JABATAN HUTAN SARAWAK

REDUCED IMPACT LOGGING GUIDELINES
FOR GROUND-BASED TIMBER HARVESTING IN THE STATE OF SARAWAK

FOREST DEPARTMENT SARAWAK

SUPPORTED BY

FAO-EU FLEGT PROGRAMME

Food and Agriculture Organization of the United Nations

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UKaid from the British people

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FOREWORD

The timber industry has been and is still a major contributor to the revenue of Sarawak and plays a significant role in the Region's socio-economic development. Revenue collected from log royalty and timber premium is used for financing the education and welfare of the people of Sarawak. The development of the industry has provided employment opportunities to the local people and created a network of roads in the interior of Sarawak thus providing access to the rural communities. However, Sarawak's timber industry is now faced with new challenges both locally and internationally, particularly on forest sustainability, legality and environmental issues. Therefore, the Sarawak Government needs to ensure that the State's forest is managed sustainably to address these issues. One of the major measures taken by the Sarawak Government was to reform its forestry-related policies, including a mandatory requirement for all long-term Forest Timber Licences to be certified by 2022. With the mandate, implementation of Reduced Impact Logging (RIL) practices is also a must in these licences.

The Forest Department Sarawak had developed a guideline on RIL in 1999 based on the experience gained from two international collaboration projects, namely the Model Forest Management Area (MFMA) with the International Tropical Timber Organization (ITTO) in 1993-2000, and the Forest Management Information System (FOMISS) with the Malaysian German Technical Cooperation in 1995-2001. This guideline has been further revised and improved in 2014 and 2018 based on field testing carried out by the Department and the experiences and feedback from the timber industry.

The effectiveness of reduced impact logging is very much dependent on a clear set of guidelines and rules which the timber industry workers are able to understand easily, accept and carry out on the ground. Through this project, we have been able to identify gaps in our current guidelines and address them accordingly through several sharing sessions and stakeholder consultation. I am impressed with the findings and outcome from this Project despite the Covid-19 pandemic. This latest revised RIL guideline will serve as a general reference for the timber industry to comply with RIL procedures when carrying out ground-based timber harvesting in the State's long-term hill forest timber licences. Continuous improvements will be made to ensure its practicality without compromising on sustainability. Implementation of this revised guideline will be done in stages, as further studies, field-testing, awareness, and capacity building will need to be conducted and enhanced.

This project will not have been possible without help from the FAO-EU FLEGT Programme and WWF-Malaysia; Sarawak Government therefore wishes to express her greatest appreciation to these two (2) agencies. I would also like to thank the members of the Forest Management Certification Technical Committee and relevant stakeholders for their valuable inputs, our consultant Dr. Bernd Hahn-Schilling, and officers and staff of the Forest Department Sarawak for their dedication and hard work.

Director of Forests
SARAWAK

ACKNOWLEDGEMENTS

We would like to record our thanks and appreciation to FAO-EU FLEGT Programme for providing the financial support to the project, and to Mr. Bruno Cammaert of FAO Regional Office for Asia and the Pacific and Dr. Jason Hon of WWF Malaysia for their guidance and advice.

This revised guideline on Reduced Impact Logging (RIL) has been prepared under the direction of the Deputy Director Abg Ahmad Abg. Morni and Assistant Directors Madeline George Pau and Ricky Jonathan Alek. Dr. Bernd Hahn-Schilling wrote the guideline, with contributions from the Forest Management Certification Technical Committee (FMCTC) and participants of the stakeholder consultation.

Our special thanks also go to all the officers of Forest Department Sarawak who had devoted their time and contributed greatly towards the successful completion of this Project.

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1.1 History and evolution of RIL Guidelines

Forest harvesting practices should support the sustained yield objective of Sustainable Forest Management, the protection of forest soils and residual vegetation, as well as the conservation of biodiversity and integrity of tropical forest ecosystems. During the 1950s, mechanized logging operations in tropical natural forests were introduced, along with an increasing global demand for timber. The impacts of employing this technology were recognized and assessed by tropical forestry professionals and research organizations during the following decades.

The *United Nations Conference on Environment and Development* (UNCED) held in Rio de Janeiro in 1992 highlighted the issue of excessive tropical forest damage as a serious threat to forest sustainability. Headed by the *Food and Agriculture Organization of the United Nations* (FAO) and the *International Union of Forestry Research Organizations* (IUFRO) proposals were developed on how to bring forest damage under control and down to acceptable levels. Besides numerous scientific publications emerging in the early 1990s some guiding reference documents emerged:

- the *FAO Model Code of Forest Harvesting Practice* (1996),
- the joint IUFRO/ FAO publication on *Research on Environmentally Sound Forest Practices to Sustain Tropical Forests* (1997), and
- the Code of Practice for Forest Harvesting in Asia Pacific (1999).

Other international organizations involved in raising global awareness include the *Intergovernmental Panel on Forests* (IPF) and its successor *Intergovernmental Forum on Forests* (UNFF) promoting the development of voluntary Codes of Practice for forest management. The *International Tropical Timber Organization* (ITTO) published the *ITTO Guidelines for Sustainable Forest Management* (SFM) and *Criteria for the Measurement of Sustainable Tropical Forest Management* (1992, updated Version 2016).

These global initiatives and publications formed the background and inputs for the evolving term "*Reduced Impact Logging*" or "*RIL*" which has now become a broadly accepted concept of an *environmentally friendly, socially beneficial and economically viable timber harvesting operation*. The practice of RIL is widely recognized as a key component that supports the goal of achieving Sustainable (or responsible) Forest Management.

The Sarawak State Government has set a clear forest policy commitment to practice SFM within the whole Permanent Forest Estate (PFE). The Forest Department Sarawak (FDS) embarked on several international partnerships fostering SFM and the development of Reduced Impact Logging methods, through cooperation with the following organizations:

International Tropical Timber Organization (ITTO) PD 105/ 90 Rev.1 (F) 1993 –1996 and 14/95 Rev.2(F) 1996-2000: Model Forest Management Area (MFMA) Sarawak. During the course of this project trials to reduce harvesting impacts through a concept named "Path Logging" were conducted.

Malaysian-German Technical Cooperation Project: Forest Management Information System Sarawak (FOMISS, 1995 – 2001), implemented by Forest Department Sarawak and the *German Agency for International Cooperation* GIZ (formerly known as German Agency for Technical Cooperation, GTZ). The project team developed a Reduced Impact Logging

Guideline and RIL Compliance Assessment System for natural forests in the MFMA (RIL Phase I) and FOMISS-Samling Pilot Area (FSPA), RIL Phase II.

Based on the experience gained during these projects and further trials FDS developed the *Guidelines/ Procedures for Reduced and Low Impact Harvesting System* (1999) which were revised several times, resulting in the current version *RIL for Ground-based Harvesting System Part 1 and Part 2 (Guideline 10A and 10B)* in *The Green Book,* published by the Planning Management Division of FDS in 2019.

In March 2019, FDS and FAO embarked on a collaboration to carry out a gap assessment of the Harmonized RIL Guidelines against international best practices and through multi-stakeholder consultations. The gap assessment and stakeholder consultation were completed by the end of year 2019. As a final project output, a revised RIL Guideline was produced which integrates the findings and recommendations of both the results of the gap assessment and the stakeholder comments, as well as internal discussions held between Forest Department Sarawak, representatives of the timber industry, and professional consultants. The document includes applicable provisions of the *FAO Code of Practice for Forest Harvesting in Asia-Pacific* and other relevant RIL Guidelines of the Southeast Asian region. In conclusion, it can be stated that the Sarawak RIL Guidelines in this current version accord with standards of international best management practices in timber harvesting.

1.2 Definition, Goals and Objectives

In the absence of a globally accepted RIL definition the Forest Department Sarawak has adopted the following version:

Reduced Impact Logging (RIL) is defined as a comprehensive set of planning, monitoring and control practices regulating timber harvesting operations that support the goal of sustainable forest management, aiming at a reduction of forest damage to an acceptable level, and at lowering adverse environmental and social impacts, while promoting operational efficiency and economic viability.

Properly implemented RIL operations render a significant contribution to the achievement of the overall goal of Sustainable Forest Management which is a declared forest policy of the Sarawak State Government.

The specific RIL objectives are summarized below:

(1) to reduce and mitigate any adverse impacts of timber harvesting on the forest environment, including its biodiversity (flora and fauna), soils, water resources, forest climate and carbon pools

(2) to reduce and mitigate any adverse impacts on local communities affected by timber harvesting operations

(3) to standardize, support and facilitate the planning, monitoring and control measures related to timber harvesting, including pre-felling inventories, resource mapping, Detailed Harvesting Plans, Road Plans, and Reduced Impact Logging Plans

(4) to provide guidance on the selection, marking, recording, mapping, and directional felling of harvestable trees, as well as on marking and recording of potential crop trees and protected trees

(5) to minimize forest and soil damage during log extraction from tree stump to the log landing site

(6) to ensure the systematic marking, proper handling and storage of logs

(7) to promote and support the development of an educated, well-trained and skilled workforce that implements forest operations on-site

(8) to ensure the health and safety for all forest workers, including tree fellers, machine operators, forest managers, supervisors and auxiliary staff involved in forest operations

(9) to safeguard timber legality through facilities enabling the reliable tracing and tracking of logs from the stump to the log landing site

(10) to improve the efficiency of all steps of forest harvest planning, implementation, monitoring and control

(11) to facilitate and support economic viability within the limitations defined by forest sustainability requirements

1.3 Scope and Coverage

The Sarawak Government is committed to ensure the forest and its resources are managed in a sustainable manner. One way to ensure sustainability especially in timber production forests is to require all long-term Forest Timber Licences in Sarawak to obtain Forest Management Certification by 2022.

This harmonized Reduced Impact Logging Guidelines is designed for ground harvesting system for log extraction in the long-term Forest Timber Licences. The Forest Timber Licences in Sarawak comprises of almost entirely Mixed Dipterocarp Forest, which makes up about 95% of the forest cover in Sarawak.

All long-term Forest Timber Licences, that are certified or in the process of being certified are required to implement their timber harvesting operation in accordance to this harmonized Reduced Impact Logging.

1.4 Stakeholders

Within the context of these Guidelines the term “Stakeholder” is used to define *any person, group, or legal public or private entity that is or might be affected by the activities of a timber harvesting operation*.

Affected stakeholders will be given the opportunity to be informed and understand the different stages of planning, implementing as well as monitoring and control of forest operations. Stakeholder categories include the following:

a) Government agencies, which provide policies, legislation, issuing of Forest Timber Licence and permits, guidelines, standards and procedures, logging activities approval (through PEC system), harvesting monitoring and control systems, as well as training and funding. Key agencies include the Forest Department Sarawak (FDS) and the Sarawak Timber Industry Development Corporation (STIDC).

b) Private forest sector organisations, which represent the interest of private companies involved in forest management and downstream processing, such as the *Sarawak Timber Association* (STA), and its forest sector training organisation *STA Training Sdn. Bhd*. (STAT).

c) Forest Timber Licence Holders, which hold legal rights to the resources within a Forest Management Unit (FMU), as defined in the Forest Timber Licence and related agreements. Licence holders of neighbouring FMUs might also be affected.

d) Forest Managers and contractors (appointed by Licence holders), who prepare RIL plans, implement and supervise forest operations on the ground, conduct staff and worker training, and take responsibility for compliance with legislation, rules and regulations

e) Local communities, which settle within or adjacent to the areas operated under a Forest Timber Licence. This stakeholder group needs to be informed about planned operations and progress of current harvesting operations in their vicinity. It also raises awareness on customary or tenure rights and any sensitive areas within the FMU, which may need to be protected from harvesting. In some cases, local communities may be represented by registered *Non-Governmental Organisations* (NGOs) which are appointed by the local communities.

1.5 Competencies, Skills and Training

Properly trained RIL staff and forest workers are an essential requirement for all steps of the RIL operation, to ensure full compliance with the RIL Guidelines and hence, to contribute to the achievement of Sustainable Forest Management.

Any person involved in planning, implementation, supervision, and in monitoring and evaluation of RIL operations should *possess the necessary competency and skills to carry out the assigned work tasks and activities in a satisfactory manner*. All work results need to comply with the requirements of prevailing laws, regulations, work instructions, technical standards, and related Standard Operating Procedures (SOPs).

Upon employment of a person in RIL operations the *Human Resource Manager* or Camp Manager/ Forest Manager *shall verify the capability and skills* of that person to carry out the required tasks according to a written job description, and to deliver the expected work results in a satisfactory manner. Clearly formulated job descriptions are necessary to identify the tasks, responsibilities, and the reporting structure by individual job function (e.g. Tree Feller, Machine Operator, Surveyor, RIL Supervisor, etc.).

In case the Human Resource Manager or Camp Manager responsible for the performance of RIL operations identifies gaps and shortcomings of a staff or forest worker in implementing the assigned tasks such person shall *undergo the necessary training to ensure full understanding and compliance with the job description and work results*. The identification of a lack in skills and competencies should be made using established methods of *training needs assessment*.

Identified training measures need to be organized by the Human Resource Manager or Camp Manager/ Forest Manager. Training options include *in-house training by qualified staff or consultants* and *external training by professional training institutions* (e.g. *STA Training Sdn. Bhd*.), depending on the type and intensity of knowledge and skills to be conveyed.

All *conducted training measures shall be documented by the Human Resource Manager* or Camp Manager/ Forest Manager, who will keep records for each employee, including date, duration and type of training, including copies of training certificates issued.

Table 1 gives an overview over the recommended requirements for key persons involved in the planning, implementation, supervision, monitoring and evaluation of Reduced Impact Logging operations.

Table 1: Recommended Competency Requirements for RIL staff and forest workers

Job function	**Recommended Competency Standard**	**Training source**
RIL planning and coordination (RIL Manager)	Diploma or Bachelor's Degree in Forestry, or at least 5 years of practical work experience	University, or public/ private training institution
Geo-location positioning (Crew Leader, Assistant CL)	Certificate in operation of Global Positioning and Navigation Systems (e.g. GPS, GNSS, GLONASS)	In-house training or public/ private training institution
Pre-felling inventory (Crew Leader, Assistant CL)	Certificate in Pre-felling forest inventory/ forest mensuration/ data processing	In-house training or public/ private training institution
Tree identification (Crew Leader, Assistant Crew Leader)	Certificate in Tree Identification	In-house training or STA Training or compatible institution
Data processing and analysis (RIL planning staff)	Certificate in Data Processing and Analysis	In-house training or public/ private training institution
Map production (RIL planning staff)	Diploma or Bachelor's Degree in Geography/ Geographic Information Systems and/ or GIS Certificate with at least 3 years practical work experience	University, or public/ private training institution
Tree felling (Tree feller)	Certificate in Tree felling	STA Training or compatible institution
Log hooking (Hook man)	Certificate in Choker Setting and Winching	STA Training or compatible institution
Log winching and skidding (Machine Operator)	Certificate in Log Extraction	STA Training or compatible institution
Log loading and unloading (Wheeled loader Operator)	Certificate in Log Loading	STA Training or compatible institution
RIL supervision and monitoring (RIL Supervisor)	Certificate in RIL Supervision and Monitoring	In-house training or public/ private training institution

2. FOREST MANAGEMENT AND GENERAL HARVEST PLANNING

2.1 Planning levels and hierarchies

Sustainable Forest Management requires a thorough, integrated planning approach across different levels, hierarchies, and time frames as illustrated in the following **Table 2.**

Table 2: Overview of planning levels, time frames and components

Planning level	Time frame	Planning elements
Forest Sector (macro-level)	Long-term 10 to 20 years	Forest Policies and Laws, Forestry Master Plan
Forest Management Unit (FMU) (meso-level)	Medium-term 5 to 10 years	Forest Management Plan, Forest Resource Assessment and Monitoring, Forest Zoning by Forest Functions, Annual Allowable Cut (AAC), General Planning of Key Forest Operations: infrastructure, harvesting coupes and sequence, silviculture, planting, transportation
Coupe, Block (micro-level)	Short-term up to 1 year	Detailed planning of forest operations: activity, location, area, time schedule, cost

The highest, macro-level planning aspect deals with forest sector planning: it describes the long-term forest management strategies and policies, as well as action plans for forest resource management, timber industry and trade development, and product development and marketing.

The most important output at the *meso-planning level* is the Forest Management Plan (FMP) for a particular Forest Management Unit (FMU). With regard to RIL operations, the FMP prescribes the spatial arrangement of harvesting coupes and the annual harvesting sequence.

Planning, implementation, monitoring and control of *Reduced Impact Logging operations* refers to the *micro-planning level* at individual Coupes consisting of harvesting Blocks, as prescribed at the meso-planning level of the Forest Management Unit.

2.2 Planning tools and technologies

Forest management planning employs several important tools and technologies which assist in the development of Forest Management Plans and Harvesting Plans. These include

- *Forest Resource Assessments* (FRAs) at FMU level: resource data are collected through a combination of remote sensing technologies (satellite imagery, aerial photos) and terrestrial forest inventories. Reliable results from FRAs are a prerequisite for the development of realistic Forest Management Plans.

- *Pre-felling forest inventories at individual Block level:* these are conducted to obtain an overview over the location, volume and quality of harvestable trees, in relation to terrain conditions and infrastructure (e.g. existing skid trails). The collection of resource data can be supported by high-resolution satellite imagery and drone technology, which can assist in the identification of higher density forests, and the position of individual canopy trees with larger diameters.

- *Reliable growth and yield projections:* these are obtained from forest resource data collected from Permanent Sample Plots (PSPs) of the FMU. The results are used to determine the Annual Allowable Cut (AAC) with growth simulation and projection software (e.g., FORMIND Forest Growth Model).

- *Forest Management Information Systems (FMIS)*: these powerful systems integrate the results from topographic maps, FRAs, forest zoning, pre-felling inventories, growth simulation, remote sensing, etc. with Geographic Information Systems (GIS) software in a holistic data management approach. FMIS cover the planning, implementation, monitoring, and control of forest resources and operational activities, including forest maps and output statistics for reporting purposes. Examples for outputs are provided in the FDS Green Book, Guideline 1 for Forest Management Plan.

2.3 Identification of production areas through forest zoning

During the forest management planning process, the areas for implementation of RIL operations are identified in a systematic process termed "forest zoning". Depending on the local conditions of a particular FMU, functional categories and sub-functions can be designated at *individual compartment or Block level,* including the following:

Conservation Function:
areas containing specific High Conservation Values (HCV) as identified during HCV studies and assessments, e.g. for conservation of rare, threatened and endangered flora and fauna, historic, cultural, religious or spiritual sites, sensitive watersheds, ecological or social research, etc.

Protection Function:
areas to be protected due to their topographic or physiographic conditions: steep terrain slopes, river buffer zones, water catchment areas, soils prone to high erodibility, etc.

Community Use Function:
areas reserved for local community use, such as shifting cultivation, fruit orchards, vegetable farms, etc.

Recreational Function:
areas reserved for recreational purposes, such as waterfalls, scenic and unique landscapes, viewpoints, etc. Some of these areas might also fall under the conservation function.

Production Function:
areas reserved for timber harvesting or/ and collection of non-timber forest products (NTFP). *RIL operations can only be conducted in areas with this function*.

These forest functions may not all be present in a single FMU, but Conservation, Protection and Production Functions will normally be identified as a minimum.

Figure 1 shows an example of a Forest Zoning Map for a Forest Management Unit.

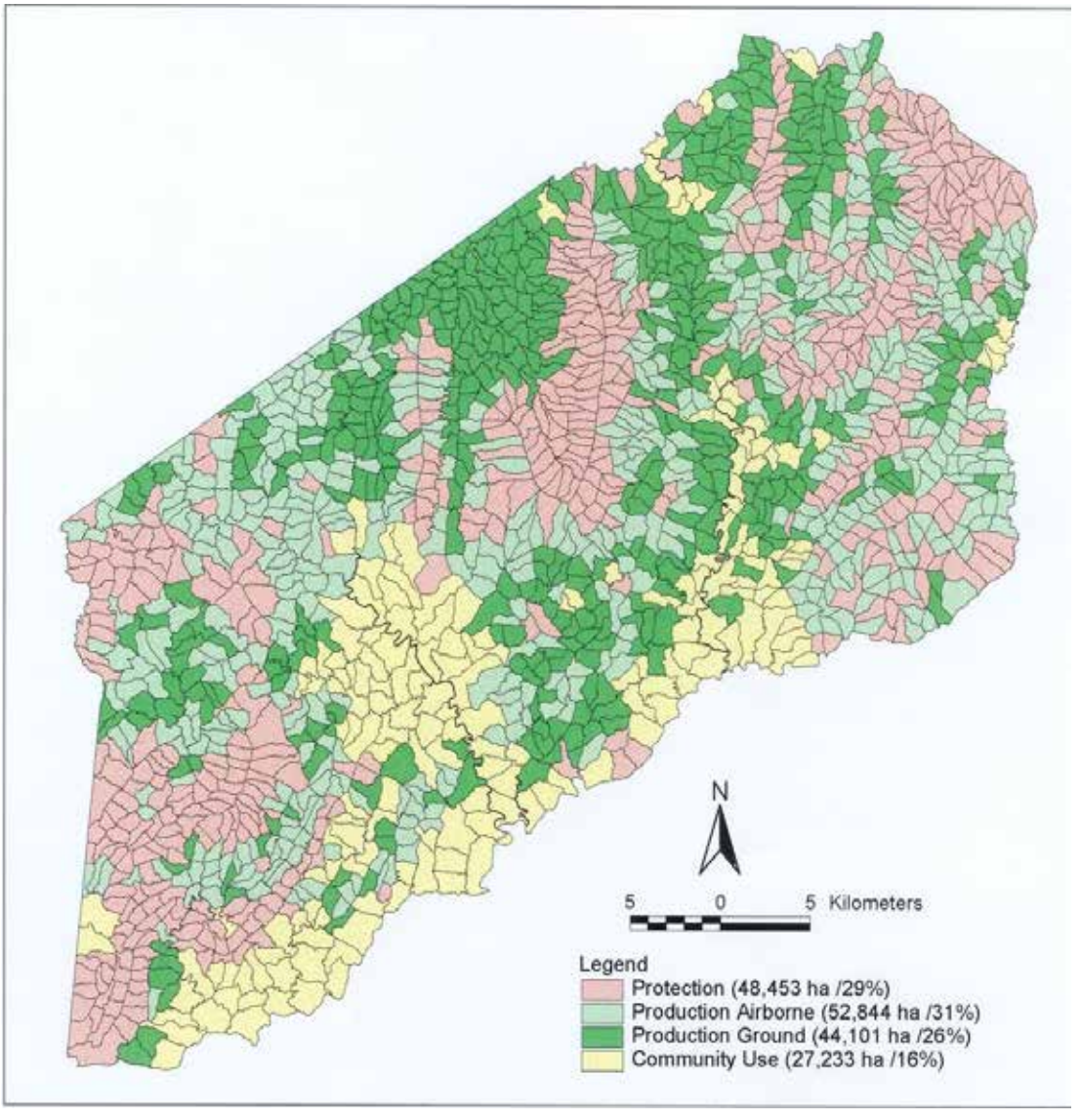


Figure 1: Example of a Forest Zoning Map

2.4 Stakeholder information and consultation

The stakeholders to be involved during planning, implementing and monitoring of RIL operations are defined in **Chapter 1.4.** Each stakeholder plays a role in this process, whereas the number of affected stakeholders and the level of information and consultation vary depending on each individual case.

As a principle of responsible forest management, all affected stakeholders need to be engaged to ensure their awareness of the planned RIL operations, and to enable them to give comments or suggestions in case of any issue of concern. FDS in collaboration with the responsible FMU Community Liaison Officer will determine which stakeholder is “affected” by a RIL operation. In many cases, the affected stakeholders would be local communities who have settled within or nearby the planned harvesting area and are registered with the authority.

Two forms of stakeholder engagement are practiced by FDS:

Stakeholder Information

Local communities and other affected stakeholders may be called for a meeting at the FMU Basecamp, or the Camp Manager/ Community Liaison Officer representing the FMU will visit the stakeholders at their village or longhouse. The information to be provided will mainly consist of:

- a map indicating the planned harvesting area (with Coupe and Block IDs),
- a time schedule indicating the estimated start and completion of RIL operations.

Stakeholder Consultation

The Camp Manager/ Community Liaison Officer will *facilitate stakeholder comments to the planned harvesting operation*s. The main purpose of this consultation is to identify any areas within the harvesting area that may need to be excluded from the operations, such as e.g., graveyards, religious/ cultural sites, or sites important for wildlife (e.g. salt licks) or non-timber forest products important for community subsistence and livelihood. The consultation may involve a joint visit to the harvesting site, enabling stakeholders to locate the area and marking on the ground.

In case any sensitive site has been identified it *needs to be demarcated and inserted into the Reduced Impact Logging Plan* (RILP) to ensure its protection from harvesting damage.

The stakeholder consultation process also serves to announce *potential employment options* and opportunities for local communities as forest workers, or for engagement of support services needed during the RIL operation.

All events held for stakeholder information and consultation *shall be documented* by the Camp Manager/ Community Liaison Officer in written minutes of meeting, which shall be signed by the Camp Manager/ Community Liaison Officer and the selected stakeholder representative(s) for evidence.

Note: In the event of changes to the RILP affected stakeholders need to be informed about such amendments.

2.5 Plan approval process

The core elements regulating forest management planning and implementation include the following documents and procedures:

a) General planning framework: *Forest Management Plan* (FMP)

b) Operational planning elements:
   - *General Harvesting Plan* (GP)
   - *Detailed Harvesting Plan/ Road Plan* (DP/ RP)
   - *Reduced Impact Logging Plan* (RILP)

c) *Permit to Enter Coupe (PEC) System:* this system ensures that the DP/ RP and the pre-felling requirements under the FMP are complied with by the Licensee, prior to the

commencement of the harvesting operation. The PEC process comprises the following five (5) operational stages which will be approved by FDS upon submission in several steps:

- Operation 1: Cut, and demarcate Coupe boundary, Block boundaries, buffer zones, protection zones
- Operation 2: Alignment and survey of proposed roads (where required), road construction, road repairs and upgrading
- Operation 3: Identification, enumeration and marking of harvestable trees, marking and recording of trees for protection
- Operation 4: Skid trail alignment, survey and construction. Preparation of RILP.
- Operation 5: Block endorsement for harvesting operation, permitted up to 9 months

Note: this revised sequence will be adopted following the revision of the current PEC form

Upon approval of the DP/ RP FDS endorses operations 1 to 4 of the PEC. Following the approval of the RILP and satisfactory pre-felling inspection of the Coupe on the ground FDS endorses Operation 5 of the PEC.

The necessary data and information for approval of plans and related maps are developed by the holder of a *Forest Timber Licence* (Licensee), in collaboration with appointed contractors, research organizations, and/ or professional consultants and/ or service providers. Written applications for approval of these plans are submitted by the Licensee to FDS for review and decision making.

The plan review process by FDS includes checks for completeness and accuracy of required data, information and related maps. Where necessary, ground inspections of plan components will be conducted by FDS to verify and reconfirm the information provided. In case of incomplete, inaccurate or otherwise unsatisfactory information FDS will request for a plan correction and amendment by the Licensee, followed by a re-submission for approval.

Ground implementation of any of these plans can only be commenced after final (written) approval by the relevant FDS Division or Unit (e.g., Management and Planning Division, Engineering Unit, etc.) has been obtained.

The FMP comprises the longer-term planning framework for the FMU. It includes the general prescriptions for timber harvesting and RIL operations. The GP provides an overview of the FMU topography and basic infrastructure, such as roads, camps, nurseries, etc. It also indicates the area subdivision into annual work areas or Coupes. The DP/ RP and RILP are designed for operational planning at the individual Coupe and Block level. *These two plans form part of the RIL Guidelines*.

The hierarchy of the forest management planning framework is shown in **Figure 2**.

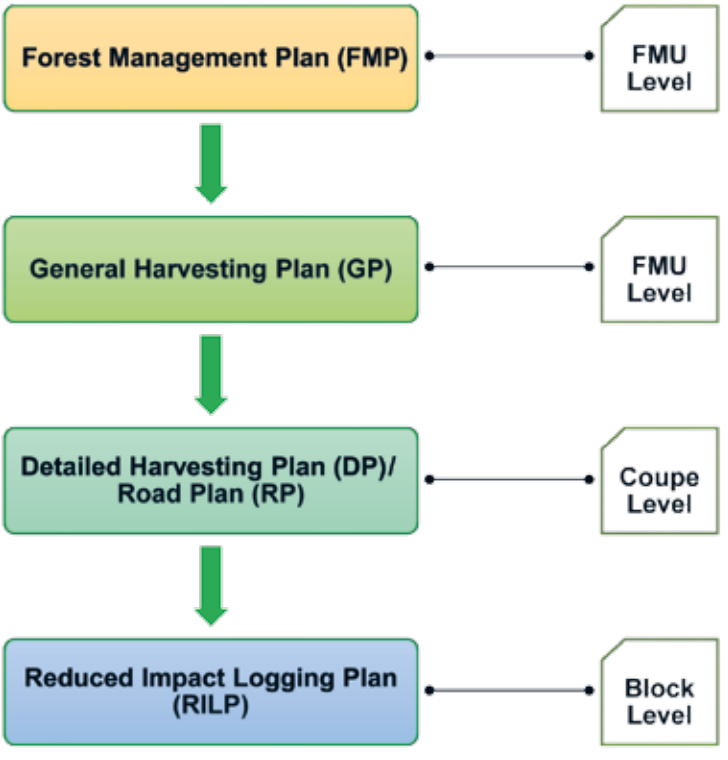


Figure 2: Hierarchy of the forest management planning framework

2.6 Plan amendments

During the implementation of general and operational plans amendments may become necessary to adapt forest operations to changes in prevailing conditions. These changes could be caused by new operational requirements, by accidental omission or inaccurate data and information provided in previous plans. Examples are changes in pre-felling inventory data and harvesting volumes, road and skid-trail alignment, exclusion areas, duration of maximum permitted harvesting time at Block level, or temporary cease or shift of harvesting operations to other areas.

The Licensee shall request for plan amendments as soon as the need for changes has been identified. Applications shall be made in written form and must be supported by relevant documents (database, plan, map, etc.), giving sound reasons for the requested plan amendment. FDS undertakes to inform the applicant on the outcome of the application for amendment within two weeks from the date of FDS receiving the application. *Field implementation of plan amendments is only permitted following written approval by FDS*.

Stakeholders need to be informed about any approved plan amendments, provided the changes will affect them.

3. PRE-HARVEST PLANNING

3.1 RIL planning steps and procedures

After the *General Harvesting Plan* for the Licence area has been approved the planning and approval process for individual harvesting Coupes and Blocks can commence. The principle routine steps for planning RIL operations comprise the following components:

- Preparation of the Detailed Harvesting Plan (Coupe level)
- Preparation of the Road Plan (Coupe level)
- Conducting the Pre-felling forest inventory (Block level)
- Preparation of the Reduced Impact Logging Plan (Block level)

Details of the required procedures to prepare and submit these plans and activities are described in the following **Sub-Chapters 3.2 to 3.13.**

3.2 Detailed Harvesting Plan and Road Plan

3.2.1 General description

Based on the planning provisions given in the General Harvesting Plan (GP), the Detailed Harvesting Plan/ Road Plan (DP/ RP) provides information on the boundaries and size of an individual annual work area or *Coupe.* Whenever possible and practical, the Coupe boundaries follow distinct natural features, such as mountain ridges or larger rivers, or administrative boundaries. Coupes are further subdivided into smaller working units called *Blocks*.

The annual working Coupes are mainly located in logged-over forest where logging roads had previously been constructed. Therefore, a combined Detailed Harvesting Plan/ Road Plan for individual coupes should be prepared based on the specifications below:

3.2.2 Map specifications

Topographic maps with a scale of 1:10,000 and contour intervals not exceeding 10 m shall be used. Such maps can be prepared either by photogrammetric mapping using stereo plotters and suitable aerial photographs, or by direct enlargement from the 1: 25,000 Land and Survey map sheets with contour intervals of 25 feet. If these two options are not available, the 1:50,000 T735/ T738 map series available from *Jabatan Ukur dan Pemetaan Malaysia* can be used for direct enlargement whereby the requirement for 10 m contour interval is exempted.

Alternatively, advanced satellite-based terrain data of the *Interferometric Synthetic Aperture Radar* (IFSAR) system can be used to develop accurate Digital Terrain Models (DTM).

Besides the topographic map layers, the DP map shall include the following information:

(1) Coupe boundaries and Licence boundary (where Coupe boundaries are identical with the Licence boundary)

(2) Boundaries of the Permanent Forest Estate (PFE)

(3) Boundaries of gazetted and/or gravity feed water catchments established by the Health Department (if any).

(4) Road network

The logging road network comprises main, secondary and feeder roads to provide access to all the harvesting blocks. The layout of the road network will consist of previously constructed logging roads and new road alignments in order to keep the maximum skidding distance to 1,000 metres. The road density should be kept at approximately 10 metres per hectare.

Subject to the approval of FDS the prescribed road density may be exceeded under unavoidable circumstances.

The location and alignment of new roads should:

- follow the natural topography (contour lines) to avoid excessive cut and fill,
- be aligned outside buffer zones (except for waterway crossings), water catchment areas, areas with identified High Conservation Value (HCV), and Terrain IV (steep terrain),
- should be aligned away from the banks of permanent waterways wherever possible, to minimize the risk of earth material entering the waterways,
- keep the number of stream crossings to the necessary minimum.

(5) Harvesting blocks: Block boundaries should follow natural features wherever possible, with a block size ranging between approximately 50 and 100 hectares. Allocation of blocks to be worked by tractors should be clearly indicated. The use of tractors within the Block must be confined to areas or sectors where the terrain slopes do not exceed 35°.

(6) Terrain IV and Shifting Agriculture (SA) areas as indicated in Forest Type Map B of the Licence Document, or as detected from 3D terrain models/ ground information.

(7) Conservation areas and buffer zones for:

a) Totally Protected Plants as listed in Part I of the Second Schedule of the Wild Life Protection Ordinance, 1998.

b) Critical resources and sensitive sites, i.e. saltlicks, mudflats, mud volcanoes, caves and limestone blocks. A buffer zone of 100 m wide around perimeter of such critical resources and sites needs to be established. Refer to *Guidelines to Establish and Protect Representative Conservation and Protection Areas in Forest Ecosystem*s. In: Green Book, Guideline 8: Guidelines for Fauna Conservation and Ecosystem Management.

c) Buffer zone for International boundaries and Totally Protected Areas, i.e. National Parks, Wildlife Sanctuaries, Nature Reserves or as otherwise indicated in the Forest Timber Licence documents: one (1) kilometre (km) width.

d) River buffer zone of approximately 20 m width on both banks of permanent waterways. If an approved EIA Report is available, the width of the buffer zone along the waterways will be according to the mitigation measures indicated in the report.

e) Buffer zone of 500 m width for Research and Ecological Plots established by the authority for research purposes.

f) Buffer zone of 100 m width for Hydro Electric Power (HEP) reservoirs, or otherwise as indicated in the prescribed mitigation measures of the approved EIA Report, or as directed by the authority.

(8) Information on harvesting Block sizes, road classification and road lengths by road class (table format).

(9) Map legend, describing points (1) to (7) above, and North Arrow, Map Scale, Scale Distance Bar

3.2.3 Boundary demarcation

Following the approval of the Detailed Plan/ Road Plan by FDS the Licensee or his appointed contractor shall commence with the boundary demarcation in the field:

(1) Demarcation of the Licence boundary (if it also serves as the coupe boundary), Coupe boundary and Block boundary.

Methods of demarcation:

- for the **Licence boundary and sections of the Coupe boundary that form part of the Licence boundary**, demarcation shall be made with **orange paint** on standing trees or permanent natural features at regular intervals along the common Licence/ Coupe boundary.
- for the **Coupe boundary**, standing trees or permanent natural features along the boundary shall be marked with **red paint** at regular intervals for easy identification.
- for the **Block boundaries,** marking on standing trees or permanent natural features shall be carried out at regular intervals using **yellow paint.**

(2) Demarcation of **approved surveyed road alignments** shall facilitate identification by the road construction team. The alignment shall be marked with a **white-coloured** vertical strip line sprayed or painted on standing trees or permanent natural features at five (5) m interval along the surveyed alignment.

(3) Demarcation of water catchment boundary, buffer zone, conservation areas and SA areas (that are under secondary forest and claimed by local people, if any).

Methods of demarcation:

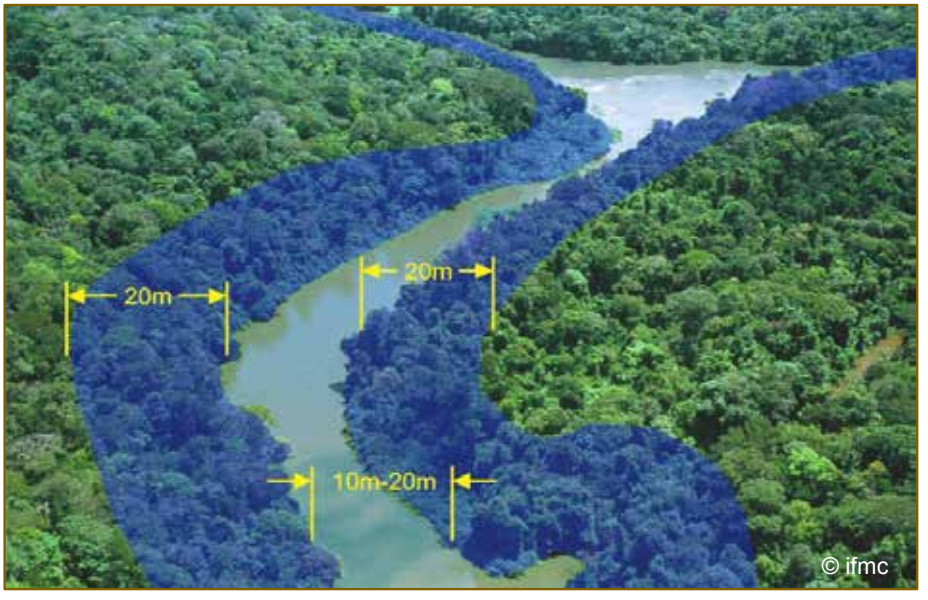
- the **catchment boundary** shall be demarcated by marking on standing trees or permanent natural features with either **blue paint** at regular intervals, **or with signboards** (indicating letters "WC" in blue) affixed to the trees with regular intervals along the boundary.
- the **boundary of river and stream buffer zones** shall be demarcated by marking standing trees or permanent natural features with **blue paint** at regular spacing intervals **and signboards** at strategic locations, such as waterway crossings. Signboards shall include either the full name ***Stream Buffer Reserve*** **or the letters "*SBR*" in blue colour on white background**, affixed to the trees along the boundary, or to wooden poles (in case no trees are found along the buffer boundary).
- for **other buffer zones**, **protection areas, areas containing HCV, Terrain IV (steep slope) areas and Shifting Agriculture (SA) areas**, boundaries shall be demarcated by marking on standing trees with **blue paint or with signboard(s)** placed along the road with arrows pointing to the direction of the boundary.

Note: The Licensee/ appointed contractor is permitted to work in SA areas, provided a written consent has been given by the landowner(s) and written approval has been given by FDS.

Figure 3a : Demarcation of common boundaries, Licence boundary in orange paint.

Figure 3b : Coupe boundary in red.

Figure 3c : Block boundary in yellow.



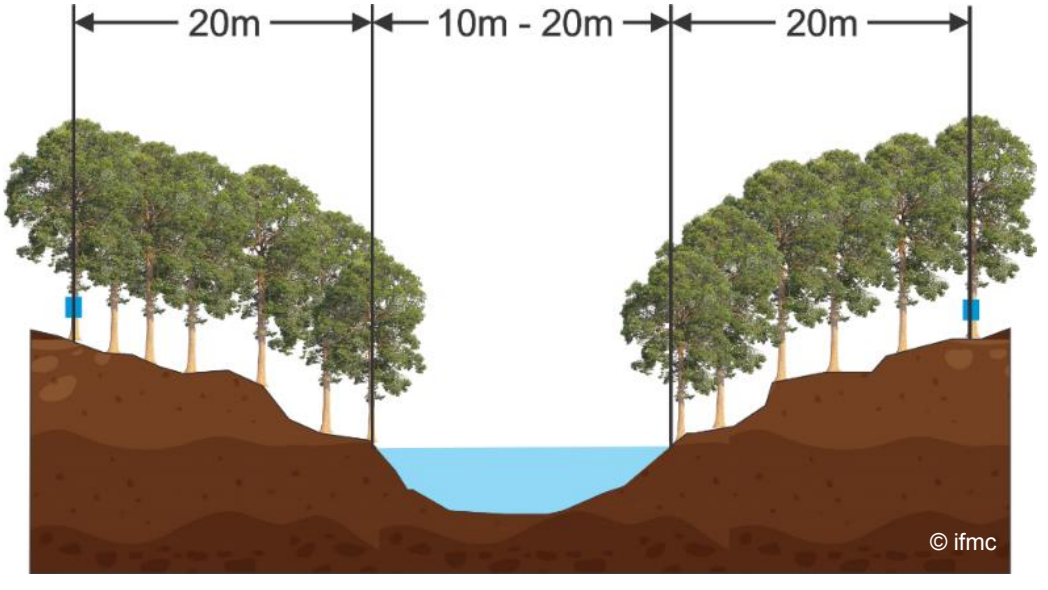


Figure 4: Width of river buffer depends on width of permanent waterways as recommended in the EIA report

Figure 5: Marking of a river buffer zone

3.3 Pre-felling inventory

The pre-felling inventory (Pre-F) is an essential first step of RIL planning. During the tree identification and mapping process in the field the following trees are recorded:

- Commercial tree species with DBH equal to or greater than the prescribed cutting limit, i.e. trees ≥45 cm DBH for Non-Dipterocarp species and trees ≥50 cm DBH for Dipterocarp species
- Protected trees
- Mother trees (seed trees)
- Potential Crop Trees (PCTs)

The pre-felling inventory is carried out by the Licensee or the appointed harvesting contractor, according to the prescriptions given in the Forest Management Plan of the Forest Timber Licence. It is conducted in all Blocks of an authorised Coupe identified for harvesting operations.

The Pre-F is commenced after the demarcation of harvesting block boundaries has been completed.

The basic steps involved include

- Tree identification, selection, and recording of tree related data, and
- Tree tagging
- Tree mapping (optional)

3.3.1 Tree selection and data recording

3.3.1.1 Team Composition

The recommended composition and functions of the Pre-F survey team are given in the following **Table 3**.

Table 3: Recommended composition of Pre-F survey team

Team member	Functions
Team leader	Overall team supervision and recording
Assistant Team Leader	Species identification, monitoring tree selection and recording, tree quality assessment, felling direction
Tree Marker	Species identification, tree selection, assist tree recording
Labourer	Tree spotting, diameter measurement at breast height (DBH), tree height, tree tagging

Note: the number of team members will be determined by the Licensee / appointed contractor

3.3.1.2 Field procedures

The Licensee/ appointed contractor are given the opportunity to choose their own tree recording and mapping approach, as long as the procedures are properly described in a Standard Operating Procedure (SOP) and all inputs relevant for development of the RIL Work Map and RIL Plan are provided. Some recommendations and points for consideration are given below:

- If skid trails are used as location reference for harvestable tree selection the recording starts from the skid trail moving inwards from the road junction to the end of the Block, or moving from the end of the Block to the road junction.
- The team leader and his assistant position themselves along an existing skid trail from previous harvesting operation.
- The tree marker(s) and the labourer(s) will cover the skid trail corridor to both sides of the trail and spot the potential harvestable trees.
- Alternatively, the Licensee/ appointed contractor can carry out the tree selection and recording through
    - *Strip-line assessment*, using a 20 m interval of parallel strip lines across the Block with enumeration of trees 10 m to the left and 10 m to the right of each strip line.
    - Recording the *tree position by geographical coordinates*, captured with Global Positioning System (GPS)
- Whichever recording method is used, it must enable the subsequent mapping of all recorded tree locations within a harvesting Block with reasonable accuracy, enabling the use of the resulting map to locate the trees on the ground.

3.3.1.3 Selection criteria for harvestable trees

Trees eligible for harvesting must fulfill the following criteria:

(1) Tree must be located inside the harvesting Block.

(2) Tree diameter at breast height (DBH) is ≥45 cm for Non- Dipterocarp species and ≥50 cm for Dipterocarp species.

(3) Tree does not belong to any protected species under the list of Totally Protected and Protected Plants. For details, refer to **Appendix 1.**

(4) Tree is not located within any prescribed buffer zone identified either by FDS or EIA (NREB mitigation measures) or HCV requirements (river and stream buffer zones, HCV site, salt licks, water catchments, etc.)

(5) Tree is not located on steep slopes, i.e. slope gradient greater than 35° (70%).

(6) Tree is not reserved as mother tree (seed tree).

(7) Tree is not a nesting tree currently used by birds or mammals (check tree for nests).

(8) Tree meets the quality criteria defined by the Licensee/ appointed contractor and produces at least one merchantable log greater than 3.6 m in length.

The decision-making process for selection of harvestable trees is illustrated in **Figure 6**.

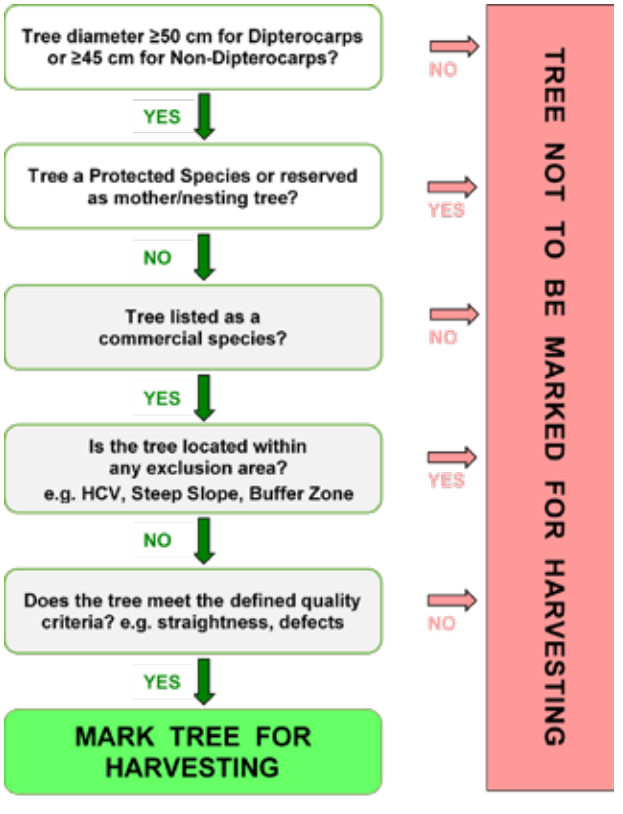


Figure 6: Decision system for eligibility of harvestable trees

3.3.1.4 Recording of selected harvestable trees

The recording of selected trees for harvesting will involve the following activities:

(1) Identifying and recording the tree species to species level, wherever possible. Identification by trade groups (e.g. *Meranti merah, Kapur*, etc.) is not sufficient as some species under a grade group might be critically endangered or fall under other protection categories.

(2) Measuring and recording the tree diameter at breast height (1.3 m above the highest ground level) or at a point just above the highest buttress, if it is higher than the breast height.

(3) Assessment and recording of stem quality, such as log straightness and damages, is recommended to obtain estimates of log value. Scoring systems for assessing log straightness and damages are provided in the FDS Green Book, *Guideline 2*: *Technical Manual for Forest Resource Assessment in Sarawak*.

(4) Visual (ocular) estimate and recording of the tree height in full metres up to merchantable height. The use of a height measurement instrument or hypsometer (e.g. *Suunto, Trupulse*, or similar) to determine merchantable height is recommended to check the correctness of visually estimated heights, e.g. by measuring every 10th tree with the hypsometer. The measurements can be used to improve the ocular estimates and minimize errors.

(5) Allocation of a consecutive tree number as identified on the tree tag.

The collected field data are recorded in the *Pre-felling Inventory Recording Sheet.* A sample sheet is shown in **Appendix 2**. For each trail, the trees on the left side and the trees on the right side are recorded in the sheet. “Left” and “Right” is viewed from the starting point of the skid trail at the back of the block. This recording sheet covers recording of trees using the skid trail corridor method.

Different recording sheets are required for *parallel strip-line assessment* and *recording of geographical tree coordinates/ positions*, respectively. Recording sheets for these methods can be prepared according to the design developed by the Licensee/ appointed contractor.

3.3.1.5 Identification and marking of trees for protection

Trees for protection include all trees that should not be damaged by the harvesting operation. These include the following trees:

(1) *Trees of any protected species*, according to the *List of Totally Protected and Protected Plants* (refer **Appendix 1**), fruit trees and mother trees

(2) Only such trees that are *in danger of being damaged* by the fall of a harvestable tree during the felling operation or nearby skid trail alignment will be identified.

(3) *Mother Trees (MT)* are defined as trees that possess good physical form, which are marked and maintained for seed production. At least two (2) commercial tree (Dipterocarp species with a DBH of 50 cm and above, or Non-Dipterocarp species with a DBH of 45 cm and above), are to be identified per every 500 m of the skid trail alignment (one tree on each side).

- Mother trees *shall be marked with* blue-coloured tags affixed around the tree which contain information such as species and species code (Totally Protected tree = TP, Protected tree = P, Mother tree = MT, and Fruit tree = FT). For mother trees the tags must also include the DBH measurement in addition to species and species code.
- Tagged trees shall not be felled and the tree feller must take precautions to minimize damage to these trees during the felling of trees which have been selected for harvesting.

(4) *Potential Crop Trees* (PCTs) are defined as follows:

- Tree likely to become harvestable tree for next cutting cycle
- Minimum DBH of 30 cm
- Tree with well-developed crown
- Tree with straight cylindrical bole
- Tree with no major bark damage
- Tree with no major bole defect
- Tree with lean of not more than 20° from the vertical
- PCTs along the skid trail corridor within a width of 60 m measured on ground distance (can be extended up to 100 m in favourable terrain conditions) shall be identified with orange tags affixed on the trees. The species, species code and DBH shall be written on the tags. Any substitution of the colour due to non-availability requires approval of FDS.
- The tagged trees shall not be felled, and the tree feller must take precautions to minimize damage to these trees during the felling of trees that have been selected for harvesting.
- All PCTs located within (a) the skid trail corridor (normally of 5 m width but can be increased to 7 m if the skid trail is constructed on side slopes and (b) cleared width of the logging road alignments (as specified in the Logging Road Design Standards) are allowed to be felled and extracted. All these PCTs must be measured and tagged with white plastic tags during the pre-felling inventory stage.
- For such PCTs that may be affected by the harvesting operation, the species of the PCT must be identified and its DBH shall be recorded in the *Stock Sheet for List of Potential Crop Trees* as shown in **Appendix 3.**

3.3.1.6 Recording of trees for protection

The following recording instructions shall apply to trees marked for protection:

(1) All trees that have been tagged for protection shall be recorded in *Stock Sheets*. Samples of Stock Sheets that may be used by the Licensee/appointed contractor are given in **Appendix 3** (Potential Crop Trees) and **Appendix 4** (Trees for Protection) respectively.

(2) The recording of trees for protection in the *Stock Sheet* are based on individual skid trail sections. Tree positions based on GPS readings are optional, but it is recommended that their locations be recorded based on the left or right of the trail to facilitate the tracking of the tree position on the ground. “Left” and “Right” is viewed from the starting point of the skid trail at the back of the Block.

Alternatively, geographical tree coordinates can be recorded using GPS for subsequent mapping with Geographic Information Systems, where available.

(3) *Undersized trees that are allowed for felling* within the skid trail corridors and the logging road cleared width shall also be recorded in a Recording or Stock Sheet as shown in **Appendix 5,** for submission to FDS.

3.3.2 Tagging and preparation of selected harvestable trees

This section describes the use of tree tags for marking of all trees eligible for harvesting.

All trees selected for harvesting are tagged using a **white-coloured plastic tag**. The tag has 6 detachable sub-sections, each of which carries an identical serial number consisting of an alphabet (Tag Code) followed by 4 digits to denote the tree number, e.g. A0001. A sample of the detachable tag is shown in **Figure 7**.

(1) Before the tag is fixed to the tree, the Coupe number, Block number, tree species, DBH, estimated merchantable height and skid trail number are written on the 6 sub-sections of the tag, using a permanent marker pen of black or blue colour.

(2) The white-coloured plastic tag shall be fixed *at the opposite side of the direction to which the tree should be felled*, so it also serves to indicate the preferred felling direction to the tree feller.

(3) The tag shall be fixed considering that the tree fall does not damage the surrounding protected trees, mother trees, or PCTs.

(4) Determination of the direction of tree fall shall also observe the need for tree fall away streams and steep valleys.

(5) In determining the felling direction, the natural lean of the tree must be taken into consideration from the safety point of view: it may not be possible to fell a tree against its natural lean.

(6) The tag shall be fixed to the tree stump area at about 0.5 m from the lower ground. It should be placed at a spot where it cannot be easily damaged or chipped off by falling branches, etc.

(7) If woody climbers are found on the harvestable tree the *climbers shall be cut to avoid hang-up of trees during the felling operation*.

(8) After the tree has been felled, the tree feller shall keep the bottom detachable sub-section, (denoted as “0”) of the tag for record purposes.

(9) The remaining 5 detachable sub-sections of the tag are denoted as “0”, “1” and “2” for identification of the tree stump (1 tag), first log (2 tags) and second log (2 tags) respectively.

(10) The top “0” sub-section of the tag remains on the stump. If it has come loose during the felling of the tree, the tree feller must fix it back to the stump.

(11) The two sub-sections (denoted as “1”) of the tag shall be fixed onto both ends of the first log.

(12) The other 2 sub-sections (denoted as "2") of the tag shall be used for the second log in the situation where the log length of a felled tree is excessive and needs to be cross-cut into 2 log sections.

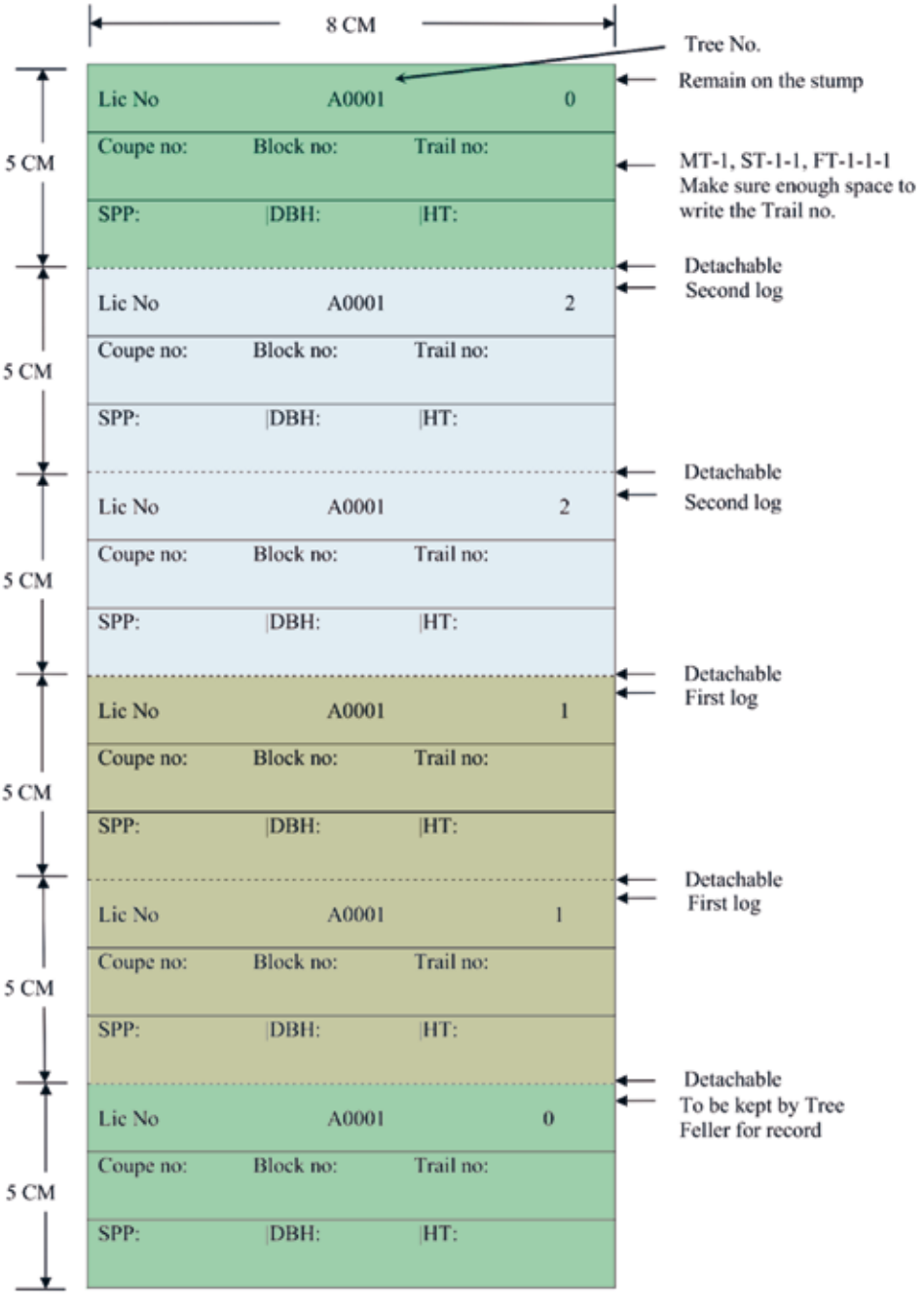


Figure 7: Sample of white-coloured plastic tag for harvestable tree

(colour coding is to denote tag sub-sections only)

3.3.3 Tree mapping

Information about tree locations is an important component of RIL planning. Once the positions of harvestable trees are known these can be used to develop an optimum skid trail network for log extraction.

The collection method for tree location data offers several options as described in **Chapter 3.3.1.2**, i.e. locations are either identified by skid trail sections/corridors, by strip line assessment, or by recording GPS waypoints.

Tree locations of *harvestable trees and mother trees may be plotted on the RIL Workmap* (refer **Chapter 3.10.1**), enabling the *merging of tree positions with the skid trail network*. This step allows for reconciliation of skid trail locations with the position of harvestable trees, and whether amendments should be made to the skid trail network to effectively reach the trees to be felled with the planned skid trail alignment and available harvesting technology.

3.4 Exclusion areas

Exclusion areas include all *areas which are to be exempted from timber harvesting operations* for a variety of reasons and requirements. Any such areas will be identified during the forest zoning process at the FMU planning level and shown in the resulting Forest Zoning Map (also known as Forest Function Map). The most important exclusion areas are those with the following identified values and functions:

- High Conservation Values (HCV) on critical and specific sites, as defined in the *Malaysian National Interpretation for the Identification of High Conservation Values* (WWF Malaysia, 2018).
- Protection Values, including
  - steep terrain (Terrain Class IV)
  - river and stream buffer zones
  - water catchment areas
- Community Use function
- Research function
- Recreation function

Any of these areas excluded from timber harvesting are identified and mapped out during the development of the Forest Management Plan and sub-ordinated General and Detailed Harvesting Plans (refer **Chapters 3.1, 3.2**).

Additional exclusion areas might still be identified during the process of conducting pre-felling inventories at Block level. These will be captured in the RIL Plan, if applicable.

The Licensee/ appointed contractor must ensure that all identified exclusion areas are properly mapped in the RIL Plan and marked on the ground using the prescribed standards. In case of any inconsistencies in mapping of exclusion areas between FMP, GP, DP and RILP the Licensee/ appointed contractor shall contact FDS for clarification and reconciliation of inconsistent or conflicting information. Any such issue shall be resolved prior to the start of harvesting operations in the concerned area.

3.5 Regulation of mother trees and canopy opening

3.5.1 Retention of mother trees

The retention of an adequate number of mother (seed) trees is critical for ensuring a sustained supply of commercial seedlings. As a preliminary standard, *at least 2 (two) mother trees per hectare shall be reserved per 500 m of skid trail length* to ensure successful commercial regeneration within the harvested areas. This standard shall remain in force until results from further studies are available which ensure the effective regeneration of the whole production area of the harvesting Block.

3.5.2 Restriction of canopy gap size

The restriction of gap sizes during tree felling is an important precautionary element of a RIL operation. Large gaps will induce the aggressive growth of light demanding pioneer species which suppress the natural regeneration of higher value Dipterocarp species and other commercial tree species. RIL operations must ensure that the preferred commercial species can regenerate successfully, to avoid costly enrichment planting operations in areas lacking adequate commercial regeneration.

In order to safeguard natural regeneration dynamics of preferred commercial species an *individual gap size of 900 m² (30 x 30 m) after tree felling shall not be exceeded*.

A practical measure to keep canopy gap sizes within the prescribed limit is the definition of a minimum distance between harvestable trees. Subject to the results of further studies FDS may introduce a minimum distance during the first review of these revised Sarawak RIL Guidelines.

3.6 Harvesting approval

The decision and approval to harvest a specific Block is subject to the following conditions:

(1) Harvesting Block is located within the productive forest area, as identified in the forest zoning process and the related Forest Management Plan.

(2) Licensee or appointed contractor have undertaken a pre-felling inventory data in the Block and presented the timber stock data and summaries to FDS.

(3) Licensee has made a formal application for Block harvesting, according to Operation 5 of the PEC system.

(4) Commercial timber stocks equal or exceed a minimum standing harvesting volume, as to be determined by FDS through further studies.

(5) Ground verification by FDS confirms the correctness of the Pre-F data collected in the harvesting Coupe.

Note: ground verification is conducted randomly by selection of several Blocks from a group of Blocks within the harvesting Coupe.

3.7 Choice of harvesting system and machinery

These RIL Guidelines are written for ground-based harvesting systems which are widely used in Sarawak's forests. Due to the differing conditions and requirements applying to airborne harvesting systems (helicopter, skyline, tower yarders, etc.) these regulations are provided in separate guidelines.

Depending on the terrain and soil conditions, the ground-based harvesting system employs different types of machinery:

- *Tractors/ bulldozers*, equipped with winching systems for winching logs from the felling site to the skid trail, over a ground distance up to about 30 m. The minimum length of the winch cable should be 40 m. Tractors are also used for skidding logs to the roadside Block landing.
- *Modified excavators*, equipped with winching systems for winching logs from the felling site to the skid trail, over a ground distance of up to 100 m (where terrain conditions are favourable).

In a single Block, harvesting machinery is typically combined as follows:

- 1-2 tractor units for log winching from felling site to skid trail, and 1-2 tractor units for log skidding from skid trail landing point to roadside landing.
- 1-2 modified excavator units for log winching from felling site to skid trail, and 1-2 tractor units for log skidding from skid trail landing point to roadside landing.

The number of units primarily varies with the Block size, the commercial stocking density, and the terrain conditions.

Currently, no ground-harvesting system other than described above is employed in Sarawak's Hill Dipterocarp forests.

3.8 Location and design of temporary camps

Temporary camps are set up by harvesting crews who shift from one harvesting Block to another Block within the assigned Coupe. The accommodation facilities are mostly mobile skid houses mounted on a type of sled frame which allows the shifting of the skid house between harvesting sites.

A camp site typically serves several harvesting Blocks. It may be used for a period of one month to several months, depending on the commercial timber volume to be extracted, and on the prevailing weather conditions.

The following standards shall be observed for temporary camp location and design:

(1) The preferable location is on higher elevations, along widened road sections.

(2) On slightly sloping ground (2-3º) to facilitate easy natural drainage.

(3) Not permitted to be established within any conservation or protection area, including buffer zones, or any other exclusion area.

(4) Unnecessary removal of vegetation is not permitted.

(5) Minimum horizontal distance from waterbodies is 50 m, unless regulated otherwise through mitigation measures stipulated in the approved EIA Report.

(6) Effective drainage shall be established around skid houses and any other buildings.

(7) A shelter for hazardous goods shall be erected at a minimum horizontal distance of 20 m from the skid house(s). All hazardous goods shall be stored here, including fuels, oils, lubricants, paints, thinners and other toxic and inflammable fluids. Appropriate provisions shall be made to avoid leakage of these fluids into the environment. Also refer to mitigation measures in the approved EIA Report, if applicable.

(8) No spillages of toxic fluids are permitted at the camp site, including areas for vehicle and machinery maintenance and repairs.

Hygiene requirements for temporary camps are provided in **Chapter 6.**

3.9 Planning of skid trail network

3.9.1 Preparation of RIL Workmap at Block level

Following the approval of the Detailed Plan/ Road Plan (DP) by FDS and subsequent field reconnaissance the Licensee/ appointed contractor shall prepare the RIL Workmap for each individual harvesting Block. The initial map shows the following features:

- existing roads and/or surveyed road alignments,
- the location of roadside log landings identified during the field reconnaissance, and
- the proposed skid trail layout within the Block.

Map type and scale: 1:5,000 topographic workmap, enlarged from the Detailed Harvesting Plan/ Road Plan (DP/ Road Plan)

3.9.2 Planning of skid trails

Depending on the frequency of use several skid trail types are defined, as shown in **Table 4**.

Table 4: Skid trail types and description

Skid trail type	Skid Trail ID	Description
Main skid trail	MT-1, MT-2, MT-3, …..	
Secondary skid trail	ST-1-1, ST-2-1, ST-3-1, ...	Branching out from main trail
Feeder skid trail	FT-1-1-1, FT 1-2-1, …	Branching out from secondary trail
Breakout trail	---	Unplanned trail branching out from any of the above, up to 20 m

The planning of skid trails shall be made considering the following requirements:

(1) Skid trails shall commence from the log landing site, which is typically located along ridges or at hill tops.

(2) The maximum skid trail gradient shall be 20° (36%).

(3) In previously logged forest areas, it is permitted to make use of skid trails with a maximum gradient of 35° (70%) over a maximum ground distance of 30 m.

(4) The maximum ground skidding distances is 1,000 m (1 km).

(5) No skid trails are allowed within river and stream buffer zones, as well as HCV and protection areas, including their buffer zones.

(6) Make use of old skid trails, provided their gradient is within the prescribed limits and they provide access to the harvestable trees.

(7) The maximum allowable skid trail density is set at 90 m/ha.

Note for use of modified excavator/ mobile yarders:
Modified excavator/ mobile yarders operate efficiently by winching logs uphill. Skid trails should preferably be aligned along ridgelines or located as high up the slope as possible to ensure an effective operation.

3.9.3 Field alignment, marking and mapping of skid trails

3.9.3.1 Team Composition

The recommended composition and functions of the skid trail alignment team are described in the following **Table 5**.

Table 5: Recommended composition of skid trail alignment team

Team member	Functions
Team leader	Overall team coordination and supervision, sketch mapping and data recording
Assistant Team Leader	Identifying and selection of skid trail alignments, GPS operation, data recording
Labourer(s)	Marking/ flagging of trail alignments, distance measuring

3.9.3.2 Standards for field alignment and marking of skid trails

The following standards shall be met during field alignment and skid trail marking works:

(1) Based on the planning results obtained from the 1:5,000 topographic workmap the skid trail alignment shall commence from the roadside log landing.

(2) Where possible and practical, new main skid trails shall be located either on the top of the ridge or to the left/ right side of the ridge.

(3) For re-entry Blocks, old skid trails from previous harvesting operations shall be used wherever possible, provided their gradient is within the prescribed limits and they provide access to the harvestable trees.

(4) The gradient of existing skid trails (from previous harvesting operation) shall not exceed 20° (36%), except for short ground distances not exceeding 30 m where the maximum allowable gradient is 35° (70%).

(5) The alignment of the skid trails shall continue until the end of the Block is reached or when a steep slope of more than 35° (70%) is encountered.

(6) Where side cutting is needed, the slope gradient shall under no circumstances exceed 35° (70%).

(7) No skid trails are allowed within river and stream buffer zones, as well as HCV and protection areas, including their buffer zones. Existing skid trails falling within these prohibited areas need to be decommissioned by marking their entrance point with a blue "X" painted on stakes or trees at the skid trail entrance area.

(8) Skid trail marking shall ensure that tractor drivers follow the marked trails only and do not break out to the sides. This is to ensure that the skid trail density is kept to the necessary minimum to extract the commercial timber.

(9) The skid trail alignment shall be marked with white-coloured vertical strip line painted on the trees or with red or red-white plastic flagging tied to trees along the alignment.

3.9.3.3 Field mapping of skid trail alignment

FDS accepts the use of two mapping options for skid trail alignment:

Option 1: Ground measurement using compass, clinometer and tape

- Skid trail mapping commences at the Global Positioning System (GPS) tie point at the roadside to which the main skid trail is connected.
- Each skid trail section is measured and recorded for ground distance, slope and bearing into the *Skid Trail Mapping Sheet* (refer **Appendix 7a**).
- Each time the slope changes by more than 10% or the alignment bends to a different direction, a new section is recorded.
- The minimum length of each section shall not be less than 10 m.
- Measurement is made along the middle of the marked skid trail for all existing trails that are to be reused.
- Distance measured parallel to the ground need to be corrected using the *Slope Correction Table* (refer **Appendix 6**) to obtain the horizontal distance, which is then entered into the Mapping Sheet
- The end of each section shall be marked with red-white plastic flagging on a tree or pole.
- After reaching the end of a main trail, the skid trail team returns to the nearest junction and continues recording the secondary and feeder trails.

Following the completion of skid trail recording and mapping in the field the *RIL Workmap* shall be updated to indicate the mapped skid trail layout, together with the existing or new road (if any) joining the harvesting Block, and the confirmed locations of roadside log landings. A sample of a *RIL Workmap* is shown in **Figure 8**.

The RIL Workmap shall be supplemented by a table listing all skid trail numbers and their respective length within the harvesting Block, as shown in **Appendix 7a**, *Sample of Skid Trail Mapping Sheet*, and in **Appendix 7b**, *Skid Trail Summary Sheet*.

Option 2: Mapping using GPS technology

An alternative mapping system is available by using a handheld Global Positioning System (GPS), which captures satellite signals to record geographical coordinates of the GPS recorder while tracking along the skid trail.

Some points to be considered for decision making:

- GPS technology has been proven to be faster than employing Option 1.
- GPS accuracy may deteriorate under thick forest canopy. Ensure to always have at least 4-5 satellites operating at the time of recording.
- The use of differential GPS (DGPS) should be considered for higher accuracy levels.
- GPS technology including post-processing with Geographic Information Systems (GIS) assists with more accurate alignment mapping and easier map development.
- GPS instruments must be properly set to before use, to avoid errors (e.g. map datum) and match with Sarawak map standards

Following GPS tracking of skid trails the RIL Workmap shall be updated to indicate the existing or new road (if any) joining the harvesting Block, and the confirmed locations of roadside log landings.

As under Option 1 above the RIL Workmap shall be supplemented by a table listing all skid trail numbers and their respective length within the harvesting Block, as shown in **Appendices 7a and 7b**.

3.10 Planning of log landings and platforms

Proper planning of log landing sites and excavator platforms is an important measure to ensure the efficiency of the log extraction process. The following standards apply:

Requirements for log landings:

(1) Not to be located within any conservation or protection area, including buffer zones.

(2) Preferably to be located adjacent to spurs/ ridges which are intended to be used as main skid trails.

(3) Location is permitted on both sides of the forest road, to avoid pulling logs across or along the road.

(4) The size of *roadside log landings* shall not exceed 900 m² per landing (e.g. 30 x 30 m).

(5) Only well-drained areas with a gradient of at least 2º shall be selected.

(6) Sites requiring major earth works shall be avoided.

(7) The minimum horizontal distance from waterbodies is 50 m.

(8) Spacing between landings shall be thoroughly planned to keep maximum ground skidding distance to 1,000 m

(9) No construction of log landings is allowed prior to the completion of the pre-felling inspection by FDS.

Requirements for platforms for modified excavator (log wincher):

(1) Selection of modified excavator/ mobile yarder *platforms within the Block*: the location of shuttle landings is to be identified after skid trail construction, as well as tagging and mapping of trees for felling have been completed. This allows easier decision making about the preferred landing location.

(2) The location and spacing of the modified excavator/ mobile yarder platforms inside the Block depend on the distribution and density of tagged trees for felling and hence, the information of tree locations or mapping of tree positions is important.

(3) Where possible, the modified excavator/ mobile yarder should be positioned directly on the skid trail. Clearing of about 20 m x 20 m around a platform area is permitted to allow for the stacking of logs prior to skidding out logs with the tractor to the roadside landing.

(4) The locations of the modified excavator/ mobile yarder platforms need not be reflected on the RIL Workmap, which forms part of the RILP. The RILP must be submitted by the Licensee/ appointed contractor to FDS by the time of application for pre-felling inspection.

(5) No construction of platforms is allowed prior to the completion of the pre-felling inspection by FDS.

3.11 Preparation and submission of Reduced Impact Logging Plan (RILP)

The RILP shall be prepared for submission to FDS after the completion of the pre-felling inventory and mapping works in the individual harvesting Blocks, as well as the planning of the skid trail network, log landings and platforms. The results of these activities can be viewed in the RIL workmap.

The RILP consists of the following set of documents:

(1) *RIL Workmap* at the scale of 1:5,000, indicating:

- topographical data: contour lines, hill tops with elevation, rivers and streams
- exclusion areas (areas containing HCV, steep areas, buffer zones, etc.)
- all existing roads and new road alignments,
- existing and new skid trail alignments
- location of all harvestable trees and mother trees (optional)
- location of roadside log landings
- location of excavator platforms (optional)

A sample of the RIL Workmap is as shown in **Figure 8**.

(2) *Summary tables* with Skid trail IDs and skid trail distances of each skid trail, as shown in **Appendices 7a and 7b**

(3) *Operational Inventory Summary Sheet* covering each Skid Trail of Individual Block (Format RILP 1 as shown in **Appendix 8a** (for trees recorded using skid trail sections), and **Appendix 8b** (for trees recorded using GPS with geographical coordinates).

(4) *Summary of Skid Trail Network and Trees to be Harvested for Individual Block* (refer Format RILP 2 as shown in **Appendix 9**).

(5) *Summary of Trees for Protection within Individual Block* (Format RILP 3 as shown in **Appendix 10**).

(6) *Summary of Trees for Protection within the Coupe* (Format RILP 3a as shown in **Appendix 10a**).

(7) Summary of the *Coupe Operational Inventory Analysis* (Format RILP 4 as shown in **Appendix 11**). This summary will cover all Blocks for which the five (5) documents listed above are completed and where these Blocks are ready for inspection by FDS.

(8) *Operational Inventory Summary Sheet for undersized trees* permitted to be felled (Format RILP 5, as shown in **Appendix 5**).

The RILP shall be submitted to FDS at the time of application for Pre-felling Inspection.

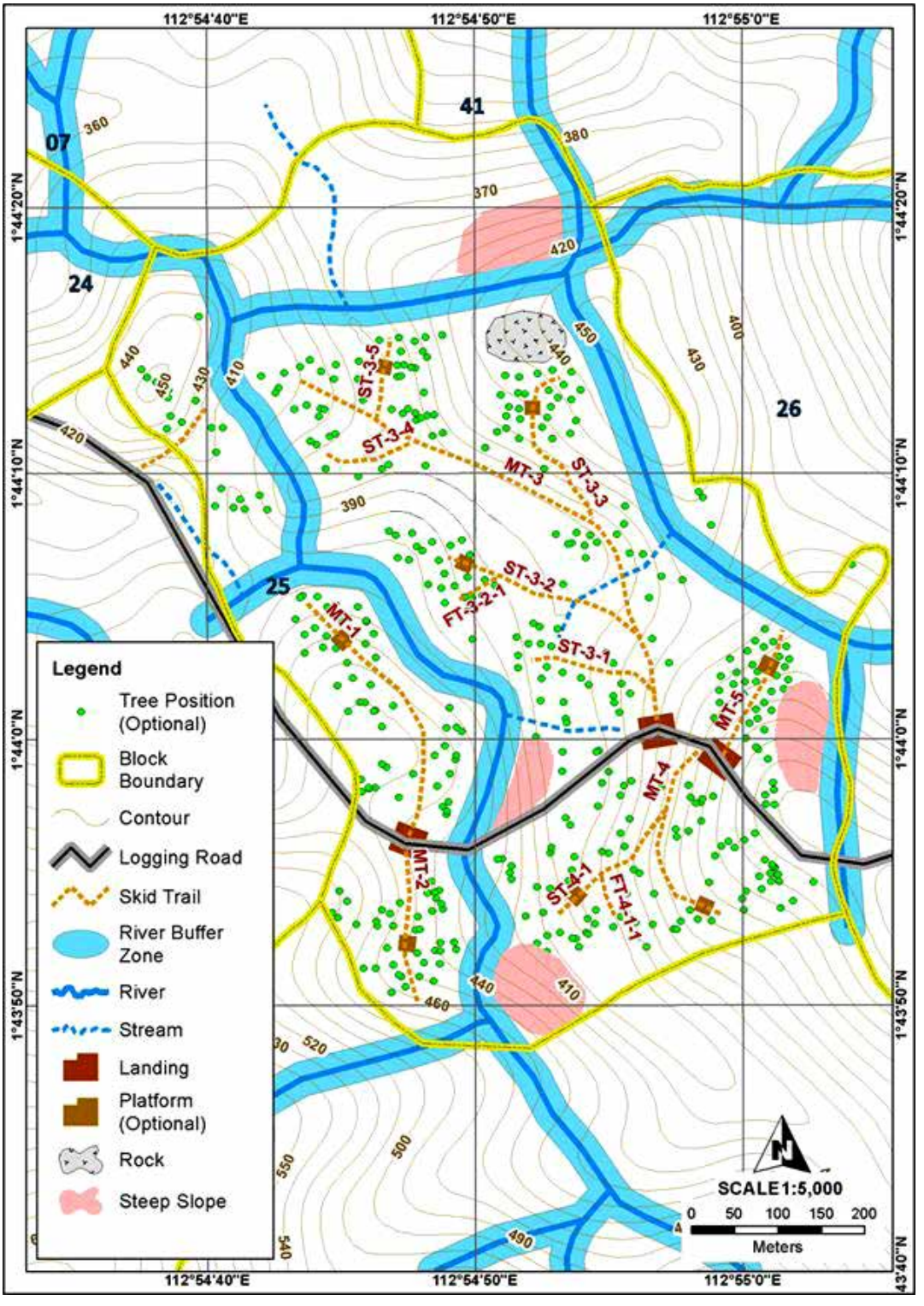


Figure 8: Example of RIL Workmap

3.12 Mapping accuracy

Geographical field data collected during pre-felling inventories, road and skid trail mapping, and tree location mapping often are affected by some degree of inaccuracy. The source of these inaccuracies is due to imprecise distance and angle measurements, slope corrections based on incorrect slope measurements, and insufficient or weak GPS signals under forest canopy.

While it is recognized that under the prevailing conditions it is not possible to produce maps without error*, it is important to keep such errors and inaccuracies within acceptable limits.* Though no prescriptions are currently made for accuracy of the map information it needs to be sufficiently reliable to facilitate field orientation and correct detection of map features on the ground. Unreliable maps will not serve the purpose and discourage their use.

As a general recommendation, for forestry applications a tolerable deviation of *linear map features* such as boundaries, roads, skid trails, contour lines, etc. as shown on the *RIL Workmap* of 1:5,000 scale is in the range of 5 to 10 m.

Regarding *point features* such as the location of harvestable trees a deviation of 10 to 15 m from the correct geographic location is acceptable for tree spotting on the ground.

3.13 Changes to RIL Plan

Changes to approved RIL Plans may become necessary when errors or omissions are detected that are significant and hence, require amendment. This situation might occur either prior to or during the harvesting operation. It is the responsibility of the Licensee/ appointed contractor to detect and correct such errors and omissions and submit a written request for plan amendment, indicating the cause and sound reasons for changes.

Following receipt of the written request FDS will undertake the review and verification and determine on the approval. Depending on the relevance of the amendment FDS will also decide on the need to inform any affected stakeholders about such changes.

4. HARVESTING OPERATIONS

4.1 Operator briefing

Prior to the commencement of harvesting in a Block, all persons involved in the operations need to be properly informed about the contents and requirements of the Reduced Impact Logging Plan (RILP). A *RILP briefing session* shall be held by the Camp Manager and/ or the responsible RIL Supervisor. Persons to be briefed include the following persons:

- Tree fellers
- Machine operators (tractor, excavator, log loader)
- Hook men
- Auxiliary workers

The key documents to be discussed in the briefing include the *Sarawak RIL Guidelines* and the *RIL Workmap*, together with the necessary support files (Summary of Skid Trail Network and Trees, Summary of Trees for Protection, etc.).

The briefing shall also cover the Block subdivision (if any) between harvesting crews, work sequence, performance targets, team coordination, safety and health standards, emergency response procedures, and daily reporting procedures. In addition, the meeting serves to clarify questions of any harvesting crew member and resolve any arising issue.

Upon completion of the briefing, the Camp Manager or responsible RIL Supervisor shall prepare a *summary of briefing points*, together with an *attendance list* which shall be signed by all participants. With their signature, participants confirm that they have understood the procedures and requirements of harvesting operations.

4.2 Maintenance of machinery, vehicles, equipment and tools

All forest machinery, vehicles, equipment and tools used during the harvesting operation need to be properly serviced and maintained in good working order and condition. This must be ensured through regular functional, maintenance and safety checks prior, during and after completion of field works. Well maintained machinery, tools and equipment also help to avoid environmental damages caused by spillage of fuels, oils and lubricants. The following activities shall be implemented:

(1) Each forest worker shall be responsible for the items assigned to his specific job function.

(2) When servicing and repair of machinery, vehicles and equipment are undertaken at the work site or at temporary camps all applicable environmental rules and regulations must be observed (refer **Chapter 4.13**).

(3) All machinery safety features shall be checked for completeness and functionality, e.g.,

- Chainsaws: handguard; chain condition, sharpness, tension; chain bar and guard, chain brake guard, chain catcher, interlocking throttle, exhaust system, tool kit.
- Tractors and excavators: roll-over protection, object protection cabs, protective wire mesh, reverse alarm, emergency engine stopping devices, spark arrestors, fire extinguisher.

(4) The *use of biodegradable oils and lubricants is encouraged* as a contribution to a safe and healthy forest environment.

(5) The condition of all items and he need for servicing or repairs shall be recorded by the responsible forest worker on regular basis, using the format provided by the employer.

(6) Upon detection of any loss or damage of an assigned item the responsible forest worker shall inform the superior and request for the repair or replacement.

(7) To protect the safety and health of forest workers and avoid accidents *it is prohibited to use any machinery, vehicle, equipment or tool that is unsafe for its designed use*.

(8) The RIL Supervisor is responsible for ensuring that regular functional, maintenance and safety checks are made by the harvesting crew.

For details on environmental safeguards to be followed during service and repair works, refer to **Chapter 4.13** (Environmental safeguards).

4.3 Construction of new roads

The Sarawak RIL Guidelines only provide a basic overview over road standards and hence, are not exhaustive. *For detailed instructions and technical specifications on forest roads, refer to the Guidelines for Forest Road Layout and Construction, 1999.*

All forest roads shall be constructed according to the planned alignment laid out in the approved *Detailed Harvesting Plan/ Road Plan* (DP/ Road Plan), as approved by FDS.

The construction of the roads shall be carried out in accordance with the basic road design and specifications as outlined in **Appendix 12 and 12a**.

Harvesting operations carried out by re-entry into previously logged forests with utilization of existing (abandoned) roads is the most common situation in Sarawak. Construction of new roads is only necessary in areas not covered by forest operations in the past. For this reason, only road repair, upgrading and maintenance works are described in the following sub-chapters.

4.4 Repair, upgrading and maintenance of existing roads

4.4.1 Road numbering and marking

All roads utilized during forest operations in the FMU shall be numbered and identified at road junctions, by erecting clearly visible sign boards showing the road identification code. The numbering system shall follow the specifications set out in **Table 6**.

Table 6: Road identification by road class

Road Class	Road Identification Code
Main Road	M-1, M-2, M-3, etc.
Secondary Road	S-1-1, S-1-2, S-1-3, etc. for secondary roads branching out from Main Road M-1, etc.
Feeder Road	F-1-1-1, F-1-1-2, F-1-1-3, etc. for feeder roads branching out from Secondary Road S-1-1, etc.

Identification of distances from Base Camps are important for orientation of road users, e.g., in the case of machinery and vehicle breakdowns, and for reporting of road incidents and damages.

Kilometre pegs shall be placed along all main and secondary roads. For main roads, the origin (i.e. KM 0) shall start from the Base Camp or the dumping station, while for secondary roads the origin shall count from the junction with the main road.

Arrow signage shall be erected on both sides of all road curves, pointing to the left or right side of the road to be used when approaching a curve.

Warning signage shall be erected at dangerous road spots or sections requiring high alert of road users, e.g. narrow and blind road spots, low visibility spots, steep road sections, spots with high risk of falling rocks, water crossings, and damaged road sections.

4.4.2 Guidance for implementation of road works

4.4.2.1 General instructions

Teams carrying out road repair, upgrading and maintenance works shall observe the following general requirements:

(1) Roads should be constructed during the dry season. Avoid working under continuously wet weather conditions, to minimize negative environmental impacts.

(2) Appropriate machinery shall be used in road works, including

- bulldozers for bulk earthworks and road formation,
- excavators for work in environmentally sensitive areas (hilly terrain slopes, near rivers and streams, and wherever minimal soil disturbance is necessary)
- road graders for shaping the road surface and ditches
- vibrating rollers for road surface compaction
- dump trucks for transportation of soil and road surfacing materials

(3) All machineries, vehicles, tools and equipment used during road works shall be fully functional and properly maintained at all times. Defective items affecting their safe operation shall not be used until necessary repairs have been completed.

(4) All persons involved in road works shall wear appropriate Personal Protective Equipment (PPE), according to job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

(5) Debris and earth material from road works shall be deposited in environmentally stable areas, and in such a manner that deposits will not erode and enter waterways.

(6) During cut and fill operations, ensure that earth material is not pushed into buffer zones or waterways.

(7) On main and secondary forest roads suitable surfacing material shall be used, such as stones, laterite or hard shale, if available within economic hauling distance.

(8) Road formation and surface layer shall be stabilized through compaction using effective soil compaction machinery.

(9) Where there is a risk of instability and erosion on bare areas, stabilisation measures shall be undertaken by seeding, re-vegetation, terracing or any other effective erosion control methods.

(10) Waste oil, lubricants, fuels, scrapped wire rope, empty oil drums and other solid and Scheduled Wastes shall be disposed in an environmentally appropriate manner, according to the provisions of the Department of Environment (DOE) and the Natural Resources and Environment Board (NREB), as outlined in the Environmental Impact Assessment (EIA) Report.

For further details, refer to the *Guidelines for Forest Road Layout and Construction, 1999.*

4.4.2.2 Road Surface Drainage

Effective road drainage is an essential requirement for the safe use of roads. Well-installed and regularly maintained drainage also helps to minimize road maintenance and repair cost. To achieve this condition the following drainage measures shall be taken:

(1) Proper road shape and camber shall be provided to facilitate the effective road surface drainage to the side drains.

(2) Side drains, culverts and sediment traps shall be installed to prevent scouring. Dimensions must be designed to accommodate expected peak water volumes.

(3) Roadside drains shall be constructed especially on hill sides, with adequate turnouts to channel water away from the road structure and into the surrounding vegetation.

(4) Cross road drainage shall be arranged by means of culverts which are laid across the roadway with a minimum fall of 5%. The culverts shall be skewed to allow easy entry of the water.

(5) To minimize soil disturbance, the use of an excavator is preferred for culvert placement.

(6) Discharge of culverts should be directed to undisturbed or vegetated areas. Where necessary for erosion control, a sediment trap or mud sill shall be installed below the culvert outlet.

(7) Culverts shall be placed at the same level or slightly lower than the bottom of the waterway to avoid flooded areas at the inlet end.

(8) The apron at the outlet end of the culvert shall be on hard ground if possible. Otherwise, scour protection is required.

(9) Adequate soil cover must be provided between the top of the culvert and the road surface.

(10) Log clusters with earth fill are not recommended for use as culverts.

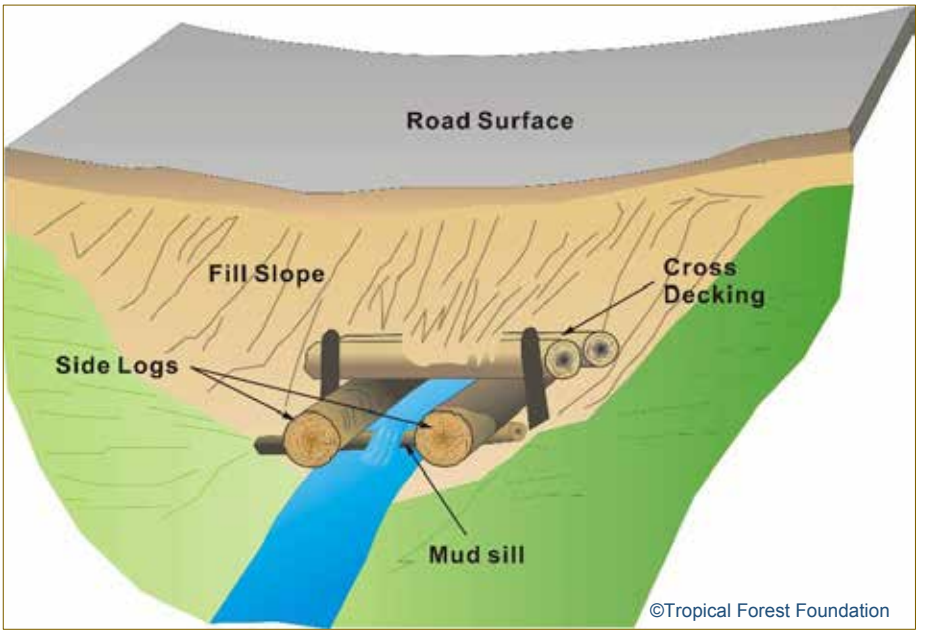


Figure 9: Design of basic log culvert

4.4.2.3 Water crossing using bridges

Bridges shall be used for crossing permanent flowing waterways and shall be properly designed. The following standards shall be observed, to ensure stability, longevity and hence, safety by road users:

(1) Wooden bridges shall be constructed from the most durable timber species available in the vicinity.

(2) Crossing of the waterways must be at right angles and approaches shall have a straight and level alignment for at least 20 m on either side, to minimize high impact on the bridge, and to ensure a safe approach to the water crossing.

(3) Installation of timber decking log bridge decks is preferred over earth fills.

(4) Abutments must be protected from scouring by the river, through the construction of wing walls or solid rock fills.

(5) Adequate headroom must be provided between the river flood level and the underside of the deck to allow for the passage of floating debris.

(6) Both sides of bridge entry points and bridge edges should be secured with guard rail logs to avoid vehicle slip into the waterway.

(7) Alternative options to wooden bridges are prefabricated steel truss or concrete bridges.

(8) Debris collected around the abutments and piers shall be removed on a regular basis.

Following completion, bridge condition and safety shall be regularly inspected and monitored to ensure user safety at all times.

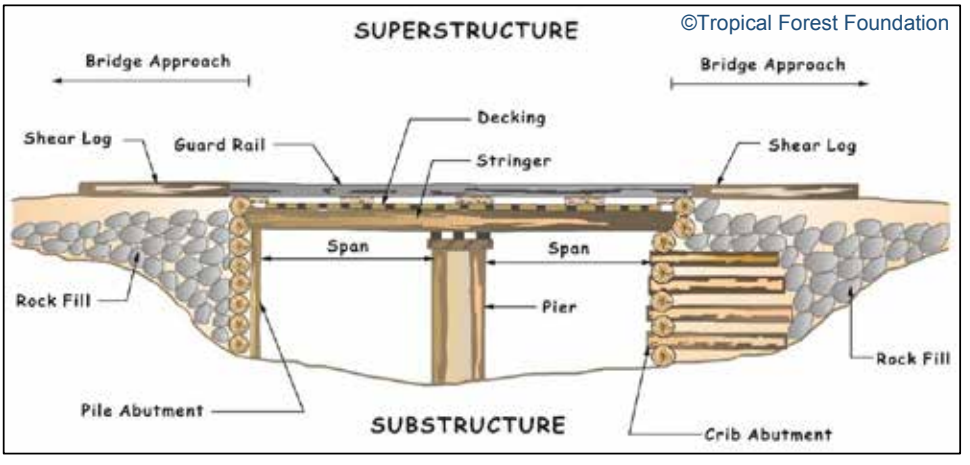


Figure 10: Typical design of a wooden bridge

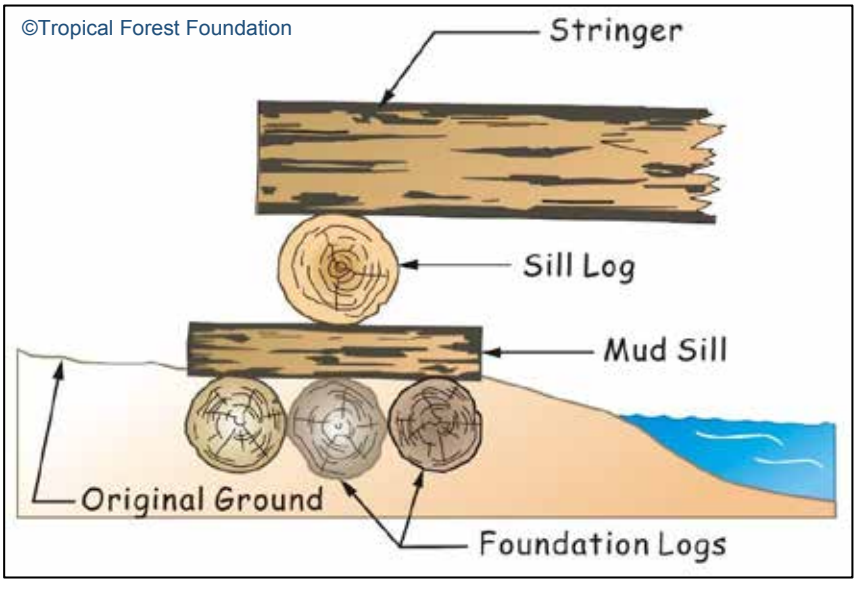


Figure 11: Abutment for wooden bridge

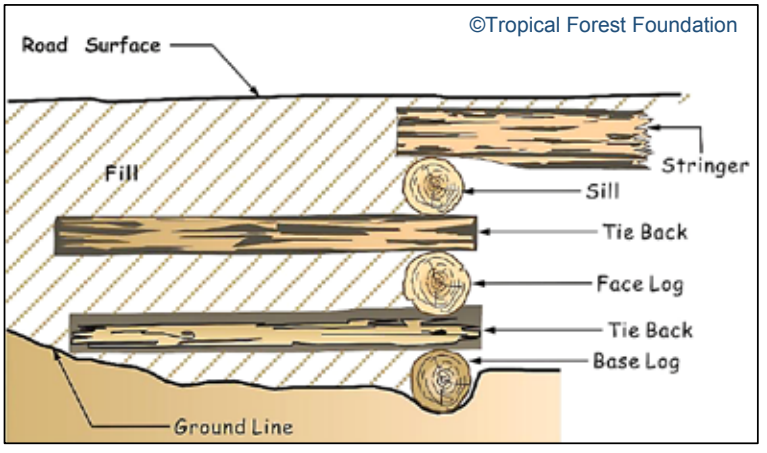


Figure 12: Crib structure for wooden bridge

Figure 13: Adequate headroom between river flood level and the underside deck

4.4.2.4 Installation of sediment traps

Sediment traps are important physical provisions for erosion control and mitigation. Points to be observed during installation include the following:

(1) The purpose of the sediment trap is to serve as a water catchment and filter for surface runoff, before the water is discharged into the waterways.

(2) The size and shape of the sediment trap needs to be adapted to the expected water volume at the point of installation.

(3) Sediment traps shall be constructed and maintained at critical points along the forest road, where a high risk of soil entering the waterways has been identified.

(4) Sediment traps are usually located along roads near waterways or other discharge points to reduce the sediment content of the surface runoff.

(5) Sediment traps shall be cleaned periodically in order to maintain their effectiveness.

Figure 14 shows a roadside trap for capture of runoff sediments.

Figure 14: Sediment trap

4.4.3 Road Maintenance works

Frequent inspections of road conditions need to be carried out to identify road damages and road failures at an early stage. This will assist in keeping maintenance cost low and to the necessary minimum.

All roads shall be adequately maintained when still in use, to ensure a stable and smooth surface, and an effective drainage system. Regular maintenance will ensure the safety of road users and avoid high wear and tear of vehicles. Points to be observed during road maintenance works include the following:

(1) The road camber shall be maintained using motor grader, to ensure that the water from the road surface is effectively channeled to the side drains.

(2) Carry out regular cleaning of ditches to ensure they are free of debris which might block effective waterflow.

(3) Culvert inlet and outlet points shall be cleaned periodically to prevent clogging and formation of stagnant ponds.

(4) Roadside vegetation in curves shall be trimmed regularly to ensure visibility and safety for road users.

(5) Maintain grass and ground vegetation along straight road sections to reduce erosion of surface materials.

(6) Road distance signage, road arrow signage, and road warning signage at dangerous road spots shall all be refreshed or renewed, as necessary to ensure the safety of all road users.

(7) Stop the movement of trucks and heavy machineries during wet periods to avoid the disturbance of the road body and development of ruts.

Figure 15 shows a motor grader undertaking grading works on a feeder road.

Figure 15: Road works with motor grader

4.5 Construction and preparation of new and existing skid trails

The construction and preparation of new and existing skid trails *shall follow the approved RILP with RIL Workmap*. The key activities to be observed and implemented are summarized below.

What should be done

a) All persons involved in skid trail works shall wear appropriate Personal Protective Equipment (PPE), according to their job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

b) Skid trail shall alignments generally follow ridges and spurs, as indicated on the *RIL Workmap*. For flat or gentle terrain areas, the skid trail shall be located on the higher and drier sections.

c) Skid trails must be constructed or prepared *prior to tree felling and log extraction*.

d) Open skid trails by felling trees on the trail. Trees larger than 20 cm dbh should be cut with chainsaw and carefully removed from the trail using tractor assistance. Pushing of skid trail shall only start after trees have been cut.

e) Skid trail construction and reopening is not permitted during wet weather, due to the high risk of mudflow and soil erosion, resulting in soil loss on steeper skid trail sections.

f) The tractor shall commence construction of the trail from Block entry point at the landing site and follow closely the painted or flagged trees. Minor deviations are allowed if sub-surface rocks or deep moist soil pockets are encountered.

g) Avoid creating sharp turns of the skid trail which could cause damage to the residual trees when skidding long logs.

h) Removal of the vegetation and soil must be done carefully using the blade of the tractor. On flat and gentle terrain, keep the blade slightly raised and leave woody debris on the skid trail.

i) Soil removal must be restricted to the minimum necessary for safe machine operation. Push soil to flat and stable areas, where possible. Avoid pushing soil to tree trunks.

j) If crossing of streams for log extraction is unavoidable this should be made at places where it can be crossed at a right angle to the stream. A rocky stream bed is a preferred location. The stream bed is to be filled with a matting of debris and small low quality logs arranged parallel to the stream, allowing water flow (refer **Figure 17**).

k) Side cutting is permitted up to a maximum gradient of 35° (70%). Limit side casting to areas where soil will not enter the buffer zone of watercourses.

l) On sloping terrain near permanent waterways (outside the buffer zone), a buried log bund with a 45˚ angle across the skid trail shall be constructed at the end of the main skid trail. This serves to channel the surface flow into the forest and to prevent water from entering directly into the waterways.

m) At the end of the skid trail a blue-painted cross sign (X) must be properly installed at the nearest tree, or on signboard mounted on wooden pole. Machine operators are only permitted to proceed up to this point.

n) Unused existing skid trails (established during previous harvesting) must be clearly marked with blue-painted cross sign (X) on the skid trail. This marking shall prohibit machine operators from entering decommissioned skid trails.

o) Ensure that all skid trail junctions are properly marked with the assigned skid trail number, by either paint marking on a tree at the junction or by erecting a signage post.

Figure 16: Tractor constructing a skid trail

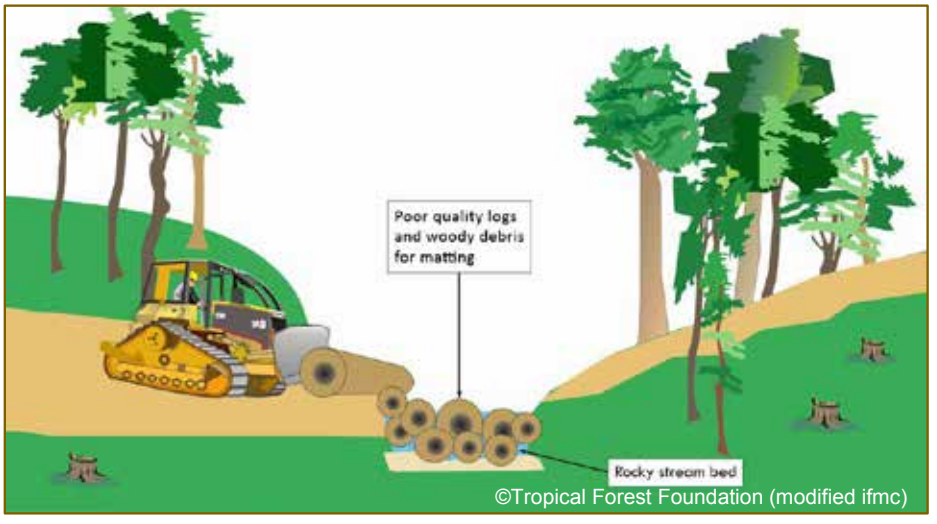


Figure 17: Design of temporary stream crossing

What should not be done

a) Construction of new skid trails not shown on the RIL Workmap, or entering prohibited skid trails from previous use (marked with blue "X") is strictly prohibited. Any need for additional skid trails must be discussed with the RIL Supervisor and Harvesting Manager or Camp Manager. If the reason for additional skid trails is found to be acceptable the Licensee/ appointed contractor shall forward a request for amendment of the RIL Workmap, and await the decision from FDS.

b) Skid trail construction or reuse is not permitted inside any exclusion area, as indicated in the RIL Workmap. In case the machine operator encounters any sensitive site not shown on the map he shall inform and seek advice from the RIL Supervisor for alternative skid trail alignment. Arbitrary deviation from the marked skid trail alignment is not permitted.

c) The width of the skid trail shall not exceed 5 m to minimize bare areas created during the construction. If constructed on side slopes, skid trail width may be increased to a maximum of 7 m.

d) No pushing of box cuts through hills and other terrain elevations are permitted, except in cases where there is no option causing less disturbance.

e) No trail sections from previous logging operations with a depth exceeding 2.5 m along steep slopes greater than 20° shall be reused, due to the high risk of collapsing side walls and serious gully erosion. Instead, detours away from the sunken trail shall be made along adjacent slopes.

f) On flat and gentle terrain areas with gradients of less than 15° (27%), the unnecessary removal of topsoil must be avoided to reduce tops soil removal and damage.

g) The skid trail shall not be constructed across streams unless unavoidable. Reasons for crossing should be presented to FDS in a written note during application of the RILP.

4.6 Log landings

4.6.1 Purpose

Log landings are mostly constructed at or near the entry point where main skid trails provide access to the harvesting Block. Wherever possible, landing sites from previous harvesting operations should be used to avoid unnecessary additional soil disturbance.

Log landing areas are designed for the temporary storage of logs, which will be subsequently transported to transit log yards or central log yards within the FMU. Besides their storage function, log landings serve to carry out debarking, quality checks, log trimming, tagging and recording, measurement, and preparation for loading onto trucks.

4.6.2 Construction and preparation of landings for log storage

Several points are to be observed during construction or reopening old log landing sites:

(1) The location of roadside landings follows the indication on the *RIL Workmap*, which is prepared for individual harvesting Blocks.

(2) The size of the roadside landing shall not exceed 900 m², e.g. 30 x 30 m, 20 x 45 m, etc.

(3) In areas with steep slopes where it is not possible to widen the road to reach the required size of the landing a storage on road shoulders may be considered as an alternative. In such case it must be ensured that the logs stored on the road shoulders do not narrow the road width, allowing normal road usage and traffic flow.

(4) The exact location of the log landing shall be reconfirmed through geo-coordinates obtained from GPS readings.

(5) When reusing old log landings no soil should be pushed around. It is sufficient to clear off any vegetation and unevenness using a road grader or tractor by scraping off the surface to provide a firm base.

(6) When clearing the log landing site, no trees or soil shall be pushed into waterways or their buffer zones.

(7) To allow for easy site drainage the log landing shall be established on a gentle slope of 2%-3% towards the forested area.

(8) Runoff of shall be channeled into vegetation or sediment traps, and not directly into a waterway.

(9) Runoff from skid trails shall be prevented from entering the landing site.

Figure 18: Locations of roadside landing

4.7 Tree felling and cross-cutting

Tree felling operations form an essential part of forest harvesting. At the same time, this activity carries high accident risks for tree fellers and support workers, due to frequently difficult terrain conditions, irregular tree crown and stem forms, woody climbers, and the prevailing weather situation. Considering these risks, prime attention must be given to a safe felling operation.

The following requirements summarise the *Do's and Dont's* of tree felling and cross cutting:

What should be done

(1) Tree felling operations shall only be commenced after

- the felling operation has been endorsed by FDS,
- the RIL crew briefing has been conducted, and
- the skid trail network has been established on the ground.

(2) All persons involved in tree felling operations shall wear appropriate Personal Protective Equipment (PPE), according to their job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

(3) Tree fellers must have participated in a safety and health training course, including provision of first aid.

(4) Felling of tagged harvestable trees shall start from the end of the main skid trail and gradually proceed backwards to the landing at the road junction.

(5) Tree fellers must always be accompanied by tractor driver/ hookman to assist with tree felling works, and in case of incidents and emergencies.

(6) During the tree felling operation, no other person (except assistant) is allowed within a radius of at least two tree lengths around the tree to be felled.

(7) Tree fellers shall always ensure the full functionality and safety of their chainsaw and tools, before cutting any tree.

(8) Only tagged harvestable trees are to be felled.

(9) Tree fellers must possess a valid tree feller certificate and be competent in directional tree felling. Key requirements during tree felling include:

- check tree for hollowness and risk of falling branches
- verify and adjust recommended felling direction
- observe the natural lean of the tree
- ensure tree will not fall across valley or broken terrain with danger of log breakage.
- ensure tree will not fall into buffer zones.
- clear around tree for safe working space, and prepare escape path
- cut any wood climbers attached to the tree
- prepare proper felling scarf, and back-cut at lowest possible level, observe retention of hinge wood
- observe maximum stump height of 50 cm above higher ground (trees without buttress)
- make use of felling wedges to force tree fall into desired direction, where necessary
- after felling of tree, watch out for falling broken branches and debris before starting cross-cutting

Refer to **Figures 19, 20, 21** for illustration of felling techniques.

(10) Wherever possible, the tree felling direction should be made at an angle of 30° to 60° to the skidding direction to facilitate the winching operation from the tree stump to the trail.

(11) Trees shall be felled into areas which do not have Potential Crop Trees, Mother Trees, or Protected Trees. Felling trees into areas with dense natural regeneration should also be avoided where possible.

(12) Wherever possible, tree crowns should fall onto the skid trail, to reduce canopy gap size and damage to the residual stand. In cases where a canopy gap already exists the tree may be felled into the same gap.

(13) Trees shall be felled away from exclusion areas, including areas containing HCV, waterways and buffer zones, water catchment areas, and other protection areas. Directional felling techniques shall ensure that the tree crown of a tree to be felled lands outside the exclusion area.

(14) Hung-up trees may be pulled down with machinery assistance, following the completion of cutting.

(15) In case the tree feller identifies an untagged tree which in his opinion qualifies as a harvestable tree he shall inform the RIL Supervisor for consultation and decision making.

(16) The tree feller shall be provided with supplementary tags (white-coloured plastic tags) for fixing to the stump and logs after the completion of felling (refer to **Chapter 3.3.2**).

(17) Tree felling operations shall be stopped during wet weather and windy conditions. The Stop/ Resume instruction shall be the responsibility of the RIL Supervisor.

(18) Cross-cutting is done to separate the tree crown from the log section:

- Cross-cutting angle should be less than 10º from the vertical line.
- Beware of tension while cross-cutting log. If necessary, make a cut on the compression side to reduce tension on the cutting side, then make the final cut. Refer to **Figure 23** for illustration.
- When making the final cut, stand on the compression side of the log.
- In case of risk of chain bar getting stuck in the wood during operation: make use a felling wedge to keep open the sawing gap.
- Long logs exceeding 22 m in length shall be cross-cut into two logs of manageable length to avoid unnecessary damages to the residual stand during winching and log skidding operations.

(19) Observe the bucking rules for optimum wood recovery:

- When bucking off the tree crown, ensure any knot-free bole section of more than 2 m is included in the commercial log. Trim-off remaining branches.
- Buttresses are to be bucked from the butt log at the point where the circular diameter of the log begins to diminish. Any remaining flanges are to be bucked off at the felling site.
- Refer **to Figure 22** for illustration.

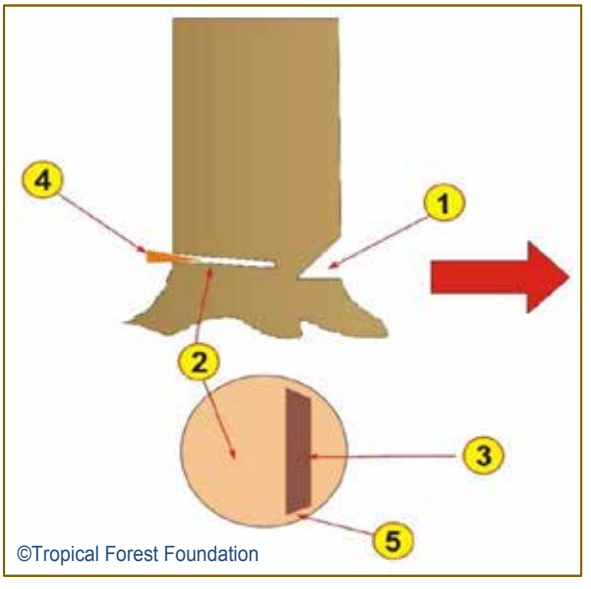


Figure 19: Felling technique and sequence for trees without buttress

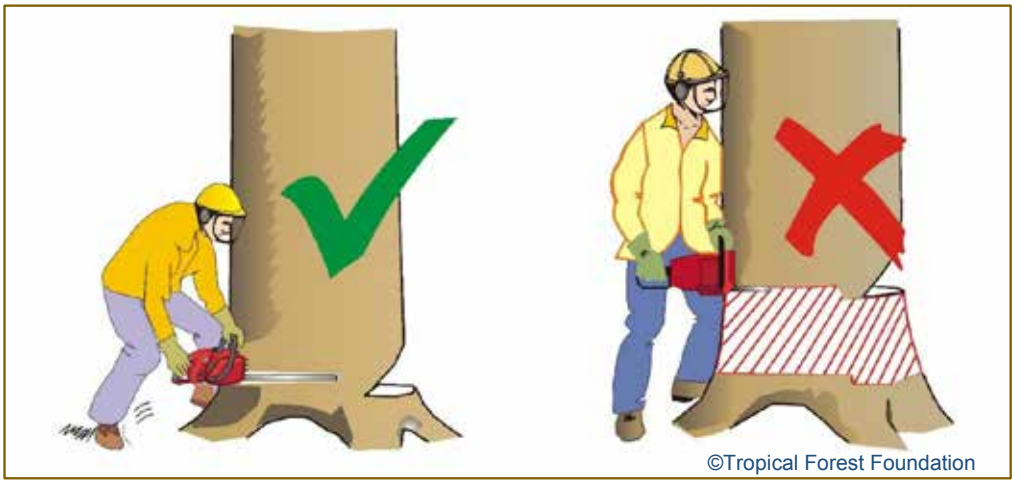


Figure 20: Correct and wrong felling height

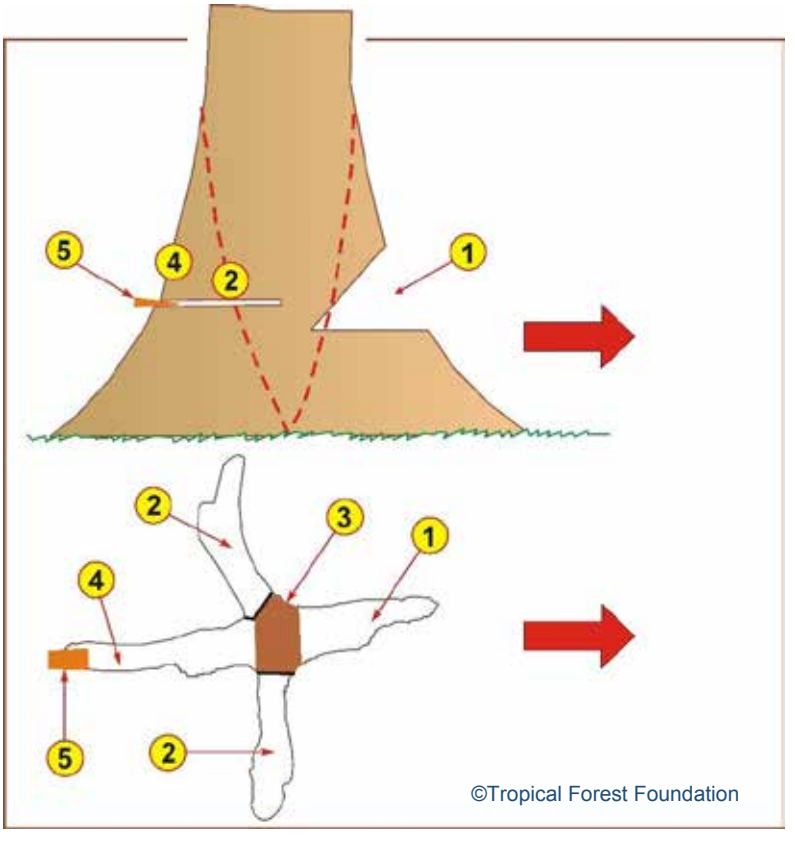


Figure 21: Felling technique and sequence for trees with buttress

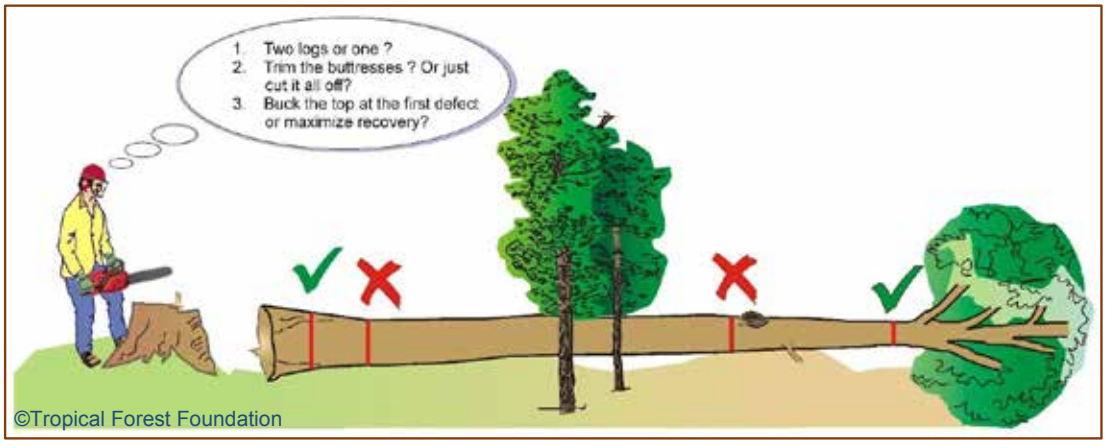
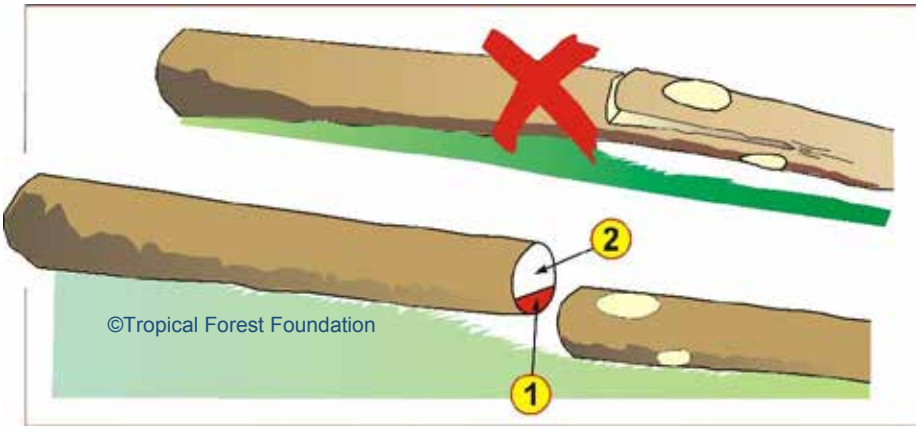


Figure 22: Correct and wrong cross-cutting and bucking of a felled tree to maximize the wood recovery of a felled tree



1 = under compression **2 = under tension**

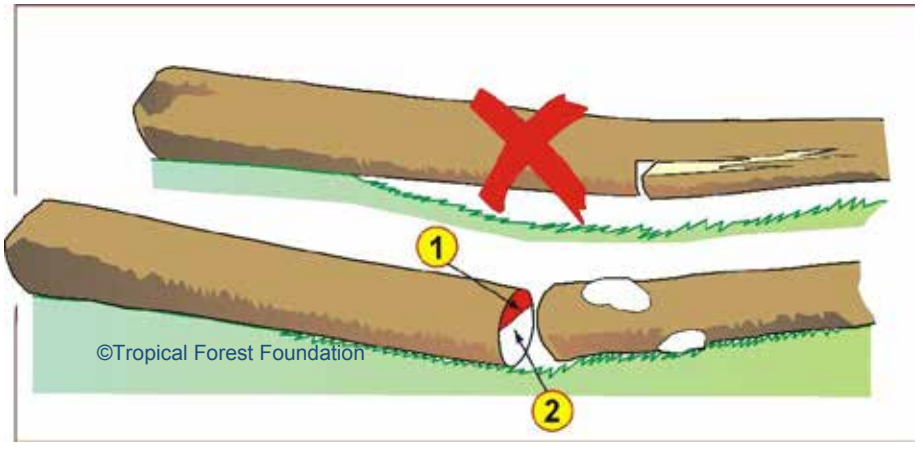


Figure 23: Correct and wrong cross-cutting of logs under tension

What should not be done

(1) No untrained person without tree feller certificate shall be permitted to fell any tree in the forest.

(2) For safety reasons: tree feller should ensure that no other person is within 2 tree lengths of the tree being felled.

(3) The minimum diameter cutting limit for harvestable trees is specified in the Forest Management Plan (FMP) of the Forest Timber Licence. Felling of undersized trees is prohibited, with the exception of trees located within five (5) m from the centre line to both sides of the skid trail.

(4) In gentle terrain, trees shall not be felled haphazardly, which may result in excessive damage and large canopy gaps.

(5) On steep slopes, trees shall not be felled directly down the slope. Directional tree felling techniques should ensure trees falling laterally across the slope, or preferably in an uphill direction to minimize breakage of the felled tree and damage to the surrounding stand.

(6) Felling of trees shall not be carried out during windy and rainy weather conditions.

(7) Totally protected plants and protected plants, and fruit trees shall not be felled unless permitted under Section 30 of the Wildlife Protection Ordinance, 1998.

(8) Tree feller shall not fell any untagged tree which in his opinion is a “harvestable” tree, unless he has consulted the RIL Supervisor for decision making and obtained approval.

(9) Felling of trees within exclusion areas, including areas containing HCV, waterways and buffer zones, water catchment areas, and other protection areas, is not permitted.

(10) Do not use machinery assistance to pull trees while being felled.

(11) Do not fell trees to bring down hung-up trees, but seek machinery assistance using winch cable.

(12) Cross-cutting

- Do not stand on the log while cross-cutting
- Do no stand on the lower side of the tree of cross-cutting is made on a hill slope (risk of rolling log)
- Do not use the tip of the chainsaw bar as this can cause kickback of the chainsaw

4.8 Log extraction to skid trail

Hookmen play an important role in log extraction to the skid trail. They will search for the best option for log winching and direct the movement of the machinery (tractor or modified excavator) along the skid trail, allowing easy winching.

Several points need to be observed to enable a smooth log extraction:

(1) All persons involved in preparation of winch line path and winching, hooking and unhooking of logs and machinery operation shall wear appropriate Personal Protective

Equipment (PPE), according to their job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

(2) For tractors the installation of an integrated arch (A-frame) is encouraged to facilitate the log extraction by lifting the log end off the ground. This technology can contribute to reduce winching and skidding damages.

(3) Dimensions of winch cable: the diameter of the winch cable should be as small as possible, enabling an easy pullout to the log but still ensure adequate pulling and break force strength for a secure operation. This can be ensured by the use of highly compacted, galvanised steel cables, which are the preferred option. For tractors, the recommended minimum cable length on the winch drum is 40 m. For modified excavators, the minimum length is 100 m.

(4) Permanent communication between hook men and the machine operator must be ensured, either through maintaining visual contact and/or through the use of radio sets.

(5) The hookman identifies a suitable, straight winching path between felling site and skid trail that avoids or minimizes damage to PCTs, mother trees and protected trees during the winching operation. The preferred extraction angle ranges from 30º to 60º to the skid trail alignment.

(6) Soil disturbance during the winching operation shall be minimized.

(7) During the winching process, no person is allowed to position himself between the log and the machine, within a corridor 10 m to the left and right of the tensioned winch cable.

(8) In cases where a log gets stuck at an obstacle (tree, rock, soil bump, etc.) the hookman shall *immediately request the stop of the winch operation* to avoid cable damage or snap. The hookman must detach the winch cable and request the machine operator to shift the machinery along the skid trail, enabling a different winching angle for log pulling. As an alternative, pulleys to be attached to nearby solid trees can be used to divert the pulling angle and overcome the obstacle.

(9) Hookmen shall frequently inspect the winch cable for damages. Broken cable wires are unsafe for winching and must be repaired or wires must be shortened or replaced.

(10) The tractor shall remain on the skid trail and use the cable winch to pull the log from the stump to the skid trail. In cases where log extraction is difficult with the use of the winch, *skid trail breakouts of up to 20 m are permitted*. In such case the tractor operator shall reverse into the forest to reach the log to be winched out. *Turning the tractor inside the forest is not permitted* to minimize soil disturbance.

(11) Log winching operations shall be stopped during wet weather and windy conditions. The Stop/ Resume instruction shall be the responsibility of the RIL Supervisor.

(12) Safety requirement: all tractors employed for winching logs to the skid trail *must be equipped with a steel protective grille* mounted on the rear of the cabin above the winch. This safety feature protects the machine operator from any impact caused by the snap of a winch cable.

(13) Use of modified excavator/ mobile yarders for log winching:

- this machinery should be positioned at strategic locations (platform or shuttle landing) within the Block, in areas with higher density of harvestable trees. Refer to the *RIL Workmap* for platform locations.

- machinery offers longer winch cable reach from the skid trail into the forest of more than 100 m. It is used for log extraction from the felling site to skid trail only (not for log transport). Where such machinery is available tractors should only be used for skidding logs to the log landing.
- platform clearing area shall not exceed 20 x 20 m around the platform is permitted to allow for stacking of logs
- concerning safety aspects, the same principles apply as for log winching using tractors.
- Details of machinery operation for log extraction are to be developed by the Licensee/ appointed contractor using their own SOP.

Following log extraction to the skid trail the logs shall be arranged parallel to the skidding direction, awaiting pickup by the tractor for skidding to the roadside log landing.

Figures 24 and 25 show the log extraction to the skid trail using tractor and modified excavator, respectively.

Figure 24: Log extraction with tractor

Figure 25: Log extraction with excavator

4.9 Log skidding to landing

Simple tractors (bulldozers) with cabin protection are currently the only machinery type used for log extraction from the skid trail log storage point to the roadside log landing. Due to the high impact of this machinery on forest soils its movement must be strictly controlled to avoid unnecessary damage. Another disadvantage is the slow speed of log transport.

Wheeled grapple skidders with chained tyres or machine tracks avoiding machinery slip should also be considered to increase the productivity of log extraction which is frequently disrupted by wet weather conditions.

The important *do's and don'ts* of log skidding operations are summarized below:

What must be done

(1) All persons involved in log hooking, unhooking and machinery operation shall wear appropriate Personal Protective Equipment (PPE), according to their job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

(2) Machine operators and hook men must possess a *training certificate* in log extraction and choker setting/winching respectively, and be competent in conducting log skidding operations. Refer **Chapter 1.5, Table 1**.

(3) In areas with gentle to undulating terrain the *use of wheeled skidders with log grapple is encouraged* to reduce ground disturbance, and to increase the skidding performance.

(4) Machine operators and hookmen must have participated in a *training course on safety and health*, including provision of first aid.

(5) Winched logs shall be skidded from the modified excavator/ mobile yarder platform to the roadside landing by the tractor only.

(6) Logs of excessive length shall be cross-cut prior to skidding, to avoid damages to residual trees along the skid trail. The *maximum log length is set to 20 m.*

(7) Log extraction *shall be stopped during wet weather conditions*. The Stop/ Resume instruction shall be the responsibility of the RIL Supervisor. Indicators for stopping operations:

- soils are saturated with mud moving down in deepened skid trail ruts for more than 10 m ground distance
- blading of skid trail would become necessary to continue skidding (which must not be done)
- formation of water ponds on any work areas, e.g. platforms, log landing sites, exposed areas, etc.
- truck operation on the road is dangerous because of slippery conditions

Figure 26 illustrates the use of the tractor (bulldozer) to skid the logs from the skid trail landing point to the roadside log landing.

Figure 26: Log skidding to landing site by tractor

What must not be done

(1) Only a single tractor at a time is allowed to carry out log skidding on a skid trail.

(2) Skidding across or within exclusion areas (areas containing HCV, rivers/ streams including buffer zones, water catchments, steep slopes, etc.) is prohibited. If stream crossing is unavoidable, crossing shall be done at a stable site with rock or gravel bed. Any exemptions shall be approved by the RIL Supervisor. Refer to **Figure 17** for illustration.

(3) Soil blading of the main skid trail and side cutting shall be avoided.

(4) Damages to residual trees along skid trails are not permitted during skidding operations.

(5) Crown debris on the main skid trail shall not be removed unnecessarily by blading with the tractor, but tracking over the debris instead is preferable.

(6) Mobile fuel tanks shall not be placed near any waterways, or within any other exclusion area.

4.10 Log preparation at log landing

Logs skidded out from the forest are stored at the pre-identified log landing areas according to the sites shown in the RIL Workmap.

The activities and aspects to be observed when working on these sites are described below:

(1) All persons involved in work at the log landing site shall wear appropriate Personal Protective Equipment (PPE), according to their job function and accident exposure risk. For details, refer to **Chapter 6.2, Table 7**.

(2) Log debarking: removing of bark from the logs.

(3) Log quality: check logs for obvious damages, such as large hollow, swellings and other major defects, and for cuts to made to improve general log appearance.

(4) Log trimming: remove residual buttresses, sections with large hollow, major defects.

(5) Apply S-nails to reduce log splitting.

(6) Log measurement: carry out measurement and record species code, mid diameter (cm), and log length (m).

(7) Log marking: Property Mark hammering at both ends of the logs to denote the Licence holder.

(8) Log tagging and recording: affix Log Production Identity (LPI) tags and company tags to both ends of the log. Tags contain information on species code, mid diameter (log length, m).

(9) Bark, offcuts, and other organic waste should be deposited in vegetated areas.

(10) The landing site shall always be kept free of non-organic waste. Any such waste must be collected in dust bins or plastic bags and disposed at the waste pit of the Base Camp.

(11) Any fuel or oil spills of machinery operating on site, and other Scheduled Wastes shall be immediately collected in leak-proof drums or containers and disposed offsite, according to the prescriptions of the DOE and NREB (refer EIA Report).

Figure 27 gives an impression of log scaling works at the log landing site.

Figure 27: Log measurement at landing site

4.11 Log loading

Loading the logs onto the truck for transport to the Point of Royalty Marking (PORM) is the final work step at the RIL Block related to log handling. Loading is normally carried out by wheeled log loaders. Steps during the log loading process are summarised as follow:

(1) The person in charge of the log landing will supervise the loading of logs onto the truck.

(2) Any person involved in loading or observing truck loading must wear the prescribed PPE (refer to **Chapter 6.2, Table 7**).

(3) The LPI number and company IDs and log related information (number of pieces, Block number, species, diameter, length, etc.) are entered into the *Transit Pass* covering the transport from the Block log landing site to the PORM.

(4) Long logs that would protrude from the end of the truck bed by more than 3 m shall be crosscut prior to loading, to avoid accident risks during trucking at sharp and narrow road curves.

(5) Upon loading logs onto timber truck, no person is allowed to stand within the danger zone covering the log storage point and the truck. The log loader shall be equipped with a

warning (strobe) light and engage it throughout its operation until log loading has been completed and the loader engine has been shut down.

(6) The end of the longest log on the truck chassis shall be flagged using a red for red/ white flag, to alert other road users.

(7) The log load is secured with at least two (2) tensioned chains or wires.

(8) A general safety check of the truck must be conducted by the lorry driver before departure (e.g. engine, front and brake lights, brake cooling system, tyre pressure, secure load, flagging, etc.).

(9) After log loading has been completed the truck driver confirms the receipt of the loaded log batch on the Transit Pass.

(10) Upon departure the truck driver shall engage the cabin top mounted strobe light to alert road users.

The loading of logs onto the timber truck is shown in the following **Figure 28**.

Figure 28: Log loading onto truck

4.12 Temporary cease of harvesting operations

A temporary cease of harvesting operations may occur due to the following reasons:

- occurrence of extended periods of wet weather, exceeding one month
- additional infrastructure requirements
- changes in operational sequencing of harvesting operations

Under these circumstances, the Licensee/ appointed contractor shall request from FDS to issue a temporary Block closure. In all Blocks with timber harvesting operations in progress the following measures shall be undertaken upon temporary cease of operations:

(1) Inform FDS about Block Number, date of stopping operations, reason for temporary cease of operations, and expected duration.

(2) Prepare summary records of trees felled and extracted.

(3) Where possible, recover any logs from the felling site and log landings

(4) Install water bumps and cross drains on all skid trails already used for log extraction

(5) Where skid trails lead to road junctions downhill: install sediment traps at junction to avoid runoff and mudflow reaching or crossing the road surface

(6) Conduct road maintenance works to ensure proper drainage

(7) Remove machinery, skid tanks, tools and equipment from the harvesting Block

FDS will carry out random inspections of sites under temporary cease of operations to verify the compliance with the prescribed management measures. Upon completion of the required activities, FDS will issue a *Block Clearance Certificate* to the Licensee or appointed contractor.

4.13 Environmental safeguards

Timber harvesting operations can cause adverse environmental impacts which mainly occur during road construction as well as road repair and maintenance works, and during tree felling and log extraction to the landing site. Efforts to minimise and avoid negative impacts are essential components of environmentally sound RIL practices.

For this reason, all forest operations bearing risks of adverse impacts should be undertaken by employing the principle of precautionary approach, i.e. *whenever an activity raises threats of harm to human health or the environment, the activity should either not be carried out, or appropriate measures shall be taken to avoid identified risks, and to prevent damages*.

The following measures shall be carried out to safeguard the forest environment:

(1) Plan and implement road and skid trail and works with the objective to *minimise soil disturbance and erosion*. Reduce road widths where possible.

(2) Stop operations and avoid the use of roads, skid trails and log landings during wet and stormy weather conditions.

(3) Wherever erosion occurs, *implement adequate mitigation measures to stop erosion*, or to channel surface runoff into vegetated areas.

(4) Carry out *frequent functional and safety checks* of all machinery, vehicles, tools and equipment, to detect any malfunction, and instantly undertake the necessary repairs.

(5) *Mobile fuel tanks* shall be placed in stable and safe locations, preferably with roof cover. Points to observe:

- Location must be at least 30 m away from skid houses and inflammable material, and at least 50 m away from waterbodies.
- Refuelling of vehicles and machinery shall be made carefully to avoid any spillages.
- Syphons and fuel nozzles shall be placed on leakproof containments when not in use.
- Daily checks shall be made a designated person to check tanks and devices for leaks, and to take necessary mitigation action in case of spillages.

(6) Wherever leakage of fuels, oils and lubricants or any other hazardous substances occur, *immediately collect spillages and soils and dispose of contaminated materials* according to the prescribed environmental management standards and practices.

(7) *Minimise forest impacts by directional felling practices,* to avoid damages to protected trees and sensitive areas (rivers/ streams and buffer zones, areas containing HCV).

(8) *Minimise damages during log skidding* from felling site to roadside log landing.

(9) During dry spells with high fire risk: undertake frequent forest monitoring and prevention measures. Prepare and conduct crew briefing on fire response plan.

The Licensee and his appointed contractor(s) implementing the planning and operation of RIL activities are responsible for the compliance with these environmental prevention and protection measures, and for the necessary environmental briefing of all forest workers involved in the harvesting operation.

5. POST-HARVESTING ACTIVITIES

Post-harvesting operations are necessary to minimize any negative impacts resulting from unavoidable operations, and to accelerate the recovery of the residual forest vegetation and soils.

The focus of forest rehabilitation activities lies on regulation of surface runoff, erosion control, reactivation of natural water flows, and on re-vegetating of exposed areas as necessary.

5.1 Rehabilitation of skid trails

In hilly areas skid trails form a network of erosion channels which need to be effectively treated to reduce or minimize adverse environmental impacts, such as sedimentation and pollution of waterways. The following mitigation measures need to be implemented after the Block harvesting operation has been completed:

(1) For skid trail sections with a *gradient exceeding 20°* (36%) the water flow must be controlled using several optional methods:

- where both sides of the skid trail are bounded by walls of soil (deep skid trail cut into surrounding terrain) *water bumps shall be constructed* through earth bunds of at least one (1) m height and at 90º angle to the skid trail alignment, at intervals of about 20 m. Water bumps will block the water flow and act as sediment traps. This construction serves to avoid gully erosion and divert skid trail runoff into the forest. For illustration, refer to **Figure 29**.

- Where at least one side of the skid trail allows the skid trail runoff to be channeled side wards into vegetated areas, *cross-drains of at least 0.5 m depth shall be constructed*, with an angle of about 45º to 60º to the skid trail alignment. Cross-drains the runoff away from the skid trail. For illustration, refer to **Figure 30.**

- Near junctions of skid trails joining a logging road sediment traps should be established where necessary, to ensure that any sediments and mudflow running down from skid trails do not reach the road. For illustration, refer to **Figure 31.**

(2) Deeply eroded/ rutted skid trails sections should be backfilled with soil from deposits formed during skid trail opening.

(3) Planting of fast growing commercial trees on the shoulders of skid trails is recommended to achieve a canopy cover over the skid trail, which will help to reduce long-term erosion. In addition, the planted trees contribute to increase the harvestable volume during subsequent cuts. For illustration, refer to **Figure 32**.

(4) Water ponds created through blockage of water flow need to be reopened and discharged.

Figure 29: Water bump blocking skid trail runoff

Figure 30: Cross-drain diverting skid trail runoff to vegetated area

Figure 31: Sediment trap at skid trail - road junction

Figure 32: Rehabilitated skid trail

5.2 Rehabilitation of log landings, watercourses and heavily disturbed sites

After all logs have been skidded out from the forest and were transported to the Point of Royalty Marking (PORM), rehabilitation activities shall be carried out on log landing sites, platforms used for modified excavators, and log landing sites. These measures will assist in reducing runoff, erosion and sedimentation of water courses and hence, enable effective forest recovery.

The recommended rehabilitation activities include the following:

(1) remove any debris from harvesting operations that has entered and blocked or reduced natural flow of watercourses, caused by temporary stream crossings or by tree crowns affecting natural water flow in rivers or streams

(2) drain all areas where water may pond to vegetated areas

(3) ripping of compacted surfaces using tractor or excavator, followed by

(4) spreading of cover seeds, or planting of grasses or creepers, and/or

(5) planting of indigenous commercial tree species, preferably on the less compacted areas at the landing periphery.

At log landing sites, any available organic material should be used to cover the exposed areas. such as bark residues which also will provide nutrients for planted seedlings.

These combined measures will produce the desirable results of halting erosion through quick soil cover, and producing commercial timber for the next harvesting event.

Figure 33 shows an image of a successfully rehabilitated log landing site.

Figure 33: Rehabilitated log landing site

5.3 Waste removal and disposal

Upon completion of harvesting operations all non-organic waste must be collected and removed from the harvesting Block and log landings. This measure shall ensure that the environment is left behind without human waste that might harm the forest with its unique flora and fauna.

Typical waste generated during timber harvesting operations include *broken winch cables, metal scrap, tyres, empty drums and fuel, oil and grease containers, oil filters, plastic bottles, packing materials, metal tins*, *and organic waste*. All non-organic and Scheduled Wastes shall be orderly collected and removed from the harvesting area, log landings and refueling pads.

Waste disposal shall be made in an environmentally appropriate and legal manner, according to the rules and regulations of the *Department of Environment* (DOE), and the *Natural Resources and Environment Board* (NREB).

Details on collection and disposal of Scheduled Wastes are provided in the EIA Report or can be obtained from the above authorities.

5.4 RIL compliance assessment

The overall compliance with the RIL Guidelines needs to be verified through a systematic assessment conducted by FDS, and/ or an independent 3rd party acting on behalf of FDS. The objectives of verifying RIL compliance by FDS are summarized as follows:

- to assess the level and quality of compliance with the provisions of the RIL Guidelines
- to provide feedback to the harvesting crews on their RIL performance
- to identify training needs of harvesting crews
- to identify any provisions of the RIL Guidelines that require further improvement

FDS has developed Standard Operating Procedures for the RIL Compliance Assessment, including the scope, timing, assessment parameters, analysis and reporting mechanism. The RIL compliance assessment will be undertaken in randomly selected Blocks, *not later than 3 months after completion of harvesting operations*.

5.5 Post-logging Block Inspection

Upon completion of all harvesting and post-harvesting operations a *Post-Logging Block Inspection* (PLBI) is carried out by FDS Officers. The focus of this inspection lies on legal aspects and the proper utilization of forest products, including verification and checks of the following details:

- Block completion date
- machinery removal from harvesting block
- unauthorized cutting of undersized trees
- complete removal of commercial timber from the block
- damages to protected trees
- complete removal of logs from log landings
- removal of logs from temporary stream crossings
- waste removal

The inspection takes into account the provisions and regulations stipulated in the *Forest Rules* (FR) of FDS.

The results of the PLBI also serve as evidence for the issue of penalties to the Licensee / appointed contractor, in cases of non-compliance with the FR. FDS will inform the Licensee / appointed contractor about all Blocks that have been formally closed, and any Blocks requiring corrective measures to be implemented before a closing can be conducted.

No entry into the harvesting Block is permitted after its closure has been declared.

5.6 Moving of machinery and equipment

Moving of machinery and equipment between harvesting Blocks needs to be organized in a careful and controlled manner, to ensure the forest environment is not unnecessarily damaged or unduly affected. Upon moving machinery, mobile fuel tanks, skid houses, fuel drums, containers, personal belongings etc. from the temporary camp site the RIL Supervisor shall ensure that the site is only abandoned after the following activities have been satisfactorily completed:

(1) Any soil contaminated with fuel, oil, lubricants, paint or other hazardous substances must be collected in leakproof containers or drums and disposed of in an appropriate manner.

(2) Any Scheduled Wastes must be removed from the site, in accordance with the prevailing rules and regulations of the *Department of Environment* (DOE), and the *Natural Resources and Environment Board* (NREB), as prescribed in the Environmental Impact Assessment (EIA) Report.

(3) All non-organic, non-toxic waste shall be deposited in waste pits which must be closed using a thick layer of soil.

(4) Pit toilets must be closed using a thick layer of soil.

(5) Water tanks, pipes and hoses shall be disconnected from the water source and removed from the site.

The RIL Supervisor shall confirm the orderly movement to the next destination by filling and signing of a company form, confirming the satisfactory completion of the above activities and the moving date.

5.7 Road closure

Following the completion of harvesting operations, RIL compliance assessment and Block closing inspections all non-essential forest roads considered as temporary and used for timber harvesting shall be closed. This activity mostly affects feeder roads. Road closure activities shall be implemented by the Licensee/ appointed contractor, covering the following activities:

(1) remove debris blockages from rivers and streams to ensure natural drainage
(2) dismantle and remove all culverts and bridges to allow unobstructed waterflow
(3) erect effective barriers at the entrance of inactive roads to prevent unauthorized access
(4) post signage on road closure and hunting prohibition

Figure 34 shows a closed feeder road following abandonment of the harvesting area.

Figure 34: Closed feeder road

Proper closure of roads following completion of harvesting operations serves to ensure effective drainage, to control illegal harvesting and hunting, and also to assist in the prevention of unauthorized settlement activities along abandoned forest roads. Physical closure can be carried out by digging trenches or placing large reject logs across the feeder road. In addition "*No hunting*" signs should be erected at the road junction.

6. SAFETY, HEALTH AND SOCIAL BENEFITS

6.1 Safety rules and regulations

Forest operations continue to be among the most hazardous industrial sectors in Malaysia and around the world. For this reason, the *International Labour Organisation* (ILO, 1998) has developed a *Code of Practice on Safety and Health in Forestry Work*, which refers to all countries and forest types. It aims to protect workers from hazards in forestry work, and to prevent or reduce the incidence of injuries and occupational illness.

At the national level, the *Department of Occupational Safety and Health* (DOSH) under the *Ministry of Human Resources Malaysia* introduced the *Guidelines on Occupational Safety and Health in Logging Operations* (2004). These Guidelines address all typical risks and hazards in forestry operations and establish rules for accident prevention. In principle, the recommended practices also apply to companies operating in the Sarawak forestry sector.

In line with the Occupational Safety and Health Act (Act 514, 1994) of the Laws of Malaysia, the employers are required to produce and publish a written *Occupational Health & Safety Policy*. Employers must inform employees about the policy and undertake periodical reviews and updates as necessary. In addition, a *Safety & Health Committee* needs to be established and a Safety and Health Officer must be appointed for supervision and monitoring of safety and health practices, as well as for training and accident reporting to the *Department of Safety and Health* (DOSH) Sarawak.

At the level of an individual Forest Management Unit, however, some aspects of these national Guidelines may not be relevant, or they need to be implemented through applying modified practices.

Key components to all efforts to avoid or minimize accidents include safety and health training at the work site, the compulsory use of prescribed Personal Protective Equipment (PPE), compliance with established SOP requirements, provision of first aid, and emergency response procedures. These topics are addressed in the following sub-chapters.

6.2 Provision and use of Personal Protective Equipment

Appropriate Personal Protective Equipment (PPE, SIRIM certified) shall be made available and provided by the employer to all RIL forest workers, planning and support staff. The employer shall also be responsible for monitoring the PPE condition and functionality, as well as PPE replacement after its prescribed lifespan has expired.

The RIL Supervisor shall be responsible for the consistent use of PPE by all persons involved in the RIL harvesting operation.

The type of PPE to be provided shall depend on the accident risk exposure of a forest worker. The minimum PPE requirements by job function are listed in the following **Table 7**.

Table 7: Minimum requirements for Personal Protective Equipment by job function

TYPE OF PPE / OPERATION / FUNCTION	Safety helmet	Safety goggle/ Helmet visor/ Spectacle	Ear plug	High-Vis Vest	Work gloves	Safety shoes/ Suitable shoes
Pre-Felling Inventory						
1. Forest Survey/inventory team	√			√		√
Harvesting Operation						
1. Chainsaw operation (tree felling, cross-cutting)	√	√	√	√	√	√
2. Machine operator (excavator)	√		√	√		√
3. Hook man	√			√	√	√
4. Supervisor/ support staff	√			√		
Log Skidding Operation						
1. Machine Operator (tractor)	√		√	√		√
Log Landing Operation						
1. Machine operator (log loader)	√	√	√	√		√
2. Debarker	√			√	√	√
3. Log scaler/ tally clerk	√			√	√	√

Note: Refer to OSHA & Guideline on Occupational Safety and Health in Logging Operations

Figure 35 shows a typical PPE outfit for a chainsaw operator.

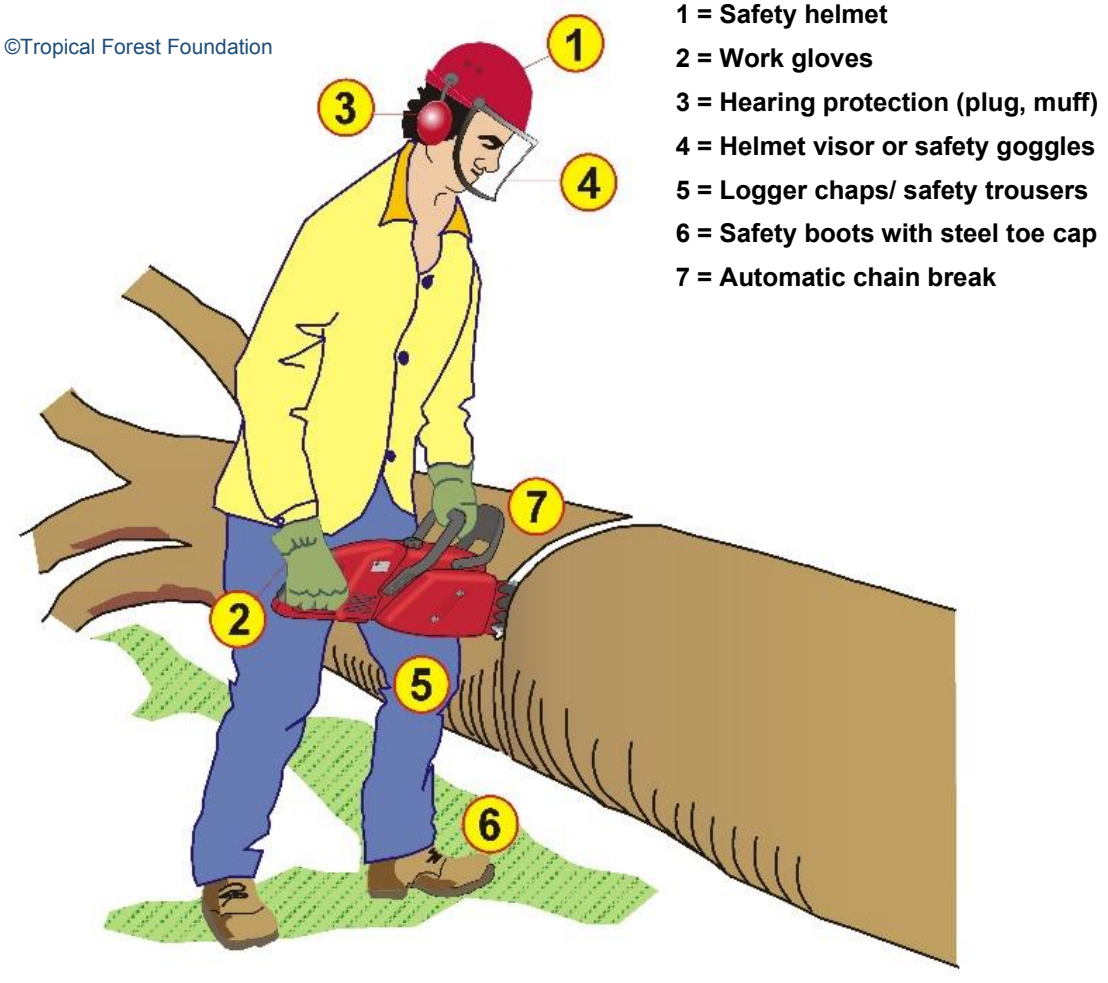


Figure 35: PPE outfit for chainsaw operator

6.3 First aid

6.3.1 First aid training

Provision of first aid at the accident site is an essential measure which can save lives. Considering the remote location of forest operations without nearby medical facilities it is imperative that key forest workers engaged in RIL operations must undergo training in basic First Aid including Cardiopulmonary Resuscitation (CPR). These include the following persons:

- Crew Leaders and Assistant Crew leaders in pre-felling surveys,
- RIL Supervisors,
- Tree fellers,
- Hook men,
- Machine operators, and
- Supervisors/ Foremen at log landing sites.

Training courses are offered by several institutions, such as, e.g. the *Malaysian Red Crescent Society Sarawak,* the *Kementerian Pendidikan Malaysia-UNIMAS,* the *National Institute of Occupational Safety and Health (NIOSH), and the St. John Ambulance Sarawak*.

It is the employer's responsibility to organize the training for the selected forest workers.

6.3.2 First aid equipment

Besides training in provision of first aid and first aid kits shall be made available to forest workers by the employer.

First aid kits are the most important tool for direct assistance and care of forest workers sustaining injuries or other impairments of health, affecting their work performance. First aid kits must contain the necessary items enabling immediate treatment. The following contents is recommended at the minimum:

- for wounds (cuts, scratches, punctures, rashes): disinfection solution/ antiseptic wound spray, plasters, sterile wound dressings and compression/ gauze bandages, rash cream, antibiotic ointment, sterile tweezers, bandage scissors, disposable latex gloves
- for treatment of insect bites: mosquito deterrent, soothing ointments
- for treatment of eye sore and irritations: eye drops

The contents of first aid kits and use of items must be recorded. *Regular refills* need to be made so that all essential items are available in case of need. Storage prescriptions for medical supplies as prescribed by DOSH need to be followed.

It needs to be ensured that the contents of the first aid kit are properly *sealed against contamination* by dirt, dust, heat, water or moisture.

The RIL Supervisor shall ensure that *first aid kits are to be placed at or close to the work sites*, enabling their instant availability: at the tree felling site, on machinery and support vehicles, and at the roadside log landing.

In addition, heavy machinery and support vehicles must be equipped with *fire extinguishers*.

6.4 Accident emergency procedures

Emergency procedures provide guidance for preparation, prevention and immediate action in case of accidents occurring during RIL operations. The Licensee/ appointed contractor shall prepare and disseminate an *Emergency Response Plan (ERP),* using the company's SOP format. The ERP describes the routine actions to be taken upon accident occurrence, including the following elements:

- provisions for permanent accessibility of all work sites
- procedures for provision of basic first aid on-site
- information and activation of emergency team, communication channels
- decision about treatment (on-site or off-site)
- transportation of accident victim to base camp, nearest clinic, or hospital
- report about accident details to the Safety & Health Officer and S&H Committee

The ERP shall include responsibilities for each action to be taken.

All forest workers involved in RIL operations shall receive an ERP briefing and must properly understand their roles and responsibilities in case of emergencies.

6.5 Hygiene in temporary camps

The establishment and maintenance of hygienic conditions in temporary camps is important to ensure safe and healthy living conditions for RIL harvesting teams. Recommended common facilities in these camps include skid houses for worker accommodation, facilities for food preparation, portable generators, washing and cleaning areas, storage areas, water tanks, pit toilets, and waste disposal pits.

The following practices are recommended to ensure safety, health and cleanliness:

(1) Skid houses

- to be positioned in safe locations, i.e. not on loose soil, not at the foot of steep slope areas, and not near steep downward slopes
- ensure effective drainage around houses, no standing water is allowed
- no hazardous goods (fuel, oil, lubricants, paint, thinner, chemicals, etc.) are permitted to be stored within, outside or underneath the skid house
- no open fire is permitted near skid houses
- netting for windows and rest places should be provided to reduce risks of mosquito-borne diseases
- sewage shall be directed to a disposal at least 20 m away from the skid house and is to be discharged in a way to avoid entering
  - catchment of drinking water supply,
  - rivers and streams,
  - any area where it could cause a health risk to camp inhabitants

(2) Portable generators

- should be positioned at least 20 m away from skid houses
- must be placed on sealed surfaces, trays or other liquid-impermeable material to ensure fuel/ oil spills can be contained and do not enter the environment
- must be frequently monitored and serviced to avoid spillages

(3) Storage areas

- shall be designed for storage of hazardous goods, i.e. with roof and on sealed surfaces or liquid-impermeable materials to ensure fuel/ oil spills can be contained and do not enter the environment
- must be placed at least 20 m away from skid houses
- must be equipped with means of spillage collection: broom/ shovel, leak proof container/ drum

(4) Water supply and use

- Water supply shall be arranged through rainwater or pumped from nearby streams water which is stored in water tanks adjacent to the skid house.
- Basic water filter shall be installed and maintained, at water intake int the tank, and at the water dispenser.
- Water for personal consumption must be boiled for safe use.

(5) Pit toilets

- shall be established at least 50 m away from water bodies and water courses, and at least 20 m away from skid houses
- to be covered with a layer of soil once every week
- to be filled up with soil upon camp abandonment

(6) Domestic waste pits

- to be established at least 50 m away from water bodies and water courses, and at least 20 m away from skid houses
- must be located above ground water table and designed in a way that runoff cannot enter the pit
- shall not be used to dispose scheduled wastes (oil and oil filters, fuel, paint, grease, chemicals, contaminated materials, etc.)
- shall be covered with a layer of soil once every week
- to be filled up with a thick layer of soil upon camp abandonment

(7) Medical supplies

Basic medical supplies shall be provided for each temporary camp for treatment of

- wounds (cuts, scratches, punctures, rashes): disinfection solution/ antiseptic wound spray, plasters, sterile wound dressings and compression/ gauze bandages, rash cream, antibiotic ointment, sterile tweezers, bandage scissors, disposable latex gloves
- insect bites: mosquito deterrent, soothing ointments
- eye sore and irritations: eye drops
- skin itchiness and fungal infections: anti-septic cream, anti-fungal ointments
- fever and cough: medication for fever treatment, cough sirup
- muscle and limb pain: pain relief, bandages

An impression of a typical temporary camp for harvesting crews is shown in **Figure 36**.

Figure 36: Temporary field camp for harvesting crews

6.6 Social amenities

In a tough work environment such as forestry, workers should be provided some basic leisure facilities which help to maintain physical and mental health. Employers are encouraged to support forest worker livelihood by providing some amenities after a hard working day in the forest. This includes equipment for recreational and physical fitness exercises, such as, e.g.

- Badminton (rackets, shuttlecocks, badminton net)
- Sepak Takraw (rattan ball, net)
- Football
- Darts (darts, dartboard)
- Board games

Any of this equipment made available will serve as an appreciation of forest workers who are lacking many leisure facilities over extended periods of time.

The Licensee and his appointed contractor shall also ensure that following completion of their duties and responsibilities, all forest workers and relatives can exercise their right of religious and spiritual customs and practices and hold their prayers and devotions irrespective of their religious affiliation.

GLOSSARY

Abutment = A (bridge) abutment is a structure which connects the deck of a bridge to the ground, at the ends of a bridge span, helping support its weight both horizontally and vertically.

Back-cut = the final cut involved in felling a tree. The back-cut should always be higher than the felling scarf.

Bucking = reduces the felled tree into marketable products for input into wood-processing plants, e.g. saw or veneer logs. The job of the bucker is not to make little logs out of large ones, but to produce a product to market specifications. This requires detailed knowledge of scaling rules and the intended markets so that the maximum value can be obtained from each tree (WENGER 1984).

Buffer zone = vegetated area retained around a sensitive area or site, where harvesting operations and disturbances are not permitted.

Buttress = A ridge of wood that develops in the angle between a lateral root and the base of a stem to provide lateral root stability to the stem.

Canopy gap = A break in the leaf canopy of the forest. Gaps permit light to reach the forest floor. The amount of light is an important factor in forest regeneration. Large gaps trigger the growth of light demanding, low density pioneer species and can suppress the successful regeneration of more shade tolerant, successional species of higher commercial value.

Catchment area (watershed, drainage basin, etc.) = the total area draining into a watercourse, lake or reservoir. A catchment is bounded by its watershed.

Chain brake = A safety device on a chainsaw designed to stop the chain in the event of a kickback.

Competency = A description of the desirable knowledge and skills a person in the workplace should possess to carry out a specific job task.

Coupe = A defined sub-unit of a Forest Management Unit and typically an area that is planned to be worked over the course of a single year (= Annual Coupe).

Crib structure (in bridge construction) = wooden structure made of logs laid crosswise on top of each other on both sides of a bridge, with the cavities in between filled with rock and /or soil.

Cross-cut = the cut through the log of a felled tree, e.g. to separate the commercial portion of a tree from the tree crown, or the cut into shorter log section (also referred to as “bucking”).

Cross-drain = drain constructed across a skid trail in an angle of 45 to 60 degrees, with the objective of diverting surface runoff to a vegetated area away from waterbodies.

Culvert = a channel or conduit carrying water under the road body from one side to the opposite side.

Debris = broken logs, branches, vines, bark or other parts of a tree felled created by tree felling, log extraction, debarking and log handling.

DBH = tree diameter at breast height, measured at a height of 1.3 m above higher ground surface

Directional felling = felling a tree into a desirable direction that avoids or reduces damage to the adjacent vegetation. The preferred felling direction is often marked on the tree.

Extraction = a term for the process of removing forest produce from its place of growth to some delivery point, either for further transport or further manufacture or both.

Exclusion area = area excluded from harvesting operations, e.g. High Conservation Value areas, steep slopes, water catchment areas, buffer zones of watercourses, etc.

Feeder road = a road connecting the current harvesting area with the main or secondary road network. Feeder roads are closed and abandoned after harvesting operations have been completed.

Felling = cutting

Felling scarf = two cuts made into the tree base in a wedge format at felling height. The cut-out wedge is removed from the tree to open up an angle forcing the tree to fall into the desired direction.

Forest = (1) generally, an ecosystem characterized by more or less dense and extensive tree cover; (2) more particularly, a plant community predominantly of trees and other woody vegetation, growing more or less closely together; (3) silviculturally, an area managed for the production of timber and other forest produce, or maintained under woody vegetation for such indirect benefits as protection of catchment areas or recreation; (4) an area of land proclaimed to be forest under a forest act or ordinance.

Forest management = the process of planning and implementing practices for the stewardship and use of forests and other wooded land targeted at specific environmental, economic, social and cultural objectives. Forest management planning is a fundamental component of Sustainable Forest Management.

Forest Management Information System (FMIS) = FMIS integrate the information from topographic maps, Forest Resource Assessments, forest land use classification, pre-felling inventories, growth simulation, remote sensing, etc. with Geographic Information Systems (GIS) software in a holistic data management approach. FMIS cover the planning, implementation, monitoring, and control of forest resources and operational activities, including forest maps and output statistics for reporting purposes. In addition, FMIS contain functions for the economic planning, monitoring, analysis and reporting of all management activities.

Forest Management Plan (FMP) = a document that translates forest policies into a coordinated programme for a Forest Management Unit, for regulating production, environmental and social activities for a defined period of time through the use of prescriptions specifying targets, action and control measures. The FMP determines and expresses the objectives of forest management in a specified forest area and describes the steps to be taken to achieve those objectives. It contains all necessary information in the form of text, maps, tables and graphs. The FMP involves a planning horizon of 10 to 20 years and guides the implementation of forest operations: what is to be done, where, when, why and by whom – according to the specified objectives.

Forest Management Unit = a defined and demarcated land area, predominantly covered by forests, managed on a long-term basis and having a set of clear management objectives specified in a Forest Management Plan.

Forest Resource Assessment (FRA) = The collection, processing and analysis of quantitative and qualitative forest resource data (trees and other forest vegetation) through a combination of remote sensing technologies (satellite imagery, aerial photos) and terrestrial forest inventories. Results from FRAs are a prerequisite for the development of realistic Forest Management Plans. FRAs are conducted at FMU level, covering the whole productive area with random or systematic sampling designs.

Forwarding = the operation of moving logs from intermediate deck inside the stand along feeder roads to a landing by the roadside for further transport.

Geographic Information System (GIS) = a framework for gathering, processing, and analyzing of spatial and related attribute data. Information is organized in data layers which can be combined through overlays to visualize the output in map formats and 3D scenes.

Grading = classification of timber and other forest produces according to established standards, including quality (defects, straightness, etc.) and dimension (diameter, length).

(Timber) Harvesting = a general term for the removal of forest produce from the forest for utilization, comprising tree felling, cross-cutting, trimming and extraction to the roadside log landing.

Hauling = a general term for the transport of loads from one point to another, e.g. logs from stump to landing or from landing to central log yard, mill or shipping point.

High Conservation Value Areas (HCV) = These are natural habitats with outstanding significance or critical importance due to their high biological, ecological, social or cultural values. These areas need to be appropriately managed to maintain or enhance those identified values.

Hinge wood = The amount of wood remaining between the felling scarf and back-cut during tree felling operations. The hinge wood ensures that the tree falls into the planned direction.

Hung-up tree = A tree which after cutting has not completely fallen on the ground but is caught in crowns or branches of other trees.

Integral arch (logging arch) = a modification to the winching system of a tractor (bulldozer) which facilitates the winching process through lifting a portion of the log.

Landing = (also bank, banking ground, log dump, ramp, ramp site, yard) any place where round timber is assembled for further transport, commonly coupled with a change of transporting method.

Log (timber assortments) = any section of the bole, or larger branches, of a felled tree, after trimming and cross-cutting.

Logger Chaps = cut-resistant safety trousers containing material designed to protect against chainsaw cuts.

Logging (timber harvesting) = the felling and extraction of trees, particularly as logs.

Log landing = a temporary storage location for logs extracted from the felling site to the roadside.

Log scaling (measurement) = measurement of log diameter(s) and log length to determine the log volume.

Main road = a permanently maintained, all-weather forest road providing basic access to all Coupes within a Forest Management Unit (FMU), designed for transportation of large timber volumes throughout the year.

Management = process of planning, organizing, implementing and controlling the efforts of organizational resources to achieve pre-defined goals (WENGER).

Management plan (or forest management plan, plan of operations, working scheme, etc.) = written, printed and/or published instrument aiming at continuity of policy and action and both, prescribing and controlling basic operations in a forest estate over a period of years.

Potential Crop Tree (PCT) = a commercial tree below the diameter cutting limit which forms part of the harvesting volume of future cuts and hence, should not be damaged during tree felling and log extraction. PCTs are defined by a set of eligibility criteria.

Reduced Impact Logging (RIL) = a comprehensive set of planning, monitoring and control practices regulating timber harvesting operations that support the goal of sustainable forest management, aiming at a reduction of forest damage, as well as adverse environmental and social impacts, while promoting operational efficiency and economic viability.

Reduced Impact Logging Plan (RILP) = an operational plan providing detailed information about harvesting areas, including topography (contour lines), rivers/streams, roads, skid trails, log landing sites, locations of harvestable and protected trees, buffer zones and other exclusion areas. The RILP contains all necessary data and information for the RIL crews to carry out the harvesting operation.

RIL Supervisor = a person of the Licensee or his appointed contractor who has been trained in planning, implementation and supervision of RIL operations. The RIL Supervisor is

responsible for the on-site guidance and monitoring of all forest workers involved in RIL operations.

Scale(ing) = to measure timber volume (individually or collectively), fuelwood (stacked) or pulpwood (normally by weight).

Sediment (silt) trap = a deep hole dug into the soil to catch sediments from runoff water flowing down a skid trail during heavy rain. In order to maintain functionality sediment traps need to be cleaned when full.

Skid trail = a simple forest trail without surfacing material, pushed into the forest to access the harvestable trees. Following tree felling the skid trail serves to skid the logs out from the felling site to the roadside log landing.

Skidding = the pulling of logs over a skid trail from the skid trail landing near the felling site to the roadside landing.

Stakeholder = any person, group, or legal public or private entity that is or might be affected by the activities of a timber harvesting operation.

Skidding = a loose term for hauling loads from stump to deck. Note: The logs may slide more or less wholly on the ground (ground skidding), or with its forward end suspended from cables (high-lead yarding), or wholly off the ground (skyline yarding, aerial skidding).

Stand = a community particularly of trees, possessing sufficient uniformity as regards species composition, constitution/structure (distribution of age and/or size classes), age, spatial arrangement, to be distinguishable from adjacent communities, so forming a silvicultural or management entity, e.g. as a sub-compartment (in some countries there is an arbitrary area minimum)

Standard Operating Procedure (SOP) = a set of stepwise instructions or work steps that describes the necessary activities of a process to achieve a defined work result, in accordance with relevant laws, industry regulations and internal process standards.

Strategic plan = a long-term plan that provides general descriptions of forest management and timber harvesting operations in a Forest Management Unit (FMU)

Stump = the woody base of a tree, as left on the ground after felling. Tree stumps carry a tree tag with basic tree information (e.g. species, diameter, commercial height) for monitoring and control purposes.

Stream = a watercourse that carries water during most times, except for dry spells. Depending on the width of the base streams can be classified into several classes. Other definitions used are based upon the continuity of water flow, such as permanent streams and non-permanent streams.

Sustainable Forest Management = the process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired products and services, without undue reduction of its inherent values and future productivity, and without undue undesirable effects on the physical and social environment (adopted from *International Tropical Timber Organization,* ITTO).

Temporary crossing = a watercourse crossing designed for short-term extraction of logs which will be removed after completion of harvesting operations.

Tree crown = branches, twigs and leaves forming the top of a tree.

Trimming = (also debranching, delimbing, knotting, lopping, etc.) cutting a felled, fallen and sometimes a standing stem clear of branches, i.e. more or less flush with its surfaces and without leaving stubs behind.

Water bump = a form of sediment trap to block the flow of water and mud along a skid trail. They are constructed at steeper skid trail sections where both sides of the trail are bounded by walls of soil (deep skid trail cut into surrounding terrain). Earth bunds of at least one (1)

m height are erected by tractor or excavator at a 90º angle to the skid trail alignment, at intervals of about 20 m.

Watercourse = a defined linear feature such as a river, stream, or gully that receives and conducts concentrated water flow for at least some period in most years. Waterflow may be permanent or periodic.

Wedge = a triangular shaped tool made of wood, plastic or metal (aluminium) which can be used to separate two objects or portions of an object, lift up an object, or hold an object in place. During tree felling operations, wedges are used to open the back-cut and force the tree to fall into the preferred direction.

Winch cable = a flexible wire rope mounted on winch drums at the back side of a tractor or on an excavator, used to winch logs from the felling site to the machine stationed at the skid trail.

LITERATURE

Asia-Pacific Forestry Commission, 1999: Code of Practice for Forest Harvesting in Asia-Pacific. Food and Agriculture Organization of the United Nations. Regional Office for Asia and the Pacific, Bangkok, Thailand. RAP Publication1999/12.

Chua, D. K. H., 1986: *Forest Engineering - Its Role in the Management of the Mixed Dipterocarp Forest of Sarawak*. Forest Department Sarawak, Kuching

Department of Occupational Safety and Health, 2004: *Guidelines on Occupational Safety and Health in Logging Operations*. Ministry of Human Resources Malaysia. UNDP Project Mal/99/006/A/01/NEX. JKKP GP (I) 01/2004. ISBN 083-2104-35-2.

Dykstra, D. P. and Heinrich, R. 1992: *Sustaining tropical forests through environmentally sound timber harvesting practices*. Unasylva 169: 9-15.

Dykstra, D. P. and Heinrich, R. 1996: *FAO Model Code of Forest Harvesting Practice*. Food and Agriculture Organization of the United Nations, Rome, Italy.

Elias, G. Applegate, K. Kartawinata, Machdudh, and A. Klassen, 2001: *Reduced Impact Logging Guidelines for Indonesia*. Center for International Forestry Research. Bogor, Indonesia.

F. E. Putz, P. Sist, T. Fredericksen, D. Dykstra, 2008: *Reduced-impact logging: Challenges and opportunities*. Forest Ecology and Management 256 (2008) 1427–1433.

Food and Agriculture Organization (FAO) – *Definition of Forest Management Plan*

Website: http://www.fao.org/3/w8212e/w8212e07.htm

http://www.fao.org/sustainable-forest-management/toolbox/modules/forest-management-planning/tools/en/?type=111

Ford Robertson, 1971 (Ed.): *Terminology of Forest Science, Technology, Practice and Products*: Society of American Foresters, 2nd printing 1983, Washington.

Forestry Department Peninsular Malaysia, 2003: *Guidelines for Reduced Impact Logging in Peninsular Malaysia*. Kuala Lumpur.

Forest Department Sarawak, 2019: *Guidelines to Establish and Protect Representative Conservation and Protection Areas in Forest Ecosystems*. In: *The Green Book*. *Guideline 8. Guidelines for Fauna Conservation and Ecosystem Management*. Manuals, Procedures and Guidelines for Forest Management Certification in Sarawak (Natural Forest). Management and Planning Division, Forest Department Sarawak, Kuching.

Forest Department Sarawak, 1999: *Guidelines / Procedures for Reduced and Low Impact Harvesting System*. Kuching.

Forest Department Sarawak, 1999: *Reduced Impact Logging trial in the FOMISS-Samling Pilot Area.* Malaysian-German Technical Cooperation Project. Misc. Report No. 22. Kuching

Forest Department Sarawak, 2000: *Final Report MFMA Phase II 1996 - 2000*. ITTO Project PD 14/95 REV.2(F). Kuching.

Forest Department Sarawak, 2014: *Guidelines for Reduced and Low Impact Harvesting Systems in Forest Management Certification (Natural Forest) Area*. Kuching.

Forest Department Sarawak, 2019: RIL for *Ground-based Harvesting System Part 1 and Part 2 (Guideline 10A and 10B)*. In: *The Green Book*. Manuals, Procedures and Guidelines for Forest Management Certification in Sarawak (Natural Forest). Management and Planning Division, Forest Department Sarawak, Kuching.

Forest Department Sarawak and Sarawak Forestry Corporation, 2018a: *RIL Guidelines for Ground-Based Harvesting System. Part 1 Covering Pre-Harvest Planning of Logging Roads, Block Layout, Landings & Skid Trails; Pre-Felling Inventory of Trees for Harvesting: Identification, Marking and Recording of Trees for Protection and Preparation of Reduced Impact Logging Plan*. Kuching, Sarawak.

Forest Department Sarawak and Sarawak Forestry Corporation, 2018b: *RIL Guidelines for Ground-Based Harvesting System. Part 2 Covering Construction of Logging Road, Skid Trail, Roadside Landing; Tree Felling; Log Skidding and Post-Harvesting Activities.* Kuching, Sarawak.

Forest Stewardship Council, 2015. FSP Principles and Criteria for Forest Stewardship. FSC-STD-01-001 V5-2. Bonn, Germany.

Garland J., Cedergren J., Eliasson L., van Hensbergen, H., McEwan, A. and Wästerlund D. 2020: *Occupational safety and health in forest harvesting and silviculture – A compendium for practitioners and instructors.* Forestry Working Paper No. 14. Rome, FAO. https://doi.org/10.4060/ca8773en

Hari Priyadi, Petrus Gunarso, Plinio Sist, Hariyatno Dwiprabowo, 2006: *Reduced-impact logging Research and Development in Malinau Research Forest, East Kalimantan: A challenge of RIL adoption*. Paper presented at the Regional Workshop "RIL Implementation in Indonesia with reference to Asia-Pacific Region: Review and Experiences, Bogor, 15-16 February 2006.

HCV Malaysia Toolkit Steering Committee, 2018: *Malaysian National Interpretation for the Identification of High Conservation Values*. Kuala Lumpur, Malaysia.

International Labour Organization, 1998: *Safety and health in forestry work: An ILO Code of Practice.* Geneva, Switzerland.

ITTO 2016: *Criteria and Indicators of Sustainable Tropical Forest Management*. Policy Development Series 21. International Tropical Timber Organization, Yokohama, Japan.

ITTO – *Definition of Sustainable Forest Management*: Website: https://www.itto.int/sustainable_forest_management/

Laws of Malaysia, 2006: *Act 514. Occupational Safety and Health Act, 1994*. Section 16, 29, 30 and 31. Commissioner of Law Revision Malaysia.

Malaysian Timber Certification Council, 2012: *Malaysian Criteria & Indicators for Forest Management Certification (Natural Forest).* Malaysian Timber Certification Scheme. Kuala Lumpur.

New Zealand Forest Owners Association Inc., 2020: *NZ Forest Road Engineering Manual. Operators Guide 2020.* Website: https://docs.nzfoa.org.nz/live/nz-forest-road-engineering-manual-operators-guide

PEFC, 2018: *Sustainable Forest Management – Requirements*. Programme for the Endorsement of Forest Certification. Geneva, Switzerland.

Putz, F. E. and Pinard, M. A. 1993: *Reduced-impact logging as a carbon-offset method.* Conservation Biology 7(4): 755-757.

Sabah Forestry Department, 2009*: RIL Operation Guide Book. Code of Practice for Forest Harvesting in Sabah, Malaysia*. Sandakan, Sabah.

Sist, P., Fimble, R. Shell, D. Nasi, R. and Chevallier, M.H. 2003a: *Towards sustainable forest management of mixed Dipterocarp forests of Southeast Asia: moving beyond minimum diameter cutting limits*. Environmental Conservation 30(4): 364-374

Sist, P., Sheil, D., Kartawinata, K., and Priyadi, H. 2003b: Red*uced-impact logging and high extraction rates in mixed Dipterocarp forests of Borneo: the need of new silvicultural prescriptions*. Forest Ecology and Management 179: 415-427

Klassen, A. and Hasbillah, 2007: *Technical Procedures for Topographic Surveys and Tree Mapping.* Tropical Forest Foundation. Jakarta, Indonesia.

Klassen, A., 2011: *Planning Considerations for Reduced Impact Logging.* Second Edition. Tropical Forest Foundation. Jakarta, Indonesia.

Klassen, A., 2006: *Operational Considerations for Reduced Impact Logging*. Tropical Forest Foundation. Jakarta, Indonesia. Tropical Forest Foundation. Jakarta, Indonesia.

Klassen, A., 2006: *Planning, Location, Survey, Construction & Maintenance for Low-Impact Forest Roads*. Tropical Forest Foundation. Jakarta, Indonesia.

Klassen, A. 2006: *Management Considerations for Successful Implementation of Reduced Impact Logging*. Tropical Forest Foundation. Jakarta, Indonesia.

Tuttle, A., 1996: *Best Management Practices for Ground-skidding in Peninsular Malaysia: Suggestions for a Code of Practice*. Sustainable Forest Management and Conservation Project. STC Report No. F6. Malaysian-German Technical Cooperation. Forestry Department Peninsular Malaysia, Kuala Lumpur.

APPENDIX 1

LIST OF TOTALLY PROTECTED AND PROTECTED TREES

SECOND SCHEDULE

(Section 2(1))

PART I
TOTALLY PROTECTED PLANTS

	Scientific Name	*Common Name*
1	All *Rafflesia* species	Bunga Pakma
2	*Dipterocarpus oblongifolius*	Ensurai

PART II
PROTECTED PLANTS

1	*Shorea macrophylla*	Engkabang jantong
2	*Shorea splendida*	Engkabang bintang
3	*Shorea helmsleyana*	Engkabang gading
4	*Shorea siminis*	Engkabang terendak
5	*Shorea palembanica*	Engkabang asu
6	*Shorea stenoptera*	Engkabang rusa
7	*Shorea pinanga*	Engkabang langai bukit
8	*Shorea ochracea*	Raru
9	All *Ficus* species	Pokok ara
10	*Sonneratia alba*	Perepat
11	*Sonneratia caseolaris*	Pedada
12	*Avincennia alba*	Api-api hitam
13	*Avincennia lanata*	Api-api
14	*Avicennia marina*	Api-api merah
15	*Avicennia officinalis*	Api-api sudu
16	*Lumnizera littorea*	Teruntum merah
17	*Koompassia excelsa*	Tapang
18	*Koompassia malaccensis*	Menggris
19	*Aetoxylon sympetalum*	Kayu gahru
20	*Aquilaria beccariana*	Kayu gahru, engkaras (I)
21	*Aquilaria malaccensis*	Kayu gahru
22	*Aquilaria microcarpa*	Kayu gahru
23	*Didesmandra aspera*	

24	*Casuarina equisetifolia*	Rhu laut
25	All *Rhodedendron* species	
26	All *Nepenthes* species	Periok kera
27	All *Orchidaceae* species	Orkid
28	*Salacca magnifica*	
29	*Johannesteysmannia altifrons*	Ekor buaya
30	*Areca triadra*	Pinang
31	*Areca jugahpunya*	Pinang
32	*Pinanga mirabilis*	Pinang
33	*Areca subcaulis*	Pinang
34	*Licaula orbicularis*	Biris
35	*Eurycomalongifolia*	Tongkat ali, sengkayap
36	*Goniothalamus velutinus*	Kayu hujan panas
37	*All Monophyllaea species*	
38	*Antiaris toxicaria*	Ipoh
39	*All peat swamp species of Madhuca*	Ketiau
40	*Calophyllum lanigerum*	Bintangor
41	*Calophyllum teysmanii*	Bintangor
42	*Cycas rumphii*	Paku gajah, pakulaut
43	All epiphytic *Lycopodium* species	Ekor tupai
44	All *Begonia* species	Riang, telinga gajah
45	All *Aeschynanthus* species	
46	All *Cyrtandra*, *Didymorcarpus* and species	Melebab
47	All species of plants listed in Appendices I and II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), excluding those already listed in Part I	

APPENDIX 2

PRE-FELLING INVENTORY RECORDING SHEET
FOR HARVESTABLE TREES MARKED FOR FELLING

LICENCE NO:	**TEAM LEADER:**
COUPE NO:	**BLOCK NO:**
SHEET NO:	**SKID TRAIL NO:**
DATE:	**NAME OF RECORDER:**

LEFT SIDE FROM THE TRAIL(FRONT/BACK)						RIGHT SIDE FROM THE TRAIL(FRONT/BACK)				
NO.	TREE TAG NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)		NO.	TREE TAG NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)

** For Licensee Record only*

APPENDIX 3

STOCK SHEET FOR LIST OF POTENTIAL CROP TREE (PCT)

LICENCE NO:	**TEAM LEADER:**
COUPE NO:	**BLOCK NO:**
SHEET NO:	**SKID TRAIL NO:**
DATE:	**NAME OF RECORDER:**

LEFT SIDE OF THE TRAIL (FRONT/BACK)				
NO	DIPTEROCARP		NON-DIPTEROCARP	
	SPECIES	DBH (cm)	SPECIES	DBH (cm)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

RIGHT SIDE OF THE TRAIL (FRONT/BACK)				
NO	DIPTEROCARP		NON-DIPTEROCARP	
	SPECIES	DBH (cm)	SPECIES	DBH (cm)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

SUMMARY

DESCRIPTION	COUNT OF NUMBER OF TREES		
	LEFT SIDE	RIGHT SIDE	TOTAL
DIPTEROCARP SPECIES			
NON-DIPTEROCARP SPECIES			

** For Licensee Record only*

APPENDIX 4

STOCK SHEET FOR LIST OF TREES FOR PROTECTION

LICENCE NO:	**TEAM LEADER:**
COUPE NO:	**BLOCK NO:**
SHEET NO:	**SKID TRAIL NO:**
DATE:	**NAME OF RECORDER:**

LEFT SIDE OF THE TRAIL (FRONT/BACK)							
NO.	CODE	SPECIES	DBH *FOR MT ONLY	NO.	CODE	SPECIES	DBH *FOR MT ONLY
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			

RIGHT SIDE OF THE TRAIL (FRONT/BACK)							
NO.	CODE	SPECIES	DBH *FOR MT ONLY	NO.	CODE	SPECIES	DBH *FOR MT ONLY
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			

SUMMARY

CODE	DESCRIPTION	COUNT OF NUMBER OF TREES		
		LEFT SIDE	RIGHT SIDE	TOTAL
TP	Totally Protected tree			
P	Protected tree			
MT	Mother tree			
FT	Fig or fruit tree			

** For Licensee Record only*

APPENDIX 5

RILP 5

OPERATIONAL INVENTORY RECORDING SHEET

(UNDERSIZED TREES ALLOWED TO BE FELLED WITHIN CLEARED WIDTH OF LOGGING ROAD ALIGNMENTS & ALONG SKID TRAIL CORRIDORS)

LICENCE NO:	**ACCOUNT NO:**
LICENSEE:	**PEC REF. NO.:**
PA HOLDER/CONTRACTOR:	**DATE OF ISSUE:**
MANAGEMENT PLAN:	**BLOCK NO./AREA (ha):**
FOREST TYPE:	**ROAD NO/ SKID TRAIL NO.*:**

TREE NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)	VOL. (m^3)
SUBTOTAL:				

TREE NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)	VOL. (m^3)
SUBTOTAL:				

PREPARED BY: **DATE OF INVENTORY:**

** To be submitted to the authority*

APPENDIX 6

SLOPE CORRECTION TABLE

SLOPE GRADIENT IN %	CORRECTION FACTOR (1/COS *)	HORIZONTAL DISTANCE (M)					
		2	3	5	10	20	52.5
		DISTANCE ALONG SLOPE (M)					
10	1.00	2.00	3.00	5.00	10.00	20.00	52.50
15	1.01	2.02	3.03	5.05	10.10	20.20	53.03
20	1.02	2.04	3.06	5.10	10.20	20.40	53.55
25	1.03	2.06	3.09	5.15	10.30	20.60	54.08
30	1.04	2.08	3.12	5.20	10.40	20.80	54.60
35	1.06	2.12	3.18	5.30	10.60	21.20	55.65
40	1.08	2.16	3.24	5.40	10.80	21.60	56.70
45	1.10	2.19	3.29	5.48	10.96	21.92	57.54
50	1.12	2.23	3.35	5.59	11.17	22.34	58.64
55	1.14	2.28	3.42	5.71	11.42	22.83	59.93
60	1.67	3.33	5.00	8.33	16.65	33.3	87.41
65	1.19	2.38	3.58	5.96	11.92	23.84	62.58
70	1.22	2.44	3.66	6.10	12.20	24.40	64.05
75	1.25	2.50	3.75	6.25	12.49	24.98	65.57
80	1.28	2.56	3.84	6.40	12.80	25.60	67.20
85	1.31	2.62	3.93	6.56	13.11	26.22	68.83
90	1.35	2.69	4.04	6.73	13.46	26.91	70.65
95	1.38	2.76	4.14	6.89	13.79	27.57	72.37
100	1.41	2.83	4.24	7.07	14.14	28.28	74.24
105	1.45	2.90	4.34	7.24	14.48	28.96	76.02
110	1.48	2.97	4.45	7.42	14.85	29.70	77.96
115	1.52	3.05	4.57	7.62	15.24	30.48	80.01
120	1.57	3.13	4.70	7.83	15.67	31.33	82.25
125	1.60	3.20	4.80	8.00	16.00	32.00	84.00
130	1.64	3.27	4.91	8.18	16.36	32.72	85.89
135	1.67	3.35	5.02	8.37	16.75	33.49	87.92
140	1.72	3.44	5.17	8.61	17.22	34.44	90.41
145	1.76	3.52	5.27	8.79	17.58	35.16	92.30
150	1.80	3.61	5.41	9.02	18.04	36.08	94.70
155	1.84	3.69	5.53	9.22	18.44	36.89	96.83
160	1.89	3.77	5.66	9.44	18.87	37.74	99.07
165	1.93	3.86	5.80	9.66	19.32	38.64	101.44
170	1.97	3.94	5.91	9.85	19.70	39.41	104.44

APPENDIX 7a

SAMPLE OF SKID TRAIL MAPPING SHEET

Sheet No:……..

LICENCE NO:	**TEAM LEADER:**
COUPE NO:	**DATE:**
BLOCK NO:	**SKID TRAIL NO:**

STATION NO.		BEARING (º)	SLOPE (%)	GROUND DISTANCE (m)	HORIZONTAL DISTANCE HD (m)	CUMULATIVE HD (m)	REMARKS
FROM	TO						

** For Licensee Record only*

APPENDIX 7b

SKID TRAIL SUMMARY SHEET

Distances by skid trail numbers

SKID TRAIL NO.	DISTANCE IN METRES
MT-1	
ST-1-1	
ST-1-2	
FT-1-1-1	
MT-2	
ST-2-1	

Table showing distance of individual skid trail to be attached to the map

** To be submitted to the authority*

APPENDIX 8a

RILP 1a

OPERATIONAL INVENTORY SUMMARY SHEET COVERING EACH SKID TRAIL OF INDIVIDUAL BLOCK (100% TREE ENUMERATION FOR HARVESTABLE TREES)

LICENCE NO:	**ACCOUNT NO:**
LICENSEE:	**PEC REF. NO.:**
PA HOLDER/CONTRACTOR:	**DATE OF ISSUE:**
MANAGEMENT PLAN:	**BLOCK NO./AREA (ha):**
FOREST TYPE:	**SKID TRAIL NO./DISTANCE (m):**

LEFT SIDE OF THE TRAIL (FRONT/BACK)				
TREE NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)	VOL. (m^3)
SUBTOTAL:				

RIGHT SIDE OF THE TRAIL (FRONT/BACK)				
TREE NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)	VOL. (m^3)
SUBTOTAL:				

PREPARED BY: **DATE OF INVENTORY:**

** To be submitted to the authority*

APPENDIX 8b

RILP 1b

OPERATIONAL INVENTORY SUMMARY SHEET COVERING EACH SKID TRAIL OF INDIVIDUAL BLOCK
(100% TREE ENUMERATION – LOCALITY OF INDIVIDUAL HARVESTABLE TREES RECORDED BY GPS)

LICENCE NO:	**ACCOUNT NO:**
LICENSEE:	**PEC REF. NO.:**
PA HOLDER/CONTRACTOR:	**DATE OF ISSUE:**
MANAGEMENT PLAN:	**BLOCK NO./AREA (ha):**
FOREST TYPE:	**SKID TRAIL NO./DISTANCE (m):**

TREE NO.	SPECIES CODE	DBH (cm)	HEIGHT (m)	VOL. (m3)	GEOGRAPHICAL COORDINATES	
					Northern Latitude Deg. / Min. / Sec.	Eastern Longitude Deg. / Min. / Sec.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
Total:						

PREPARED BY: **DATE OF INVENTORY:**

** To be submitted to the authority*

APPENDIX 9 **RILP 2**

SUMMARY OF SKID TRAIL NETWORK & TREES TO BE HARVESTED FOR INDIVIDUAL BLOCK

FOREST TIMBER LICENCE NO:		COUPE NO:	
BLOCK NO.	**BLOCK SIZE (ha)**	**PEC REF. NO.**	**DATE OF PEC ISSUED**
RILP SUMMARY			
SKID TRAIL NETWORK		**HARVESTABLE TREES**	
SKID TRAIL NO.	**DISTANCE (m)**	**TAG CODE**	**NO. OF TREES**	**REMARKS**
TOTAL				
SKID TRAIL DENSITY (m/ha):				
TREE DENSITY (No. of trees/ha):				
PREPARED BY:				
DATE:				

** To be submitted to the authority*

APPENDIX 10

RILP 3

SUMMARY OF TREES FOR PROTECTION WITHIN INDIVIDUAL BLOCK

LICENCE NO.:	COUPE NO.:	BLOCK NO.:

SKID TRAIL NO.	LENGTH OF SKID TRAIL (m)	NUMBER OF TREES TO BE PROTECTED					
		TP	P	MT	FT	PCT	TOTAL
GRAND TOTAL							

ABBREVIATIONS	
TP - Totally Protected tree	MT - Mother tree
P - Protected tree	FT - Fig tree or fruit tree
PCT - Potential crop tree	

** To be submitted to the authority*

APPENDIX 10a

SUMMARY OF TREES FOR PROTECTION WITHIN THE COUPE

LICENCE NO.:			COUPE NO.:					
SKID TRAIL NO.	BLOCK SIZE (ha)	Total length of skid trail (m)	NUMBER OF TREES TO BE PROTECTED					
			TP	P	MT	FT	PCT	TOTAL
GRAND TOTAL								

ABBREVIATIONS
TP - Totally Protected tree
P - Protected tree
MT - Mother tree
FT - Fruit tree
PCT - Potential crop tree

** To be submitted to the authority*

APPENDIX 11

SUMMARY OF COUPE OPERATIONAL INVENTORY ANALYSIS

LICENCE NO.:				COUPE NO.:			
PEC REF. NO.:							
BLOCK NO.	BLOCK AREA (ha)	TOTAL LENGTH OF SKID TRAILS	TOTAL NO. OF TAGGED TREE	ENUMERATED VOL. (m3)	AVERAGE NO. OF TREES PER HA	AVERAGE VOL. / HA	AVERAGE VOL./ TREE
TOTAL							

** To be submitted to the authority*

APPENDIX 12

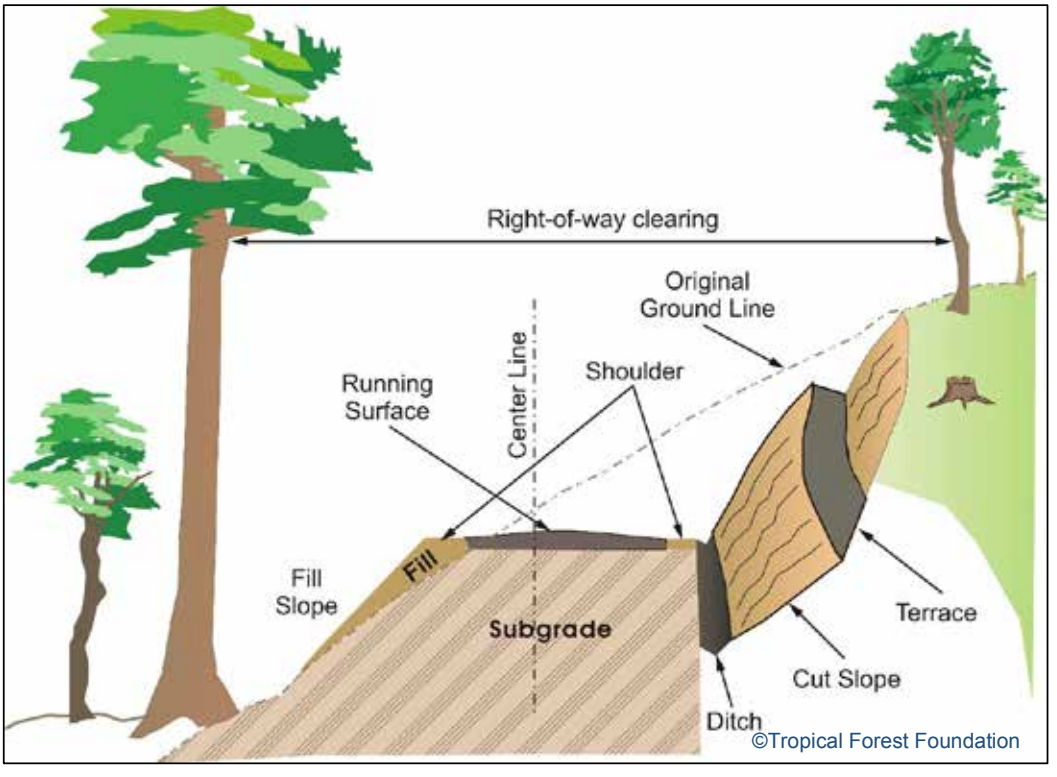
LOGGING ROAD DESIGN STANDARDS*
(for new road construction)

Description	Road Class		
	Main Road	**Secondary Road**	**Feeder Road**
Lanes	Dual lane	Single lane	Single lane
Design speed	50 km/hr to 60 km/hr	25 km/hr to 40 km/hr	15 km/hr to 25 km/hr
Formation width	9 m to 12 m	8 m to 10 m	6 m to 8 m
Cleared width	40 m to 50 m	30 m to 40 m	20 m to 30 m
Maximum road gradient: • Favourable grade i.e. uphill towards forest • Adverse grade i.e. uphill towards mill • Preferred maximum length at maximum grade	8% to 10% 6% to 8% 1,000 m	10% to 14% 8% to 12% 1,000 m	14% to 18% 10% to 14% 1,000 m
Road camber	2% to 6%	2% to 6%	2% to 6%
Super elevation	1:10	1:12	1:15
Minimum curve radius	50 m	30 m	20 m
Embankment (height to width) • Hill side • Valley side • Rocky terrain	 1:1 1:2 1:0.2 to 0.5	 1:1 1:2 1:0.2 to 0.5	 1:1 1:2 1:0.2 to 0.5
Culverts • Type • Size	Corrugated/ Round metal pipes or Timber/ log type culverts Big enough to allow free flow of water and to prevent ponding	Corrugated/ Round metal pipes or Timber/ log type culverts Big enough to allow free flow of water and to prevent ponding	Corrugated/ Round metal pipes or Timber/ log type culverts Big enough to allow free flow of water and to prevent ponding
Bridges • Type	• Wooden • Pre-fabricated steel truss or concrete bridge	• Wooden • Pre-fabricated steel truss or concrete bridge	• Wooden
• Minimum width	4 metres	4 metres	4 metres

** Based on Forest Engineering Plan*

APPENDIX 12a

DESIGN OF TYPICAL ROAD CROSS-SECTION IN HILLY TERRAIN



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