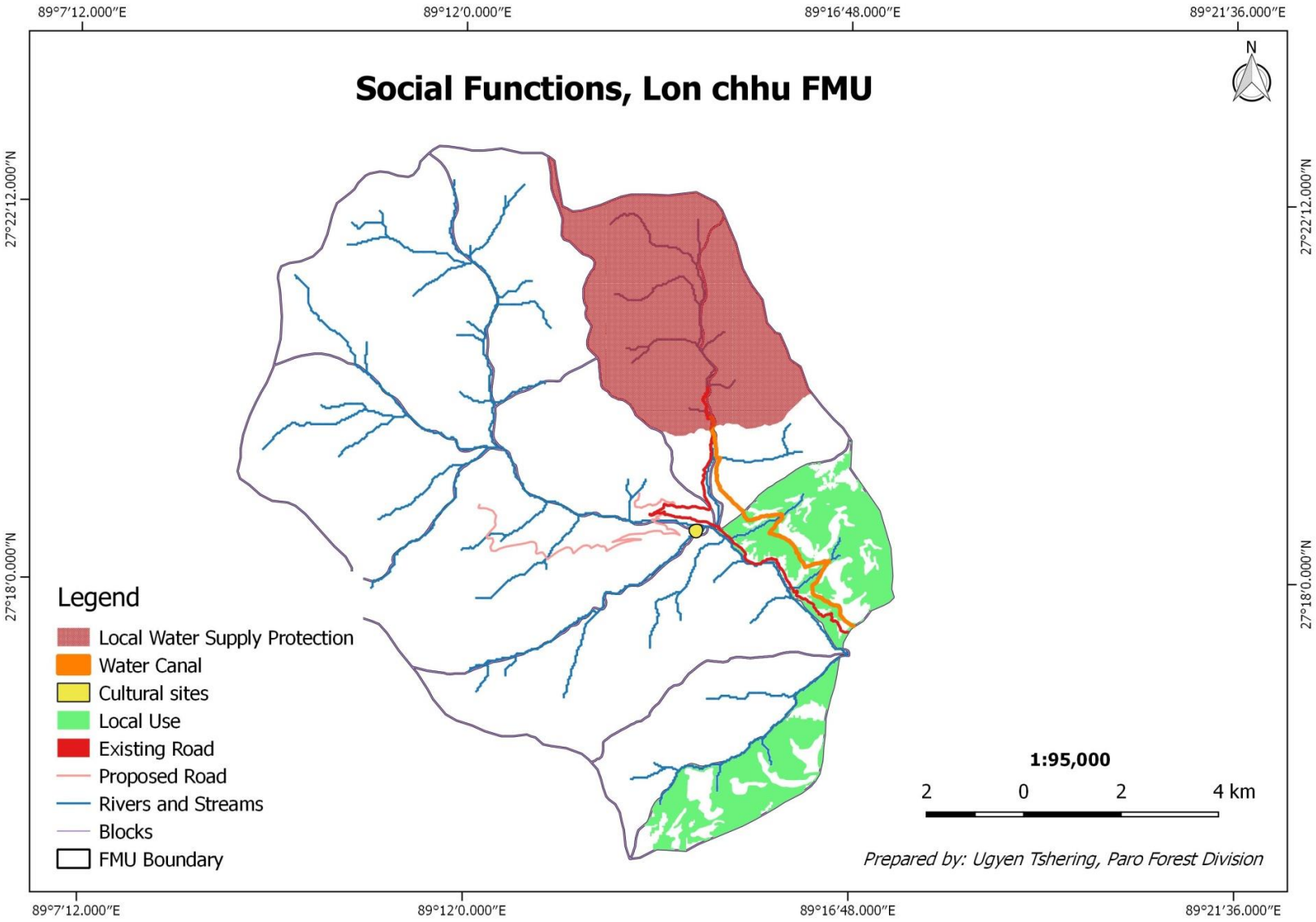
Map 1. 6 Soil Conservation Function



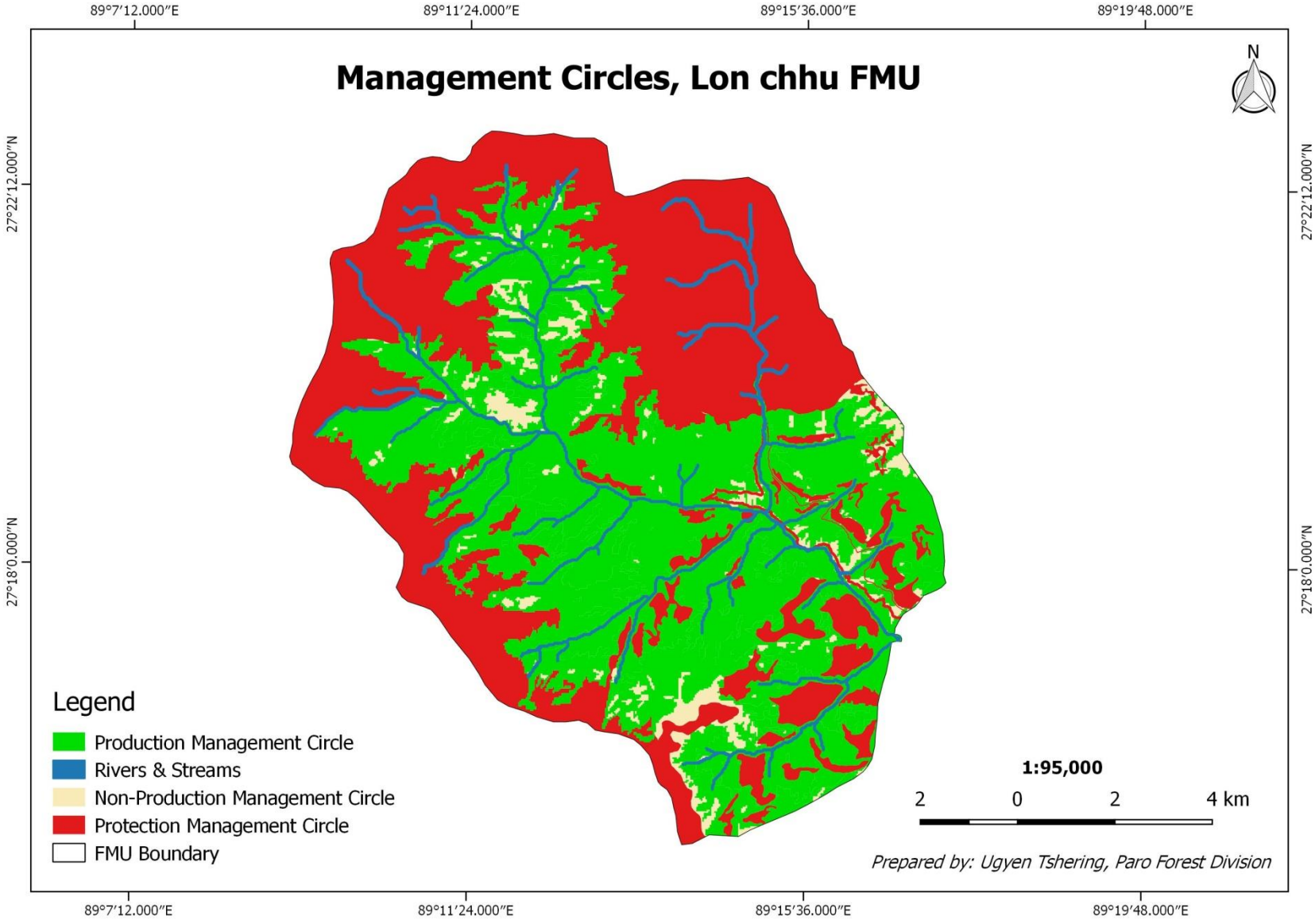
Map 1. 7 Water and Watershed Conservation Function



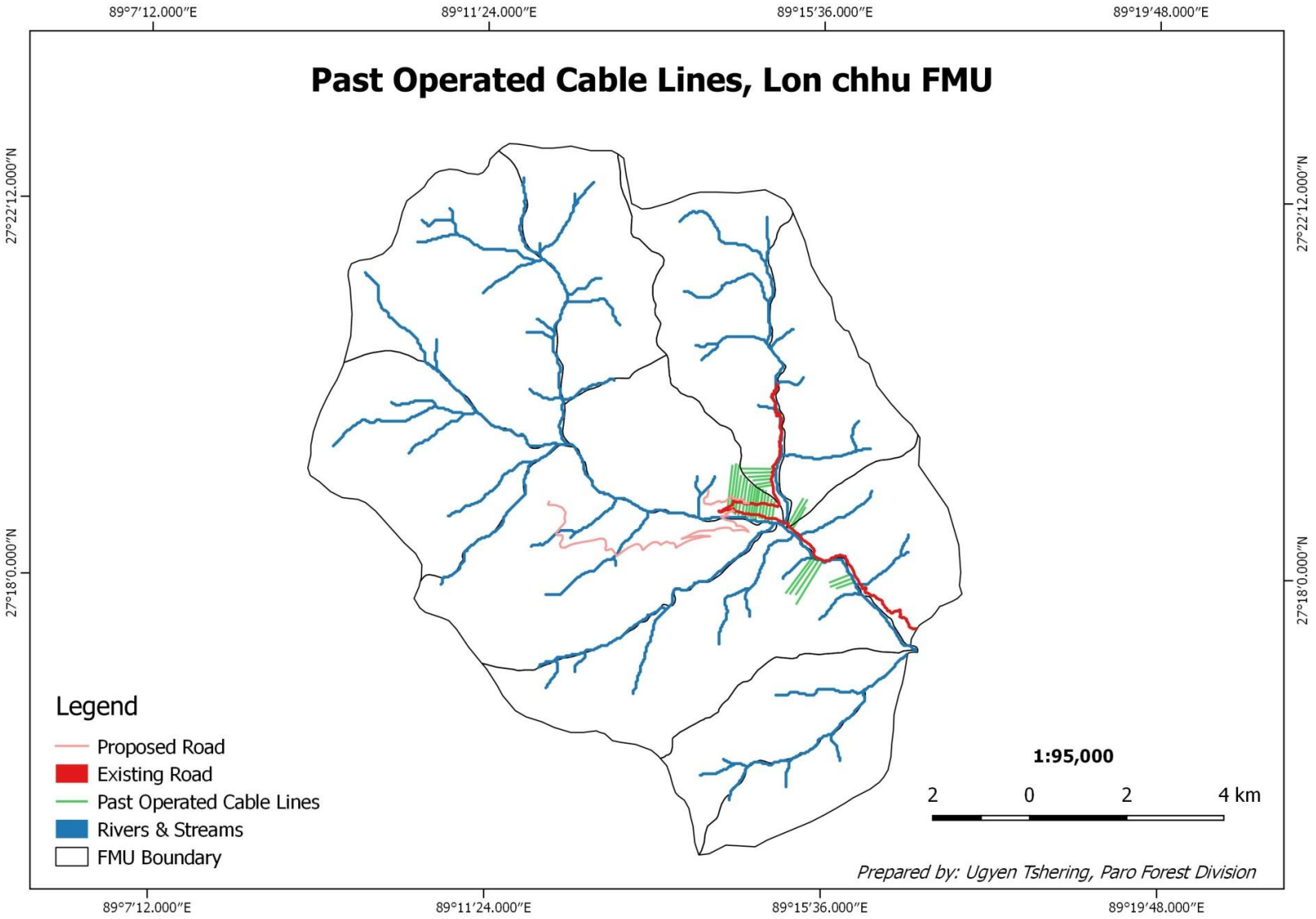
Map 1. 8 Social Function



Map 1. 9 Management Circles



Map 2.0 Harvested Cable Lines of FMU



Annexure
Annex 1. Compartment Description and Prescription

Block: Marpjerry Compartment: I

Altitude: 2600 m – 4031m
Aspect: Northern
Terrain: Moderate to steep
Total area: 613.94 ha
Protection: 182.44 ha
Non-production area: 20.16 ha
Production area: 411.34 ha
Note: *Function likesoil conservation, wildlife protection and non-forest overlaps*
.

Forest description
This compartment comprises mixed conifer of about 35%, fir (19%) and about 13% blue pine stand. The main species that are found in this compartment are Blue pine, Spruce, fir, Oak and other miscellaneous species. Except for that fir stand, all other timber species are of middle aged. Most of the Blue pine and Spruce at the lower altitude are of young age. The uppermost part of this compartment is quite steep and devoid of any tree cover. In past management, no timbers have been allotted from this compartment.

Prescription
A small ridge forms the common boundary between Selelaand Lon-chhu FMU. This compartment being very close to the settlement, people might place demand from this compartment. Thus, this compartment will be used for meeting the rural timber demand in this plan period under Single Tree Selection System. However, priority should be given to Samagewog for resource allocation.

Block: Marpjerry Compartment: II

Altitude: 2600m – 4360m
Aspect: South and South-East
Terrain: Moderate to steep
Total Area: 794.48ha
Protection: 353.32 ha
Non-production: 97.28 ha
Production: 343.87 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
Forest type within the production circle consist mixed conifer forest with 22%, about 13% of fir and 8% blue pine forest. The uppermost part of this sub-compartment is devoid of and tree cover. The primary timber species that is present in this area are Spruce, Blue pine, fir and many other miscellaneous species.

Prescription

This compartment will be used for commercial harvesting under Group Selection System in this plan period.

Block: Marpjerry Compartment: III

Altitude: 2640m – 4360m
Aspect: Northern and North-Eastern
Terrain: Moderate to steep
Total area: 1670.51ha
Protection: 521.23 ha
Non-production: 53.44 ha
Production: 1095.84 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
The main composition of the species is mixed conifer with 34%. The remaining forest types area fir (23%) and 8 % blue pine within production forest. The uppermost portion of this compartment is devoid of any vegetation cover and during most of the seasons, this portion remains under snow cover. The vegetation is characterized by fir grown at the higher elevation followed by Spruce and then Blue pine mixed with Spruce and Oak.

Prescription
This compartment will be used for commercial harvesting under Group Selection System in this plan period.

Block: Rosha Compartment: I Sub-compartment:

Altitude: 2750m – 4645m
Aspect: North-Eastern
Terrain: Moderate to steep
Total area: 1673.34 ha
Protection: 747.67 ha
Non-production: 19.14 ha
Production: 906.53 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
This compartment consist all three forest type with mixed conifer (36%), fir forest (17%) and blue pine (1%). The bank of the rivers at the lower elevation is characterized by the mixture of Spruce, Blue pine, Oak and some Acer species.

Prescription
This compartment will be used for commercial harvesting under Group Selection System in this plan period.
Block: Rosha Compartment: II Sub-compartment:

Altitude: 3130m – 4613m
Aspect: Eastern and North-Eastern
Terrain: moderate to steep
Total area: 1330.41ha
Protection: 714.76 ha
Non-production: 16.93 ha
Production: 598.72 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
This compartment is dominated by fir forest with 38% and only about 7% is mixed conifer forest within the production working circle. The mountain peak of this compartment remains under the permanent snow cover throughout the year. Scattered and matured fir stand is present just below the snow line and other conifer mixed with Oak and Acer species are found as we descend the mountain. The glacial present in this compartment is one of the sources of Lon Chhu (river) which supports various aquatic lives and form one of the tributary of HaaChhu (river).

Prescription
This area will be subjected to commercial harvesting under Group Selection System only only at the lower belt. Upper belt will be preserved as the habitat for musk deer and other fauna and avi-fauna species.

Block: Haa-nga **Compartment: I** **Sub-compartment**

Altitude: 3171m – 4689m
Aspect: South-Western and North-Eastern
Terrain: moderate to steep
Total area: 1684.42 ha
Protection: 1037.17 ha
Non-production: 120.15 ha
Production: 527.10 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
The main forest type within the production area of this compartment is fir with 26 % and remaining 5% is mixed conifer forest. The area is covered with some alpine grasses during the summer and in most of the seasons this area remains under snow cover. The tree species that are found in this compartment are matured Fir, Spruce, Juniper, Larch, Rhododendron, Birch and some Acer species at the bottom of the valley.

Prescription
Prescribed for commercial harvesting under Group Selection System can be carried out at the bottom of the valley but rest of the area will be kept aside for animal protection.

Block: Haa-nga **Compartment: II** **Sub-compartment**

Altitude: 3290m – 4318m
Aspect: Western
Terrain: Moderate to steep
Total area: 1027.14ha
Protection: 576.03 ha
Non-production: 49.35 ha
Production: 401.76 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
About 31% of the production area is fir forest and remaining 8 % is only mixed conifer forest. The principle tree species are Fir, Spruce, Larch, Juniper, Birch, Maple, Rhododendron and other miscellaneous species.

Prescription
The production area for this plan period will be used for commercial harvesting under Group Selection System. Upper portion of this compartment will be strictly reserve for faunal protection.

Block: Haa-Nga **Compartment: III** **Sub-compartment**

Altitude: 2750m – 4000m
Aspect: Southern and South-Western
Terrain: Moderate to steep
Total area: 882.41 ha
Protection: 233.19 ha
Non-production: 28.64 ha
Production: 620.59 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
Only about 11% of the forest within the production area is mixed conifer. The uppermost portion is without any tree cover and this portion is usually used by herders to browse their cattle and yaks. The tree species found in this compartment are Spruce, Blue pine, Fir, Juniper, Larch, Maple, Birch, and many Rhododendron Species.

Prescription
This compartment will be used for commercial harvesting under Group Selection System.

Block: Sokono **Compartment: I** **Sub-compartment**

Altitude: 2600m – 3840m
Aspect: South-Western
Terrain: moderate to steep

Total area: 780.66 ha
Protection: 199.97 ha
Non-production: 66.14 ha
Production: 514.55 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
This compartment is very adjacent to the village called Langpaand Nobgangand the settlement intersects with the boundary of Lon Chhu FMU. Local people have been using the forest that lies within this compartment for their daily livelihood. The timber species that are found in this compartment are Fir, Blue pine, Spruce, Oak and other miscellaneous species. The forest within the production working circle of the compartment is 38 % mixed conifer forest, 26 % Blue pine stand and 2 % fir forest.

Prescription
The forest of this compartment have been using by the local inhabitants for their daily livelihoods. Beside this, the drinking and irrigation channel passes through this compartment and community people of nearby FMU and Sama gewog are responsible for protection of the channel. Therefore, to avoid any damage to channel through timber harvest by community outside Sama gewog, rural timber and forest resources will be given only to community people of Sama gewog in this plan period by FMU. Any damage to channel through timber harvest should be responsible for community people of Sama gewog.

Block: Sokono **Compartment: II** **Sub-compartment:**

Altitude: 2750m – 3800m
Aspect: Western
Terrain: Moderate to steep
Total area: 932.35 ha
Protection: 367.45 ha
Non-production: 45.92ha
Production: 518.98 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest Description
Since there is presence of outlet for drinking and irrigation channel in this compartment and compartment serve as important catchment area for water resource, about 550.59 ha has been delineated as catchment area in this plan period and will be under protection working circle. Negative impact on water resource and channel through construction of forest road and timber harvest have also been raised by the Dzongkhag Administration of Haa vide letter No.DAH/ENV(03)2018-2019/3176 dated 19 December 2018. Therefore, in this plan period, only 20 % of mixed conifer forest, 4 % blue pine and 4 % fir forest will be subject for harvest.

Prescription
This compartment will be used for commercial harvesting under Group Selection System in this plan period. However, NRDCL and FMU should ensure no damages to the channel.

Block: Sokono **Compartment: III** **Sub-compartment:**

Altitude: 2750m – 4680m
Aspect: Eastern
Terrain: moderate to steep
Total area: 1274.83 ha
Protection: 1181.28 ha
Non-production: 0.70 ha
Production: 92.86 ha
Note: *Function like soil conservation, wildlife protection and non-forest overlaps*

Forest description

In this plan period, about 1155.06 ha have been delineated as catchment area for drinking and irrigation water source. The area was delineated as per public consultation and issue raised by the Dzongkhag Administration on negative impact on water resource through forest road construction and timber harvest. Therefore, in this plan period, only about 93.24 ha have been prescribed for production of timber, and in this area, about 39% of the production area is mixed conifer forest and 27 % of fir and 1 % blue pine forest.

Prescription
This compartment will be used for commercial harvesting under Group Selection System in this plan period.

Annex 1 Road Standard

Road Standards

As stated before, the road standards developed in the east by TFDP will be implemented for design, drainage and construction of all forest roads in the Lon Chhu FMU. Following are the standards:

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 as to balance cut and fill 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 work commencing.
- 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 300 m), 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 centre line 30cm higher than the edges.
- Stabilize and revegetate 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. Roads should not be constructed in areas, which are prone to flooding in the monsoon seasons. In areas where side slopes of 70% or greater extend for a distance of 100 m 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 40 cm deep and 65 cm 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 30 cm) 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 erodable material then the distance between the culverts must by reduced by 50%.

Road gradient %	Distance between culverts (metres)
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 700 mm 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 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 50 m in erodable soils and must be cleaned regularly.

Road Construction

All trees above 10 cm diameter should be felled and removed from the road alignment and standing volume removed from these trees must be accounted into AAC for the particular operation yea and update in the operational plan by FMU. 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 stabilise 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 favourable 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.

Annex II: Environmental Impact Assessment of Forest Road

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT LONCHU FMU, HAANGA BLOCK, HAA 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. J.K.Nepal, Sr. Engineer, Forest Resource Division, NRDCL HO, Thimphu. Tel. no. 02-323834/323868. Email: jk.nepal@nrdcl.bt

5 Project objectives : Timber harvesting & afforestation of harvested areas

6 Relevence to overall planning : Revision of Forest Management Plan

7 Funding and costs : Funded by NRDCL, Thimphu
Nu. 4,500,000.00

8 Project description

8.1 Project location : From 27°18 '49.41" N, 89°14' 41.04" E to 27° 18' 58.11" N, 89° 14' 10.28" E

Table 1: Road location details by Dzongkhag and Geog (Haa Nga block)

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 1500	Haa	Samar	None	None

8.2 Category of road : Access 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	1,575.00
Volume of excavated material		
a) Excavation in soil all type	cum	3,755.08
b) Excavation in rock all type	cum	5,792.69
Average road gradient	%	±6
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	3
Bridges	no	NIL
Total length of bridges	m	
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	cm	1,496.00
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:

Sl. No	Particulars	Quantity		
1	Safety fuse	180 coils	(Approx)	
2	detonator	315 Nos.	(Approx)	
3	D-chord	255 m	(Approx)	
4	Jelatine	405 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 + 1+500	1,500.00	10 -120	Paro formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		1,500.00			

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+376	N A	Hume pipe culvert	NIL	NONE	NIL	NONE
0+376 + 0+477	N A	Hume pipe culvert	NIL	NONE		
0+477 + 1+376	NA	Hume pipe culvert	NIL	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	1 + 500	Mixed conifer forest	15,000.00	2 years	NIL

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	Tenure/ownership	Remarks
Labour camp	Mixed conifer forest	2000 per annum	Govt. reserve forest	Till project completes
Others				

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

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	8 + 500	Mixed conifer forest	850,000.00	8 years	NIL

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	Tenure/ownership	Remarks
Labour camp	Mixed conifer forest	2000 per annum	Govt. reserve forest	Till project completes
Others				

12.2. Protected area : The protected areas such as Soil protection, local water supply protection, Reparian protection, Wild life protection etc. shall be identified 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)
Haa	Samar	None

Source of information: as per attached No Objection letter of the Gup, Samar 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. 85,000.00 (Lumpsum)
House	NIL	NIL
Infrastructure	NIL	NIL

14.1. Monitoring Program

Monitoring of the construction works will be done by Site supervisor, Lonchu Unit, NRDCL, including time to time monitoring by the Unit Manager, Lonchu Unit under Rinpung Regional Office, Thimphu. The Regional Manager, Thimphu Regional Office, NRDCL Thimphu, 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.

(J.K. Nepal)
Sr. Engineer
Forest Resource Division, NRDCL HO

ENVIRONMENTAL MANAGEMENT PLAN FOR CONSTRUCTION OF 10.00KMsFOREST ROAD AT LONCHU FMU UNDER RINPUNG REGIONAL OFFICE, NRDCL, THIMPHU, HAA DZONGKHAG.

Sl. No.	Activity	Potential Negative Environment Impact	Mitigation Measures	Public Participation and Coordination	Socio-Economic and cultural considerations	Budgeting	Supervision	Monitoring
1	Work camp location, operation & closure, restriction on workers (sanitation, fuel wood collection, poaching etc.)	• Garbage, oil & grease pollution Damage to vegetation & wildlife	• Provide sanitary facilities and restore • Provide fuel to workers	• DoF&PS • Awareness of labours	• Consider local culture and compensate, if required	• Incorporated	• Unit Manager • Site supervisor	• Regional Manager • Engineer, NRDCL HQ • External team
2	Explosive & toxic waste management	• Fire & explosion hazard • Ground & surface water pollution	• Do not store near surface water • Use plastic sheeting under hazardous material • Collect waste properly & dispose off safely	• Contact Ministry of Home & Cultural Affairs in case of hazard or needing material innihilation	• Consider local drinking water sources	• Incorporated	• Unit Manager • Site supervisor	• Regional Manager • Engineer NRDCL HQ • External team
3	Water Management	• Sedimentation of surface water • Slope failure • Creation of new gullies • Water seepage	• Build check dams • Tap excess water by catch drains and dispose off to natural gullies	• Involve locals when deciding about discharge location • Dzongkhag administration	• Irrigation channel and drinking water supplies need consideration	• Will be incorporated if required.	• Unit Manager • Site supervisor	• Regional Manager • Engineer NRDCL HQ • External team

(J.K. Nepal)
Sr. Engineer
Forest Resource Division, NRDCL HO

Annexure: 3 Tree Marking Guidelines

Marking guidelines for the group selection system

The group selection system aims 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 favourable 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 groups spaced at specified interval will be harvested removing all tress over 10 cm DBH.
- The group will be located along extraction lines
- The distance between the extraction lines will be no less than 60 m.
- The distance between the groups, along the extraction lines, will be less than 50 m.
- The shape of the harvested groups 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 groups.
- 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 tress must surround the selection groups. 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; 2-4 m in the fir stands and no wider than 4 m in the Spruce and mixed stands.
- The maximum size of the groups will be on an average less than 0.15 hectares 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 as opening.
- Boundaries of opening should, where possible corresponds to change in slope. An 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 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 economical value will not be harvested; it will be left for preserving biodiversity.

Marking guidelines for the single-tree selection system

Felling under the single-tree selection system should be done in accordance with the following guidelines:

- Trees marked for harvesting will be evenly distributed throughout the stand.
- Diseased, malformed, dead and decaying trees will be marked on a priority basis; especially these are hampering the better ones (unless objectives of biodiversity conservation dictate otherwise). These trees can be marked even if below the set diameter limit of 50 cm. however, care should be taken that no large openings are created in the stand by marking these trees.
- Trees of exploitable size should be marked, particularly if defective or lacking in vigor; mature and over-mature trees over 50 cm DBH outside bark to be marked.
- No more than one third of the stand volume should be marked for harvesting.
- In mixed stands, an even and suitable distribution of species should be left standing.
- Fruiting trees and some hollow trees which will have less economical value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines forBlue pine under Seed Tree System

- The seed tree system is used in pure pine stands or missed stands consisting of mixture of pine and Spruce with pine predominating.
- The Seed Tree System will be used in the above stands only on suitable sites.
- The system will not be used on steep and exposed, South or South -West sites.
- In mixed stands an equal distribution of pine and Spruce will be left standing
- Slope characteristics, wind firmness and aesthetic value will be considered.
- About 20 to 25 trees per hectare (i.e. approximately 22 to 26 meters apart) will be left standing.
- Diseased, malformed and dying trees will be cut on priority basis.
- Trees left standing will not be oldest or tallest in the stand. Over mature trees will be cut on priority basis.
- Trees left standing will be of good health and form to ensure good seed source.
- The shape of the area chosen for the seed tree can be irregular.
- Maximum size of a contiguous area harvested using this system should not exceed one hectare.
- Fruiting trees and some hollow trees which will have less economical value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines for Thinning in Blue pine Stands

Thinning will be carried out in immature stands. The objective of thinning is to increase growth and quality of stands and at the same time provide small dimension. Healthy, vigorous trees will be released by cutting

Considering the fact that there is a great variation in the age, density and condition of the immature stands care has to be taken not to cause damage to the thinned stands. The primary aim is to achieve even spacing of the remaining tress in the stand.

- The stand for thinning will be identified from the forest type maps and verified in the field.
- The stands identified for thinning, if falling within the harvestable limits of cable cranes, will be subjected to thinning.
- Observation and monitoring of dwarf mistletoe infestation on Blue pine; trees infected with mistletoe should be given first priority for felling. Complete burning is needed.
- Mark for thinning 20% of standing volume.
- Marking of trees for thinning will depend on the number of stem per hectare, age or size class, and the spatial distribution.
- Only low thinning will be done in most of the stands, where only dead, dying, suppressed, diseased and defective trees will be marked first.
- In stands less than 10 m average height the target spacing should be approx. 4.5 x 4.5 m or about 500 tress per hectare.
- In stand with pole crop (average height 10-20 m) the spacing of tress after the thinning should be no more than 5-6 m, or approx. 300-400 trees per hectare.
- In stands which at present have less than desired tree density and spacing; only trees that grow in clusters, very close together and competing for light and nutrient can be removed. Diseased trees, especially those infected with mistletoe can be removed.
- Care must be taken not to create large opening in the thinned stands.
- Diseased, malformed and suppressed trees will be thinned on a priority basis.

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 (only) forest area.
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.

Annex 4: Haa Dzongkhag Administrative Approval

རྫོང་ཁག་བདག་སྐྱོང་།།
DZONGKHAG ADMINISTRATION
HAA: BHUTAN
རྫོང་ཁག་མཐའ་འཁོར་གནས་སྡུད་ཡིག་ཚང་།
OFFICE OF THE DZONGKHAG ENVIRONMENT UNIT

DAH/ENV(16)/2018-2019/ 6935

May 24, 2019

Administrative Approval

The Dzongkhag Administration is hereby pleased to accord administrative approval for Lonchhu Forest Management Unit at Lonchhu under Samar gewog in favor of Chief Forest Officer, Territorial Division Office, Paro, DoFPS. This administrative approval is issued based on the letter sent to us vide letter No. TDO/RAMS-3/2018-2019/2088 dated May 16, 2019 regarding the consideration from your side on all the recommendations provided by this administration vide letter No. DAH/ENV(03)2018-2019/3176 dated 19th December 2018.

However, the proponent may process and obtain rest of the approvals/clearances including the Environment Clearance (EC) for the activity from concerned competent authority as per rule in force.

Phurba Wangdi
Offtg. DZONGDAG

Cc:
1. Office Copy

Annex 5: Sama Gewog Administrative Approval

ROYAL GOVERNMENT OF BHUTAN
GEWOG ADMINISTRATION
SAMAR GEWOG
HAA DZONGKHAG.

Ref:SG(26)/2019-2020/119 Date:27/05/2019

ཁོངས་ལེན་ཐྲི་རྟགས།

རྒྱ་ཚོས་༢༧/༠༥/༢༠༡༩ལྟ་ སོ་ནམ་དང་ ནགས་ཚལ་སྐྱག་ཁག་གི་ ནགས་ཚལ་དང་གློང་ཀ་ཞབས་ཏོག་ལས་ཁུངས་ཀྱི་ མངས་སྡེ་ནགས་ཚལ་སྡེ་ཚན་ཡིག་ཚང་ལས་ གནང་ཡོད་པའི་ཡིག་ཐང་ TDO/RAMS-3/2019-2020/2089 ནང་གསལ་ རང་བཞིན་འཐོན་བསྐྱེད་གོང་འཕེལ་ལས་འཛིན་ཚད་ཀྱི་ གྲུང་ཚུ FMU འཛིན་སྐྱོང་འཆར་གཞི་ ༢༠༡༩-༢༠༢༠ དང་འཁྱིལ་ཏེ་ ཤིང་ལམ་གསར་པ་བཟོ་སྐྲུན་གྱི་དོན་ལུ་ རྒྱལ་ཡོངས་རང་བཞིན་གནས་སྐྱབས་སྐྱབ་ཚོགས་ལས་ གནང་བ་ཞུས་དོན་ལུ་ ལས་འགུལ་དེ་ཀྱི་དོན་ལུ་ ས་དམངས་ཚེད་འཐུ་བདག་སྐྱོང་གི་ ཡིག་ཚང་ལས་ ཡང་ གནད་བ་དགོས་པ་འབད་ཡོད་པ་ལས་ དཔལ་ཕར་ རང་བཞིན་འཐོན་བསྐྱེད་གོང་འཕེལ་ལས་འཛིན་ཚད་ཀྱི་ ཁ་ཐུག་ལས་ འཆར་གཞི་དང་འཁྱིལ་ཏེ་ ལས་བཟོ་སྐྲུན་གྱི་ལྷ་ཚུ་ འབད་བའི་སྐབས་ལུ་ གཡུས་ཚན་གྱངས་ནོར་བུ་སྐང་གི་ ཞིང་ཆུ་དང་ འཐུང་ཆུ་འཐོན་སའི་བཀའ་གྱི་ ས་གནས་དང་ ས་ཁོངས་ཚུ་ནང་ལས་ཕར་ མེད་པ་ ཆུ་བཀག་དང་འཁེལ་བ་མེད་པའི་ ས་ཁོངས་ཚུ་ནང་ལས་ཕར་ ཆུལ་ཡོངས་རང་བཞིན་གནས་སྐྱབས་ཚོགས་དང་ ནགས་ཚལ་ལས་ཁུངས་ཀྱི་ གནང་བ་དང་འཁྱིལ་ཏེ་ ལས་བཟོ་སྐྲུན་འབད་བར་ ཚེད་འཐུ་བདག་སྐྱོང་གི་ཡིག་ཚང་ལས་ ཉོག་འཛིན་མེད་པའི་ཁྲལ་བ་ལུ། ཞེས་རང་ལུགས་གནམ་ལོ་ ས་མོ་ཕག་ལོ་ རང་ཟླ་༣ ཚའི་ཚེས་ ༡༣ ལུའམ་ རྒྱལ་ཚེས་༢༧/༠༥/༢༠༡༩ ལུ་ས་དམངས་ཚེད་འཐུ་ཡིག་ཚང་ལས་

ཞུལབ།

ཨང་:-

༡། རྫོང་ཁག་སོ་ནམ་འགྲོ་དཔོན་མཆོག་ལུ་སྐྱན་ཁྲལ། ཚེ་དབང་ སྒྲོབས་རྒྱལ།
ཡིག་ཚང་གི་འབྲེལ། རྟགས་ ས་དམངས་ཚེད་འཐུ།

Annex 6: Record keeping formats

Block: Compartment: Sub-compartment:

MC	WC	Date	Name and Address	Permit #	TMB #	Particulars			Volume (m3)			Comments
						Species	Product Type	Amount	Marked	Recovered	Firewood	

Commercial Allotment

Block: Compartment: Sub-compartment:

MC	WC	Year of Activity	Commercial Activities					Volume (m3)		Extracted (FDC)	Firewood (lops/tops)	Other Activities	TMB #	Comments (Include detailed description of cable line location in relation to mappable features)
			Cable Lines			Groups/Patches/ Other		Marked						
			Line #	Length (m)	Azimuth	Total #	Total Area (ha)	# of trees	Vol.					

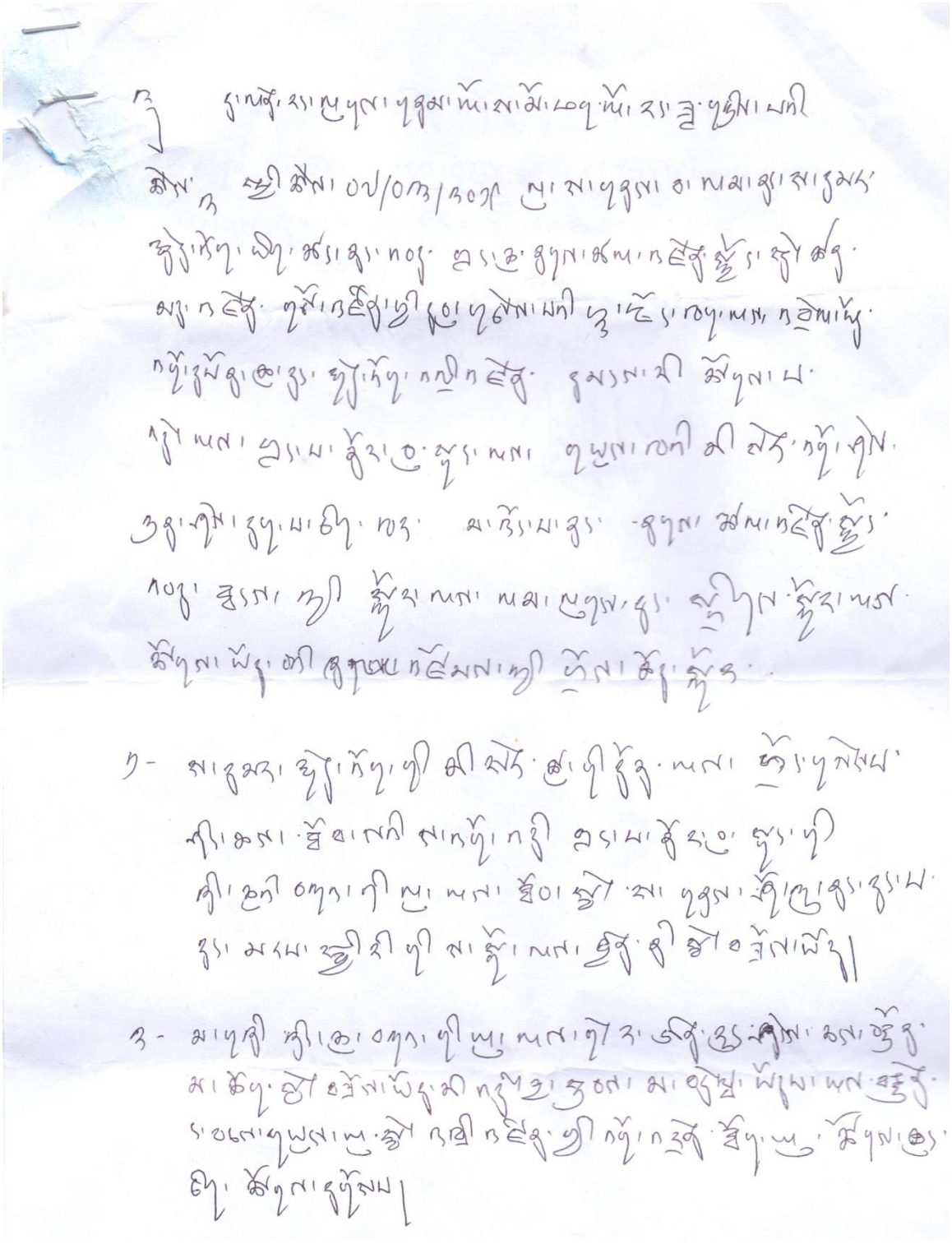
Stand Tending and Regeneration

Block: Compartment: Sub-compartment:

MC	WC	Cable line #	Year	Stand Tending		Regeneration						Comments or Other Activities
				Activity	Area (ha)	Natural/ Plantation	Species	Year Surveyed	Area (ha)	Survey Results (stems/ha or survival percent)	Resurvey?	

Use for brushing, planting, weeding, and spacing or ground preparation activity

Annex 7: Public consultation report



Public Consultation Meeting on Lon chhu FMU Plan Revision
Territorial Division Office, Paro

Venue: Sama Gewog Office
8 March 2019

Sl#	Name	Designation/Occupation	Place	Signature
1	Tshewang Tobgay	Gup	Samar	[signature]
2.	Sangla	Range Officer	Haa	[signature]
3	K.L. Chamlagai	NRDCL Lingchu	Langchu	[signature]
4	Tashi Dorji	Longchu FMU	Sr. FR	[signature]
5	Tobgay	Nubgang	public	[signature]
6.	Karma Rinchen	NRDCL, Incharge	Londchu	[signature]
7.	Sonam Nima	Public	Longchu	[signature]
8.	Tshewang Namgay	-11-	-11-	[signature]
9.	Rinchen Tshering	-11-	-11-	[signature]
10	Naphey	Tshogpa	11	[signature]
11.	Kinley Tenzin	RM, NRDCL	11	[signature]
12	Nidup Dorji	NRDCL, JE	11	[signature]
13	Singye Wangdi	FR I	Haa, Lonchhu	[signature]
14	Wangchuk.	Fr, JKSNR	-do-	[signature]
15.	Phuntsho	Sr. FR. III	JKSNR	[signature]
16	Singye Namgyel	mangmi	Samar	[signature]
17	Pema Zangmo	Nubgang (Public)	Samar	
18.	Tshuki Dorji	Range office	Haa	[signature]
19	Sonam Jamtsho	FR I	SFMU	[signature]
20.	Tshering Nima	Sr. Fr.	Amu	[signature]
21.	Dorji Wangchuk	Sr. FR III	[illegible] FMU	[signature]
22	Karma Nidup	FR II	[signature]	[signature]
23	Ugyen Tshering	Sr. FO	paro	[signature]

Annexure 8: Data Recording Forms

1. Timber Extraction Records for Cable lines and Adhoc areas

FORM 1.1 :Timber Extraction Records from Cable Line

Form 1.1: Timber Extraction Records from Cable Line					
Name of the FMU:					
Block:		Compartment:			
Cable Line No.:		Year of Operation (M/Y):			
Cable Line Length (m):		No. of Group(s):			
Azimuth (degree):		Clear-felled Area (ha):			
GPS Coordinate	Top Endmass (dd/mm/ss):				
	Bottom Endmass (dd/mm/ss):				
Start Date:		End Date:			
Details of Standing and Log Volume Marked from Cable Line (m3)					
Species	**Standing Volume Marked (m3)**	**Log Volume (m3)**	**Poles(m3)**	**Firewood (m3)**	**Woodchips (m3)**
Blue Pine					
Hemlock					
Spruce					
Fir					
Chir Pine					
Broadleaf					
Total					
	Details of Royalty Realized				
	On logs (Nu.):				
	On firewood/Lops & Tops (Nu.):				
	Total Royalty (Nu.):				

Description

FORM 1.1 is to be maintained one for every cable line operated in a year. The standing volume must be transfered from the Marking List maintained by the marking officer prior to operation of the cable line. The Log volume and the volume for Firewood/Woodchips must be entered post operation of Cable line. The data for Log volume, volume for Firewood and Woodchips can be transferred from **FORM 2.1**

FORM 1.2: Timber Allotment Records from Adhoc area

Form 1.2: Timber Extraction Records from Ad-hoc area					
Name of the FMU:					
Block:		Compartment:			
Purpose:					
Forestry Clearance No.:					
Length of Road/Transmission Line (m):					
Clear-felled Area (ha):		Area (substitute/land lease):			
Year of Operation (M/Y):					
Start Date:		End Date:			
Details of Standing Volume Marked from Ad-hoc Activities (m3)					
Species	**Standing Volume Marked (m3)**	**Log Volume (m3)**	**Poles(m3)**	**Firewood (m3)**	**Woodchips (m3)**
Blue Pine					
Hemlock					
Spruce					
Fir					
Chir Pine					
Broadleaf					
Total					
	Details of Royalty Realized (On Production Basis)				
	On sawn timber (Nu.)				
	On logs (Nu.):				
	On Poles (Nu.)				
	On firewood/Lops & Tops (Nu.):				
	Total Royalty (Nu.):				

Description

FORM 1.2 is to be maintained one for every adhoc activity in a year. The standing volume must be transferred from Marking List maintained by the Marking Officer prior to operation of the adhoc area. The Log volume and the volume for Firewood/Woodchips must be entered post operation of adhoc area. The data for Log volume, volume for Firewood and Woodchips can be transferred from **FORM 2.2**

2. Monthly Timber allotment records

FORM 2.1: Monthly Commercial Timber Production Details from Cable lines

Form 2.1 Monthly Commercial Timber Production Details from Cable Lines														
Name of the FMU:														
Month/Year:														
Date	COSDTMO No.	Cable lines no	Logs (A)			Poles (B)			Total volume (A+B)	Firewood		Woodchips	
			Volume (cft)	No. of Pieces	Species	Volume (cft)	No. of Pieces	Species		Species	Volume(cft)	Species	Volume (cft)

Description

FORM 2.1 is to be used for maintaining data of Commercial Timber Production from cable lines on actual production basis every month.

FORM 2.2: Monthly Commercial Timber Production Details from Adhoc areas

Form 2.2 Monthly Commercial Timber Production Details from Ad-hoc Areas													
Name of the FMU:													
Month/Year:													
Date	COSDTMO No.	Ad-hoc Area	Logs (A)			Poles (B)			Total volume (A+B)	Firewood		Woodchips	
			Volume (cft)	No. of Pieces	Species	Volume (cft)	No. of Pieces	Species		Species	Volume(cft)	Species	Volume (cft)

Description: FORM 2.2 is to be used for maintaining data of Commercial Timber Production from Adhoc areas on actual production basis every month.

FORM 2.3: Monthly Rural Timber Allotment (New Construction/ Renovation/ Extension)

Form 2.3 : Monthly Rural Timber Allotment Details (New Construction/ Renovation/ Extension)											
Name of the FMU:											
Month/Year:											
Sl. No.	Date of Issue	Name of the Applicant	CID No.	Address	Thram No.	House No.	Permit No.	Purpose (New Construction/ Renovation)	Sanction Letter No. and Date	Volume Marked	
										Standing Volume (m3)	Log Volume (cft)

Description

FORM 2.3 is to be used for maintaining data of Rural Timber allotments made for New Constructions, Renovation, Extension, Cow shed construction..etc from the FMU on monthly basis.

FORM 2.4: Monthly Rural Timber Allotment (Firewood, Flag Poles, Fencing Poles, Others)

Form 2.4: Monthly Rural Timber Allotment Details (Firewood, Flag Poles, Fencing Poles, Others)																				
Name of the FMU:																				
Month/Year:																				
Sl. No.	Name of the Applicant	CID No.	Address	Thram No.	House No.	Date of Issue	Permit No.	Purpose	Sanction No. and Date	Type and Quantity of Forest Produce Supplied								Total Qty (m3)
										Firewood (m3)		Fencing Post		Flag Poles		Others		
										Standing Vol. (m3)	Actual Prod.	Standing Vol. (m3)	Nos.	Standing Vol. (m3)	Nos	Standing Vol. (m3)	Nos	

Description

FORM 2.4 is to be used for maintaining data of Rural Timber Allotment made for Firewood, Flagpoles, Fencing Poles, Others..etc from the FMU on monthly basis.

FORM 2.5: Monthly NWFP Supply Record FORM

Form 2.5: Monthly NWFP Supply Record															
Name of the FMU:															
Month/Year:															
Sl. No.	Name of the Applicant	CID No.	Thram No.	House No.	Address	Permit No.	Date of Issue	Purpose	Sanction No. and Date	Description and Quantity of NWFP Supplied					
										Stone (m3)	Sand (m3)	Soil (m3)	Bamboo (nos.)	Gravel (m3)	Others

Description

FORM 2.5 is the cumulative data recording form for NWFP extracted from the FMU on a monthly basis.

3. Annual Timber Allotment Records

FORM 3.1: Annual Commercial Timber Extraction from Cable Lines FORM

Form 3.1 : Annual Cable Line Operation Data															
Name of the FMU:															
Reporting Year:															
Block/ Compartment No.	Cable Line					Total clear felled area (ha)	Standing volume for each species							Total standing volume (m3)	
	No./ Year	Length (m)	GPS Coordinate (Top and Bottom Endmass)	No of Groups/ Area (ha)	Corridor Area (ha)		Blue pine (m^3)	Hemlock (m3)	Spruce (m3)	Fir (m3)	Mixed Conifer others (m^3)	Chirpine (m^3)	Broadleaf (m3)		

Description

FORM 3.1 is the cumulative data recording form for ***STANDING VOLUME*** extracted from all the cable lines operated in a year. The data can be transferred from **FORM 1.1**

FORM 3.2: Annual Commercial Timber Extraction from Ad-Hoc areas

Form 3.2: Annual Ad-hoc Timber Extraction Data										
Name of the FMU:										
Reporting Year:										
Block/ Compartment	Activities	Clear Felled Area (Ha)	Standing Volume for Each Species							Total Standing Volume (m^3)
			Blue Pine (m^3)	Hemlock (m3)	Spruce (m3)	Fir (m3)	Mixed Conifer (m3)	Chirpine (m^3)	Broadleaf (m3)	
	Road (FMU/ Forest Road)									
	Road (Others)									
	Transmission line									
	Sanitation									
	Others									

Description

FORM 3.2 is the cumulative data recording form for ***STANDING VOLUME*** extracted from all the Adhoc Working areas operated in a year. The data can be transferred from **FORM 1.2**

FORM 3.3: Annual Commercial Timber/Firewood supply from cablelines and adhoc areas

Form 3.3: Annual Commercial Timber/ Firewood Supply												
Name of the FMU:												
Reporting Year:												
Quantity Harvested from PLANNED OP Activities (m^3)						Quantity Supplied from UNPLANNED Activities (m^3)					Total Standing Vol. (m^3) (a)+(b)	Remarks
Standing Vol. (m3) (a)	*Log Vol.(m3)*	*Firewood (m3)*	*Woodchips (m^3)*	*Others (m^3)*	Standing Vol./m3 (b)	*Log Vol.(m3)*	*Firewood (m3)*	*Woodchips (m^3)*	*Others (m3)*			

Description

FORM 3.3 is the cumulative data recording form for Commercial Timber extracted from both cablelines and adhoc working areas in a year. The data for this form can be transferred from **FORM 1.1, 1.2, 3.1** and **3.2.**

FORM 3.4: Annual Rural Timber Supply

Form 3.4 : Annual Rural Timber Supply												
Name of the FMU:												
Reporting Year:												
Quantity Supplied in Standing Form											Total Standing Volume Supplied (m^3)	Remarks
Rural House Building Timber			Poles (m^3)		Fencing Post (m^3)		Firewood		Others			
No.	Standing Vol. (m3)	Log Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)		

Description

FORM 3.4 is the cumulative data recording form for Rural Timber extracted from the FMU in a year. The data for this form can be transferred from **FORM 2.3** and **2.4.**

FORM 3.5: Annual NWFP supply

Form 3.5: Annual NWFP Supply								
Name of the FMU:								
Reporting Year:								
Year	Product Types							
	Bamboo (Nos.)	Sand (m3)	Top Soil (Tm3)	Stone/ Boulders (m3)	Gravel (m3)	Leaf Mould/ Litters (m3)	Mushroom (Kgs.)	Others (Unit)

Description

FORM 3.5 is the cumulative data recording form for NWFP extracted from the FMU in a year.

FORM 3.6: Royalty Statement

Form 3.6: Royalty Statement													
Name of the FMU:													
Year	Month	Cable Line No./ Name of Ad-hoc Area	Type of Forest Produce Extracted								Total Amount (Nu.)	Dispatch No. and Date	Remarks
			Logs		Firewood/ Lops & Tops		Poles		Sawn Timber				
			Volume (cft)	Amount (Nu.)	Volume (m3)	Amount (Nu.)	No./ Volume (cft)	Amount (Nu.)	Volume (cft)	Amount (Nu.)			

FORM 3.6 is the form for recording royalty details for timber marked and handed over to NRDCL from both cable lines and ad-hoc areas.