

ENVIRONMENTAL MANAGEMENT GUIDELINES
FOR PLANTATION FORESTRY
IN SOUTH AUSTRALIA

Developed by

Forestry SA

(part of the Department for Administrative & Information Services)

in conjunction with

The South Australian Forest Industry

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Would readers please note that due to changes to the South Australian Public Service soon after these Environmental Management Guidelines were completed, the names of several Government Departments have changed.

Where the following appears:

Please read:

PISA¹ Forestry

Forestry SA²

PISA¹ Sustainable Resources

PIRSA³ Sustainable Resources

Department of Environment &
Natural Resources

Department for Environment,
Heritage & Aboriginal Affairs

¹ Primary Industries South Australia

² Part of the Department for Administrative & Information Services

³ Primary Industries & Resources South Australia

FOREWORD

There has been growing concern, both within Australia and internationally, about environmental issues. This is now expressed in the need to undertake future development in an ecologically sustainable manner.

The plantation industry has been developing in South Australia for over 100 years. Although forestry is considered to be an environmentally favourable practice there is still a need within the industry to be ever mindful of its environmental responsibilities.

To ensure that forest growers are complying with accepted environmental standards the major forest growers, Primary Industries SA Forestry (PISA Forestry), Auspine and CSR, along with the Australian Forest Growers, have developed Environmental Management Guidelines for Plantation Forestry in South Australia.

In endorsing these Environmental Guidelines of Plantation Forestry in South Australia, our organisations are committed to adhering to principles and management practices encompassed in this document.

By using these Guidelines in our planning and management we believe that the forest industry in South Australia can move forward and provide regional development in an environmentally sustainable manner.

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AIM:

These guidelines are aimed at ensuring that plantation forestry in South Australia is planned and managed in a sustainable manner and is carried out to comply with the following legislation:

- Soil Conservation and Land Care Act 1989
- Water Resources Act 1997
- Native Vegetation Act 1991

Specific objectives include:

- Protecting soil and water values by the use of appropriate management practices.
- Maintaining site productivity and adopting practices that ensure sustainable use.
- Protecting areas of high scientific and ecological value by appropriate survey and planning.
- Minimising any adverse offsite impact of plantation forestry operations.
- Ensuring that plantation forestry operations are carried out in an efficient and effective manner.
- Maintaining a healthy plantation.
- Protecting landscape, geomorphic, archaeological and heritage values.

Use of these guidelines:

These guidelines are to be used in the planning, implementation and monitoring phases of plantation forestry operations.

The guidelines were developed by the plantation forest industry with the major contributors being Primary Industries SA Forestry (PISA Forestry), CSR Timber Products, Auspine Limited, and Victorian Plantation Corporation in conjunction with PISA Sustainable Resources, the Department of Environment and Natural Resources and SA Water.

1. INTRODUCTION

Plantation forestry was initiated by the South Australian Government in 1875.

Initially areas of native forest were cleared to make way for the expansion of the plantation forest resource. Since the early 1970's forest plantation establishment has been largely confined to cleared agricultural land or land that has previously grown a plantation.

The area of plantation, both public and private, in South Australia is in the order of 120,000 hectares.

Commercial plantation forestry is carried out in the South East Region, the Mount Lofty Ranges, Kangaroo Island and the Lower Flinders Ranges.

The plantations support a range of industries which contribute to the prosperity of the regions in which they grow.

Responsible management of the forest environment is recognised by both public and private forestry organisations as being important to ensure that plantations are managed in an ecologically sustainable manner.

In keeping with the "Forest Practices Related to Wood Production in Plantations : National Principles" management guidelines have been developed to cover relevant activities associated with the establishment, growth, protection and utilisation of forests. They also address the requirements of the National Forest Policy Statement.

Good land management is paramount to ensure that plantation areas are able to sustain their productivity with time. In recognition of the importance of maintaining the productive potential of the land on which plantations grow, considerable emphasis has been given to the use of responsible land management practices as detailed in these management guidelines.

While the objective of growing plantations is to produce roundwood for industry and provide a commercial return to growers there is an obligation for growers to conduct their business in an environmentally responsible manner.

Responsible management will take account of the following:

- Erosion control
- Water quality protection
- Soil fertility
- Native Flora and Fauna - including rare and endangered species
- Pests and diseases
- Landscape, Geomorphology, Archaeology and Heritage values.

These guidelines are based on the concept of land capability. They are not prescriptive as not every situation can be anticipated. A prescriptive approach cannot take into account the different levels of technology available and new developments over time. Good management outcomes need to be the focus rather than the methodology. However the guidelines do provide a framework within which managers and field operators must carry out plantation management operations consistent with sound land management by applying the principles, standard practices and specified variations in each situation that is encountered.

The concept of land capability is explained in the next section (2.1).

The classification of land into land capability classes is based on soil characteristics, topography, rainfall and slope. It can be done on a scale appropriate to the planning operations in a primary production activity - in these guidelines, plantation forestry. It can be scaled up into a district or regional basis for planning purposes but in the practical application, local parameters should be used so that 'micro' features such as soil and slope variations are fully considered. In the plantation forestry situation this requires the amalgamation of information already available, however more detail will usually need to be obtained from the soil survey than has been in the past.

2. LAND CAPABILITY

2.1 Introduction

These management guidelines have been developed for various land classes. The land classification system adopted uses the land capability concept.

Most land classification systems used throughout the world are based on land capability. The concept is simple: All land has some degree of environmental limitation for a particular use. The limitation may be so severe that the particular land use may not be possible without the risk of land degradation. Between these two extremes of very high and very low capability is a range of situations providing progressively more intensive or stringent management to make the land use succeed and to minimise the risk of land degradation. ("Mount Lofty Ranges Soil Erosion Management" 1988 - 1990, P.R. Butler and G.J. Cock, June 1991).

Land capability is the capacity of land to sustain a particular land use, as determined by those land qualities which influence its productive potential and specific management requirements. Land capability defines the physical attributes of land, which are relevant to a particular use; it does not specify what can and cannot be done on an area of land. Land capability is usually described by a class number, indicating the degree of any physical limitation. ("Guidelines for the Assessment of Agricultural Land" developed by David Maschmedt, Greg Cock and Peter Butler of PISA).

Land capability describes the ability of land to accept a type and intensity of use with minimum risk of permanent damage to the soil resource. Land used beyond its capability ultimately loses its productive capacity. ("Land Capability in the Mt. Lofty Ranges", produced by the Central Hills Soil Conservation Board).

Plantation forestry land capability is based on the same concept as other agricultural land. The system used here has been adopted from the "Guidelines for the Assessment of Agricultural Land" developed by David Maschmedt, Greg Cock and Peter Butler of PISA.

2.2 Plantation Forestry Land Capability Classes

For plantation forestry purposes, eight land capability classes have been defined. The class of the land is determined by one or more limiting factors characteristic of that land. The key factors in order of importance to plantations are:

- (1) Water erosion potential
- (2) Drainage and soil depth
- (3) Degree of rockiness
- (4) Soil fertility
- (5) Wind erosion potential.

These factors are discussed in more detail in Section 2.3.

Critical values of each of these factors are used to place land into land capability classes. The overall land capability class is determined by the most limiting factor. For example, land which is found to be Land Capability Class III for water erosion potential and Class I for drainage is considered as Class III land for management purposes.

The following table illustrates the link between land capability classes, and the environmental management guidelines for plantation forestry.

Table 1 Land Capability Classes, Land Use Options and Broad Management Recommendations for Plantation Forestry

CLASS	CAPABILITY	LAND USE OPTIONS	MANAGEMENT RECOMMENDATION
I	Very High	Commercial and protection plantation forestry	Standard Practice
II	Very High	Commercial and protection plantation forestry	Standard Practice
III	High	Commercial and protection plantation forestry	Standard practice with slight modifications
IV	Average	Commercial and protection plantation forestry	Standard practice with some modification
V	Fair	Commercial and protection plantation forestry	Modified practices required
VI	Low	Protection Forestry	Intensive microsite practice required
VII	Very Low	Protection Forestry	Very intensive practice required
VIII	Nil	Non Forestry	Conservation

2.3 Critical Factors

Water Erosion Potential

This is a measure of the inherent potential of the land to erode. A number of factors affect water erosion potential including slope gradient, adjacent rising ground, rainfall, and soil characteristics.

Two factors are considered in determining water erosion potential for plantation forestry land.

- (1) Soil characteristics - erodibility is influenced by its capacity to absorb rain that falls on it, its resistance to raindrop impact and drainage. These features are measured by soil survey prior to establishment. Table 6 details information used to determine the four main soil erodibility classes.
- (2) Slope gradient - the slope gradient is combined with the soil erodibility to estimate the water erosion potential. The relationship between slope gradient, soil erodibility and water erosion potential is in Table 7.

Drainage

Drainage refers to the rapidity and extent of removal of water from the soil. Soils can be classified as being very well drained through to permanently inundated depending upon the permeability of the soil and position in the landscape. Appendix III describes drainage classes used in this classification.

Rockiness

Rockiness is measured to determine the ease of establishment of trees on a particular site. Generally, with increasing rockiness, there is increased mechanical site preparation required to establish a forest plantation. For determining the degree of rockiness an assessment is made of the amount and distribution of surface and subsurface rock.

Soil Fertility, Depth and Structure

The soil fertility and associated soil chemistry is critical to the long term viability of tree crops. Major elements of concern for plantation forest growth are nitrogen, phosphorous, potassium, copper and zinc and these may be applied where deficient as inorganic fertiliser. Major elements of concern for water quality released from forested water catchments providing drinking water are sodium, manganese and iron. The availability of these can be determined by soil analysis and observing growth characteristics of existing vegetation. Soil organic matter is also important for establishing trees and their long term health and vigour, through nutrient cycling and moisture conservation. An objective of plantation forest establishment is to conserve as much organic matter as possible from the previous crop.

The depth and structural condition of soils are both factors which are considered in determining the erosion potential outlined above. These two factors, critical in the productive potential of plantation forests are described by soil survey in the planning stages of plantations.

Wind Erosion

This is a measure of the inherent potential of land to erode under the action of wind, as determined by the soil, topography and climate. Wind erosion will usually occur when vegetative protection is low and soil particles are light enough to be moved by the wind. This usually involves sandy soils with limited clay content on exposed sites. It is only a transitory problem in 1st and 2nd years.

2.4 Site Quality and Land Capability

There is no established link between Land Capability and the technical forestry term of Site Quality (SQ).

Site Quality is the assessed productive capacity of a particular site in terms of wood volume production. Climatic and site values such as plant-available supplies of water, water logging, rockiness and soil fertility are used to estimate productivity without the benefit of silvicultural practices, ie the basic fertility can be estimated but not the "add on" from silvicultural practices. Accurate classification into Site Qualities is not possible until a standing forest plantation is assessed for volume of wood produced.

Land Capability is an expression of the degree of environmental limitations for primary production and the amount of management inputs required. Climatic and site values are used as described, with erosion potential being the critical limiting factor. There is no established relationship between Site Quality and water erosion potential.

2.5 Climatic Factors

Climatic Factors, particularly the amount of rainfall and its timing, play a key role in governing the potential productivity of land with respect to plantation forestry, whether commercial or protection orientated. In general, only areas with greater than 600 mm annual rainfall are considered suitable for commercial plantation forestry (depending on species and land improvement benefits eg. salinity), therefore, in this classification system, only the physical characteristics are used to separate the land capability classes.

There are commercial plantations below this rainfall and they often have other non-timber benefits such as ameliorating salinity.

3. MANAGEMENT PRINCIPLES

3.1 Introduction

In developing and implementing the management guidelines there are a number of principles that need to be recognised. These are outlined in two sections - for standard practices and for non-standard practices. These principles form the basis of the management guidelines that are outlined for plantation establishment and timber harvesting operations.

Practices directed towards the management and conservation of native flora and fauna, landcare, geomorphology, archaeology and heritage values are included in the principles of standard practice.

Pests and diseases are best controlled by integrated pest management techniques.

Forest plantation establishment requires intensive management inputs to achieve the objectives of near 100% seedling survival and near 100% "get away" (optimum early growth) in the first spring while ensuring that the soil resource is conserved. Early productivity is dependent on satisfactory "get away".

Standard Practices that promote satisfactory "get away" include:

- soil cultivation in the form of ripping, ploughing or mounding.
- competition control, prior to planting to reduce competition from weed species
- application of fertiliser soon after planting as required in combination with good weed control.

Variations from these standard practices to manage or overcome increasingly severe limitations are called non-standard practices.

3.2 Principles of Standard Practice

Critical Factors

The following critical factors are considered when establishing and managing plantations:

- Erosion control.
- Water quality protection.
- Soil fertility.
- Protection of environmental, social and amenity values.

The following major principles of planning for standard practice address the above factors and their application ensure sustainable development of forestry plantations:

Planning:

- mapping and assessing soils
- mapping drainage water flow
- design and construction of firebreaks, tracks and roads
- mapping and documenting relevant environmental and social values
- planning for harvesting operations.

These principles are described as follows:

Water Quality Protection

- Watercourses and drainage lines identified at site survey are to be mapped as part of forest operational planning.
- planning for future operations must take into account that site preparation activities, harvesting operations including machinery movements, and other activities must all be conducted in an environmentally sensitive manner to minimise disturbance to watercourses and drainage lines.
- artificial drainage lines (ie culverts, runoffs and man-made drains) should minimise concentrated water flows onto plantation areas, and should be integrated into natural drainage lines where possible.
- cultivation techniques should minimise the harmful effects of the artificial collection, concentration and redirection of water within the plantation. Intermittent ground preparation can be used. Run-off from and into plantation areas must be carefully managed.
- underground water quality should be maintained.

Soils

Soils are surveyed to assess both land capability and as a basis for planning subsequent establishment, maintenance and harvesting operations.

Construction of Firebreaks, Tracks and Roads

Firebreaks, tracks and roads should be located to minimise adverse impacts on soil and water, and to facilitate future harvesting activities, fire protection requirements, tending operations and where relevant, recreation activities. Techniques for construction are well documented in various publications and are taught in the PISA Forestry, Forest Roding Course.

Harvesting Operations

Logging activities must be carried out with minimum impact on soil and water to pre-determined standards. Operations must cease when standards are not able to be met. Planning for plantation establishment must, as far as practicable, provide for logging requirements in future years.

Other Environmental, Social and Amenity values

Planning for plantations must incorporate measures to identify and protect where necessary, a range of important non timber values including the following:

- Native Flora

Plantations are generally planted as monocultures and once established carry relatively low populations of native flora. The requirements of the Native Vegetation Act, 1991 must be followed with the establishment of new plantations.

- Native Fauna

Plantations have the capacity to become significant havens for native fauna. It is accepted that plantation forest cycles and the distribution of age classes will continue to provide habitat for fauna. In general no specific areas shall be managed for fauna conservation.

The intensive scrutiny needed for plantation management will enable the presence of rare and endangered species to be observed. The occurrence of rare and endangered species in plantations may require special arrangements for their conservation.

- Pests and Diseases

The introduction and spread of plant, insect and animal pests, and plant diseases in plantation areas should be prevented.

- Landscape, Geomorphology, Archaeology and Heritage

Significant landscape, geomorphological, archaeological and heritage values should be recognised and recorded in the planning phase and their protection incorporated into the management of the plantation area.

3.3 Principles of Non-Standard Practice

Non-Standard Practice is applied to land having greater environmental constraints and therefore requiring greater or more specific management inputs carefully applied. It generally refers to land capability classes IV to VII.

Critical Factors

The following critical limiting factors must be considered:

- Erosion control
- Water quality protection
- Soil fertility
- Imbalances in soil chemistry

These principles are in addition to those described under point 3.2 for Principles of Standard Practice and they are as follows:

Erosion Control

- Concentrated water flows from tracks and soil cultivation increase the risk of erosion and erosion control techniques must be included in site preparation so that water runoff is controlled and managed.

Water Quality Protection

- Techniques that reduce soil movement into watercourses and drainage lines must be used to ensure water quality is maintained in all areas.
- Vegetated buffers adjacent to streams and watercourses must be maintained.
- Mechanisms to reduce the downward speed of water such as intermittent cultivation techniques and contour banks should be considered during the planning process.
- Methods to reduce the length of water flow should be considered in planning.
- Infiltration - ensure that the quality of water entering the recharge areas in aquifers is maintained.

Soil Fertility

- Fertiliser should be used where necessary to ensure plantations maintain the minimum level of productivity required by the forest owner.
- Techniques to maintain the quality of underground water should be employed.

Imbalances in soil chemistry

- Remedial soil treatments should be conducted where required, eg measures to ameliorate salinity.

4. MANAGEMENT GUIDELINES STANDARD PRACTICES

The principles of management are applied in specific management guidelines and in the following are summarised for the:

- site preparation and plantation establishment stage;
- harvesting stage.

(These apply to the first and subsequent rotations)

4.1 Site Preparation and Plantation Establishment Stage

Organic Matter and Nutrient Retention

Retention of organic matter and nutrients from the previous plantation is desirable particularly on soils which have low levels of clay. One technique is to minimise the disturbance of the duff layer during site preparation operations. Techniques for retaining organic matter such as low residue logging, and chopper rolling or minimal windrowing should be adopted where practical.

Windrowing

Timber residue left after clear felling may be formed into windrows for burning or left in situ with or without mechanical incorporation into the soil. Finer organic matter such as small branches and needles should be retained in situ where possible. Soil disturbance must be minimised.

The windrows should generally follow the contours in undulating to steep country, and should be kept at least 10 metres away from watercourses and drainage lines to minimise the potential for erosion following burning of the residue. Debris should not be placed into any watercourse, or heaped across a drainage line. On steep ground, alternatives to windrowing should be used.

Soil Cultivation

The following are alternative cultivation techniques used to both till the soil and to achieve a level of competition control. Any can be used as part of standard practice.

- Ploughing

Ploughing is generally used for competition control and soil tillage, particularly where herbaceous and/or woody vegetation is present.

- Ripping

Ripping is used on rocky, shallow, hard pan or heavy soils. It is a form of line cultivation. Ripping is generally perpendicular to the contours, and down to a depth of 30-75 cm depending on the site. Use of a minimounder for backfilling the rip lines behind the rippers is helpful for consolidating the cultivation benefit and minimising the risk of erosion of rip lines on those sites for which it is suited. Timing of ripping is important to optimise the cultivation benefit. The Spring prior to planting is optimal to ensure shattering of subsoils and in-fill of the rip line before planting.

- **Mounding**

Mounding is particularly beneficial in areas with poorly drained soils, seasonally high water tables or shallow soils. It is a strip cultivation technique suitable on flat land and middle to lower slopes.

Mounding is generally done perpendicular to the contours on sloping land, ensuring that water is not concentrated in any one cultivation line. Contour mounding is a technique requiring further development before broadscale use.

Mounding should be carried out at least several months prior to winter to allow consolidation of the disturbed soil.

Competition Control

Soil cultivation (as discussed previously) and herbicide application are the most common competition control techniques.

Herbicide spraying of plantation areas is generally undertaken at planting and again in the second year using chemicals appropriate for the control of the particular weed spectrum and applied within the specifications of the registered product label. Buffer zones are left adjacent to water courses and upslope and downslope from fire breaks and access tracks to reduce the speed of water runoff from the site in these areas.

Herbicide use must be in accordance with label directions. Buffer strips for herbicide use near reservoirs and major streams are as for fertilisers as described below.

Drainage Management

Major streams and the associated riparian areas must be left vegetated and undisturbed wherever possible. Uncultivated buffer strips are left during establishment activities, with a minimum width of 20 metres either side of major stream banks.

Watercourses should retain a 5 metre vegetated buffer strip on each side. Avoid felling trees and driving machines into watercourses. Rehabilitation techniques should be used where required to stabilise problem areas.

In re-establishment of plantations in drainage lines, spot preparation techniques should be used.

Nutrition

The need for fertiliser may be ascertained by soil survey, visual assessment, growth plots and/or foliar analysis.

Nutritional requirements of the plantation should be monitored throughout its life. Particular emphasis should be given to nutrition in the first five years, and after each thinning. Fertilisers are generally applied only on an "as needed" basis to meet the requirements of the growing trees and to ensure that plantations meet minimum growth standards.

Fertiliser must not be applied to plantations within 20 metres of the high water mark of reservoirs or major streams.

Aerial application of fertiliser should not be carried out within 200 metres of the high water mark of reservoirs or major streams.

Construction of Fire-breaks, Roads and Tracks

Care should be taken to use recognised construction techniques that limit the impact on soil and water. The PISA Forestry, Forest Roding Course contains the required technical information for addressing environmental considerations. Techniques are well documented in various publications.

Native Flora

If the site survey and planning phase indicate that provisions in the Native Vegetation Act need to be observed, advice should be sought from the Department of Environment and Natural Resources (Native Vegetation Conservation Section). In some cases, approval may be required from the Native Vegetation Council where damage to native species may occur in forest plantation establishment operations.

Native Fauna

A register of South Australian rare and endangered fauna species is maintained by the Department of Environment and Natural Resources.

Forestry staff should be aware of the rare and endangered fauna species likely to occur in their region.

Pests and Diseases

Plantations and surrounding areas should be monitored for the occurrence of pests and diseases.

Integrated strategies for the prevention of pests and diseases becoming established or spreading should be formulated and appropriate control measures put in place. Where chemicals are used applications must be in accordance with the registered product label.

Regeneration of plantation species in adjacent native forests and roadsides should be controlled.

Landscape, Geomorphology, Archaeology and Heritage

Landscape, geomorphological, archaeological and heritage features should be identified on plantation land and land on which the establishment of plantation is proposed.

Significant features should be protected in the planning and management of the plantation areas and input sought from sources appropriate to each of these features to determine significance as part of the planning process.

4.2 Harvesting Stage

Soil Disturbance

Extraction, loading and haulage of logs must be carried out with minimum soil disturbance and impact on water runoff. Some factors to be considered are load size, number and extent of machinery movements, planning of routes and selecting appropriate areas.

Extraction and haulage operations will be suspended when the soil has become saturated with water, and significant soil or track damage is likely to occur.

Maximum acceptable levels of soil damage for each site caused by wheel tracks should be determined for each area prior to the harvesting operation commencing as part of the regional or district planning process. It is recognised that the level of soil damage that is acceptable will vary depending on location. Any soil damage that exceeds the maximum levels shall be stabilised immediately and repaired as soon as practicable.

Extraction should cease whenever water is running in extraction tracks.

When harvesting operations cease in a forest compartment, steps must be taken to ensure that water can not continue to run down wheel ruts (by the use of slash, diversions etc.).

Culverts and Drains

It is important that culverts or drains are not blocked or the flow of water impeded during forestry operations, including harvesting operations. Routine maintenance should be scheduled as part of normal operations.

Streams, Watercourses and Drainage Lines

During harvesting operations, precautions must be taken to minimise the numbers of trees that are felled into streams and watercourses. Tree tops should be removed if they do fall into these areas. Machinery must not enter streams and watercourses except at properly constructed crossings and movement across drainage lines should be minimised.

5. MANAGEMENT GUIDELINES NON STANDARD PRACTICES

In addition to the techniques in Section 4. Management Guidelines - Standard Practices, the following steps should be considered, depending on the situation.

Erosion Control

It is strongly recommended that water be allowed to follow its natural course by ensuring that cultivation techniques and machinery traffic do not cause water flows to be collected and concentrated in one place.

Strip, intermittent or spot soil cultivation can be used in appropriate situations.

Vegetation cover is able to be partly retained by strip, intermittent or spot herbicide application. Herbicide application can also be considered after planting.

Logging operations will cease when the soil becomes saturated and significant soil or track damage is likely to occur.

Water Quality Protection

- as for erosion control.
- filter strips consisting of vegetated buffer strips with a minimum width of 5 metres depending on local experience and land capability are left between plantations and adjacent nearby watercourses and streams. The width in each case depends on that required to slow the water flow and allow for the depositing of any sediment.
- vegetated buffer strips are left along roads and tracks adjacent to any nearby watercourses and streams.
- watercourses are not treated with herbicide. Buffers are not treated with herbicide except for spot application or late spraying. Drainage lines may be treated with herbicide by careful spot application. Watercourses are not planted. Noxious weeds are able to be treated in all these situations, providing due care is exercised. Refer to watercourse management information for more detail, and wherever possible, alternatives to chemicals should be used.
- water from culverts is dispersed into vegetated areas, preferably within adjacent plantation areas.
- runoff control systems need to be included as part of forest plantation management.
- where appropriate, sequential harvesting can be used to maintain the impact of growing trees and regulate water discharge rates.
- mechanical measures - where it is not possible to establish effective strips an alternative filter made from hay bales or geotextile fabric may be used during establishment, roading and harvesting phases.

6. ENVIRONMENTAL MANAGEMENT GUIDELINES FOR EACH PLANTATION FORESTRY LAND CAPABILITY CLASS

Table 2 Management Guidelines Summary Table

Management Guidelines	Plantation Forestry Land Capability Class						
	I	II	III	IV	V	VI	VII
<u>Standard Practices</u>							
1. Erosion Control	ü	ü	ü	ü	ü	ns	ns
2. Water Quality Protection	ü	ü	ü	ü	ü	ns	ns
<u>Non-Standard Practices</u>							
1. Erosion Control				ü	ü	ns	ns
2. Water Quality Protection				ü	ü	ns	ns

The table demonstrated the build-up in required inputs for commercial plantation forestry as land capability falls from I to V.

ü indicates the requirement to incorporate the standard or non-standard practice to limiting factors.

ns indicates land not generally suitable for commercial plantation forestry in South Australia due to technical difficulties and economic factors

The following pages show a summary of the critical values for each Plantation Forestry Land Capability Class. The limiting critical value determines the Class.

6.1 Plantation Forestry Land Capability Class I

"Land capable of being used for commercial plantation forestry on a permanent basis providing proper land management procedures are used."

Critical Values

- Erosion potential:*

Soil erodibility:	low with	}	0-1° slope
	moderate/high with	}	
	very high with	}	

- Drainage:*

Well drained.

Soil root zone never saturated for more than a few days after soaking rain.

- *Degree of rockiness:*
No outcrops.
Nil to minor surface stones.
- *Soil Structure:*
Non hard setting or cracking surface.
Non dispersive subsoil.
- *Soil fertility:*
Adequate.
Soils require no more than maintenance N and P applications.

Management Guidelines

- *Standard Practices.*

6.2 Plantation Forestry Land Capability Class II

"Land capable of being used for commercial plantation forestry on a permanent basis providing proper land management procedures are used."

Critical Values

- *Erosion potential:*

Soil erodibility:	low with	1 - 5 ⁰ slope
	moderate/high with	1 - 4 ⁰ slope
	very high with	1 - 3 ⁰ slope.
- *Water logging:*
Moderately well drained. Soil root zone saturated for a week after soaking rain.
- *Degree of rockiness:*
Stones and rocks present but insufficient to interfere with cultivation.
- *Soil Structure:*
Dry consistency of very firm or greater. Includes hard setting, massive loamy sands-sandy clay loams and blocky clays.
- *Soil Fertility:*
Moderately low. Marginal deficiencies which are readily correctable.

Management Guidelines

- *Standard Practices.*

6.3 Plantation Forestry Land Capability Class III

"Land capable of being used for commercial plantation forestry on a permanent basis providing proper land management procedures are used."

Critical Values

- *Erosion Potential:*

Soil erodibility:	low with	5 - 10 ⁰ slope
	moderate/high with	4 - 8 ⁰ slope
	very high with	3 - 4 ⁰ slope.

- *Drainage:*

Imperfectly drained. Soil saturated for several weeks after soaking rain.

- *Degree of rockiness:*

Sufficient stones, rocks to require some cultivation. Some hard rock outcrops (less than 10%) in reefs.

- *Soil structure:*

Moderately dispersive soils.

- *Soil fertility:*

Low. Significant deficiencies of several nutrients.

Management Guidelines

- *Standard Practices*

There is a need to design run-off control and filter strips for upslope and track run-off.

6.4 Plantation Forestry Land Capability Class IV

"Land capable of being used for commercial plantation forestry on a permanent basis provided careful planning and sensitive management practices are applied."

Critical Values

- *Erosion Potential:*

Soil erodibility:	low with	10 - 18 ⁰ slope
	moderate/high with	8 - 12 ⁰ slope
	very high with	4 - 6 ⁰ slope.

- *Wind erosion potential*

low to high sandhills.

- *Drainage:*

Imperfectly drained soil which is prone to saturation early in season.

- *Degree of rockiness:*
Land which has 10-50% rock outcrop concentrated in reefs.
- *Soil Structure:*
Hard setting surfaces where getaway will be inhibited.
- *Soil fertility:*
Low.

Management Guidelines

- *Standard Practices with Non-Standard Practice variations and in particular:*
 1. Water Erosion risk:

Consider intermittent strip soil preparation if cultivation is required. This results in uncultivated gaps in the strips. Consider retaining a grassed strip between planted rows to reduce water flow and hold soil together by the use of strip herbicide application. Use filter strips above tracks. Ensure harvesting operations meet minimum requirements.
 2. Wind erosion risk:

Consider minimising soil disturbance by strip cultivation and strip weedicide, maintaining grass cover between rows.
 3. Poorly drained soils:

Consider using mounding and restrict harvesting operations when soil becomes saturated.
 4. Rockiness:

Rock outcrops over less than 25% of the ground surface, are manageable with ripping.
 5. Infertile soils:

Routine applications of P and N and trace elements as required according to guidelines in the (PISA Forestry) Forestry Manual.

6.5 Plantation Forestry Land Capability Class V

"Land suitable for commercial plantation forestry only when specialised establishment and management techniques are applied."

Critical Values:

- *Erosion Potential:*

Soil erodibility: low with 18 - 25⁰ slope
 moderate/high with 12 - 20⁰ slope
 very high with 6 - 15⁰ slope.

- *Wind erosion potential*
high sandhills in high rainfall areas.
- *Drainage:*
Poorly drained. Soil remains saturated for several months.
- *Degree of rockiness:*
Too stony, for normal establishment (50% or more rock).
- *Soil Structure:*
Hard setting surfaces where getaway will be inhibited.
- *Soil fertility:*
Severe deficiencies.

Management Guidelines

- *Standard Practices with Non-Standard Practice variations and in particular:*
 1. Water erosion risk:

Design for upslope run-off to prevent soil movement. Intermittent strip cultivation using timely ripping or mounding. This should be in the previous Spring/Summer. Retain grass cover between rows. Consider post planting blanket herbicide application as an alternative.
 2. Wind erosion risk:

Minimise soil disturbance, by strip cultivation and weedicide application, that maintains the grass cover between rows.
 3. Poorly drained soils:

Mounding is required.
 4. Rockiness:

If 50% or more rock, manageable with ripping.
 5. Infertile Soils:

If there are severe nutrient deficiencies, commercial plantation forestry is only possible with regular inputs of fertiliser and/or legume pasture development.

6.6 Plantation Forestry Land Capability Class VI

"Land too steep for conventional commercial plantation forestry. Suitable for protection forestry only."

Critical Values.

- *Erosion Potential:*

Soil erodibility:	low with	25 - 45° slope
	moderate/high with	20 - 35° slope
	very high with	15 - 25° slope.

- *Degree of rockiness:*

Too rocky/stony for conventional plantation establishment.

- *Mass movement potential:*

Slopes where substrate has low strength or where strongly laminated rocks dip parallel to ground surface.

Management Guidelines.

General considerations:

- Too steep for "conventional" commercial plantation forestry* due to the current state of economics and technology which could change over time. Consider protection forestry.
- Individual tree planting in suitable microsites only. Not commercial plantation forestry.
- Any clearing of debris prior to planting should ensure minimal soil disturbance.
- Buffer strips should be left along all drainage lines.

*** Note:**

In these guidelines "conventional" commercial plantation forestry is regarded as that which is carried out on land that is generally in the slope range of zero to 20°. Commercial plantation forestry is not currently practiced in South Australia on areas of land that are generally over 20° in slope as ground based harvesting systems cannot be used. In these situations, cable logging systems are able to be used and therefore commercial forestry can be practiced. As there are not large areas of steep land planted to commercial plantation forestry in South Australia and there are no further plantings planned, guidelines for managing land above 25° are not included.

6.7 Plantation Forestry Land Capability Class VII

"Land with extreme limitations which requires protection by perennial vegetation. Any plantation forest establishment would be for protection and conservation, and not for production."

Critical Values.

- *Erosion Potential:*

Soil erodibility:	low with	45° + slope
	moderate/high with	35° + slope
	very high with	25° + slope.

- *Mass Movement potential:*

Land affected by landslide, earthflow or other hillside mass movement.

Management Guidelines.

General considerations:

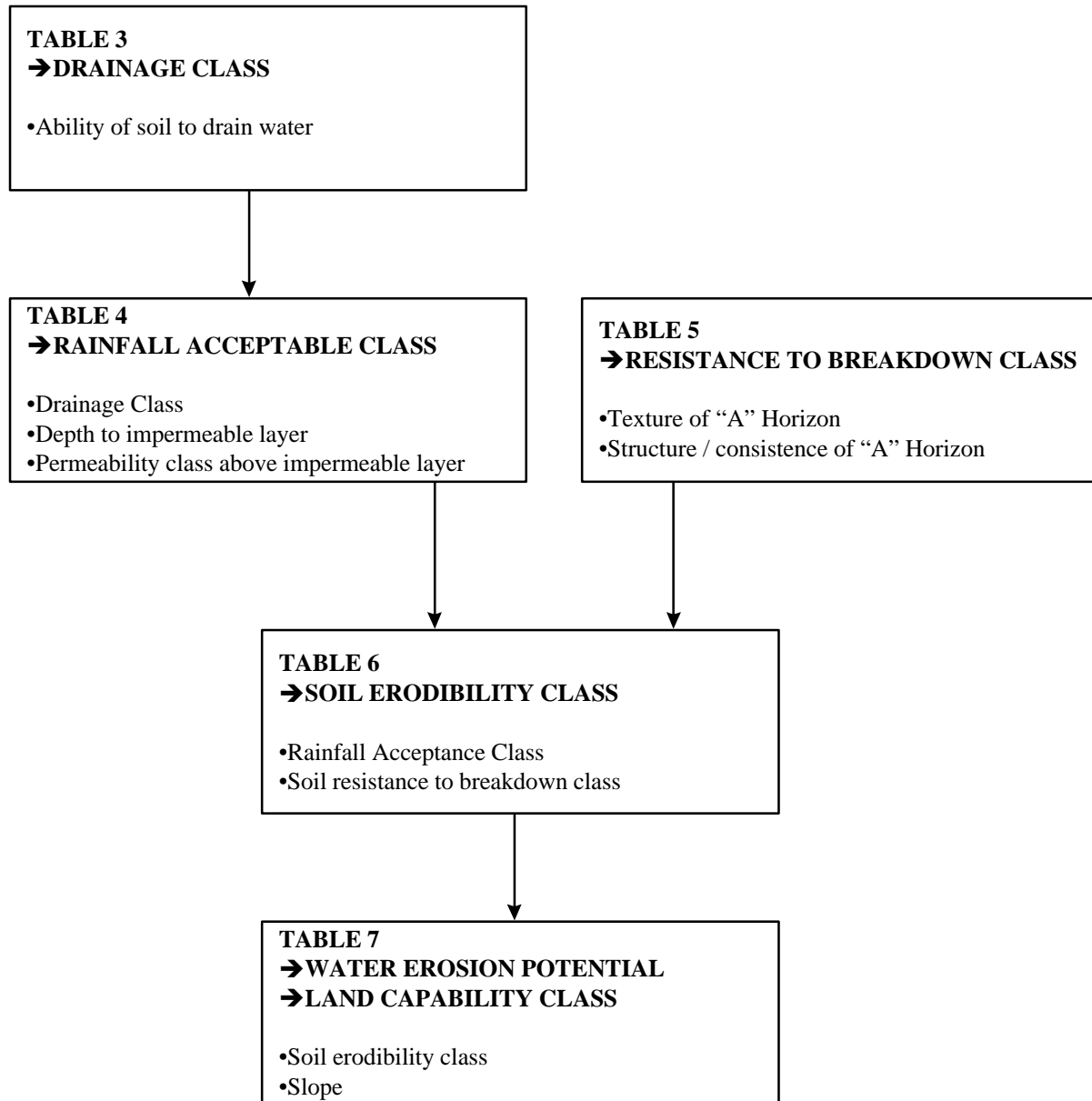
- Too steep for commercial plantation forestry. Protection forestry may be essential on some areas.
- These areas must be protected by trees, shrubs or grasses with fencing to protect them from grazing animals. Maintenance of ground cover is essential, therefore spot herbicide only.

7. TO DETERMINE LAND CAPABILITY

The process of determining the erosion based land capability class is shown in the following flow diagram and described below:

FLOW CHART TO DETERMINE EROSION BASED LAND CAPABILITY CLASS

Showing criteria used to determine each class used to determine land capability class.



The estimation of Water Erosion Potential (WEP) and Erosion Based Land Capability for soils in plantation forest areas is based on criteria used for estimating WEP for agricultural soils. It combines an estimate of soil erodibility with the slope of the site.

Soil Erodibility

Soil erodibility is a measure of the ability of the soil to absorb rain, resist raindrop impact and drain water. The first step is to determine the overall drainage class of the soil based on the classification criteria listed in Table 3 and this is used to determine Drainage Class in Table 4.

The Depth to the Impermeable Layer is then determined based on the soil survey data, and put into 1 of 3 categories, >100cm, 50 - 100cm, <50cm.

An estimate of the Permeability Class above the impermeable layer is made based on the following criteria :

- 3 Highly permeable eg. sand
- 2 Moderately permeable eg. loam
- 1 Impermeable eg. clay

A determination of Rainfall Acceptance Class is then made by combining the Drainage Class, Depth to Impermeable Layer and Permeability Class using Table 4.

The next stage involves an estimate of Soil Resistance to Breakdown Class. This is made by firstly determining the texture of the "A" Horizon, and then classifying the structure/consistence according to the second column in Table 5. An estimate of Soil Resistance to Breakdown Class can then be determined in Column 3 of Table 5.

From the combination of Rainfall Acceptance Class and Soil Resistance to Breakdown Class an estimate of Soil Erodibility Class can then be made from column 3 in Table 6.

Soil Erodibility Class is a measure of the inherent ability of a particular soil to erode, but does not take into account slope.

Water Erosion Potential and Plantation Forest Land Capability

The Water Erosion Potential for a particular site is estimated by combining the Soil Erodibility Class with slope. A classification for Water Erosion Potential for plantation forestry sites is given in Table 7 for various combinations of slope and Soil Erodibility Class.

An estimate of Land Capability based on Water Erosion Potential can then be determined, using the relationships given in Table 7.

This classification is based on a point estimate of soil erodibility and slope, but does not account for length of slope or characteristics of the site above this point. Any impact from these site variables can be allowed for when estimating the Land Capability from the Water Erosion Potential.

The table has been developed from guidelines developed for agricultural situations and from experience in plantation forest areas in the Mt. Lofty Ranges.

TABLE 3 - DRAINAGE CLASS

Land is classified with respect to drainage conditions or susceptibility to water logging, according to the length of time during which all or part of the soil profile is saturated following water addition. The following drainage classes are used.

<u>Drainage Class</u>	<u>Classification Criteria</u>
Rapidly drained	Soil is never wet for more than several hours.
Well drained	Soil is never wet for more than several days.
Moderately well drained	Soil is wet for up to one week..
Imperfectly drained (A)	Soil is wet for several weeks.
Imperfectly drained (B)	Imperfectly drained soil which is prone to saturation very early in the season.
Poorly drained	Soil is wet for several months.
Very poorly drained	Soil is wet for most of the year.
Inundated	Land is permanently under water.

* Adapted from D Maschmedt's "Guidelines for Assessment of Agricultural Land", for Forestry use.

TABLE 4 - ESTIMATION OF RAINFALL ACCEPTANCE CLASS

Drainage Class from Table 3	Depth to Impermeable layer	Permeability Class above impermeable layer (see text)	Rainfall acceptance class
5-6 Rapidly drained Well drained	>100	3	1
		2	1
		1	2
	50-100	3	1
		2	2
		1	2
	< 50	3	2
		2	2
		1	2
3-4 Moderately well drained Imperfectly drained (A) Imperfectly drained (B)	>100	3	2
		2	2
		1	3
	50-100	3	2
		2	3
		1	3
	< 50	3	3
		2	4
		1	4
1-2 Poorly drained Very poorly drained Inundated	>100	3	4
		2	4
		1	5
	50-100	3	4
		2	5
		1	5
	< 50	3	5
		2	5
		1	5

McDonald eta (1984) Aust. Soil and Land Survey Field Handbook

TABLE 5 - ESTIMATION OF SOIL RESISTANCE TO BREAKDOWN CLASS

Texture of “A” Horizon	Structure/Consistence	Soil Resistance to Breakdown Class
Sand	Loose, soft, single grained	Very low
Loamy sand	- Non coherent, single grain - Soft poorly structured - Hard massive	Very low Very low Low
Sandy loam	- Non coherent - Soft, firm\weak structure - Hard\massive	Very low Low Moderate
Loam	- Soft, weak structure - Firm hard massive	Low Moderate
Loam, Clay loam	- Friable/strong crumb	High
Clay loam, Clay	- Hard, poor structure - Soft, firm/self mulching	High Moderate
Clay	- Cracking	High

TABLE 6 - ESTIMATION OF SOIL ERODIBILITY CLASS

Rainfall Acceptance Class from Table 4	Soil Resistance to Breakdown Class from Table 5	Soil Erodibility Class
Very High 1	High Moderate Low Very low	Low Low Low Moderate
High 2	High Moderate Low Very Low	Low Low Moderate Moderate
Moderate 3	High Moderate Low Very low	Low Moderate Moderate High
Low 4	High Moderate Low Very low	Moderate Moderate High Very high
Very low 5	High Moderate Low Very low	Moderate High Very High Very High

TABLE 7 - ESTIMATION OF WATER EROSION POTENTIAL

Two factors are considered in determining water erosion potential for plantation forestry land:

- (1) Soil erodibility a measure of the capacity of the soil to absorb rain, its resistance to raindrop impact and its drainage characteristics.
- (2) Slope gradient.

These two factors are combined, in the following manner, to estimate Water Erosion Potential.

Soil Erodibility Class from Table 6	*Slope Range (Degrees)	Water Erosion Potential	Land Capability (Erosion based)
Low Moderate/high Very High	} 0 - 1 } }	Low	I
Low Moderate/high Very High	1 - 5 1 - 4 1 - 3	Moderately Low	II
Low Moderate/high Very High	5 - 10 4 - 8 3 - 4	Moderate	III
Low Moderate/high Very High	10 - 18 8 - 12 4 - 6	Moderately High	IV
Low Moderate/high Very High	18 - 25 12 - 20 6 - 15	High	V
Low Moderate/high Very High	25 - 45 20 - 45 15 - 45	Very High	VI
All soils	45+	Extreme	VIII

*Adapted from D Maschmedt's "Guidelines for Assessment of Agricultural Land", for forestry use.

8. CHECKLISTS

When planning or managing a plantation it will be important for growers to be ever mindful of their environmental responsibilities.

Planning and management must ensure that all the aspects that ensure a positive environmental outcome are considered. To help growers be confident that all aspects are considered two checklists have been developed.

Firstly a checklist to be used on the determination of the site characteristics for each land unit. This determination is the basis for the use of the Environmental Management Guidelines.

Secondly a checklist to assess compliance with the Environmental Management Guidelines for both the planning process and the implementation of forestry practices by managers.

These checklists are shown as Appendices I and II.

APPENDIX I - SITE CHARACTERISTICS FOR EACH LAND UNIT

SITE CHARACTERISTICS FOR EACH LAND UNIT	
ITEM	COMMENT
Drainage Class (Table 3, EMG's)	
Soil Erodibility Class (Table 6, EMG's)	
Maximum slope	
Water Erosion Potential (Table 7, EMG's)	
Land Capability Class	
Rockiness	
Soil: <ul style="list-style-type: none"> • Assessed and mapped • Fertility • Depth • Structure 	
Susceptibility to wind erosion	
Drainage flow mapped	
Special environmental, social, amenity or heritage values mapped and documented	

APPENDIX II - DESCRIPTIONS AND OUTCOMES FOR EACH LAND UNIT

PRESCRIPTIONS AND OUTCOMES FOR EACH LAND UNIT			
ITEM	PLANNED Y/N/NA	OUTCOME Y/N/NA	REMARKS
<u>STANDARD PRACTICE</u>			
Roads, tracks & firebreaks construction; <ul style="list-style-type: none"> • Standards in PISA Forestry Forest Roding Course applied • no adverse soil impact • no adverse water impact • establishment, tending, harvesting and fire protection needs met 			
Site preparation; <ul style="list-style-type: none"> • organic matter and nutrients retained • windrows meet requirements for setback, alignment & location, minimal soil disturbance, and retention of litter layer, small branches & needles. • cultivation tailored to site with specified buffers preserved adjacent streams & water courses and spot site preparation in drainage lines • minimal concentration of water flows • no soil erosion • Herbicide use; compliance with label specifications. and necessary buffers observed • Chemical fertilisers applied on a needs basis & buffers for land-based and aerial application met • No adverse effect on water quality 			
Harvesting operations <ul style="list-style-type: none"> • soil impact within predetermined standards • water impact within predetermined standards 			

PRESCRIPTIONS AND OUTCOMES FOR EACH LAND UNIT			
ITEM	PLANNED Y/N/NA	OUTCOME Y/N/NA	REMARKS
Fauna - needs for rare & endangered species met Introduction and spread of pests & diseases prevented			
Significant landscape, geomorphic, archaeological & heritage values recognised, recorded and protected			
NON-STANDARD PRACTICE (where applicable)			
Erosion control <ul style="list-style-type: none"> • water follows natural course • intermittent or spot cultivation used • herbicide application strip, intermittent or spot &/or delayed • logging operations cease when soil saturated Water quality protection <ul style="list-style-type: none"> • 5m min. filter strips adj. Streams & watercourses • vegetated buffer strips along roads & tracks adj. streams & watercourses • herbicide use avoids watercourses; spot application in drainage lines • water from culverts to vegetated areas, preferably plantation • run-off control systems • sequential harvesting • mechanical water control/quality measures 			

NOTE: Y = Yes, N = No, N/A = Not Applicable.

GLOSSARY

◇ **Buffer Zones**

Generally undisturbed and vegetated areas adjacent to watercourses and streams.

◇ **Clearfelling**

The final harvesting operation in an area of plantation forest involving the cutting down of all trees.

◇ **Commercial Plantation Forestry**

In the South Australian context, the planting and management of trees for the production of timber in the form of logs for the wood processing industry.

◇ **Competition Control**

The management of unwanted vegetation in a pine plantation currently achieved by applying herbicide, or hand chipping (weeding). It also applies to ploughing, slashing or grazing to remove unwanted vegetation.

◇ **Debris**

The branches and defect logs that remain on site after a clearfelling operation.

◇ **Drainage line**

These are a lower category of watercourse which do not have a clearly defined bed and banks. For practical purposes a conventional passenger vehicle could be driven safely across this type of watercourse, whereas this would not be possible in a normal watercourse. These will not normally be shown on a 1:50 000 map by a blue line.

In effect it is a gully where water would drain soon after a rainfall event.

◇ **Extraction**

The removal of logs from within a forest area to an adjacent roadside or firebreak.

◇ **Harvesting**

The cutting down and removal of trees from forest areas for sale.

◇ **Haulage**

The transport of logs from the forest edge to a wood processing plant.

◇ **Intermittent cultivation**

The interruption of a soil cultivation strip used to reduce the risk of subsequent erosion.

◇ **Land Capability**

An expression of the degree of environmental limitations for primary production and the amount of management input required to ensure sound land management.

◇ **Loading**

The transfer of logs from a firebreak or roadside onto a road haulage vehicle.

◇ **Major stream**

A 3rd order or higher stream. The ordering of streams begins at the source and increases as further branches add to the network.

◇ **Minimounder**

A device trailing behind a ripper tine that backfills the loosened soil into the ripline to minimise erosion risk.

◇ **Plantation establishment**

The planting of seedlings to produce a tree crop. It also encompasses the immediate pre and post-planting phases of site preparation, competition control and fertiliser application.

◇ **Plantation Forestry**

A forest created by the planting of trees for the purpose of producing timber or other products, or for conservation or protection of land or other natural features.

◇ **Protection Forestry**

Forest established and or managed for the protection and or rehabilitation of areas of land.

◇ **Site preparation**

The range of activities undertaken to ready an area for the planting of a tree crop. This can include any combination of a range of activities including ripping, ploughing, mound ploughing and spot cultivation.

◇ **Site Quality**

The assessed productive capacity of a particular site in terms of wood volume production.

◇ **Spot cultivation**

Soil tillage at the planting site for each seedling.

◇ **Stream**

As for watercourse.

◇ **Strip cultivation**

Soil tillage (including any of ripping, ploughing, mounding) in a line across an area of land in preparation for planting seedlings.

◇ **Watercourse**

The bed of a river, creek or other channel in which water flows whether ordinarily, intermittently or occasionally and any water therein.

◇ **Windrow**

Debris from previous forestry activities (usually tree branches and defect log left on site after a clear falling operation) heaped into rows ready for disposal by burning.