

LIBERIA

Code of Forest Harvesting Practices



Forestry Development Authority

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I INTRODUCTION

1.1 Towards best practice timber harvesting

The Forestry Development Authority (FDA) has developed this Code of Practice for Timber Harvesting to provide a clear set of guidelines to help foresters and logging companies select practices to be followed when carrying out harvesting operations under forest management contracts (FMC) and timber sales contracts (TSC).

The purpose of these guidelines is to prescribe a code of timber harvesting practice, to which the FDA requires all contract holders to adhere.

The planning requirements for forest areas under FMCs and TSCs are different with respect to some of the activities. However, the requirements regarding good logging practice remain the same and these are described in this code.

. Practices that conform to the regulations or guidelines should, at least in theory, achieve a desired outcome such as the harvest of commercial timber from a specified area of forest in a way that meets standards for sustainable forest management. Sustainable forest management recognizes the importance of all products and services provided by the forest, including timber, water quality, soils, biodiversity, and the livelihood of people that live or work in the forest.

Liberia's response to these concerns has been to develop principles, policies and guidelines for improved forest management and timber harvesting practices. This is reflected in the new forest policy, forest legislation, forest management guidelines and codes of practice.

The goal of sustainable forest management cannot be reached unless improved harvesting practices are widely adopted by loggers. The emphasis in this document is on the harvesting practices themselves. If these are improved, then it is more likely that the ecological, environmental and cultural value of the country's forests will be maintained while at the same time providing for sustainable yields of commercial timber from those forests

The Code itself will not ensure sustainable forest management. However, with effective implementation through reduced-impact logging guidelines, participation in the planning process by all stakeholders, and integration with other sustainable forest management instruments the Code will assist in minimizing negative impacts of timber harvesting.

1.2 Development of the Code

The Code contains practices and sets standards, which have been developed based on research and practical experience in tropical forests. Specifically, the FAO Model Code of Forest Harvesting Practice and Regional Code of Practice for Reduced-Impact Forest Harvesting in Tropical Moist Forests of West and Central Africa form the basic framework for this code.

The Code will not be applied retroactively. However, contract holders operating in areas that have been logged before should be aware that existing roads, log landings, bridges and other infrastructure that do not meet current Code provisions will have to be upgraded according to this Code.

The Code will be reviewed on a regular basis by the FDA following consultations with the timber industry and other interested parties.

1.3 Objectives

The objectives of the Code of Practice for Timber Harvesting are to:

- Provide forest operators with a set of guidelines and standards for improved forest harvesting practices that improve standards of logging/utilization and reduce environmental impacts, and so contributing to the conservation of forests through their wise use.
- Promote the health and safety of forest workers
- Provide a framework for effective control of timber harvesting operations with predetermined guidelines and benchmark.

There are two different types of statements in the code: ‘shall’ (in some cases phrased as an imperative) and ‘should’ statements. The ‘shall’ statements are to be applied in a practical manner to all logging operations. The ‘should’ statements show the desirable practice for most situations and should be interpreted taking account of local conditions

II PLANNING REQUIREMENTS

2.1 Forest Management Planning

Broad scale planning is carried out by the FDA to determine which areas may be allocated as commercial forest areas, protected areas or multiple use forest areas.

Forest Management Plans are required for all forest management contracts. There are three levels of planning required in each forest management plan:

- **Operational planning** covers the background, conditions and plans for the entire contract area
- **Detailed planning for operations** covers activities to be carried out within a 5-year period; and
- **Annual planning** covers the previous year's activities and operational plans for the following year including Silvicultural prescription/treatments

Timber Sales contract holders are required to prepare at least the Annual Planning process.

All these planning activities shall be made in accordance with the Code of Practice for Timber Harvesting. Good planning at the operational level has been shown to significantly reduce both operational costs and the environmental impact of timber harvesting.

Two types of field inventories shall be required for proper forest management planning. First, the contractor shall complete a general inventory of the entire contract area to provide data on the sustainable forest management plan, rotation, and annual allowable cut volumes per species. Second, the contractor shall complete pre-harvesting enumeration to define the harvestable trees for the annual harvesting plan.

2.2 Pre-Harvest Enumeration

Pre-harvest enumeration shall be completed in advance of, and must receive approval from the Authority, cutting any trees at the start of each harvesting period. Regulations and the individual Timber Sale and Forest Management Contracts define the timing and process for completing and pre-harvesting procedures.

However, pre-harvest enumeration shall:

- Facilitate harvest planning;
- Provide data to develop Silvicultural treatments;
- Assist in determining which species are locally rare or regenerate poorly under current harvesting regimes.

Pre-harvest enumeration shall conform to the following standards:

- All blocks shall be surveyed for 100% stocking of trees 50 cm dbh using regular grid (north-south/east-west) in each kilometer square blocks to develop tree location map;
- On FMC, a proper permanent grid for the entire five-year section of the contract area shall be opened, with all gridlines permanently marked and kept open by clearance of undergrowth when necessary.
- Temporary gridlines at 20m interval from the permanent gridlines should be established for each Km-square block in order to facilitate the work of the inventory crews.

Moreover, the following parameters shall be assessed and recorded during the field inventory for each marked tree:

- Location and the number of the tree;
- Botanical identification of tree species;
- Girth or diameter at dbh
- Quality features and visible defects a high for
- Location of size of any utilizable dead trees
- Topographic features that may influence harvest planning.

III EXCLUSION AREAS AND BUFFER STRIPS

3.1 Exclusion Areas

Exclusion areas include (a) protected areas, (b) protected animal species habitat (c) protected tree species (ex. IUCN Red List Trees, etc) (d) sites that are especially susceptible to degradation (e) watercourses and (f) cultural and customary tenure areas. Buffer strips of different widths will be used to protect such areas.

3.1.1 Protected Areas

Protected areas are those areas that must be excluded from logging. Protected areas include:

Conservation areas (e.g. biodiversity reserves)

Declared protected areas under national legislation

Areas of cultural importance (such as historical, archaeological and spiritual sites)

Areas required for community needs (which may include cultural sites as well as settlements and farms).

3.1.2 Protected Animal Species Habitat:

Areas of high protected animal species habitat, high density of protected species, and habitat trees – define habitat tree – any tree with high potential or obvious characteristics for providing shelter or habitat for wildlife.

3.1.3 Protected Tree Species

These are mostly the CITES and IUCN and national red list species including rare, endangered and mother tree/seed species.

3.1.4 Sites susceptible to degradation

No harvesting operations shall be carried out on areas with slopes gradient above 30%.

3.1.5 Watercourses

Watercourses are natural channels, which carry water for some period in most years. Flows may be periodic or permanent. Watercourses include natural springs, rivers, streams or creeks, gullies, swamps and lakes. The width of a watercourse is to be measured from bank-to-bank during normal wet season (i.e. the period of peak water flow), and may include a flood plain area which may be a swamp.

3.1.6 Cultural and Customary tenure areas

Areas that fall under cultural and customary tenure of local communities shall be excluded from the harvesting plan area and in some cases depending on the size and location of the cultural or customary tenure they can be removed from the contract all together. See section on Social Issues for more details.

Table 1 shows the range of watercourses that are defined as exclusion areas.

Table 1: Watercourse Definitions

Natural springs	A natural spring is a place where groundwater flows out of the ground. A spring may be intermittent or continuous (perennial).
Creeks	Creeks are watercourses in which water may flow or pond for more than six months in most years, and whose beds are of stony, gravely or exposed bedrock materials.
Streams	Streams are watercourses in which water may flow or pond for about six months in most years, and whose beds are of soil and whose banks are often covered with vegetation.
Rivers	Rivers are those watercourses where water flows all year around in most years.
Gullies	Gullies are steep-sided channels. Their beds are normally of soil and may be covered with vegetation. Water will flow or pond for less than six months in most years
Swamps	Swamps have standing surface water for six months or more in most years
Lakes	Lakes have surface water present all year round for most years

3.2 Buffer Strip Protection

Buffer strips are required whether or not an exclusion feature is identified on available maps. Field inspection during pre-harvest inventory work will identify the areas that require buffer strips before forest operations start, and depending on the type of feature and how wide the strip shall be.

Table 2: Buffer strip distances

Type	Minimum width
Conservation and declared protected areas or other buffer boundaries	50 meters
Cultural, spiritual and historic sites	100 meters
Villages, farms, settlements	100 meters
Rare, endangered, mother/seed trees	10 meter radius
Watercourses:	
Width <10m	15 m on each bank
Width < 20m	20 m on each bank
Width < 40 m	30 m on each bank
Natural springs	50 meters circumference
Lakes,	25 meters from the waters edge
Creeks and streams	15 meters from the waters edge
Gullies	15 meters from the waters edge
Lakes	25 meters from the waters edge
Swamps and other wetlands	15 meters from the waters edge

River banks are defined as the permanent edge of the river regardless of the seasonal recession of the water levels, whereas the waters edge is determined from where the water is at that given point in time.

3.3 Management of Exclusion Areas and Buffer Strips

3.3.1 Exclusion areas and their buffer strips shall be managed as follows

- No trees shall be felled within exclusion areas or their buffer strips except merchantable species that grow in the wetland areas (e.g. niangon, abura, leucinia etc.) which shall be extracted by using 25-meter cable extending to the log from the crawler tractor standing on the skid trail and only upon approval from the Authority per tree harvested (with an FDA officer present) and only during dry season when wetlands are dry.
- Machine access within exclusion areas and their buffer strips is not allowed, except at designated watercourse crossing points, which should be by the shortest

possible distance.

- No earthworks, or spoils from earthworks, shall end up in a exclusion area or its buffer strip
- No harvesting debris shall be pushed into exclusion areas or their buffer strips.
- Trees shall be felled away from buffer strips and watercourses. If it is not possible to fell the tree away from the buffer strip or watercourse it shall not be harvested.
- Where trees inadvertently fall into a watercourse or its buffer strip, the head as well as any accompanying logging debris should be pulled clear, unless unacceptable damage to the bank or buffer strip is likely to occur.

WATERCOURSES AND BUFFER STRIPS

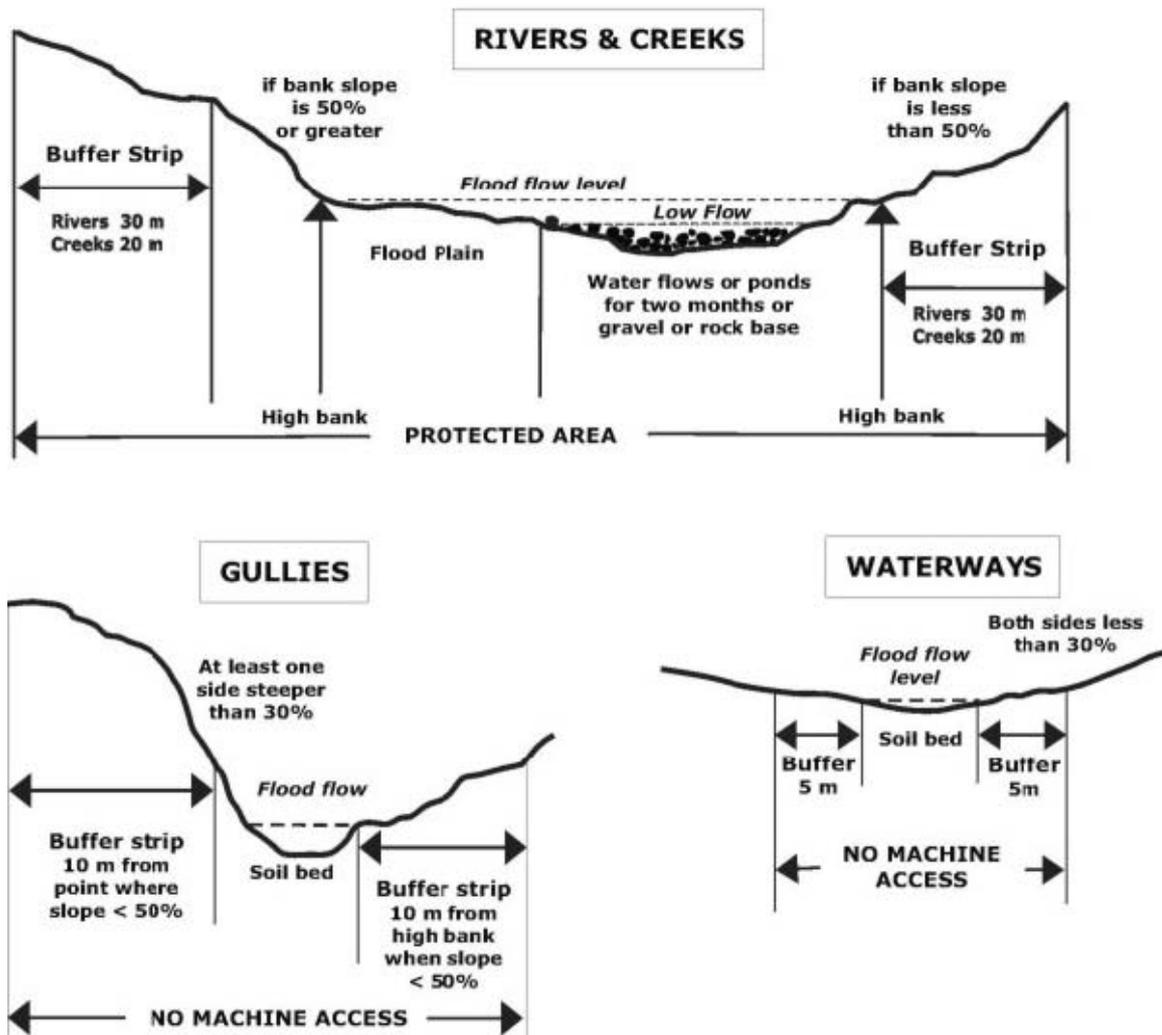


Figure III-1 Buffer strips along watercourses

IV CONSTRUCTION WORKS FOR LOGGING

4.1 Roads

Roads provide needed access to the forest. At the same time, roads can produce significant amounts of sediment and can be one of the greatest adverse impacts on the local environment, on water quality and on aquatic life. Roads can produce significant erosion, cause gullies, and have an impact on groundwater, wildlife and vegetation.

Road planning is key to ensuring that a road meets the current needs of the user, that it is not overbuilt, that it minimizes impacts on the environment and to the people along the road. A well planned, located, designed and constructed road will be cost-effective in the long term by preventing road failure, eliminating repair needs, and reducing maintenance.

Roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation. The most efficient spacing of roads can be derived by looking at the cost tradeoffs between skidding distance and road spacing.

4.1.1 Road classification

(a) Primary forest roads

These are permanent, all-weather roads that provide access from public roads to the FMC or TSC area. They should be capable of carrying log volumes of about 2,000 m³ (\approx c. 60 truck loads) or more per week and may be in service during the entire logging operation of a 5-year management plan (FMC) or during the operations of a TSC.

(b) Secondary forest roads

These are roads that provide access to a logging compartment, connecting feeder roads and log landings to primary roads. They will carry log volumes of about 1,000 to 2,000 m³ per week and will be in service for 1-2 years only. Secondary roads are often upgraded to primary roads as the logging operations proceed.

4.1.2 Road Planning

In planning the location of roads the following factors shall be considered:

- Primary and secondary forest roads shall avoid all protected and exclusion areas and their respective buffer strips.
- Roads shall be kept at least 40 m away from the edge of buffer strips (e.g. 55 m from the banks of creeks, the edge of a gullies), except at designated watercourse crossing points.
- Roads shall be located wherever possible on well-drained soils and slopes where drainage will move away from the road. Roads should, therefore, follow the natural terrain by conforming to the contour, rolling the grade and minimizing the use of cuts and fills.

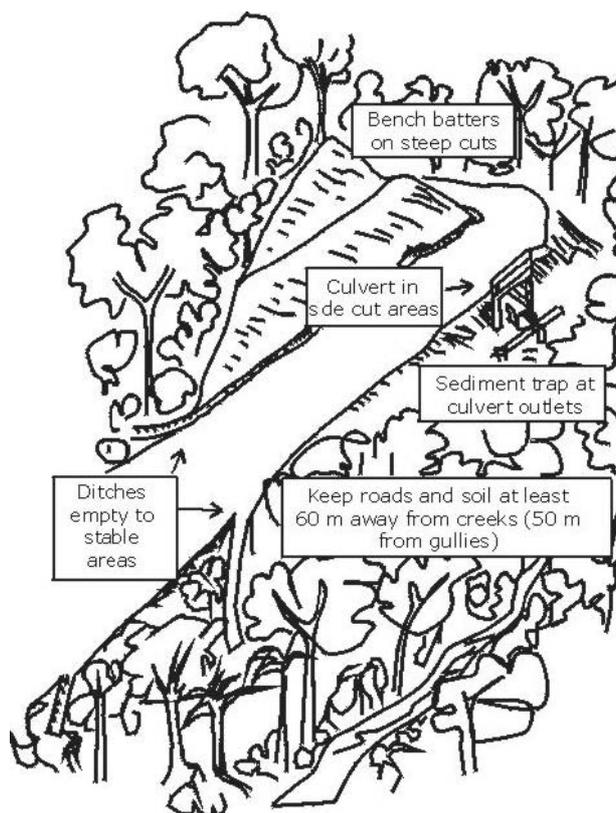


Figure IV-1 Road location and drainage

- Roads should be located on ridges as much as possible.
- Efforts should be made to avoid locations that require box cuts, to avoid steep and very flat terrain where drainage is more difficult to control, and unstable locations such as swamps, marshes, landslides, steep slopes, massive rock outcrops, flood plains, and highly erosive soils
- Efforts should be made to minimize the number of watercourse crossings

4.1.3 Survey requirements for inspection

After planning the proposed primary and secondary road network contractors shall request that FDA carries out a field inspection. This inspection should be undertaken with community representatives when appropriate. The contractors will survey and mark the center of roads on the ground, and all proposed watercourse crossings prior to the inspection, and shall remark as necessary after the FDA has given approval and prior to any construction. The field inspection of the road network will be part of the block inspection for the approval of the yield.

(a) Road Construction

Road construction costs are mostly influenced by the standard of road built, particularly road width, type of surfacing, and the steepness of the terrain. A road with cuts and fills on steep cross slopes greatly increases the time of construction, amount of earthwork, the areas of clearing, and adds length to cross-drains and other drainage structures

(b) Timing of construction

The construction of primary and secondary forest roads shall take place in the dry season only, and construction should commence within 12 months before logging. Preliminary roadway clearing should take place within 1 month of final construction to reduce sedimentation from untrained or poorly drained sites.

(c) Roadway construction

The construction of primary and secondary forest roadways shall take into account the following factors:

- Merchantable stems along the road reserve should be felled and preferably extracted before clearing. While clearing, trees should be pushed into the road reserve and not into the adjacent forest.
- Hazardous trees, which have a significant probability of falling onto the roadway, shall be removed during construction
- Soil heaps, berms and debris stockpiling along the roadway are not permitted; instead topsoil should be stockpiled for use in cut and fill batters and/or in borrow pits. Organic debris should not be used as fill.
- All road drainage works shall be completed before gravelling work commences.
- Gravelling is required for primary roads and is recommended for secondary roads. Road surfaces on bridge approaches, culverts and swampy terrains shall be graveled.
- All road fill and paving material shall be compacted. Minimum compacted gravel thickness is 15 cm depending on the type of soil as advised by the Authority. Softer areas should require additional thickness where as rocky areas may require less gravel.
- Minimum primary road spacing of 1200m within a compartment is highly recommended.

(d) Side slopes

Although primary and secondary road may not be located on slopes of greater than 15 %, the side slopes of roads may have a greater slope. In such circumstances additional construction is required to mitigate the impact of the roads:

- Side cut roads shall not be located on slopes greater than 40%.
- Full bench construction should be adopted instead of half bench construction on slopes steeper than 25% (see fig. IV-4).

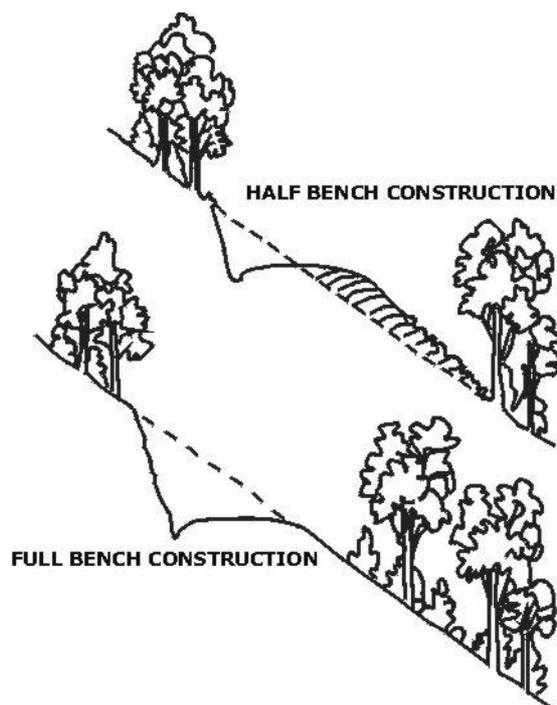


Figure IV-2: Half and full bench construction

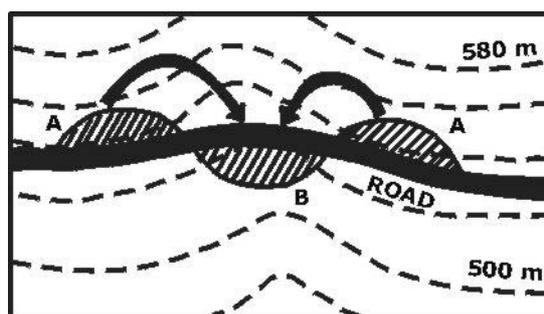


Figure IV-3: Balance cuts and fills

- Cuts and fills should be balanced in gentle terrain so that as much of the excavated material as is practical can be deposited in the roadbed fills sections (see fig. IV-3).
- The maximum fill for batter slope is 40%. All cut batter slopes should be benched at 3 m vertical intervals.
- Trees at the top of steep cut batters should be cleared if erosion or wind-blow is liable to occur.

(e) Road grades

Primary and secondary forest roads shall not be constructed with grades (slopes) of more than 10% and 15% respectively since on steep roads drainage is difficult to control. However:

- Steeper grades (up to 20%) for short sections (maximum 200 m) would be acceptable, if this shortens construction significantly or reduces earthworks, provided that adequate drainage is installed.
- Any two sections of road at maximum gradient should be separated by 100 m

of level gradient.

(f) Road widths

Every effort shall be made to minimize the width of forest roads. Road widths depend on the class of road, the type of soils and the forest through which the roads are to be constructed.

The maximum road widths for forest roads on loam and clay soils are shown in Table. The maximum road widths for forest roads on sandy soils are shown in Table. The widths of roads on laterite soil should be intermediate between the limits given in the tables above.

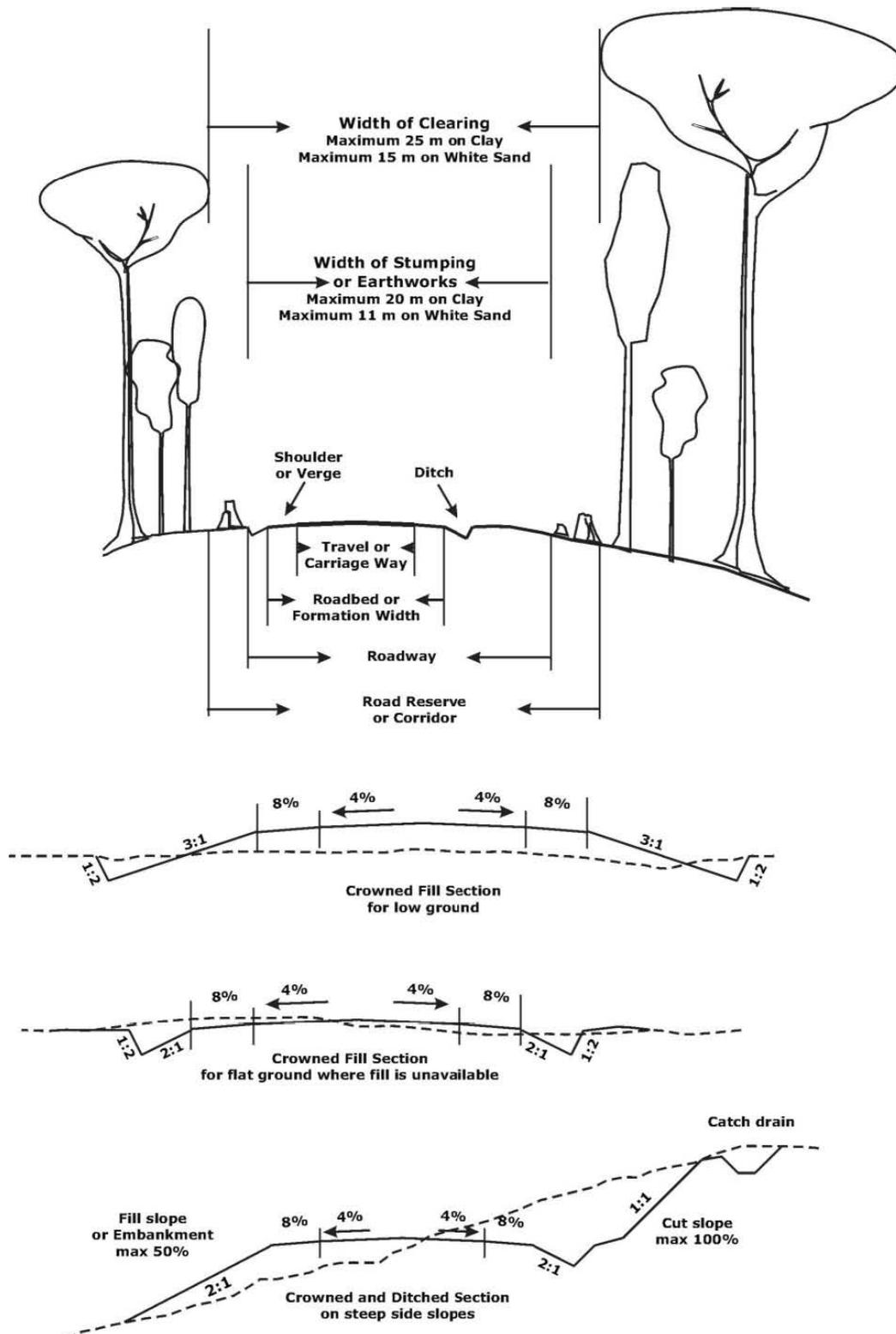
Road class	Limit of Clearing	Limit of Roadway	Limit of Road Bed	Limit of Travel Way
Main road	25	20	9	6
Secondary road	20	15	8	5

Table IV-1 Maximum road width for loam and clay soil.

Road class	Limit of Clearing	Limit of Roadway	Limit of Road Bed	Limit of Travel Way
Main road	15	11	9	6
Secondary road	15	10	8	5

Table IV-2 Maximum road width for sandy soil

- Primary and secondary roads on clay and loam soils should have trees removed alongside the road to allow sunlight onto the road to dry the surface quickly after rain. Roads on white sand soils should be protected from rain and direct sunlight by limiting clearing to the roadbed and ditches to maintain trafficability.
- On primary and secondary roads, tree stumps should be grubbed on at least one side of the road to allow for movement of tractors and other heavy machinery that would damage the road surface.
- Passing spots shall be provided on roads with a roadbed narrower than 7 m, at least every 500 m and at bridge approaches and hillcrests.
- Where side cutting is not necessary, earthworks should be limited to the width for the roadbed plus ditches (table drains) on either side.



(g) Curves

On all primary and secondary roads curves shall be fitted to the topography; i.e. along the contour. Curve widening is required on corners to allow for off-tracking of trailers. To increase vehicle stability on a bend, banking (raising) the outer part of the curve is recommended. Shoulders may need to be cleared on the inside of the curve to

obtain the required sight distance to ensure traffic safety. The minimum radius of the curve is related to the visibility and the speed the vehicles will be traveling on the road.

Guidelines for recommended minimum sight distance and minimum curve radius are shown in table IV-3

Road class	Design speed (km/hr)	Minimum sight distance (m)	Minimum radius (m)
Primary road	70	100	50
Secondary road	50	60	30

Table IV-3 for minimum sight distance and curve radius

4.2 Drainage

Drainage problems often cause the largest impacts from roads with regard to erosion, sedimentation, and degradation of water quality. Poor drainage will also lead to rutting, scouring and gullying, while standing water and seepage under the roadbed may lead to road failure; in all cases necessitating extensive maintenance or even expensive repairs or diversions. These aspects make road drainage the single most important aspect of road construction and maintenance.

4.2.1. General

In all phases of forest road preparation, adequate drainage shall be constructed to ensure the stability of the roads and so reduce their impact on the forest. Wherever practicable, permanent drainage should be installed in advance of other construction to keep works as dry as possible. Temporary drainage shall be provided where there is likely to be a significant delay in installing permanent drainage

4.2.2 Methods of drainage

On both primary and secondary roads a crowned road surface shall be required. Additionally:

- Ditches (table drains) shall be installed alongside all roads, constructed to a minimum depth of 30 cm below the level of the crown of the road.
- Turnout drains (side drains/outlets) shall be constructed at specified spacing.
- Crossroad drainage (pipes or culverts) should be used where turnout drains are not possible.

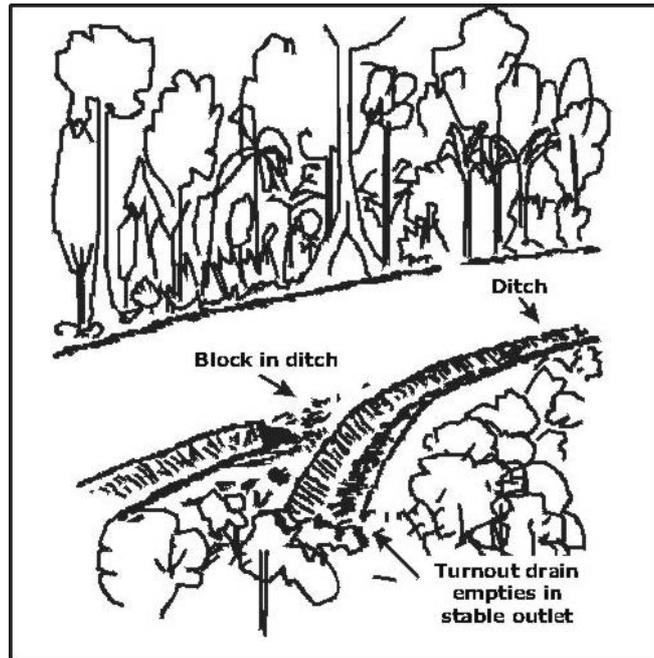


Figure IV-5 Turnout drains

- For roads constructed on highly erodible soils on slopes, drains may require special treatment such as lining with gravel or stones, log or rock bars, as well as stepping and frequent outlets to reduce scouring.
- Earth fills should have adequate drainage to prevent water build up and ponding behind the fill.
- Side cuts shall also be provided with catch drains along the topside to collect surface runoff

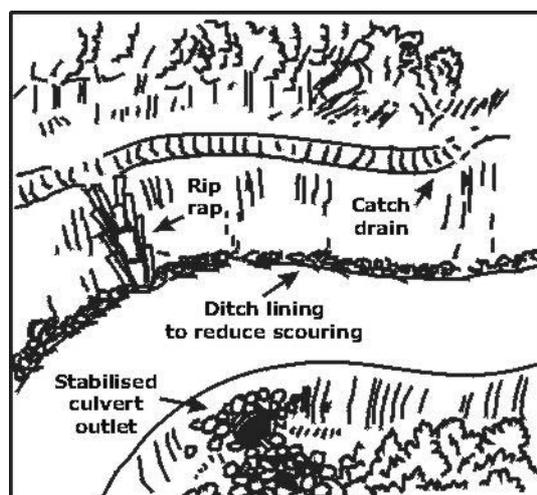


Figure IV-6 Additional drainage requirements

4.2.3 Spacing between drains

Turnout drains or culverts shall be constructed:

- At changes of slope

- Within 50 m of watercourse crossings

Maximum drain spacing guidelines are shown in table.

Gradient (%)	Drain spacing (meters)
0-5	80
5-10	40
10-15	30

Table IV-4 maximum drain spacing

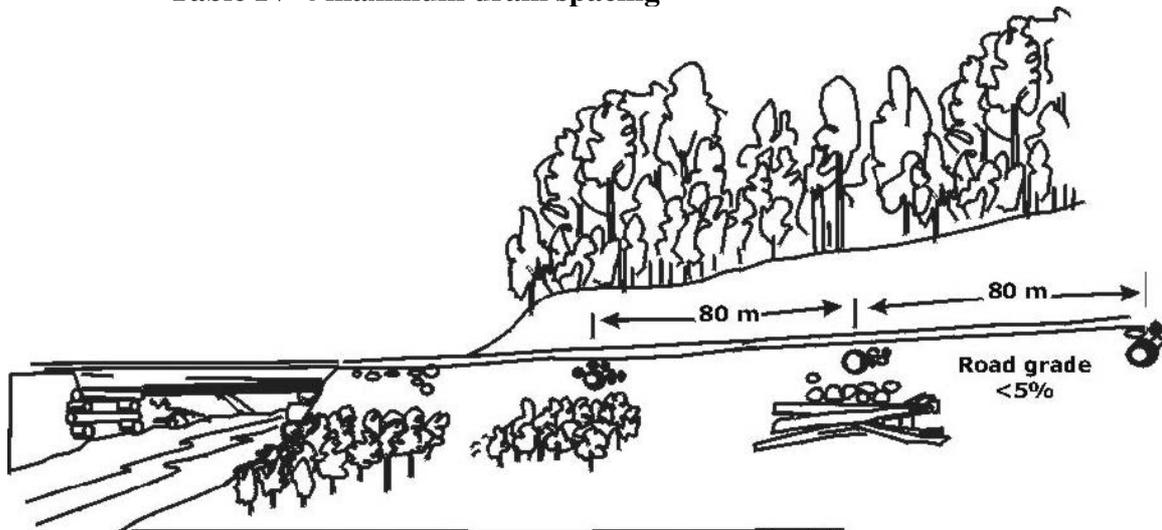


Figure IV-5 Drain spacing

4.2.4 Drain out-flow

Ditches shall not drain directly into watercourses. Rather turnout drains (outlets) shall be installed at least 50 m before meeting a watercourse to divert water into the surrounding vegetation. Where turnout drains are not practicable, drainage diversion using culverts shall be used.

- All drains shall have stable outlets, protected by vegetation or rock or log barriers, particularly in fill areas.
- Sumps or silt traps shall be constructed in ditches at all four corners of watercourse crossings.
- In steep terrain silt traps should be constructed at the end of turnout drains.

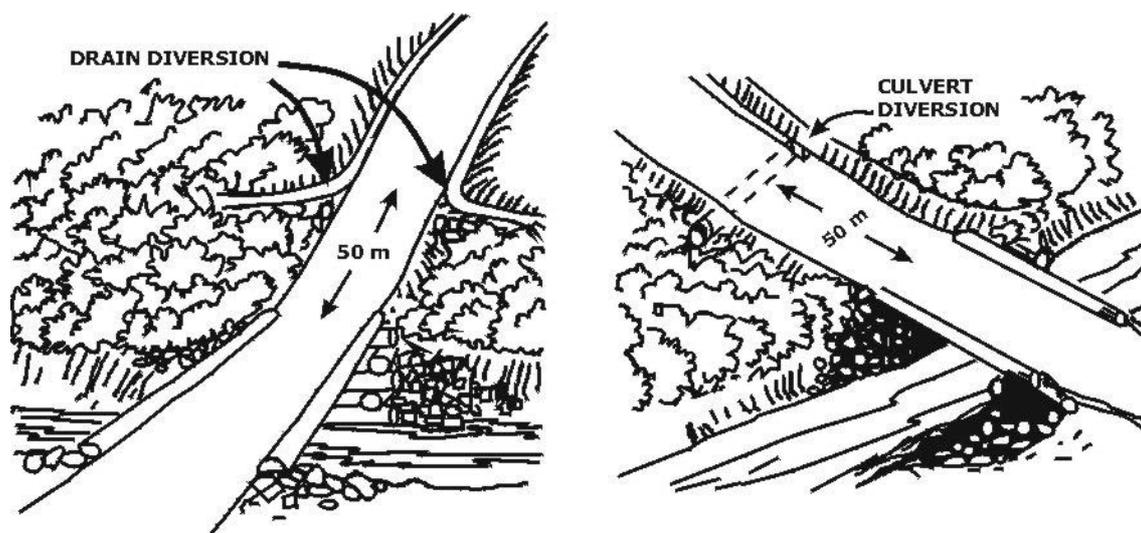


Figure IV-6 Drain diversion by turnouts or culvert

4.3 Road maintenance

For all primary and secondary forest roads maintenance shall be carried out regularly, and at least on an annual basis. The crown of the road surface and road shape shall be maintained to allow effective drainage. Additionally:

- Surfacing gravel or loam should not be pushed to the road edge or into drains.
- Soil, vegetation and other materials that would obstruct water flow shall be cleared from ditches.
- Turnout drains, culverts and bridges shall be kept clear and in a good working condition at all times.
- Bridge decking, foundations and sidewalls should be checked regularly.
- Any debris that has been pushed into the watercourse shall be removed.
- Water should flow freely under bridges, and silt traps should be cleaned regularly.

4.4 Watercourse Crossings

4.4.1 Types of Crossings

Table IV-5 shows the classification of watercourse crossings. Note that corduroy with earth fill and/or log clusters is not permitted for crossing any watercourse in any situation.

Type of crossing	Description
Bridges	Bridges shall be used for road crossings of all rivers and creeks. They may also be used for other watercourses.
Culverts (or pipes)	Culverts shall be used for crossing gullies and other waterways if bridges are not constructed.
Fords	Fords are not permitted on primary and secondary forest roads, only for skid trails, and they should be corduroyed.

Table IV-5 Classification of watercourse crossing

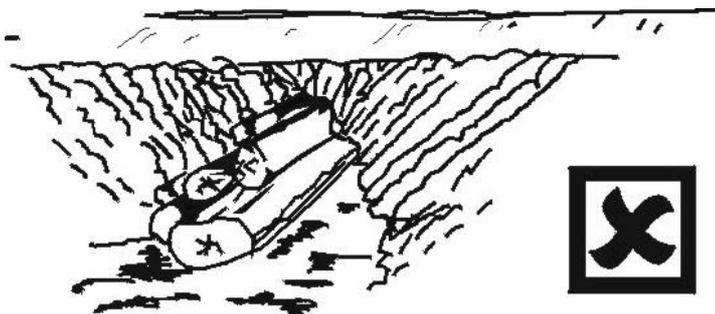


Figure IV-7 Log clusters with earth fill are not allowed

4.4.2 Construction of Watercourse Crossings

(a) Location of crossings

Watercourse shall always be crossed at right angles. Additional criteria for selecting the location of crossing points are that sites:

- Are immediately downstream of straight and stable watercourse sections
- Have easy high bank access
- Do not require deep box cuts
- Require minimum alteration to the high bank

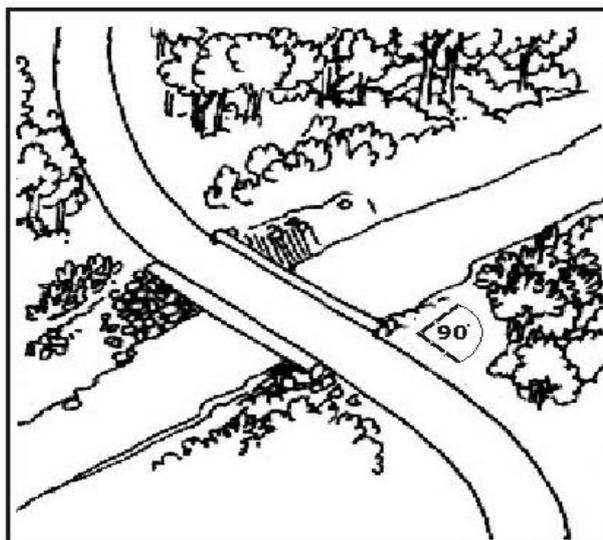


Figure IV-8 Cross watercourses at right angles

(b) Earthworks

In the construction of roads and bridges, river and creek beds shall not be filled in. All earthworks shall be carried out so as to prevent soil from entering the watercourse, and all spoil shall be removed to outside the buffer strip or alternatively should be

placed in road fills. Watercourse buffer strip vegetation should be retained to the edge of the crossing.

Temporary crossings are permitted to allow equipment involved with the construction of the crossing to be moved to the other side, provided that:

- The width of the temporary crossing is limited to 4 meters.
- The temporary crossing is made on the final crossing alignment, so as to reduce disturbance to watercourse banks and buffer strip vegetation

During bridge construction oil, chemicals, excess concrete and other waste should not enter the watercourse.

4.5 Bridges

All bridges on primary roads shall be, and all bridges on secondary roads should be, sufficiently elevated to allow wet season flood flows to pass without damage to the crossing or its foundation. The bridge span should extend at least 120% of the width of the watercourse measured from bank to bank; i.e. extend beyond the river or creek channel by 10% on either side. All approaches shall have a straight and level alignment for a minimum of 20 meters on either side.

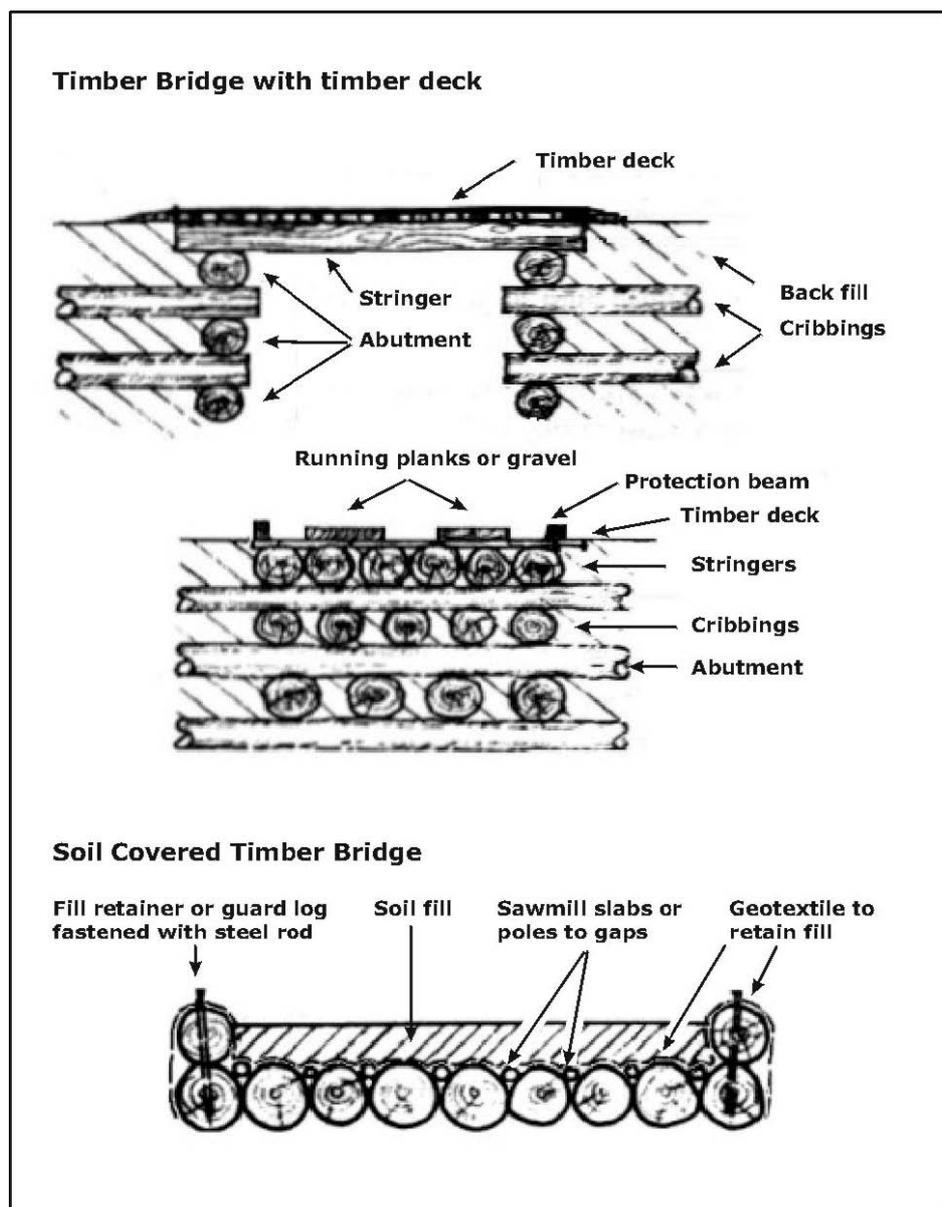


Figure IV-9 Bridge construction

4.5.1 Bridge construction

In constructing timber bridges the following criteria shall be considered (Fig xx illustrates two timber bridge types).

- All parts of timber bridges should be constructed using durable timbers with high strength property/density not less than 850kg/m³, such as Dahoma, Irvingia, Klainodoxa, Ekki, based on approval by the Authority. Decks should be constructed with durable sawn timber.
- Soil fill or covering is not allowed unless the stringers are completely covered with a material such as geotextile and have guard logs on both sides
- Foundations should be excavated to a solid base and not formed by pushed material

- All parts of the bridge shall be well anchored to prevent their washing away (see fig. 123)
- The stream banks adjacent to the bridge should be stabilized using wing walls of durable logs or other equivalent construction
- Silt traps shall be built at the four corners of bridges

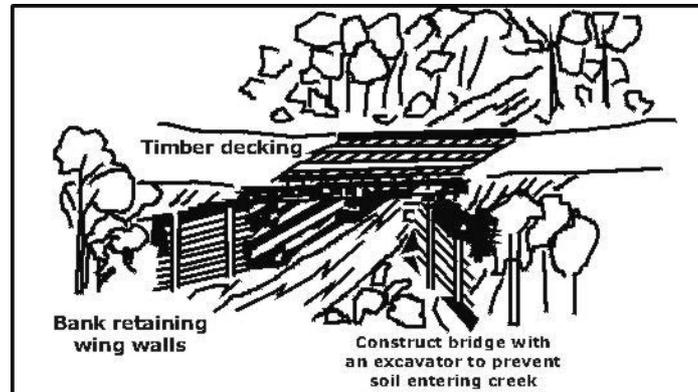


Figure IV-10 Stabilizing bridge abutments and stream banks

4.5.2 Culverts

Culverts should be set at or marginally below the level of the natural watercourse bed (see fig.123). They may have an earth fill but are to have stable abutments to the level of the running surface to prevent soil entering the watercourse. Simple log culverts should be constructed for small seasonal water flow crossing the road. They should consist of three logs, of which two are the basic layer with the third log on top and covered with gravel.

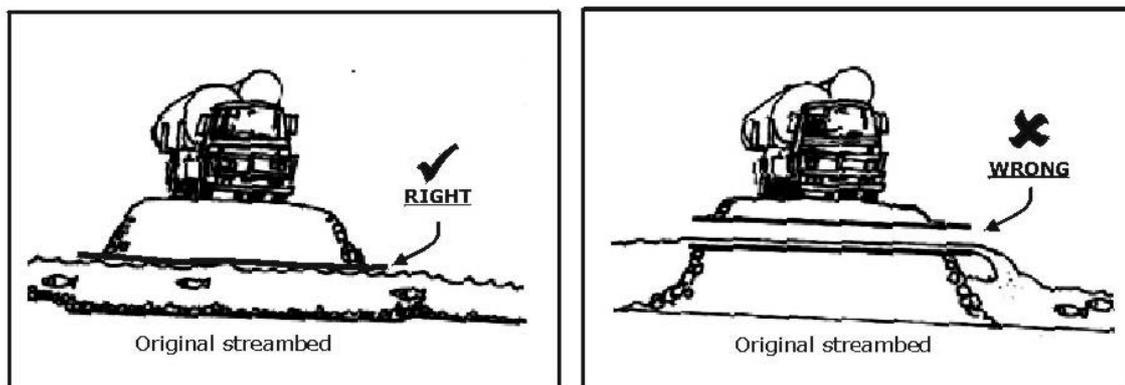


Figure IV-11 Culvert should be set at the level of the streambed

Culverts shall be laid at a grade that will minimize silting up and excessive scouring at the discharge end. They should have a headwall to prevent erosion, and should have an opening with a diameter of 45 cm or larger depending on the wet-season flood-flow level. In case of log culverts it is recommended to use at least three-log culvert if high flood flows are expected. Provisions shall be made at culvert inlets and outlets to minimize erosion caused by flow entering or discharging; sediment traps of logs

and/or rocks shall be required in place where high water flows are expected (see fig.234).

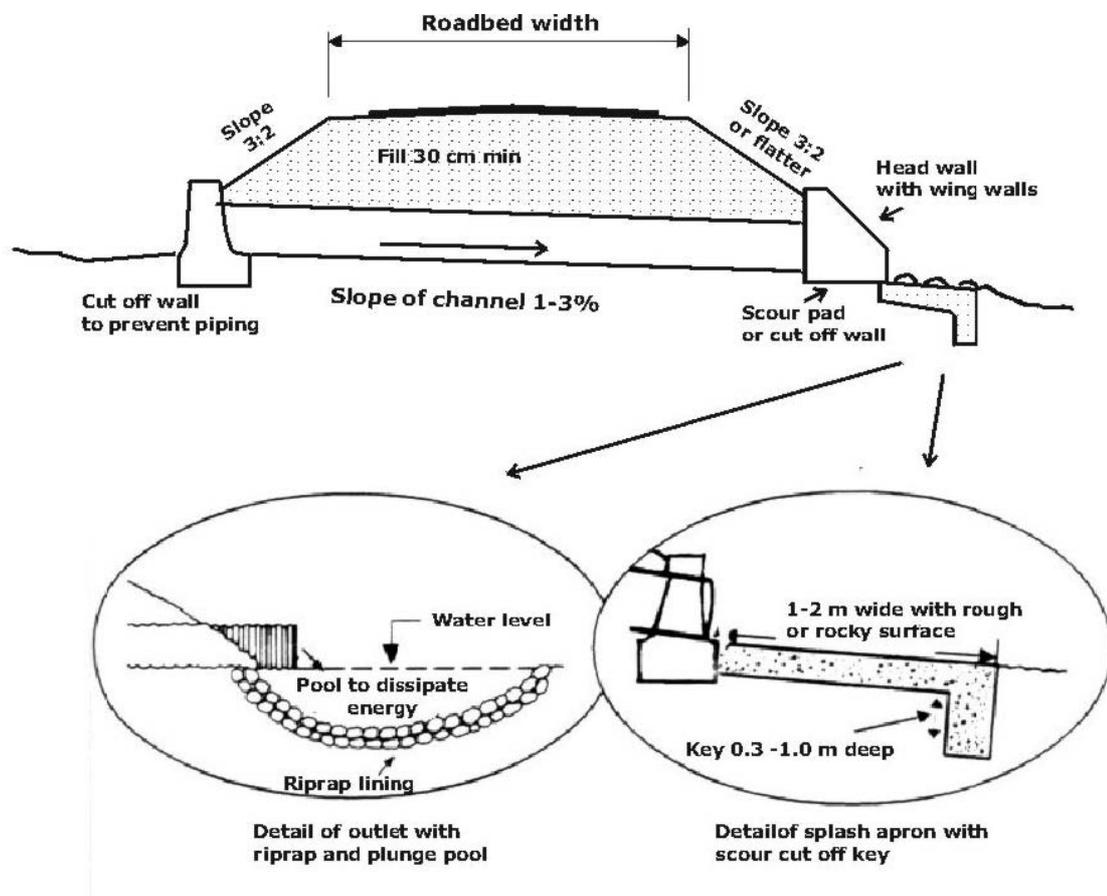


Figure IV-12 Culvert installation and outlet protection details with splash apron or riprap lined plunge pool for energy dissipation and scour control

Culverts shall not discharge over fills without adequate protection (e.g. rip rap, geotextile). Sumps or silt traps shall be constructed in ditches at all four corners of culverts to prevent siltation and blocking. Log culverts shall require geotextile or another retaining mechanism to retain backfill.

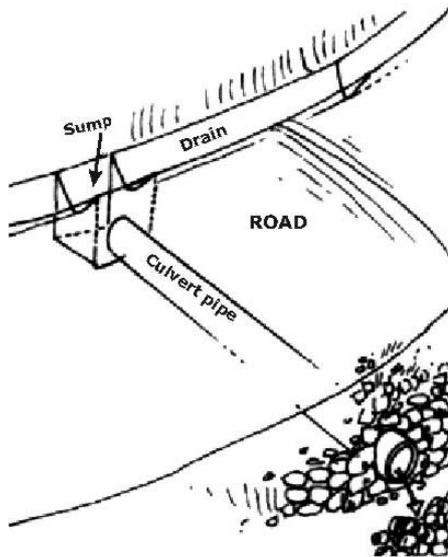


Figure IV-13 Provisions at culvert inlets (sumps) and outlets (energy dissipaters) to minimize erosion caused by flow entering or discharging

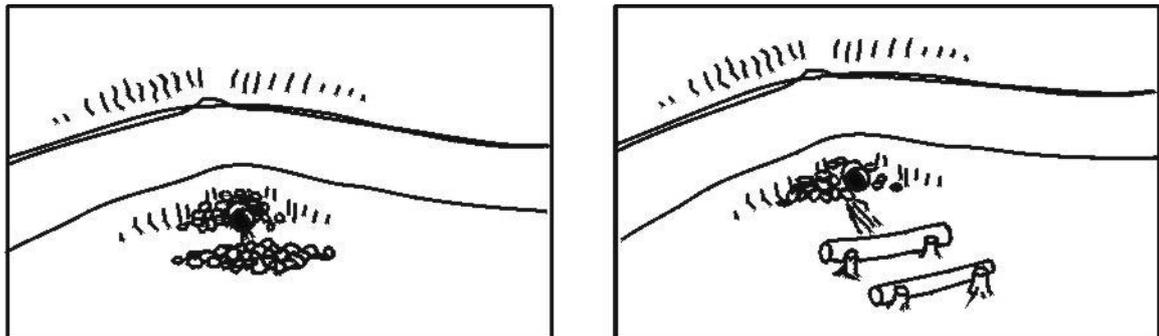


Figure IV-14 Sediment traps of logs, rocks, etc. will be required in places where high water flows are expected

4.5.3 Fords

The construction of fords (or low-level watercourse crossings) shall minimize earthworks and impact on the streambed. They shall be built to allow water to flow at all times, and should provide protection against scouring below the crossing (unless the bed is solid gravel or stone), and should be corduroyed to minimize impact on creek bed. The corduroy shall be removed when the ford is no longer in use.

4.6 Log landings

Log markets should be constructed to facilitate log sorting and loading activities. Spacing and size of log markets depend road density, topography, volume to be harvested, projected skid trail pattern, log size, storage time and logging equipment used. Hence, spacing and size of log markets should be determined during the planning phase. Remember that roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation.

4.6.1 Location of log landings

Log landings (or log markets) should be sited at such intervals as to minimize the number and total length of skid trails, but they should normally not be less than 250 m and not more than 1000 m apart (see fig. 456 and fig. 789). Log landings shall be located:

- At least 30 m from the edge of buffer strips (e.g. 45m from the bank of a creek or the edge of a gully) so that mud and debris do not enter watercourses.
- At sites that accommodate efficient skidding patterns and directions.
- On a gentle sloping elevated area, or on ridges or benches, in order to facilitate free drainage at all times, reduce the amount of side cutting, and encourage uphill skidding to disperse runoff into surrounding vegetation.

Log landings should not form part of the public roadway, and should be located 50 m from the public roadway to avoid deterioration of the road formation, road drainage facilities, and reduce hazard to the public except when this would significantly reduce earthworks while maintaining adequate drainage of both road and market. However, trees on the road construction site marked and felled, should be deposited on temporary roadside landing and integrate into the production process.

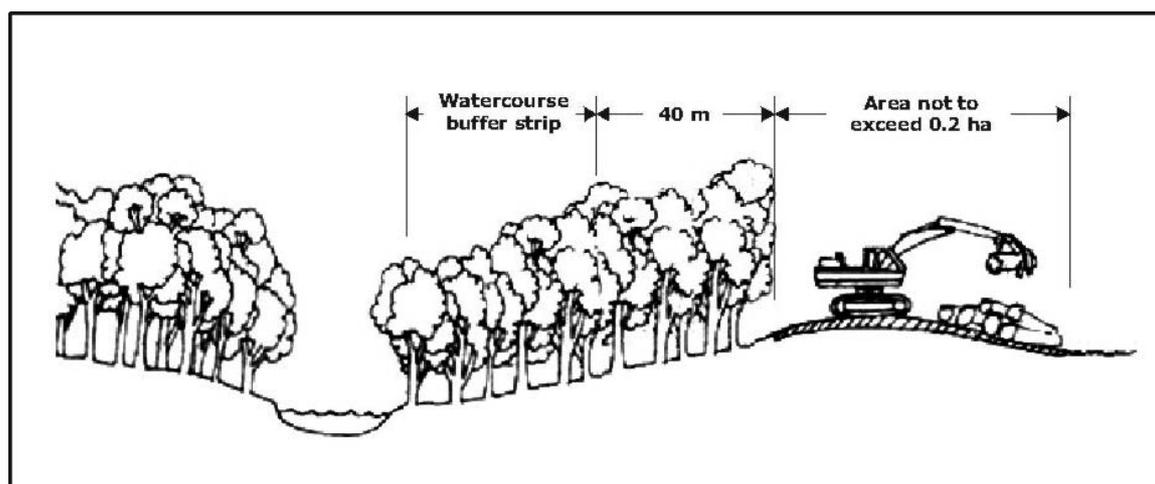


Figure IV-17 Location and size of log landings

4.6.2 Size of log landings

The size of a log landing will depend on the expected volume and number of logs to be stockpiled. It should be large enough to facilitate the sorting of logs, to allow for entry (skidder) and exit (loader) points. A log landing should not exceed 1400 m² (35 m x 40 m) in size, and the total area occupied by landings should not exceed 0.42 ha per unit area of 100 ha, i.e. 3 landings per km sq block.

Private roads or road sides in the contract areas can be and sometimes should be encouraged as the landing areas where this can reduce environmental impacts.

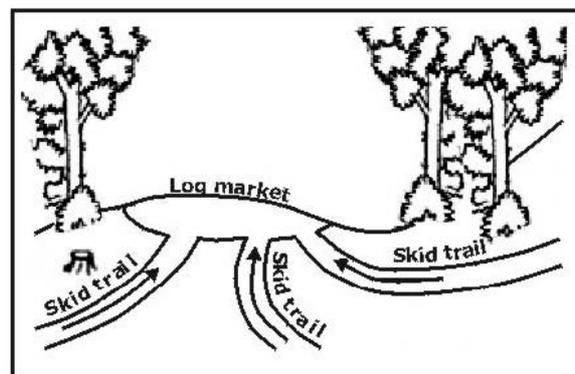


Figure IV-18 Landings should be located on gently sloping elevated areas, with skid trails approaching from below

4.6.3 Log landing construction

All merchantable trees shall be felled from the log landing site and extracted before clearing (these trees will be part of the approved yield from the block).

Log landings shall be well drained. Proper drainage requires:

- A domed surface to prevent the ponding of water.
- Ring drainage around the perimeter to prevent surface ponding.
- Drains to channel runoff to vegetated areas.

Log markets should have designated entry (skidder) and exit (log loader) points.

4.6.4 Log landing operations

Skid trails should approach landings from below to avoid directing runoff of water to the landing. This will reduce the amount of mud and water entering log markets from skid trails or roads. Likewise:

- Skidding across the roadway shall not be permitted because this may lead to deterioration of the road formation and (road) drainage facilities.
- The use of heavy machinery on saturated soils should be minimized to limit erosion, ponding, rutting, mixing and the compaction of the soil.

- Hauling on wet roads should be minimized
- Log landings should not be bladed off to keep them operational
- Debris and waste should be placed so as not to restrict drainage of the landing

4.7 Borrow Pits

Forest roads are typically built from local materials that must support heavy logging trucks and should have a surface that, when wet or when extremely dry, will provide adequate traction for vehicles. In many cases, the native soil material is too soft, too unstable or impossible to compact (white sand). Surfacing both improves structural support and reduces road surface erosion. Gravel, crushed aggregate, or loam are the most common improved surface materials used.

Use of local material sources, usually borrow pits, can produce major cost savings, compared to the cost of hauling materials from distant sources. Typical borrow pits can have major adverse impacts, including sediment from a large denuded area and impacts on wildlife. Thus borrow pit planning, location and development should be done with care.

The extraction of gravel or loam from road cutting areas during the formation of the road is preferred to the development of large borrow pits. All merchantable trees shall be harvested on the proposed borrow pit site (these will be included in the approved yield). Additionally:

- Catch drains should be constructed around the uphill side of the pit to prevent runoff entering the area
- The base of the pit shall be drained at all times. Drains shall not directly enter watercourses
- The face of the pit shall be maintained in a stable condition at all times
- At least one side of the pit shall have a gentle slope to allow easy wildlife access

V. LOGGING OPERATIONS

5.1 Tree Marking

Tree marking standards will be determined and regulated by the FDA's chain of custody system. During the commercial stock survey all commercial trees above their respective minimum cutting diameters will be marked and numbered according to those standards.

- Following FDA approval of the yield all trees to be felled will be marked in the manner required.
- For all trees included in the yield the recommended felling direction shall be indicated.
- Seed trees and trees belonging to protected species shall be marked accordingly, and a 20m radius protection zone shall be established. However, no tree within 10 meters of a seed tree shall be felled.
- Rare, and endangered species (according to the IUCN Red List and Authority Regulations) shall be appropriately marked and designated as preserve trees to maintain the natural diversity of tree species;

5.2 Skid trails

5.2.1 Location

The design of the skid trail network should be based on an assessment of the following factors:

- Location and density of roads and log landings
- The number and location of trees to be harvested
- The logging equipment used
- The minimization of watercourse crossings
- The avoidance of soils with low load bearing capacity

The total area occupied by skid trails should not exceed 8% of the total area of the block or compartment (or a total linear distance of 200 m per hectare).

Skid trails shall not be constructed in areas excluded from harvesting and buffer strips. The maximum allowable gradient for skid trails is 35%. Skidding on slopes greater than 30% is only permitted/ allowed for short distances (less than 30 m) where adequate provision for drainage is possible to prevent excessive erosion. Uphill skidding is recommended since this gives operators better control over the movements of the log, and also tends to encourage the greater dispersion of runoff water into the surrounding area and not onto the skid trail. All skid trails should be as straight as possible to minimize damage to residual trees, to prevent damage to the log being extracted, and to maximize skidding efficiency.

5.2.2 Survey requirements

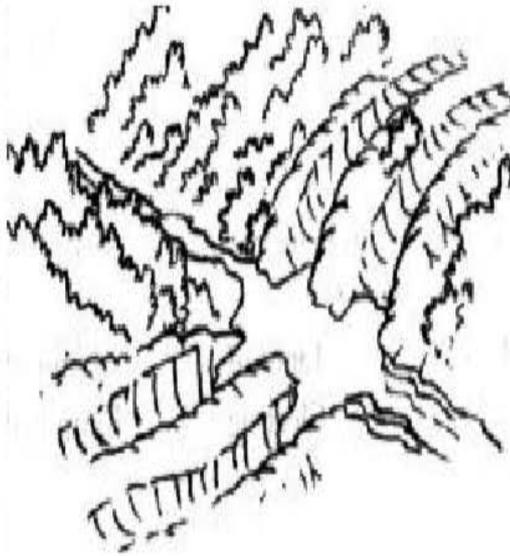
The proposed skid trail layout in a block shall be marked in the field prior to inspection and approval by the FDA using flagging tape, paint marks or by blazing. Skidder and chain-saw operators (and their assistants) should inspect the proposed alignments with the bush manager prior to commencing construction. Watercourse crossings shall be marked as such on the tree location map and on the ground

5.2.3 Timing of construction

The approved skid trail layouts shall be marked before the start of the felling operation to assist the feller in determining the direction of fall and to improve safety and efficiency of the logging operation. The construction of skid trails shall take place in the logging season only.

5.2.4 Construction

Skid trails shall be opened by a crawler tractor. The construction of skid trails should not require any earthworks. The maximum skid trail width is 4 meters. Avoid trees above 30 – 50cm dbh during skid trail construction.



Skid trail causing unacceptable damage to stream banks and channel, especially with steep banks, erodible soil and unstable channel base

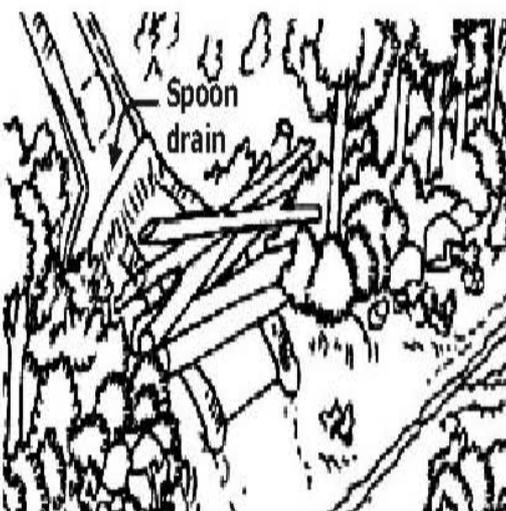


Designated opening



Temporary crossing using logs and poles or a culvert

Crossing removed once skidding is completed to allow watercourse to flow unrestricted along its original course



Spoon drain

5.2.5 Watercourse crossings

Proposed watercourse crossings shall be marked on the block map, and shall be marked in the field prior to inspection and approval by the FDA using flagging tape, paint marks or by blazing. Crossings should be constructed in dry weather.

Watercourse crossings shall be selected in places where the bank slope is minor and the watercourse bed is firm. Width of the crossing should be less than four meters. Buffer strip vegetation shall not be otherwise disturbed. Skid trails shall cross waterways at right angles with straight approaches of at least 10 m on either side. Temporary crossings (log culvert with corduroy) shall be provided to cross gullies in any situation, and waterways if water is flowing at the time of operation. Corduroy with earth fill is not allowed because this would effectively block the water flow and may divert its course.

Non-commercial logs shall be used in the construction of crossings where needed. Abutments and approaches should be higher than the stream banks. During construction soil should not be pushed past the high bank, into watercourses or onto the top of a crossing.

Crossings shall be removed after completion of the operation. Crossing material should be placed more than 10 meters away from the high bank. Its removal should not disturb the watercourse banks.

5.3 Felling

5.3.1 Timing of operation

Felling is only permitted in the logging season. Felling in a specific block shall commence once FDA has given its authorization. All commercial trees included in the approved yield shall have been marked for felling and their predetermined felling direction indicated and seed trees and protected trees also shall have been clearly marked.

Each felling crew should include three members (crew leader who operate the chain saw part of the time, main chain saw operator and an assistant). They shall be provided with radio for general communication and quick rescue in case of emergency.

Felling can commence when forest road and log landing construction is completed, and when skid trails have been marked on the ground. All operators (skidding and chain-saw) shall be familiar with the harvest area and have discussed the operational plan with the bush manager and/or their supervisor. The felling crew shall take both the harvesting map and the file of information on trees to be harvested into the forest.

All vines/lianas attached to the selected trees or trailing from the canopy should be cut in advance of felling so that they die and become brittle and prevent nearby trees from being pulled over or broken when the harvested tree falls.

5.3.2 Restrictions

Felling is not allowed within protected or exclusion areas and their respective buffer strips except species that are grown in wetland habitat. Felling is not allowed on slopes steeper than 30%. Felling shall commence at the rear end of the block and proceed along the main skid trail towards the log landing

If trees fall inadvertently into watercourses or their buffer strips, the tree head as well as any accompanying logging debris should be pulled clear.

5.3.3 Directional felling

Chain-saw operator and assistant should be trained in directional felling, and shall be adequately equipped at all times. Directional felling is required to:

- Avoid damage to the felled tree (by cross-felling, falling on obstacles, down-slope felling) minimize damage to designated seed trees and other protected trees.
- Facilitate easy log extraction, thereby minimizing ground disturbance.
- Avoid disturbance to watercourses, exclusion areas and buffer strips.
- Prevent trees from hanging up in adjacent canopy trees.
- Minimize canopy openings by felling into gaps formed by previous felled trees or natural tree fall.
- Avoid blocking the skid trail.
- Increase work safety.

5.3.4 Directional felling restriction

Felling crews should check trees suspected of being unsound before felling. Once cutting of a tree is started, that tree should be felled, even if it is found during felling to be unsound. The stump height should be as low as practicable (approximately no more than 30 cm) to maximize saleable volume. Stump heights over 30 cm are acceptable if there is a butt defect. Buttressed trees should be cut at a height not greater than the point, at which buttresses can be trimmed to provide a diameter equal to that immediately above the buttressed section. When it is not appropriate to trim the buttresses the tree should be cut immediately above the buttress. The logs and the stump are numbered and recorded with species and number of the harvesting block for legal reasons and work control.

5.4 Log Preparation

All log preparations should be carried out at the stump. This ensures that the non-utilizable parts of the tree remain in the forest. The felled tree shall be cross-cut (top and junk) so that splitting does not occur when a log is moved during extraction.

Operators should top and junk boles to obtain the maximum volume, consistent with highest value of saleable logs, and to reduce skidding damage. All buttress flutes, knots and branches should be trimmed flush with the main stem to gain maximum log quality and volume, and reduce soil disturbance and assist skidding. S-hooks or plates should be used before extraction as necessary on log susceptible to end splitting and to maintain quality.

5.4.1 Cross-cutting

Cross-cutting shall be done at the tree stump or at the bush landing. No crosscutting shall be carried at road side.

5.4.2 Safety Rules for Cross-cutting and bucking

- Always evaluate the distribution of tension and compression at the crosscutting point before applying the cut and position yourself on the compression side;
- Use appropriate working techniques to avoid timber wastage through shattering or splitting of the trunk;
- Give clear instructions on qualities, lengths and diameter for bucking at felling site and conversion at landing.

5.4.3 Log marking

Log markings enable logging operators, service providers, and costumers to locate and control all harvesting and extraction activities over space and time.

Each log shall display:

- The number of the tree and the block number;
- The number of the log within the tree 1,2,3, or ABC, if segmented, alphabet shall be used;
- The logo of the logging company ;
- Area of the log origin.

5.5 Skidding

Skidding shall commence only after the felling has been completed in a block and the felling crew has moved to another block.

Machine access is prohibited in areas excluded from logging and their buffer strips. Logging machinery is not allowed to cross watercourses except at approved and properly constructed crossing points. Trees felled inadvertently into a buffer strip should be extracted carefully without much disturbance to the buffer strip. Skidding along or across primary and secondary forest roads should be avoided.

5.5.1 Pre-skidding

- The maximum gradient permitted on skid trail shall not exceed 30%.
- Any tree within the skid trail and having a diameter larger than 15cm should be cut by chainsaw before the machine opening the skid trail passes.
- Crawler tractor should be used to open skid trail and pre-skid logs from the stump to the skid trail. Avoid trees above 30 cm dbh during skid trail construction.

5.5.2 Skidding to landing

- Skidding is only permitted in the logging season.
- Skidding to the landing shall be done by a wheeled skidder equipped with grapples. Logs should be winched the maximum distance possible to reduce soil disturbance associated with skidding. Machines shall be equipped with an integral arch or similar device to lift the end of the log off the ground to avoid soil damage and an increase in skidding resistance.
- Winches shall be fitted to all extraction machines, and it is recommended that the minimum length of wire rope of 25 m (19-22 mm diameter).
- Skidder and tractor blades shall be raised when traveling and skidding.
- Operators should reverse along skid tracks towards the concentrated log on the skid trail, and head or butt haul to reduce travel distance.
- The wheeled skidder should never move off the skid trail especially when all logs are concentrated along the skid trail during the pre-skidding.
- Maximum skidding load should not exceed two (2) logs.

Each skidding crew is equipped with chainsaw in addition to the standard complement of tools and safety gear.

5.5.3 Log Storage

The logging supervisor shall ensure that only trees approved in the yield are felled, and all saleable timber is extracted from the stump area and brought to the log landings. Logs should be stockpiled in well-drained log landings and shall be sorted in such a manner as to facilitate their inspection and scaling by FDA chain-of-custody staff and other authorized monitors. Logs stored at landing should be sprayed with permissible fungicides and insecticides to protect against bio-deterioration. Only chemicals approved by the Authority and Environmental Protection Agency shall be used.

5.6 Truck Loading, Transporting and unloading

Excavator type or rubber-tired or tracked front-end loaders should be used for loading and unloading logs where possible. Trucks shall not be loaded in excess of their capacity. Any protruding limbs bark or trailing material shall be removed before

the truck departs the loading point. Pit loading shall only be permitted and is limited to logs that can not be possible for excavator or rubber tired or track front end loader. The pit used shall be immediately refilled with the same excavated material removed.

5.6.1 Loading

Loading in forest harvesting is to facilitate the evacuation of extracted timber which had already been bucked, classified, sorted and scaled. Transportation should be done by means of tractor with attached trailer or flat bed to its destination (processing mill or port of exit). Loading operation is often associated with several constraints. Therefore the following measures shall be observed.

- All employees shall keep a distance of at least 20 meters away from loading truck during loading operations;
- All logs shall be stack on cross-bolts to facilitate handling by loader and to delay or restrict insect or fungal attack;
- No person should be in the cab or on the platform of truck while loading is in progress.

5.7 Road Transport

Transporting logs shall be completed by truck either directly from the bush landing/processing sites to its final destination/point of delivery. The following rules for road transporting should be fully observed and adhere to:

- Secure load firmly against log slippage or fall by means of stanchions, chocks, cables, or chain and binders to prevent log movement during transport;
- Each log should be secured by at least two cables or chain binders;
- For cost and safety reasons, vehicle brakes and stirring should always be in good technical condition. and should not be over loaded in excess of their capacity;
- All vehicles shall maintain safety and maintenance records for inspection by FDA or other authorities.
- Vehicle maintenance and inspection must be carried out at monthly intervals at a minimum for breaks, steering and other essential maintenance.
- Loads should not exceed the truck deck capacity and the bearing capacity of roads and road infrastructures;
- Never tow trucks across unstable section of the road by crawler or skidder;
- For efficiency and safety, the trailer unit should be loaded on to the tractor before traveling unloaded;
- Personnel should be in possession of their faculties before driving an articulated vehicle (no driving trucks or other operational equipment if the conductor has been drinking alcohol, taking drugs, or other has a physical impediment or condition that may cause the driver to perform in an unsafe manner);

- Never transport un-authorized passengers, bushmeat, fire arms or protected wildlife;
- Remove timber within two months to avoid insects and fungal attack
- Remove hanging bark and limbs after chaining.
- Observe speed limits;
- Truck loaded with log shall only be unloaded using the required front-end loader.

5.8 Concentration of Harvesting Operations:

Harvesting operations are finally concentrated at either the processing mill or at shipment port of exit. It is at this stage when sound decisions are to be made in order to sustain the productivity and realize the profit margin. Successful harvesting output depends on product, product quality and the market. To maintain the quality of the products harvested certain conditions will have to be guaranteed.

5.8.1 Processing Mills

- Logs off-loaded should be stacked according to species and grade on cross bolts
- Buck logs to market and contract requirement before sawing;
- Logs should be sprayed from time to time with pre-approved wood preservatives especially in the wet season while awaiting saw milling.
- Processed wood products shall be stacked under well ventilated shade using stickers between sawn timber to avoid sap staining
- End-faces of sawn timber should be painted to reduce face checks and splitting
- Produce quarter-sawn timbers to reduce shrinkage and increase market value.

5.8.2 Shipment Port

- Seal the faces of logs with anti-cracking chemicals to prevent face checking and splitting
- Spray the stacked log with permissible insecticides and fungicides
- Debark logs if necessary and spray before stacking;
- Logs must be properly stacked on cross-bolts to avoid direct contact with the moist ground and prevent discoloration from the exudates of other species; and
- Logs that are susceptible to crack and splitting should be S-Hooked to maintain quality and value.

5.9 Weather Limitations on Logging Operations

Road construction and maintenance, skidding, loading and hauling when conditions are wet cause extreme damage to soil and water. It is also inefficient and often dangerous. Areas most likely to be workable in wet weather are those with less than 20% slope on stable soil types such as brown / white sand and laterite

The annual plan should specify wet and dry weather coupes

5.9.1 Felling

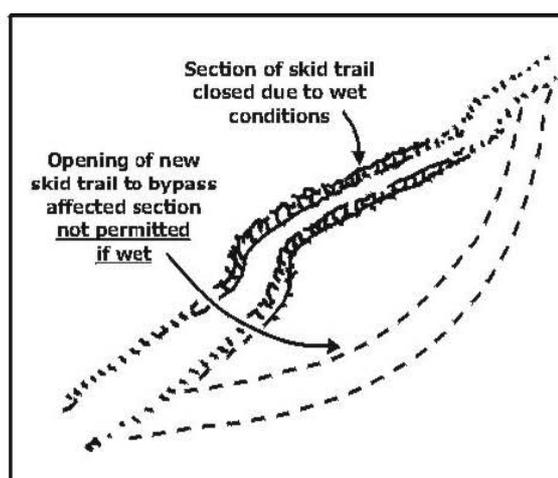
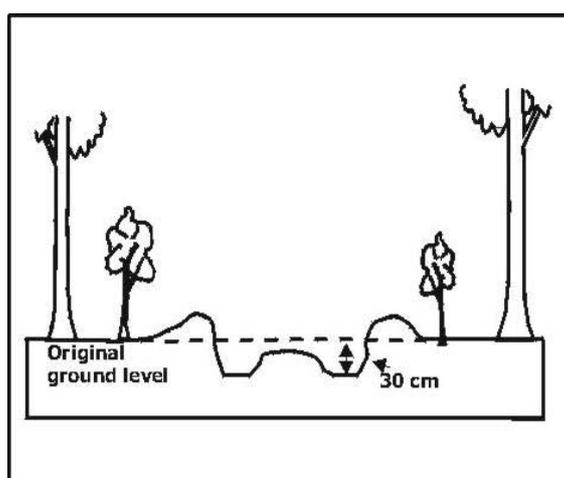
Felling should cease when winds prevent accurate and safe directional felling, and when ground conditions are too slippery to allow the felling crew to move safely and quickly away from the falling tree, and when log extraction or hauling is not possible due to weather and/or soil conditions. Felling should always be limited to ensure the volumes cut at any one time can be promptly skidded and hauled.

5.9.2 Road skid trail construction and skidding

Road construction operations and skidding should cease when:

- Soils are saturated and turbid water or mud is flowing down a skid trail.
- Turbid water or mud is flowing from a skid trail or road into a watercourse.
- Soils are rutted to the extent that the depth of mud is greater than the rim of wheeled machinery or reaches the final drive on caterpillar-type machinery.

Any affected section of the trail or road shall not be by-passed by opening up a new trail/road alongside or close by.



5.9.3 Log landing operations

Construction or operations on log landings shall cease when:

- Water is ponding on the surface of the log landing.
- Soils are rutted to the extent that the depth of mud is greater than the rim of wheeled machinery or reaches the final drive on caterpillar-type machinery.

5.9.4 Trucking

Trucking shall be halted when:

- Trucks cannot move unassisted along the roads because of slippery conditions.
- Turbid water or mud runs in wheel ruts, and forestry roads are rutted to the extent that the depth of mud is greater than halfway of the rim of wheeled machinery or deemed by the Authority representative to have substantial environmental impact.

5.9.5 Recommencement of operations

Soils need to be allowed to drain after heavy rainfall events before forest operations recommence. Skidding, loading and trucking operations may recommence only after water or mud ceases to flow on affected skid trails, landings and forest roads, and mud depths fall below the maximum permitted levels.

VI Non-timber Forest Product (NTFP) Management Practices

NTFPs are resources derived from the forest besides timber and other wood based materials e.g., plywood, particleboard etc., that provides security, health care, materials for implements and construction, fodder, fuel wood and livelihood to rural communities specially those living in the uplands. This includes wood extractives, barks, leaves, roots, sap, fruits and also non-timber yielding materials such as rattan, bamboo, coconuts etc.

NWFPs are of significance primarily in household and local economics. The economic benefit that can be derived from non-timbers forest products have been identified as a major opportunity for community forest projects.

Most significantly, NTFPs play in important part in sustainable forest management. The exploitation of many NTFPs depends on keeping forest intact without decimating a while range of forest resources.

6.1 NTFP Sustainable Management Practices

- Logging contracts should incorporate the sustainable management practices in their harvest plan;
- Capacity building in the NTFP sustainable management and utilization should form part of social agreement to be provided for the local communities. The training shall emphasis on the techniques in harvesting, processing, marketing and cultivation/propagation
- Local communities shall be given the opportunities to access the forest for NTFPs as long as the harvest is sustainable;
- Logging companies shall regulate and monitor the harvesting of honey. This is to mitigate the burning /setting fire on the bee hives
- Local communities shall be allowed to harvest, collect the NTFPs in the concession areas as long as these exercise are sustainable
- Extraction and road building machines should prevent the destruction bamboo clumps in the forest areas.

VII POST-HARVEST ACTIVITIES

Rehabilitation of logged areas is required to prevent further deterioration of the logged area and downstream soil and water values, and to encourage forest regeneration. All areas should be left in a clean and tidy condition

7.1 Block closure

Blocks shall be closed once the logging of the approved yield has been completed. A block that has been closed shall not be re-entered and shall remain closed until the next scheduled cutting cycle except for the collection of non-timber forest products by the local communities.

Logging operations in a specific block should be completed in a single logging season. The only exception to this rule that may be applied is when weather conditions have prevented the approved yield to be felled and extracted. In such cases the FDA shall provide an extension to complete harvesting operations.

7.2 Road maintenance and closure

The primary and secondary forest road network shall be maintained in good condition. There should be no ruts in the surface and the road surface should be crowned. Likewise all ditches, turnout drains and cross-road drainage that will not be removed shall be left in good working condition.

Roads not to be used until the next rotation shall be closed to all traffic by placing a large log across the roadway, or digging a ditch across the roadway. For roads that are being decommissioned log culverts and temporary bridges shall be removed to allow unobstructed water flow. All bridges and permanent culverts that are not to be removed shall be checked regularly (and at least annually) including decking foundations and sidewalls. All silt traps shall be cleared regularly. Indigenous commercial tree species should be planted on closed roads after operations are completed.

7.3 Log landings

All closed log landing sites should be restored so that proper drainage occurs. All areas where water may pond shall be drained, and drains installed. All log landing drains shall be cleared regularly until the landing has stabilized. Indigenous commercial tree species should be planted on the landing after operations are completed.

Log landings on clay or loam should be ripped at 90° to the drainage direction to promote natural re-vegetation. Silvicultural treatment shall be introduced through

enrichment planting of commercially valued species. Bark and debris should be disbursed evenly across the site to assist in stabilization.

The site shall be cleaned of all refuse including oil/fuel drums, wire rope, tires and machinery parts.

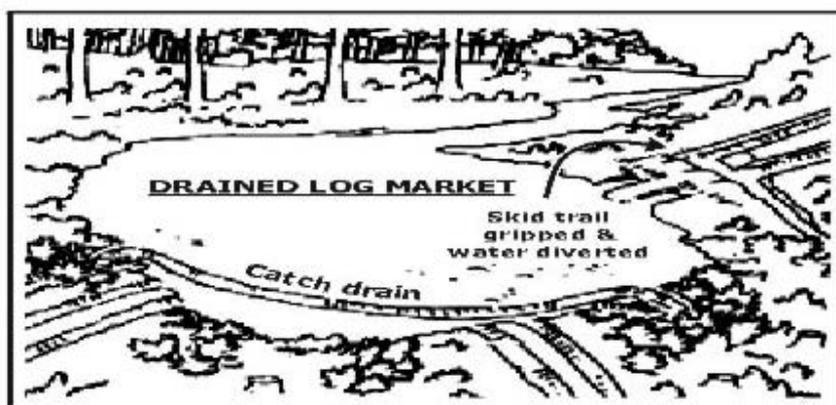


Figure VII-1 Drain log markets and divert water flowing to markets once logging is completed

7.4 Skid Trails

Temporary skid trail crossings of waterways and gullies shall be removed after completion of harvesting operation in the block. Removal should not disturb the watercourse banks. All material used in the construction of temporary crossings shall be moved at least 10 meters away from the watercourse. Action shall be taken to restore water flow to its original watercourse where necessary.

On higher gradients of skid trails the clearing and maintenance of drains may be required until skid trails have stabilized.

Where it may apply, contractors should plant indigenous commercial tree species in open skid trail areas where it may enrich the species diversity, improve stand quality or provide erosion prevention.

7.5 Borrow Pits

Borrow pits shall be decommissioned by:

- Removing any non-biodegradable material and burying all biodegradable waste
- Stabilizing steep cuts
- Re-grading the drain on the uphill side and ensuring that runoff cannot enter the pit
- Draining the surface of the pit if water is likely to pond

7.6 Field Camps

Temporary field camps shall be closed by taking the following steps:

- The site shall be cleaned of all refuse including oil/fuel drums, wire rope, tires and machinery parts, as well as building materials, and all biodegradable waste shall be buried.
- All areas where water may pond shall be drained (but drains are not to empty directly into watercourses) and drains shall be cleared regularly until the campsite has stabilized.
- Campsites should be ripped at 90° to the drainage direction to promote natural re-vegetation. Bark and debris should be disbursed evenly across the site to assist in stabilization.

VIII OPERATIONAL HYGIENE

Maintenance, servicing and fuelling of logging equipment involves materials which could cause serious harm to soils and waters if released; pollution of groundwater or watercourses by oil, fuel, lubricants or other hazardous materials will eventually affect all flora, fauna and humans not only near the spill but also downstream.

Not maintaining a clean and tidy operation is a sign of poor worker attitude, careless management and disrespect for the environment

8.1 Workshop & Wood Processing Facilities

Workshop and wood processing facilities shall be located at least 100 m away from any watercourse or water body. The appropriate public health inspector or similar designated agency may assess plans, approve and inspect workshops, sawmills and associated infrastructure. Approval for their construction may depend upon the preparation of an environmental impact assessment. Provision shall be made in plans for the removal or burial of non-toxic solid waste, and for the collection and disposal at approved designated waste disposal facilities of fuel and oil waste.

8.2 Field Servicing and Maintenance

Field fuel tanks, refueling points, chemical mixing points and maintenance areas shall be located:

- In well-drained areas such as log landings or road junctions.
- Outside areas excluded from harvesting and their buffer strips.
- No closer than 100 m to any habitation
- More than 100 m away from any watercourse.

Care shall be taken to prevent spillage during refueling or repairs. Adequate equipment – e.g. hand pumps – should be provided and used. Sump oil shall not be dumped in the harvesting areas, but collected and removed to the designated waste disposal facilities. All containers used in the transport, storage and use of toxic materials shall be leak proof, marked as “hazardous” and clearly labeled with the contents’ name.

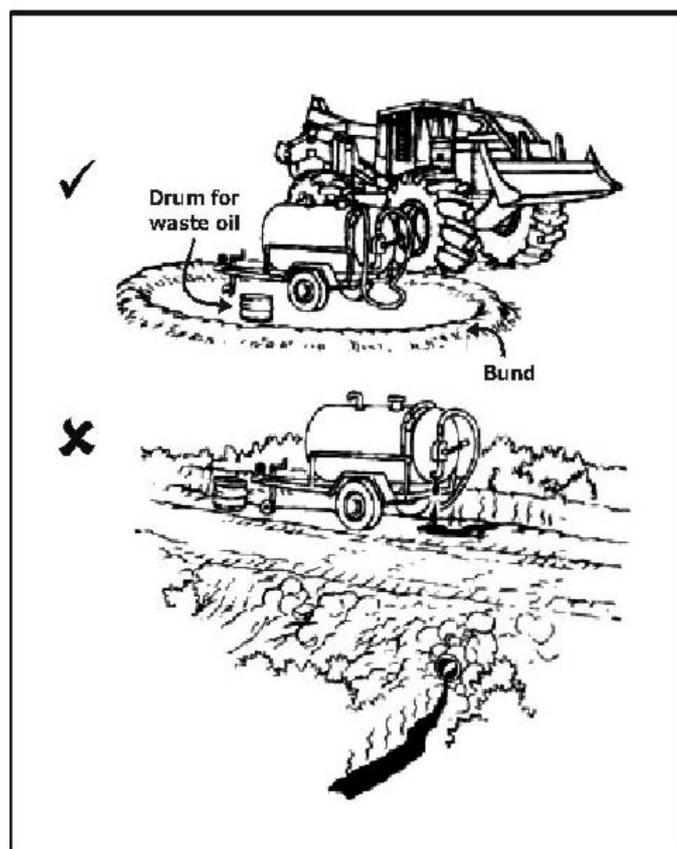


Figure VII-1 Care shall be taken to prevent spillage during refueling

8.3 Hazardous Chemical Handling and Storage

Hazardous chemicals include preservatives, pesticides and herbicides. The FDA must be notified and give approval before a company starts using any pesticide, herbicide or preservative in or near the forest. The company must obtain the relevant “Chemical Technical Data Sheet” and submit a copy to the FDA every time it is to be used. Chemicals must only be used when necessary to achieve defined management aims described in the Management and/or Annual Plan, and approved by the FDA, and in strict accordance with the manufacturer’s instructions. The instruction shall specify:

- The types of chemical to be used (oil-borne, organic solvent base, or water-borne)
- % concentrations;
- Active ingredient (toxic component of preservative formulation);
- Application levels ; and
- Method of treatment.

Hazardous chemicals shall be stored in a well-drained area at least 100 m from any watercourse and no closer than 100 m to any habitation. Drains are to be directed to a closed, stable and flood free disposal pit, situated at least 50 m from a watercourse or water body.

Toxic materials are to be stored in a locked, dry, well-ventilated storeroom. Wet products are to be effectively separated from dry products. All entrances are to be

clearly marked with a sign reading “warning – hazardous chemical storage - authorized persons only” or equivalent. Containers should not be stored on the floor, but are to be elevated above the floor on pallets or other means, to allow regular inspection and rapid identification of leaks. All containers used in the transport, store and use of toxic chemicals are to be leak proof, marked as “hazardous” and clearly labeled with the contents’ name. Access to the storerooms of toxic materials should be restricted to authorized personnel.

It is recommended that concrete bunds with a capacity of twice the storage capacity of the largest storage container are to be provided around all storage facilities

8.4 Waste Management

Toxic substances include (spent) hydraulic fluid, coolant, lubricants, fuel (gasoline/diesel/kerosene), industrial cleaners, paints and resins, preservatives (including timber treatment chemicals), distillates, insecticides and herbicides, and workshop waste, waste oil and contaminated sludge

Toxic materials shall be collected in containers securely sealed and either dumped at designated waste disposal facilities, waste pits or returned to the supplier in accordance with the approved environmental impact plan.

Only approved waste pits shall be used for specific waste products. All waste pits are to be covered with at least one (1) m of soil and located at least 100 meters from any watercourse or water body and at least 1- 1.5m above the groundwater table. Signs should be erected identifying the waste pits.

Toxic materials shall never be disposed of into watercourses or lakes. Equipment used for applying chemicals shall not be washed in watercourses.

Excess chemicals are to be either removed from the forest or chemically treated (neutralized) in an approved manner. Empty containers are to be safely disposed and not reused.

All refuse introduced to the forest e.g. pieces of wire rope, packing material, bottles, containers, etc. shall be removed from the forest, placed in a refuse pit, buried and covered to a level surface. Fuel and oil drums, used oil filters, oily rags, empty grease gun cartridges, worn machinery parts, paint tins, etc. shall be removed to a designated disposal area; or returned to the supplier. Discarded machinery shall be removed from the contract area to the designated waste disposal facilities.

8.5 Wildlife management in contract areas

- Logging companies shall apply measures to discourage and limit illegal hunting in their concession areas.
- No company workers shall possess and /or transport fire arms, bush meat and/or hunters in company vehicles, even outside the concession area and a ban on abetting or facilitating hunting;

- All workers are prohibited from hunting outside demarcated Hunting area;
- All workers are prohibited from hunting protected animals;
- All workers are prohibited from using snares;
- All workers are prohibited from selling bush meat(in commercial quantities) in company camps and worksites;

8.6 Alternative protein sources for wildlife protection in concession areas

- The company shall make available smoked fish, pork, canned meat, beans, dairy milk, chicken, groundnuts,(leguminous products) and/or fish;
- Encourage fishing using hooks and collection of snails in a sustainable manner;
- Promote activities that provide vegetables or animal proteins.

IX CAMP HYGIENE

Maintenance of safe, healthy and pleasant living and working conditions for personnel is a prerequisite for a motivated and fit workforce, hence productivity

9.1 Camp Design

Permanent camps should be protected from wind storm by planting non-invasive and fast growing ornamental species. Grasses around camp building should not be hooked out, but rather periodically trimmed/brushed. This will prevent soil erosion.

Site plans for camps should include designs for sewage, water supply, waste water and waste disposal. These will be evaluated as part of the environmental impact assessment that accompanies forest management plans. FDA staff in conjunction with staff from other agencies, such as the EPA, will inspect sites on a regular basis.

Camp areas shall be well drained so that water does not pond or create mosquito-breeding areas. The camp shall be checked regularly for any areas where stagnant water can accumulate.

9.2 Water Supply and Domestic Waste Water

Camps are to be supplied with purified potable water obtained from running streams, rainwater, and wells or by water tanker. All water storage tanks should be properly screened to prevent the breeding of mosquitoes.

9.3 Wastes and Refuse Disposal

An adequate number of plumbed toilets or pit latrines shall be provided. Plumbed toilets should drain into a septic tank. Pit toilets shall be located at least 100 m away from watercourse and water bodies. Sewage shall be discharged so it neither enters the catchments of drinking water supplies, nor intakes into a stream. All pit toilets must be sprayed with environmentally recommended chemicals once every week. Domestic waste water shall be directed to a disposal area (or septic tank) at least 20m away from the nearest building. All drains (waste water and sewage) should be kept covered.

Provision shall be made for refuse disposal areas in pits located at least 100 meters away from watercourses, 50meter away from habitation or farmland, The pits shall be dug above the groundwater table, and where runoff water cannot enter. Refuse shall be covered with soil to depth of 30 cm at least once per every one month. And it shall be sprayed once every week with biocide but not with fuel oil alone.

9.4 Camp Construction Requirement

- All permanent buildings in concession areas shall be made of solid materials such as cement, bricks, stone, processed hard wood and designed with comfort and convenience in mind;
- All camp houses and roads shall be lit at night and equipped with drinking water points (stand pipes)

Living quarters for workers shall have:

- Clean running water;
- Lighting and power socket;
- Sanitary facilities (shower and toilet) draining to a septic tank

A camp located at some distance from the social, school and commercial facilities of a town or village shall have:

- A dispensary with treatment and recovery rooms for basic medical assistance, and equipped with basic medical supplies;
- In case of emergency, there shall be an evacuation procedure (rescue chain) for severe accidents and emergencies with rescue equipment;
- A primary school;
- A company store offering basic goods at competitive prices, with ample stocks of meat, poultry and fish to reduce pressure on local wildlife (hunting)
- Social and cultural facilities: club, video room, church

All logging camps shall be supplied with clean water that shall be duly tested on a regular basis. Any necessary filtering and treatment shall be provided at the source.

9.5 Additional Facilities

Medical care shall be provided by the company whether or not public health services are available in the area where workers and their families live.

Educational, recreational and spiritual services should be provided, where such services are not available nearby.

X HEALTH AND SAFETY

10.1 General

Employers have the main responsibility for safety and health in forestry work. They shall install and maintain work systems and methods which are safe and without risk to health.

Employers shall provide insurance for all employees and workers. All machine operators shall receive the necessary training and instruction to ensure competency to safely operate equipment for the job they are assigned to do.

Operators should know what the job requirements are, what other machines are working in the area, and be aware of any hazardous conditions that may arise.

Basic first-aid training (and refresher courses) should be provided to all personnel involved in field operations, wood processing, workshop, etc.

All logging companies shall install a system whereby accidents, dangerous occurrences and occupational diseases are reported, recorded and investigated, and ensure that the necessary adjustments are made to prevent or reduce the incidence of these accidents, dangerous occurrences and occupational diseases in the future.

Working hours shall not exceed the number prescribed by national law or collective agreements. Working hours shall be arranged to provide adequate periods of rest, which include: short breaks during work hours, sufficient breaks for meals, nightly rest and weekly rest.

10.2 Emergency Rescue

Provision shall be made for the quick evacuation of a person in the event of an injury or illness that requires medical assistance. Radio or telephone links shall be available at the worksite to contact rescue services in case of an emergency. Where professional help is not available within a reasonable distance, consideration should be given to the creation of the necessary dispensing and health-care facilities.

10.3 Felling

10.3.1 Protective Clothing and Safety Equipment

A first-aid kit shall be provided to every felling crew and located close to where felling crews are working. All felling crew members shall be provided with and wear:

- Safety helmet (that shall be replaced every year/once it is damaged before the end of the year)
- Hearing protection (e.g. earmuffs or earplugs whether damage or not;
- Safety boots with steel toecaps

Additionally chain-saw operators shall be provided with and wear:

- Chain-saw gloves lined with cut-resistant material
- Eye protection (e.g. mesh face guard, goggles)
- Leg protection lined with cut-resistant material (e.g. chain-saw chaps)

10.3.2 Equipment Safety

All chain-saws shall be maintained in good working order and all safety devices shall be operational at all times. Specifically all chain saws should be equipped with:

- A chain brake, which is activated manually by the front handle guard
- A front handle guard for protection of the left hand from the chain
- An on/off switch which is reachable with the right hand on the throttle
- A throttle control lock-out which prevents the chain-saw from being started unexpectedly, because two levers have to be pressed simultaneously
- A rear handle guard for protection of the right hand in case of chain breakage
- An anti-vibration system, consisting of rubber shock absorbers between the engine block and handles
- A chain catcher
- A spiked bumper (for safe and accurate cross-cutting)
- An exhaust that directs fumes away from the operator
- A chain guard for avoiding injuries and protecting the chain during transportation
- A chain-saw toolkit for corrective and preventative maintenance.

10.3.3 Safe working practice

Chain-saw operators should always have an assistant and shall never work alone in case of accidents. No persons should approach closer to the feller than twice the height of the tree being felled, unless the feller has acknowledged that it is safe to do so. Operators should clear undergrowth and debris away from the base of the tree to provide an adequate and safe working space. Two alternative escape routes should be cleared - one at 135° and one at 215° - to the intended felling direction (see fig. 567).

Chain saws should not be operated above shoulder height because of the risk of kickback and the resulting backward rotation of the guide-bar. The use of machines to pull trees while they are being cut should never be permitted.

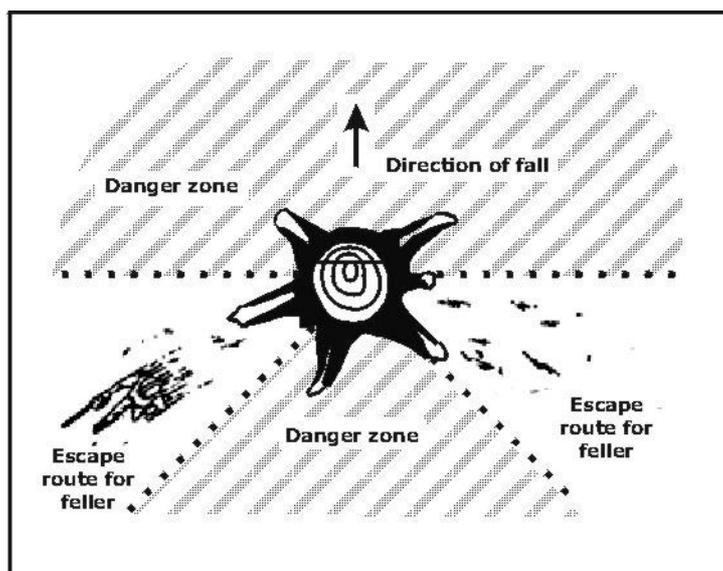


Figure IX-2 Clear two alternative escape routes

10.4 Heavy Machinery

10.4.1 Definition

Heavy machinery includes bulldozers, skidders and log loaders, motor graders, excavators, etc.

10.4.2 Protective Clothing and Safety Equipment

Operators of heavy machinery and their assistants shall be provided with and wear:

- Safety helmet (that shall be replaced every year)
- Hearing protection (e.g. earmuffs or earplugs)
- Safety boots with steel toecaps
- Heavy-duty work gloves (for handling wire rope)
- Dust masks or respirators when appropriate

10.4.3 Equipment Safety

All heavy equipment requires regular maintenance to achieve and maintain safety standards and good working condition. All heavy machinery shall be equipped with:

- A safety cab which conforms to the Roll Over Protection Structure (ISO 3471 and ISO 8082) and Falling Object Protection Structure (ISO 8083) standards
- Access to and exit from machinery designed to provide hand and footholds of a convenient height and spacing
- Securely mounted seats and seat belts
- Rear portion of cabs fitted with protective wire mesh (except loaders, excavators and graders)

- Reversing alarms to alert people machines are backing up
- Securely guarded pulleys, shafts, belts and fan blades
- Engine emergency stopping devices that are not self-returning, those are clearly marked, and easily accessible from the normal operating position. The engine starter should be interlocked with the transmission or clutch to prevent the engine from starting when left in gear.
- Parking brakes must be capable of keeping the machine and its rated load stationary on all slopes likely to be encountered
- First-aid kit and fire extinguisher (operators should be trained in their use)
- Exhaust systems fitted with spark arrestors

Farm tractors not equipped with the provisions listed above shall not be used for timber extraction.

No modifications shall be made to a machine that:

- Interfere with operator visibility
- Interfere with access to and exit from the machine
- Exceed the rated payload or gross combination weight of the machine resulting in overloading the braking and/or steering system or the ROPS capacity rating

The safety cab of any item of heavy machinery shall not be modified, drilled, welded or altered in any way nor should any attempt be made to straighten any part of the frame when it has suffered damage

10.4.4 Skidding

Skidding should not be carried out in site conditions where the stability of the machine cannot be assured. Skidding across slopes should be avoided because of the significant decrease in skidder stability. No objects (equipment) shall be carried on the skidder unless a space is provided for that purpose and the object can be firmly fixed into place.

10.5 Vehicles

10.5.1 Equipment Safety

All vehicles, including logging trucks, dump trucks, fuel tankers and personnel carriers, require:

- Regular maintenance to achieve and maintain safety standards and a roadworthy condition
- Full insurance
- Compliance with national requirements for safety and mechanical roadworthiness
- Securely mounted seats and seat belts
- Securely guarded pulleys, shafts, belts and fan blades

- First-aid kit and fire extinguisher

To protect the cabin from penetration logging trucks should incorporate an adequate log barrier or guard between the load and the cabin.

Logging machinery and vehicles using public roads shall have an amber flashing light on top of the cab or other prominent point installed and reversing alarms.

10.5.2 Safe Working Practice

Trucks shall not be overloaded. All loads shall be secured with at least two approved load binders. Protruding limbs, bark and trailing material shall be removed before the truck leaves the log landing. Side stanchions on trucks and trailers shall be vertical after loading and bunks aligned properly.

10.6 Hazardous Chemicals

Workers applying hazardous chemicals must receive training and full information on the risks involved in the use of protective equipment and first-aid techniques. Workers handling chemicals must wear protective clothing as recommended on the container label. It is the company's responsibility to ensure that its workers use all protective clothing provided. Chemicals must always be utilized with the proper equipment, as recommended by the manufacturer. The equipment must function properly and be free from leaks and blockages. Worker should be allowed to take bath or properly clean him or herself with water immediately after using the spraying chemical.

10.7 Workshop and Log Yard Workers

Workshop mechanics and other workers, and workers in log yard areas shall be provided with and wear protective clothing, hearing protection, eye protection, respirators, and/or gloves, as appropriate for the equipment being used (e.g. welding, angle grinding, spray painting).

10.8 Fire Precautions

Operations shall cease in times of high fire risk. All machines and chain-saws should be fitted with spark arrestors. Machinery should be clear of surplus oil and fuel. Any rubbing, damaged, frayed, kinked or leaking hydraulic hoses and fittings should be replaced. Refueling shall only be carried out in designated areas where the ground is clear of all inflammables for a distance of 5 meters in all directions from the machine.

All welding activities shall be done at least 10 meters away from flammable materials. No fire shall be left unattended in the forest, and fires for cooking or other purposes shall only be lit in designated areas cleared of flammable material within a 5-m radius around the fire.

XI HARVEST CONTROL, MONITORING AND ASSESSMENT

Harvesting assessment is a systematic check to be taken to determine or verify that harvesting operations followed the annual harvest plan and achieve its technical, financial and environmental objectives while complying with established standards of management plan guidelines.

Monitoring and assessment are key elements of sustainable forest management which the contract holder shall be responsible to conduct. The Authority and contract holder shall provide opportunity for independent monitoring and evaluation:

- During harvesting through the monitoring and control of operations;
- After harvesting by means of internal and external assessment.

All monitoring requirements established in the Timber Sale and Forest Management Contracts and regulation shall be implemented and regulated under the supervision of the FDA contracting officers.

XII SOCIAL ISSUES

12.1 Land and forest use rights and responsibilities

All contract holders shall be expected to respect legal or customary rights to land and forests, as well as respect for cultural, traditional and local values and customs. Forest management contracts and timber sales contracts provide the contract holders and operators with a right to operate in a given area. Contract holders should immediately inform the FDA of any illegal forestry activity in their contract area.

Social agreements between contract holders and affected local forest communities define and describe the codes of conduct and other agreements concerning forest use rights and responsibilities, benefit sharing arrangements, the use of local labor, compensation for crop damage, etc., between the two parties. They also describe conflict management arrangements.

12.2 Work place relations, rights and responsibilities

12.2.1 Terms and conditions of employment

The terms and conditions of employment shall be in accordance with Liberian labor laws.

12.2.2 Equal opportunity employment

- Women and men shall be paid equal remuneration for the same work or work of equal value.
- Employers will maintain registers of all employees, together with employment records (including PAYE and NIS contributions). These registers will be available for scrutiny by the FDA and other relevant government agencies
- Employees shall not be discriminated against based on race, sex, religion, colour, or ethnic origin or sickness.

12.2.3 Prohibition against forced labor

- Employers shall ensure fair remuneration and humane working conditions in return for all services rendered
- Given the nature of forest management practices and the logging industry employers shall inform employees of the terms and conditions of service prior to the time they are hired, and prior to the assumption of duties, an employer shall document and inform an employee of his/her wages by task or by day (or other specified time period).
- Employers shall observe ILO Convention 182 on forced labour.
- Employers shall not knowingly employ persons under the age of 14 in keeping with the International Labour Organization Convention 182

12.2.3 Employment and training opportunities for local populations

- Contract holders should give priority to employing equally qualified persons who live in communities within or adjacent to the contract area.

12.2.4 Education and training for workforce and local populations

- A range of educational and skills training programs for the purpose of enhancing workers' job performance and promotion within the workplace should be made available on an appropriate basis, and as included in the contract holder's business plan.
- Educational and vocational skills programs should be made available to communities within or adjacent to the contract area.
- Wherever possible, certification for educational and skills training programs should be issued by a recognized institution or body.

12.2.5 Protection of Forest Wildlife Resources

The contract holder shall apply appropriate measures to discourage and limit illegal hunting including:

- A prohibition on all workers from possessing and/or transporting firearms, bush meat and/or hunters in company vehicles, even outside the concession area.
- A prohibition on all workers from hunting protected animals. Transgressors should be reported to the FDA and local police for prosecution.
- A prohibition on all workers from using snares.
- A prohibition on selling or preparing bush meat in company camps and worksites
- Reporting all illegal activities promptly to FDA and other relevant authorities.

XIII GLOSSARY

Abutment	End support for bridge culvert or similar structure
Adverse grade	Grade up which a loaded logging truck must travel
Batter	Inclination or shape of a cutting beside a road or track
Berm skid	Ridge of soil typically along the outside edge of a road shoulder or trail. It intentionally or unintentionally directs surface runoff onto or alongside the roadbed or skid trail
Biodegradable organisms	Capable of being decomposed by bacteria, fungi or other living organisms
Biodiversity	The range of diversity of plants or animals, including the diversity of different species, the variation found within species and the variety of ecosystems
Borrow pit earthwork, typically a loam	An area where excavation takes place to produce materials for such as fill material for embankments and surfacing material. It is a small area outside the roadway for obtaining sand, gravel, laterite, or without further processing
Box cut there	A road cut through a hill slope or, more commonly a ridge, in which there is a cut slope on both sides of the road. Also called through cut
Bucking	Cross-cutting of a log in shorter sections
Bridge	A structure that provides for vehicle access over a watercourse
Buffer strip area or	Strip of vegetation left intact along a watercourse or other sensitive site during and after logging.
Buttress the	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
Camber	The amount of cross-fall on a road
Catch drain	A drain constructed above a batter to prevent erosion of the batter by surface water
Catchment such	An area or basin of land bounded by natural geomorphologic features

	as hill crests and ridges from which water drains and flows to a watercourse, lake, wetland or estuary
Chain brake	A safety device on a chain-saw designed to stop the chain in the event of a kick-back
Channel continuously.	A waterway that contains flowing water either periodically or continuously. A channel has a defined bed and banks that confine the water
Chaps to	Chainsaw chaps are half-trousers which are contain material designed to protect against chain-saw cuts
cm	centimeter
Compaction	The process of reducing the apparent volume of the soil, by reducing the empty spaces between particles and increasing the density of the soil under the influence of pressure. Compaction is desirable when a soil is to be used as the base of a road, because it improves stability and reduces infiltration. For the same reasons, compaction is undesirable in the forest, because it has a negative effect on plant growth and survival and soil life.
Compartment	A sub-division of a concession frequently of several thousand hectares. It is normally defined along natural boundaries
Competency workplace and	A concept that focuses on what is expected of a person in the workplace rather than on the learning process. It embodies the ability to transfer and apply skills and knowledge to new situations and environments
Corduroy weight contact	Cording or matting involving the use of suitable logs to spread the weight of the load and separate machine tyres or tracks from direct soil contact during harvest operations, thus reducing ground pressure and rutting
Coupe which	A defined area of forest of variable size, shape and orientation, on which harvesting takes place; usually to be harvested over one year
Cross-cutting	Cutting through a felled log. Sometimes called bucking
Cross-drain track,	A ditch and earth bank constructed at approximately right angles to a track, preventing water from building up speed along the track and allowing redirection of running water into surrounding areas

Crown (convex) water	A crowned road surface has the highest elevation at the centre line and slopes down on both sides. Crown is used to facilitate draining off the road surface
Cultural area	Area of social, cultural, historical, religious, spiritual, archaeological or anthropological importance to forest dwellers; usually to indigenous populations. Includes villages, farms, gardens and sites which are culturally sensitive.
Culvert	A conduit, typically of made of metal, concrete, plastic or (hollow) logs, set beneath the road surface, to move water from the inside of the road to the outside of the road. Culverts are used to drain (inside) ditches and watercourses (commonly gullies) that cross the road. Also called koker
Cut-and-fill the	A method of road construction in which a road is built by cutting into the hillside and spreading the spoil materials in adjacent low spots and as compacted or side cast fill slope material along the route. A ‘balanced cut-and-fill’ utilizes all of the ‘cut’ material to generate the ‘fill’. In a balanced cut-and-fill design, there is no excess waste material and there is no need for hauling additional fill material. Thus, cost is minimized.
Cut slope	The artificial face or slope cut into soil or rock along the inside edge of the road
Cutting cycle years as	In selective (polycyclic) harvesting systems: the planned number of between successive harvests on an area of forest. It is also referred to as felling cycle
Dbh	Diameter at breast height; 130 cm above the ground
Debris rocks,	Organic material, rocks and sediment (leaves, brush, wood, stones, rubble, etc.) often mixed, that is undesirable in a channel or drainage structure. Compare sediment
Directional a felling in	A concept that focuses on predetermining the final direction of fall of a felled tree. It includes selecting a particular direction of fall based on a predefined set of criteria and the felling techniques and aids involved in felling the tree in the selected direction

Ditch disposal.	A channel or shallow canal along the roadbed intended to collect water from the road and adjacent land for transport to suitable point of disposal. Also called table drain or (incorrectly) side drain
Erodibility	See soil erodibility
Erosion	See soil erosion
Exclusion area	Area which is excluded from harvesting
Favourable grade	Grade down which an unladen logging truck must travel
Feeder road called	A road connecting log markets to a secondary or primary road; also called spur road
Fill the	Excavated material placed on a prepared ground surface to construct the road sub-grade and roadbed template. Also called embankment
Fill slope	The inclined slope extending from the outside edge of the road shoulder to the toe of the fill. Also called embankment slope
Flood plain	A level or gently sloping area on either side of a watercourse contemporary channel that is submerged at times during high water of periods of flooding.
Ford	A rock, other hardened or corduroy structure that is built across the bottom of a watercourse channel that is usually dry, to allow improved vehicle passage during periods of low water or no flow and minimizes channel disturbance or sediment production
FMC	A Forest Management Contract is for greater than 50,000 ha and duration of 25 years.
Geotextile	Any permeable textile material used with soil, rock or any other geotechnical engineering related material, as an integral part of a man made product, structure or system, usually related to the passage of water
Grade Also	The slope of the road along its alignment. This slope is expressed in percent – the ratio of elevation change compared to distance travelled. Also called gradient
Groundwater including	The part of the subsurface water that is in the zone of saturation,

	underground streams
Guard log prevent	Log along the outside of a bridge, above the main stringer logs to gravel from falling off the bridge into a watercourse
Gully season	Steep sided drainage channel where water may flow during a wet or only after a rainfall
Gullying	Scouring of the soil by high velocity water flow resulting in channels where water runs down a slope, embankment or roadbed
ha	hectare
Habitat tree hollows).	A habitat tree is a mature living tree selected to be retained during harvesting because it has features of special value for wildlife (e.g. hollows).
Harvesting debris	Broken logs, branches, twigs, vines, epiphytes and other tree related vegetative material brought down as a result of felling or skidding
Hauling the	Transport of forest products, particularly logs, from the log market to the processing facility, commonly by way of logging trucks
Headwall retain	A concrete, masonry or timber wall built around the inlet or outlet of a culvert to increase inlet flow capacity, reduce risk of debris damage, the fill material and minimize scour around the culvert inlet or outlet
Hung-up trees:	A tree which has not completely reached the ground following cutting
Inlet	The opening of a drainage structure or culvert where the water first enters the structure
In-slope	The inside cross-slope of a road surface, typically measured in percent. In-slope is used to facilitate the draining of water from a road surface to an inside ditch. An in-sloped road has the highest point on the outside edge of the road and slopes downward to the ditch at the toe of the cut slope, along the inside edge of the road
Integral arch	An extension to the body of extraction equipment, which raises the anchor point of the wire rope and thereby lifting the load off the ground, also called logging arch
Junking	Trimming of the butt end of a felled log. Also (incorrectly) called bucking

km	kilometer
Landing	See log market
Logging	Logging is the process of harvesting timber from trees. This includes felling, skidding, loading and transporting forest products, particularly logs. Pre-harvest inventory, tree and skid trail marking can be part of the process
Log deck	See log market
Log market	A cleared area, usually adjacent to the roadbed where logs are assembled after being skidded, awaiting subsequent handling, loading and transport. Also called ramp, log deck or landing
Logging arch	See integral arch
m	meter
mm	millimeter
²	
m	square meters
³	
m	cubic meters
Outlet:	The opening of a drainage structure or culvert where the water leaves the structure. The outlet should be lower than the inlet to ensure that water flows through the structure
Out-slope	The outside cross slope of a road surface, typically measure in percent. Out-slope is used to facilitate the draining of water from a road or trail directly off the outside edge of the road or trail. An out-sloped road or trail has the highest point on the uphill or inside of the road or trail and slopes down to the outside edge of the road Potential crop Stems of commercial species remaining after the cut and forming the basis tree of subsequent cutting cycles
Riprap	Layer of large, durable materials (usually stone or rock) used to protect exposed soil to minimize erosion
Roadbed	The formation between the ditches or tops of embankments, including the travel way and shoulders
Roadway	The formation between the extreme limits of the earthworks, from the top of the cut slope to the toe of the fill or graded area. Also called road formation or width of earthworks
Road reserve	The area that corresponds to the limit of the ground affected by the road, usually equals the width of clearing

Rutting :	Road or skid trail surface damage in the form of deep tracks made by the passage of wheels or tracks. This typically a result of high wheel pressure on saturated or low load bearing soils. These conditions worsen with heavy loads, high traffic volumes and inclement weather conditions
Scour	Erosion or soil movement in a watercourse bed, bank, channel, or behind a drainage structure, typically caused by increased water velocity or lack of protection
Sediment	Fragments of rock, soil, and organic material transported and deposited in bed by water, wind or other natural phenomena
Sedimentation	Deposition of material suspended in water or air, usually when the velocity of the transportation medium drops below the level at which the material can be supported
Sediment trap	See silt trap
SFP	State Forest Permit; non-exclusive permit allowing the holder to remove a certain quota of timber from an area, valid for one year
Shoulder	The strip along the edge of the travel way on either side of the road, commonly flush with the travel way for roads on stabilised soil. It is generally only used by passing vehicles but may be used for travel by track machines. Also called verge
Side cast	Road construction material that is not used for fill and is pushed to or placed on the down slope side of the road. Such material may travel long distances down slope before coming to rest
Side drain	See ditch
Silt trap diverted	Hole created to divert sediment laden water, creating enough residence time to allow solid material in suspension to drop out, before it is back into a body of water or drainage structure
Sight distance	The distance along a road or track that a driver can see other objects (usually other vehicles)
Skidding trees means skidder, but equipped	A method of ground-based extraction in which logs, poles or whole trees are dragged from the felling point to the log market, commonly by means of a tractor equipped with a cable-arch or a grapple known as a skidder, but also by means of farm tractors, crawler tractors, or bulldozers with a winch or chains. Also called yarding

Skid trail market	Trail along which a log is dragged by a extraction machine to the log market
Soil erodibility	The inherent susceptibility of a soil to erosion
Soil erosion surface	The process by which soil particles and aggregates are worn away and moved by the actions of wind or water in the from of raindrops, runoffs, and waves
Spoon drain carry	A shallow open drain, normally traversable by vehicles designed to carry water to the side of a road or skid trail
Stakeholders impact dependent	Individuals or groups of individuals who have an interest in, or an on, the outcomes of a decision as well as groups or individuals to some degree on the outcome for their personal or institutional goals
Stanchions	Upright posts or supports for confining logs on trucks, trailers or other vehicles
Strategic plan of	Long term plan, which provides a broad description and broad details of future harvesting and management.
Sustainable specified continuous of undesirable	forest management The process of managing forests to achieve one or more clearly objectives of management with regard to the production of a flow of desired forest products and services, without undue reduction its inherent values and future productivity and without undue effect on the physical and social environment.
Swamp have ground with	A generally or permanently waterlogged area which may or may not associated tree or palm vegetation; or a tract or low, poorly drained with patches of open water in which reeds, rushes and sedges occur. Swamp sediments are dominated by still water deposits, commonly high organic content
Table drain	See ditch
Temporary	A crossing of a watercourse by a skid trail or road construction

crossing	equipment designed for removal following short term use, having a designated opening to take typical peak flows, e.g. a log culvert, and a cover of slash or small stems for a running surface
Topping	Severing the crown of a felled tree from the usable stem, usually at the first heavy branch. Also called junking
Travel Way	That portion of the road constructed for use by moving vehicles (excluding shoulders). Also called Carriageway
TSC	Timber Sales Contract; contract of less than duration of ≥ 3 years and a total area $\geq 5,000$ ha
Turbid water	Water bearing significant quantities of soil particles
Turnout drain	Excavations designed to divert water away from the ditch and roadway in order to reduce the volume and velocity of roadside ditch water. Also called outlet, lead-off, mitre or side drain
Unstable areas	Sites susceptible to one of the forms of mass soil movement or accelerated soil erosion as a result of the interaction of such factors as steepness, soil properties, parent and surface geology and the position in the land form profile
Verge	See shoulder
Washboard	A series of ridges and depressions across the road caused by soil and aggregate road surfaces by the lack of surface cohesion. This typically is a result of the loss of fines in the road surface caused by dry conditions or poorly graded material. These conditions worsen with excessive vehicle speeds and high traffic volumes
Water body	Watercourses and surface water such as lake, lagoon, sea or ocean
Watercourse	Defined depression or channel that receives and conducts perennial or intermittent flows of surface water for part or all of the year in most years. Watercourses includes rivers, creeks, gullies and waterways
Wedge	A high impact plastic, aluminum or hardwood wedge driven into the back-cut to assist felling
Wire rope	Flexible twined metal alloy or steel rope to tie, pull or lift loads; in this context the cable by which logs are winched or attached to the skidder. Also cable
Winch	A rotating powered drum used to haul in or pay out a cable (wire rope)
Wing wall	Masonry, concrete or timber structures built onto the side of culvert

inlet and outlet headwalls or bridge abutments, designed to retain the roadway fill and direct water into or out of the drainage structure or underneath the bridge while protecting the road and fill from erosion.

XIV APPENDIX

DBH Cutting Limits

DIAMETER AT BREAST HEIGHT CUTTING LIMITS			
Species (Trade Name)	Minimum Diameter Limit (cm)	Species (Trade Name)	Minimum Diameter Limit (cm)
<i>Azelia</i> spp. (Doussie, Apa)	70	<i>Alstonia boonei</i> (Emien)	70
<i>Aningeria robusta</i> (Aningerie)	80	<i>Antiaris africana</i> (Ako)	60
<i>Chlorophora excelsa</i> (Iroko, Odoum)	80	<i>Bombax</i> spp. (Kapokier)	70
<i>Entandrophragma angolense</i> (Tiama, Edinam)	90	<i>Brachystegia leonensis</i> (Naga)	90
<i>Entandrophragma candollei</i> (Kosipo)	90	<i>Canarium schweinfurthii</i> (Aiele)	80
<i>Entandrophragma cylindricum</i> (Sapeli)	90	<i>Ceiba pentandra</i> (Fromager)	90
<i>Entandrophragma utile</i> (Utile, Sipo)	100	<i>Daniellia</i> spp. (Fara)	70
<i>Guarea cedrata</i> (Bosse)	80	<i>Didelotia</i> spp. (Broutou, Zing, Bondu)	60
<i>Guibourtia ehie</i> (Amazakoue)	60	<i>Distemonanthus benthamianus</i> (Movingui)	80
<i>Khaya</i> spp. (Khaya, Acajou)	70	<i>Erythrophleum</i> spp. (Tali, Sassawood)	80
<i>Lovoa trichilioides</i> (Lovoa, Dibetou)	70	<i>Gilbertiodendron</i> spp. (Limballi)	60
<i>Mansonia altissima</i> (Bete)	60	<i>Lophira alata</i> (Azobe, Ekki)	80
<i>Mitragyna ciliata</i> (Abura, Bahia)	80	<i>Mammea africana</i> (Oboto, Kaikumba)	60
<i>Nesogordonia papaverifera</i> (Kotibe)	60	<i>Nauclea diderrichii</i> . (Kusia, Bilinga)	80
<i>Pycnanthus angolensis</i> (Ilomba)	70	<i>Piptadeniastrum africanum</i> (Dahoma, Mbeli)	80
<i>Tarrietia utilis</i> (Niangon)	60	<i>Pterygota macrocarpa</i> (Koto, Ake)	60
<i>Terminalia ivorensis</i> (Framire)	70	<i>Sacoglottis gabonensis</i> (Ozouga, Akouapo)	70
<i>Terminalia superba</i> (Limba, frase, Afara)	70	For all other species, not listed above	60
<i>Tetraberlinia tubmaniana</i> (Sikon)	60		
<i>Tieghemella heckelii</i> (Makore, Douka)	100		
<i>Triplochiton scleroxylon</i> (Wawa, Samba, Obeche)	90		
<i>Turreanthus africanus</i> (Avodire)	80		

Slope Angles in Degrees and Per Cent

Degrees (°)	Per cent (%)	Per cent (%)	Degrees (°)
1	2%	1%	0.6
2	3%	2%	1.1
3	5%	3%	1.7
4	7%	4%	2.3
5	9%	5%	2.9
6	11%	6%	3.4
7	12%	7%	4.0
8	14%	8%	4.6
9	16%	9%	5.1
10	18%	10%	5.7
11	19%	12%	6.8
12	21%	14%	8.0
13	23%	16%	9.1
14	25%	18%	10.2
15	27%	20%	11.3
16	29%	22%	12.4
17	31%	24%	13.5
18	32%	26%	14.6
19	34%	28%	15.6
20	36%	30%	16.7
21	38%	32%	17.7
22	40%	34%	18.8
23	42%	36%	19.8
24	45%	38%	20.8
25	47%	40%	21.8
26	49%	42%	22.8
27	51%	44%	23.7
28	53%	46%	24.7
29	55%	48%	25.6
30	58%	50%	26.6
31	60%	55%	28.8
32	62%	60%	31.0
33	65%	65%	33.0
34	67%	70%	35.0
35	70%	75%	36.9
36	73%	80%	38.7
37	75%	85%	40.4
38	78%	90%	42.0
39	81%	95%	43.5
40	84%	100%	45.0
41	87%		
42	90%		
43	93%		
44	97%		
45	100%		