STANDARD OPERATING PROCEDURE: CREATION AND MAINTENANCE OF FIRE LINES

FOREST RESOURCES PLANNING AND MANAGEMENT DIVISION
DEPARTMENT OF FORESTS AND PARK SERVICES
2025

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CHAPTER I
PRELIMINARY

1. Background

The increasing frequency of forest fires in Bhutan, attributed to climate change, presents an urgent threat to the nation's environment, infrastructure, and communities. In the first quarter of 2025, 32 forest fire incidents were reported, devastating approximately 6,201.46 acres of land. This alarming trend underscores the importance of proactive and strategic measures to mitigate risks and protect vulnerable assets. Among the most cherished and irreplaceable assets at risk are Bhutan's cultural and religious monuments, including Lhakhangs, Goendeys, and monasteries. These structures, deeply embedded in the nation's heritage, are often located in remote, forested areas, making them highly susceptible to rapid fire spread. The loss or damage to these sites would not only compromise Bhutan's cultural identity but also impact communities that rely on them for spiritual and social well-being. To address this critical challenge, the establishment of firelines around religious monuments emerges as a pragmatic and essential intervention. Firelines serve as physical barriers that halt the advancement of flames, creating protective zones around sacred structures. These buffers provide invaluable response time for firefighters to manage outbreaks and prevent the fires from escalating into catastrophic events. Furthermore, firelines contribute to reducing the risk of loss and ensuring the safety of communities residing near these monuments. Therefore, this Standard Operating Procedure (SoP) is designed to scientifically guide the creation and maintenance of firelines, ensuring they meet safety standards while minimizing ecological disruption. By implementing this measure, Bhutan can safeguard its cultural heritage, reduce fire-related losses, and strengthen disaster resilience.

2. Objectives of this SoP

2.1. Define fireline specifications and standardize maintenance: Establish optimal dimensions for firelines based on monument locations and outline protocols for inspections, debris removal, regrowth suppression, and seasonal reinforcement.

2.2. Guide fuel reduction measures: Provide systematic methods to remove flammable materials like vegetation and deadwood within designated protective perimeters of established firelines.

2.3. Stakeholder involvement and budgeting: Involve relevant stakeholders in implementing this intervention to minimize the risk to religious monuments.

3. Scope and application of the SoP

The scope and application of this SoP shall be limited to the following:

3.1. This SOP shall apply to the construction of fire lines undertaken as a preventive measure to protect critical infrastructure, strategic assets, vulnerable communities and forested areas.

3.2. This SOP shall not apply to fire lines constructed reactively during active forest fire incidents for the purpose of suppressing or redirecting advancing flames.

CHAPTER II
CREATION OF FIRELINES

4. Standard Procedure for Creating Firelines.

The construction of firelines involves systematic planning, precise execution, and rigorous quality checks to ensure their effectiveness in preventing the spread of forest fires. This procedure outlines the essential steps required for fireline establishment, including pre-operation planning, construction practices, and verification measures. As per the forest and nature conservation code of best management practices of Bhutan, 2020, the standard width of fireline should be **5 meters** irrespective of any forest types. The fireline must be created before the onset of the dry season and should be periodically maintained to ensure its optimal effectiveness.

4.1. Pre-Operation Planning

Effective fireline construction begins with thorough preparation, ensuring all elements are accurately assessed and resources are properly organized:

- Site Analysis: Conduct a desktop review using tools such as Google Earth Pro or GIS to delineate the boundaries and determine the spatial area for fireline construction. Identify key features such as terrain, vegetation density, and proximity to vulnerable assets.
- Surveying: Perform an on-site survey using GPS to mark the precise fireline path around the designated monument. Document terrain challenges and conduct timber and pole assessment that fall within the fireline's intended course.
- Team Composition: Assemble a team, assigning a leader to oversee operations and crew members to carry out specific tasks.
- Equipment Checklist: Prepare and verify all required equipment, including tools for vegetation clearance, machinery for plowing, personal safety gear, and communication devices. Ensure all resources are readily available and functional.

4.2. Fireline Construction

The following steps outline the practical execution of fireline creation, emphasizing adherence to ecological and engineering standards:

- Vegetation Clearance: Remove all obstructions, including surface fuels, shrubs, and trees, along the fireline path. Take care to minimize ecological disruption during the clearing process.
- Plowing and Soil Exposure: Plow the designated fireline area to scrape away residual vegetation until barren soil is exposed. This step is critical to depriving fire of fuel sources.
- Debris Management: Collect the cleared debris and residual vegetation at a designated site. Depending on environmental condition, dispose of the materials through controlled burning, composting, or other sustainable methods.

- ❖ Thinning exercise: In order to upscale the effectiveness of the firelines created, conduct thinning exercise within the span of 5 meters on both sides of the fireline path considering the feasibility of ecological condition and cultural sensitivities. This will ensure to widen the defensible space and will enhance the protection of the monument.
- ❖ In locations where fireline construction traverses sloped or steep terrain, slope correction shall be undertaken to ensure a uniform fireline width of 5 meters is maintained across all gradients.

4.2.1. Condition A: If there are no trees and poles to be extracted from the fireline path and adjacent thinning area:

- ❖ The unit cost per square meter, as outlined in Section 6, shall be applied.

4.2.2. Condition B: Protocol for Extraction of Trees and Poles from Fireline Path and Adjacent Thinning Area

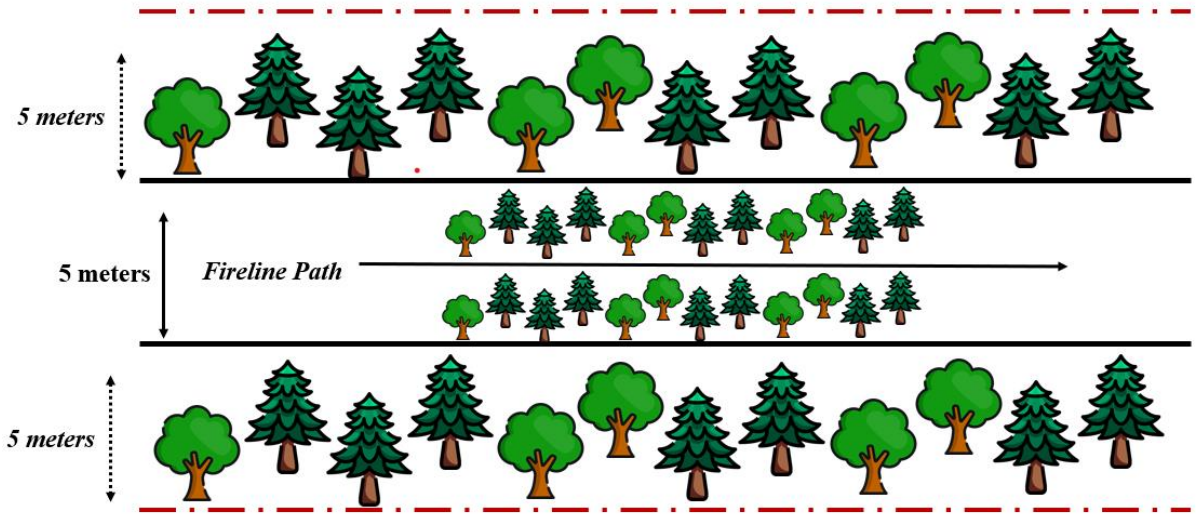
A. Preliminary Review

- ❖ Upon completion of the desktop assessment and confirmation of the presence of trees and poles within the proposed fireline alignment, the concerned Division shall initiate a detailed field verification.

B. Field Enumeration

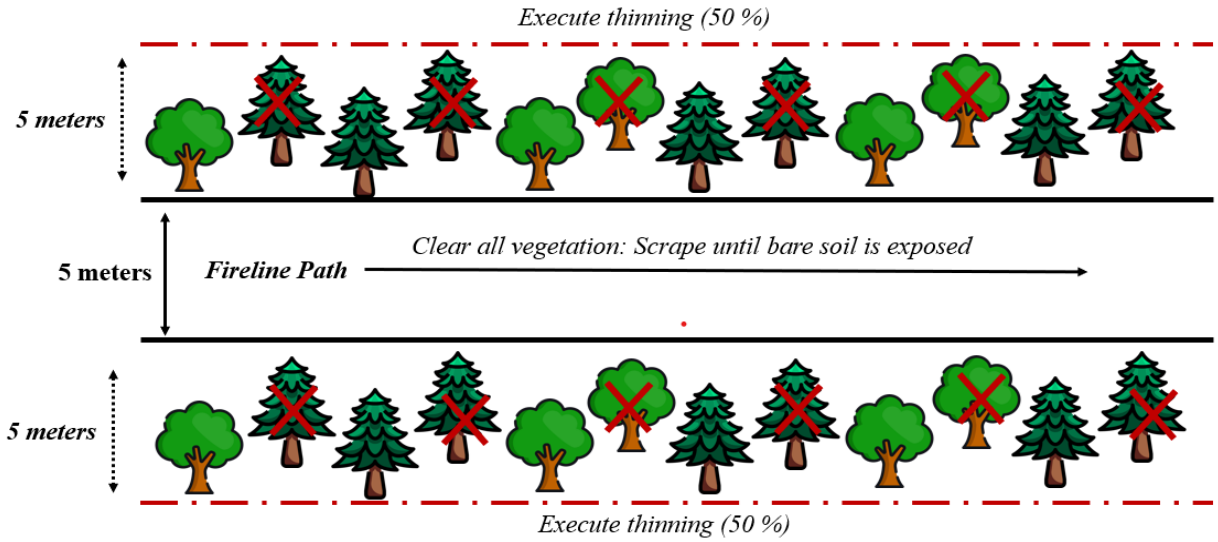
The Division shall conduct a comprehensive enumeration of all extractable resources located:

- ❖ Within the designated 5-meter fireline corridor, and
- ❖ Within an additional 5-meter buffer zone adjacent to the fireline path. *(Refer to Annexure I: Data Collection Sheet for standard enumeration format.)*



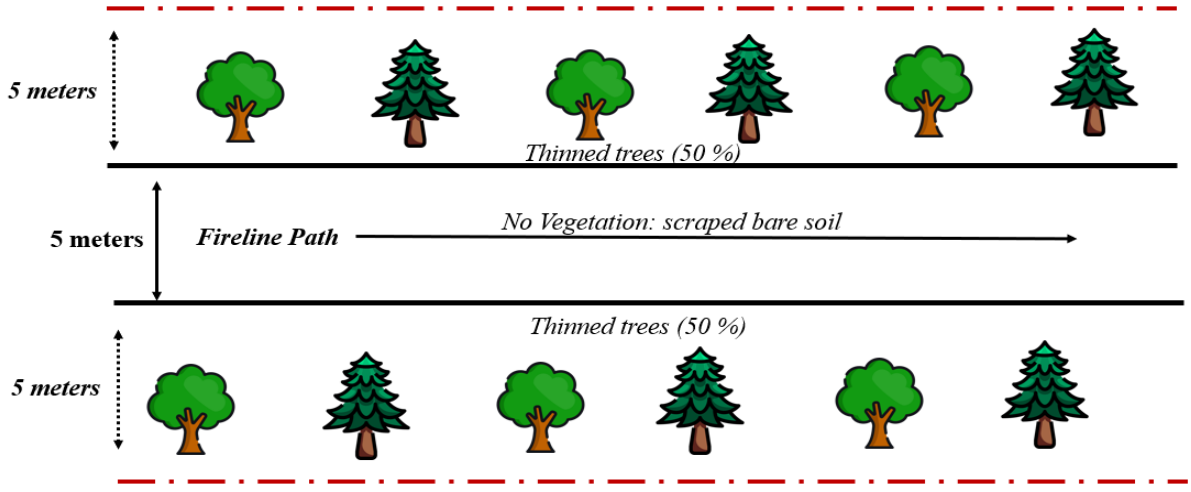
C. Site Allotment for Extraction

- Following the completion of the resource assessment, the Division shall allot timber extraction sites as per the provisions of Forest and Nature Conservation Act 2023/Forest and Nature Conservation Rules and Regulations, 2023 and Timber Extraction and Marketing Modality for Third Party Operations, 2023.
- All the resources within designated 5-meter fireline corridor shall be allotted for extraction.
- The resources within the adjacent 5-meters buffer zones shall be allotted on the thinning basis for extraction retaining 50 % of the total volume enumerated.



D. Construction of Fireline

- Fireline construction shall commence after resource extraction, with costs calculated as per the unit rates specified in Section 6.



4.3. Verification and Quality Assurance

After construction, each fireline must undergo rigorous verification to ensure functionality and compliance with standards:

- Continuous Line Integrity: Verify that the fireline forms an uninterrupted barrier along the designated path.
- Exposed Mineral Soil: Ensure complete exposure of mineral soil across the entire fireline, with no residual vegetation left intact.
- Width Compliance: Confirm that the fireline meets prescribed width requirements, tailored to the monument's location and surrounding forest type.
- Flammable Material Clearance: Check for and eliminate any "bridges" of flammable material that could compromise the fireline’s effectiveness.

4.4. Additional Considerations

To enhance the effectiveness and sustainability of firelines:

- Safety Measures: Implement protocols to ensure crew safety during construction, including the use of protective equipment and proper training.
- Environmental Impact: Monitor and minimize ecological disruption during the clearing and plowing processes.
- Community Involvement: Engage local communities to assist with fireline maintenance and monitoring.
- Seasonal Readiness: Reinforce firelines ahead of fire seasons by conducting additional inspections and applying targeted improvements.

CHAPTER III
MAINTENANCE OF FIRELINES

5. Maintenance of Firelines

Effective and sustained maintenance of firelines is essential to ensure their functionality and reliability in mitigating fire risks. The maintenance consists of two components: regular upkeep and long-term care, with detailed actions outlined below:

5.1. Regular Upkeep

Regular maintenance activities are critical during the fire season to preserve the integrity of the firelines:

- Scheduled Inspections: Conduct routine inspections on a monthly basis during the fire season to identify and address any vulnerabilities promptly.
- Vegetation Management: Remove newly emerging plant growth along the fireline path to prevent fuel accumulation and maintain a clear barrier.
- Repair Work: Address any signs of erosion or structural damage to restore the fireline's effectiveness. This includes filling in gaps, leveling the surface, and stabilizing loose soil.
- Debris Clearance: Regularly remove fallen branches, litter, and other obstructions that may compromise the fireline's functionality.

5.2. Long-Term Care

Long-term maintenance ensures the continued effectiveness of firelines over extended periods, especially in response to environmental changes:

- Post-Rainfall Monitoring: Inspect firelines following heavy rains to identify and mitigate erosion or sediment deposition that could compromise their structure.
- Vegetation Control: Implement measures to suppress regrowth of invasive species or high-risk flammable vegetation within and around the fireline perimeter.
- Maintenance Records: Maintain detailed records of all maintenance activities, including inspection dates, issues identified, and corrective actions taken. This documentation ensures accountability and informs future planning efforts.
- Seasonal Reinforcement: Strengthen firelines before the onset of high-risk fire seasons by performing additional inspections and applying necessary enhancements.
- Community Engagement: Involve local communities in ongoing maintenance efforts through awareness programs and collaborative activities to foster shared responsibility and ownership.

CHAPTER IV
UNIT COSTING FOR FIRELINE CREATION AND MAINTENANCE

6. Unit Costing of Fireline creation and maintenance

As per the *Norms and Standards for Nursery and Plantation, 2020*, unit costs for the creation of firelines have been defined. However, these prescribed rates were primarily intended for the protection of plantations and are minimal, making them impractical for broader application. Therefore, for the construction of firelines aimed at mitigating forest fires, the revised rates presented herein shall apply.

Table I. Unit costing of construction and maintenance of firelines

Sl. No	Items of work	Quantity	Unit	Rate	Remarks
1	Creation of fire line with an average width of 5 meters	1	m^2	Nu. 14.5	New
2	Maintenance of fire line (average width 5 meters)	1	m^2	Nu. 8	Maintenance

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6.1. Cost Estimation for fireline construction

As per the notification of MoF (MoF/DPBP/Rules/2023-24/373 dated 22/11/2023): National Workforce Wage rates:

Table II. National Workforce Wage Rates

Category	Revised rates (Nu)	Remarks
I	600	Highest skilled among NWF: e.g. auto mechanic, carpenter
II	530	Supervisors, metalsmiths, plant operators.
III	470	Examples: auto electricians, plumbers, linemen.
IV	**435**	**Jobs requiring fewer specialized skills or less supervision: e.g. sweepers, wiremen, sawyers.**
V	400	Unskilled workers. These are those who do not have the technical/trades skills required in Categories I-IV.

Let's calculate Cost per m²

- Uniform width = 5 meters
- Length (Assuming that one man/day) = 6 meters
- Area covered (one man/day) = 30 m2.
- Unit cost (Nu/m²) = Daily wage / Area per man/day
- Unit cost (Nu/m²) = 435 /30 = **14.5 Nu/m2**

Rationale for Determining One Man-Day for Construction of 35 m² Fireline

- The allocation of one man-day for constructing 30 m² of fireline is justified by the range of activities required to construct a complete and functional fireline. These activities include: Clearing of understory vegetation and establishment of a ploughed fire break which consists of clearing shrubs, grasses, and other understory vegetation, followed by scraping and exposing the mineral soil to create a continuous ploughed fire break of uniform 5-meter width.

Table III. Cost Projections for construction of firelines of different areas/lengths

Length (m)	**Width (m)**	**Area (m²)**	**Man-days**	**Unit Cost (Nu/m²)**	**Total Cost (Nu.)**
6	**5**	**30**	**1.00**	**14.5**	**14.5**
100	5	500	16.67	14.5	7,250
200	5	1000	33.33	14.5	14,500
300	5	1500	50.00	14.5	21,750
400	5	2000	66.67	14.5	29,000
500	5	2500	83.33	14.5	36,250
600	5	3000	100.00	14.5	43,500
700	5	3500	116.67	14.5	50,750
800	5	4000	133.33	14.5	58,000
900	5	4500	150.00	14.5	65,250
1,000	5	5000	166.67	14.5	72,500
Unit Cost (Nu/m²) = Daily wage ÷ Area per man-day					
Man-days = Area ÷ 30 m²/day					
Total Cost = Man-days × Nu. 435					

Reviewed and endorsed by the 74th Session of the Technical Advisory Committee Meeting dated 30/10/2025.