DISCLAIMER

This document outlines soil management guidelines for Tasmanian farmers. The Department of Primary Industries, Water and Environment (DPIWE) and the Tasmanian Farmers and Graziers Association (TFGA) accepts no responsibility for any application of this information.

The information is believed to be accurate and reliable but no warranty to this effect is given. No liability is accepted by the DPIWE, TFGA, their employees, nor any other person for any claim which may arise from any person using the information in the document.

Where information from other authorities has been provided, the data is included and used in the form provided by others. The responsibility for the accuracy of the information does not reside with DPIWE or TFGA.

This document is not exhaustive. It is an overview. Professional advice should be sought for interpretation of legislation and guidelines where required.

ACKNOWLEDGEMENTS

The Tasmanian Farmers and Graziers Association and the Department of Primary Industries, Water and Environment would like to acknowledge the following:

• Natural Heritage Trust for their support in the development of the project
• Farmers involved in the meetings that took place at or near Forest, Sisters Creek, Riana, Gawler, Kindred, Sassafras, Cressy, Pipers River, Scottsdale, Nile, Fingal, Swansea, Ross, Richmond, Hamilton, Furneaux Group and King Island
• Members of Agricultural Consultants Tasmania
• Members of the steering committee
• DPIWE research, extension and policy officers
Agriculture is a major contributor to the State’s economy and will remain so well into the future. Tasmanian agriculture depends on its soil, water and vegetation resources for on-going sustainable crop and animal production. Consequently, Tasmanian farmers need to protect the resources that they rely on by adopting environmentally sound soil management practices.

Soil management practices continue to improve on many Tasmanian farms. However, instances of unsustainable soil management practices remain. A single inappropriate action has the potential to cause permanent soil degradation.

As a comprehensive, yet simple to read, set of recommended soil management practices these guidelines will greatly assist in improving soil management practices in Tasmania.

By adopting or maintaining improved soil management practices, farmers will be better placed to gain opportunities to sustain production and attain marketing advantages. They should also be in a better position to meet their environmental obligations.

By acknowledging and supporting the adoption of improved soil management practices, contractors and processing companies, who share in the duty of soil management with farmers, will also share in the benefits.

This is not a set of rules and regulations. It is a user-friendly blueprint that farmers can consult as a guide to improving their soil management techniques - and therefore increasing or at least sustaining their returns.

Our soil is often an undervalued asset but there is a growing understanding of the range of techniques needed to prevent deterioration. We are therefore confident that farmers will welcome this important initiative.

Kem Perkins OAM
President TFGA

David Llewellyn MHA
Minister for Primary Industries, Water and Environment
INTRODUCTION

These guidelines have been prepared as part of a joint Department of Primary Industries, Water and Environment – Tasmanian Farmers & Graziers Association project funded through the National Heritage Trust. The project is a response to the need for a comprehensive, yet simple to read, set of recommended soil management practices for both cropping and grazing.

Due to the diversity of Tasmanian soils and farming practices, these guidelines are not prescriptive or applicable to all circumstances. Alternative ways to improve soil management practices can be developed.

The guidelines provide farmers with a set of management practices to address the issues of soil and water quality protection. Guidelines have been outlined for maintaining soil structure and soil organic matter, reducing soil erosion, managing salinity, avoiding soil contamination, managing riparian land and planning an effective soil management strategy.

Farmers, contractors and processing companies share in the duty of soil management. Therefore, guidelines for contractors and processing companies are included as an integral part of planning an effective soil management strategy.

A major component of the development of these guidelines has involved an extensive consultation process. Farmer groups were consulted at or near Forest, Sisters Creek, Riana, Gawler, Kindred, Sassafras, Cressy, Pipers River, Scottsdale, Nile, Fingal, Swansea, Ross, Richmond, Hamilton, Furneaux Group and King Island. The document was positively received by each farmer group.

It is not the purpose of this document to extensively repeat information from other documents. The document provides a summary of present information and practices, in accordance with other relevant documents. References and contacts that provide further detailed information are listed where appropriate.

This document is not designed to be read from cover to cover. It is organised to allow the user to consult specific recommendations and information relevant to the on-farm situation.

As principles and current best practices may change over time due to improvements in technology, this document is to be reviewed and updated when deemed necessary by farmers or regulators.
<table>
<thead>
<tr>
<th>INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER 1</td>
</tr>
<tr>
<td>1.1</td>
</tr>
<tr>
<td>1.2</td>
</tr>
<tr>
<td>1.3</td>
</tr>
<tr>
<td>CHAPTER 2</td>
</tr>
<tr>
<td>2.1</td>
</tr>
<tr>
<td>2.2</td>
</tr>
<tr>
<td>2.3</td>
</tr>
<tr>
<td>2.4</td>
</tr>
<tr>
<td>2.5</td>
</tr>
<tr>
<td>2.6</td>
</tr>
<tr>
<td>2.7</td>
</tr>
<tr>
<td>CHAPTER 3</td>
</tr>
<tr>
<td>3.1</td>
</tr>
<tr>
<td>3.2</td>
</tr>
<tr>
<td>3.3</td>
</tr>
<tr>
<td>3.4</td>
</tr>
<tr>
<td>CHAPTER 4</td>
</tr>
<tr>
<td>4.1</td>
</tr>
<tr>
<td>4.2</td>
</tr>
<tr>
<td>4.3</td>
</tr>
<tr>
<td>4.4</td>
</tr>
<tr>
<td>CHAPTER 5</td>
</tr>
<tr>
<td>5.1</td>
</tr>
<tr>
<td>5.2</td>
</tr>
<tr>
<td>5.3</td>
</tr>
<tr>
<td>CHAPTER 6</td>
</tr>
<tr>
<td>6.1</td>
</tr>
<tr>
<td>6.2</td>
</tr>
<tr>
<td>6.3</td>
</tr>
<tr>
<td>GLOSSARY</td>
</tr>
<tr>
<td>REFERENCES / CONTACTS</td>
</tr>
</tbody>
</table>
This chapter discusses requirements for planning an effective soil management strategy. The following strategies are recommended:

- know your soils and land capability;
- develop a Whole Farm Plan;
- work with contractors and processing companies.

Using land capability units as a basis for a Whole Farm Plan, farmers will be better able to match their management practices with the ability of the soil to support those practices. Farmers that work with contractors and processing companies are more likely to maintain their strategy to improve soil management on their property.
1.1 Know your soils and land capability

Guidelines
- Be aware of the distribution of soil types on your farm
- Conduct field assessments and use soil maps to clarify soil distributions.
- Define land capability units according to features such as soil type, erosion hazards and climatic hazards.
- With the aid of a Whole Farm Plan, match soil management practices to identified land capability units.

Knowledge of the land capability on your farm provides the basis for effective planning and sustainable soil management practices. Land capability assessment provides a ranking of the ability of an area to support a range of agricultural activities on a sustainable basis.

Knowing your soil

Assessment of land capability requires knowledge of soil types on your farm. The following is a summary of the main soil types used for cropping:

- **Black cracking clays** have a black, well structured, swelling clay overlying a mottled brown to greyish-brown clay. Mainly occurring in the Midlands and south-east Tasmania;
- **Cressy soils** have a dark grey-brown/brown loam/clay-loam topsoil overlying a red-brown/grey-brown clay. Scattered between Cressy and Westbury;
- **Deep sands** consist of deep uniform sands, with topsoils ranging from red-brown to grey-brown. Occasionally occurring along the north coast, the Midlands and in south-east Tasmania;
- **Duplex soils** have a distinct texture contrast between topsoil and sub-soil. Mainly occurring in the Midlands and south-east Tasmania, scattered along the east coast, Meander Valley and Derwent Valley;
- **Ferrosols (Krasnozems)** are red-brown/red, strongly structured, gradational, clay-loam/clay soils that generally become darker, more acidic and higher in organic matter further inland. Occurring in the north-west and to a lesser extent in the north-east.

The DPIWE booklet “Managing Tasmania’s Cropping Soils” provides detailed information on Tasmanian soil types that are used for cropping. Further details of tests, recommendations and case studies relating to the management of each soil type are included. The booklet is available from DPIWE and via the DPIWE website.

Soil maps

Soil maps can provide information on soil types and their distribution. These maps are available to the public through the Service Tasmania Shopfront and the LIST website (www.the-list.tas.gov.au).

While half of the agricultural land in Tasmania has been mapped, the reliability of this information varies across the state. The scale of some of these maps may not be appropriate for use at the farm scale.

A soil map super-imposed onto an aerial photograph. Initials indicate soil types. Yellow lines represent soil boundaries and red lines represent roads.
Land capability units

Land capability units are a sub-division of the landscape according to various soil features. Similar land capability units require the same level of management and are capable of the same level of productivity. Many of the land capability boundaries will be obvious, but others require field checking.

The Tasmanian land capability classification system is based on soil type, slope and climate. The classification system comprises seven classes ranked in order of increasing degrees of limitation in relation to agricultural use and agricultural versatility. Therefore, Class 1 is the best (most versatile) land and Class 7 the poorest. An important assumption during assessment is that a better than average level of management is being applied to the land.

Some of the major constraints to agricultural use of land in Tasmania include:
- shallow soil depth;
- coarse rock fragments;
- poor drainage;
- uneven or unreliable rainfall distribution;
- erosion hazard (based on soil texture, structure, dispersion and slope characteristics);
- salinity hazard;
- frost, flood or wind hazards.

Grose (1999) provides detailed guidelines regarding the classification of agricultural land in Tasmania. Contact DPIWE about this publication and other information about the Tasmanian land capability classification system.

Matching soil practices to land capability

Land capability units provide the basis for planning appropriate management of agricultural land. By understanding the variations and limitations of land capability on the property level, farmers are better able to plan for appropriate soil management practices. See Section 1.2 for further information about developing a Whole Farm Plan.
1.2 Develop a Whole Farm Plan

**Guidelines**
- Use land capability units as a basis for developing an effective Whole Farm Plan.
- Use aerial photographs to produce a basic Whole Farm Plan.
- Use computer software to produce a more sophisticated Whole Farm Plan.
- Where possible, attend a Whole Farm Planning course.
- Use a farm plan as documentation of responsible land management.

Whole farm planning is an on-going process that changes and adapts according to new technologies and practices. A Whole Farm Plan can present farmers with opportunities to integrate financial stability with improved soil management.

Using land capability units as a basis for a Whole Farm Plan, farmers will be better able to match their management practices with the ability of the soil to support those practices. See Section 1.1 for further information about assessing soil types and land capability units on your farm.

An integral part of farm planning requires that farmers work with contractors and processing companies. See Section 1.3 for further information.

**Mapping**

An aerial photograph (scale ranging from 1:2500 to 1:5000) can provide the basis for mapping and matching permanent features with land capability units.

Improved mapping information can be obtained from computer software packages. These range from simple calculation packages to complex packages that work with Global Positioning Systems, aerial maps or satellite images.

**Attending a course**

A Whole Farm Planning course trains farmers to develop effective farm plans. Farm planning courses are organised by a range of services. The Farm Business Improvement Scheme (FarmBis) currently provides support for farmers to participate in management training. Contact a FarmBis co-ordinator in DPIWE for further information.

**A record of responsible management**

Adherence to an effective Whole Farm Plan provides a record of responsible land management. Farmers using this documentation as a Quality Assurance system are better placed for potential market advantages.

Computer software is available for planning and recording farm operations and outcomes to satisfy quality standards.

FarmBis can provide further information about defining quality standards and monitoring management practices. Contact a FarmBis co-ordinator in DPIWE for further information.
1.3 Work with contractors and processing companies

Guidelines

• Work with contractors and processing companies so that they recognise your personal requirements for managing land in a sustainable manner.
• Favour contractors and processing companies that encourage and support the adoption of sustainable soil management practices.
• Favour contractors and processing companies that conduct activities that at least meet the standards for managing land in a sustainable manner.
• Favour contractors and processing companies that are licenced through their improved soil management practices.

Farmers, contractors and processing companies share in the duty of soil management. Therefore, an integral part of planning a soil management strategy requires improved interaction between each of these stakeholders.

Farmers

The principle recommendation for farmers is to favour and work with contractors and processing companies that are licenced through their improved soil management practices. Farmers interacting with contractors and processing companies are more likely to maintain their strategy to improve soil management.

By working with licenced contractors and processing companies, farmers are better able to plan for appropriate soil management practices. See Section 1.2 for further information about developing a Whole Farm Plan.

Contractors and processing companies

The duty of soil management extends to contractors and processing companies. Recommended practices for contractors and processing companies include:

• encouraging and supporting the adoption of sustainable soil management practices by farmers;
• providing adequate advance notice to farmers before arriving on their farms, so that farmers can take steps (where possible) to minimise the potential impact from proposed operations;
• consulting each farmer to recognise their personal requirements for managing their land in a sustainable manner;
• conducting activities that at least meet the standards for managing land in a sustainable manner;
• using appropriate implements. See Section 2.4 for further information;
• managing traffic, especially on wet soil. See Section 2.6 for further information;
• managing fertiliser and chemical applications. See Section 5.1 for further information;
• preventing disease, pest and weed invasion. See Section 5.3 for further information.

By acknowledging and supporting the adoption of appropriate soil management practices, contractors and processing companies will gain opportunities to sustain production, improve their collective image and attain marketing advantages for their produce.
This chapter discusses requirements to maintain soil structure and soil organic matter. The following strategies are recommended:

- maintain vigorous root growth;
- incorporate stubble and green manure crops into soil;
- manage a flexible grazing system;
- use appropriate implements;
- manage soil moisture levels;
- manage traffic and tillage, especially on wet soils;
- repair soil that is already compacted.

Soil structure is defined as the way in which soil particles and the pore spaces between them are arranged. Soil with good structure tends to have a high proportion of stable aggregates (ranging from 2 to 10 mm in size) with many interconnected and resilient pores. This allows for improved plant productivity as a result of enhanced aeration, infiltration and drainage and increased activity of beneficial soil organisms. It also allows for improved root growth to access water and nutrients.

Degraded soil has a high proportion of small particles and few water stable aggregates. The reduction of pore size and continuity results in massive blocks that restrict root growth and plant productivity. Compacted soil requires more cultivation to prepare a seedbed and this additional cultivation causes further deterioration in soil structure. A surface crust may develop that prevents seedlings emerging and reduces infiltration of water.

Organic matter contributes to improved soil structure and reduces the risk of compaction by binding soil particles into stable aggregates. Organic matter also contributes to an improved capacity for the soil to retain nutrients, retain moisture and support a greater population of beneficial soil organisms. Such organisms include bacteria, fungi, earthworms, ants, dung beetles and slaters.

In turn, beneficial soil organisms help to maintain soil organic matter turnover and nutrient cycling. Soil structure is improved when thread-like fungal growths and mucus coverings of soil organisms help to produce soil aggregates.
2.1 Maintain vigorous root growth

Guidelines

- For a long-term pasture phase, sow perennial pasture.
- Manage grazing of pastures to ensure optimum root growth.
- Between cropping phases, sow green manure crops.
- Conduct soil tests and seek professional interpretations to determine the optimum fertiliser requirements for vigorous plant growth.
- Apply the appropriate type and rate of fertiliser evenly and with precision

Vigorous root growth improves soil structure, increases soil organic matter levels and provides protection from erosion.

Pasture

Through vigorous root growth, a well-managed perennial pasture phase can improve both soil structure and soil organic matter levels. These soil benefits are greatest when the pasture phase (and root development) exceeds 2 years.

An effectively managed grazing system can improve pasture and root growth and thereby improve soil organic matter, soil structure and stock performance. See Section 2.3 for further information about managing a flexible grazing system.

Green manure crops

If long-term pasture is not possible, a green manure crop is recommended between cropping phases. Longer growing seasons for green manure crops mean greater benefits to the soil.

Green manure crops that produce rapid root growth include short rotation ryegrass and oats.

Lupins or tick beans are useful for producing organic matter that is high in nitrogen. The high nitrogen content in legume residues also stimulates biological activity to improve the rate of nutrient cycling.

Further information is available in the DPIWE leaflet “Green Manure Crops — a Powerful Soil Management Tool”.

Green manure crops (lupins and oats).

Vigorous pasture.
Matching fertiliser applications to plant requirements

Fertiliser applications need to be matched to the requirements for vigorous root growth. Too little fertiliser results in poor plant growth, while too much fertiliser is economically wasteful and can lead to soil contamination. See Section 5.1 for further information about managing fertiliser applications so as to avoid soil contamination.
2.2 Incorporate stubble and green manure crops into soil

Guidelines

- Slash and mulch stubble and green manure crops to improve incorporation.
- Consider spraying short rotation ryegrass and oats with herbicide to improve incorporation.
- Where necessary, graze or bale stubble and green manure crops to reduce the amount to be incorporated.
- Avoid burning stubble if it can be effectively managed through practices described above.
- Avoid excessive cultivation.

Incorporation and subsequent decomposition of stubble and green manure crops into the soil improves soil structure and soil organic matter levels.

However, high amounts of green manure crops or stubble can be difficult to incorporate into the soil. Inadequate incorporation of organic residues into soil can result in ineffective decomposition. In such cases, improvements to soil structure and soil organic matter levels are minimal. High amounts of organic residues can also hinder cultivation operations and increase the risk of pests and diseases.

Incorporating

Slashing and mulching stubble and green manure crops can improve their subsequent incorporation into the soil.

For some green manure crops, herbicide spraying approximately 3 weeks before ploughing allows for improved incorporation into the soil. For example, short rotation ryegrass and oats can be sprayed off in July before setting seed.

Green manure crops that are incorporated at the beginning of their flowering phase offer the greatest benefits to soil structure and soil organic matter. This stage of growth provides the best combination of quality and quantity for improved incorporation and decomposition rates.

Stubble and green manure crops that have set seed contain high amounts of woody tissue and low amounts of nutrients. This slows their rate of incorporation and decomposition into the soil.

Stubble requires suitable temperatures and moisture to allow for effective decomposition of the high amounts of dry woody tissue. Depending on these conditions, effective stubble decomposition may range from several months to several years.

Incorporation of stubble is not always necessary. Some crops (such as cereals and peas) can be direct drilled through a layer of chopped stubble on the soil surface.

Grazing and baling

High amounts of stubble and green manure crop can be utilised through baling and effective grazing. If baling, a larger amount of organic residues can be removed by harvesting closer to the soil surface. Note that the removal of excessive quantities of crop material that is highly alkaline can increase the risk of soil acidification. For further information, see Section 5.2 about managing soil acidification and Section 2.3 about managing a flexible grazing system.

Although burning can effectively remove stubble, organic residues are lost to the atmosphere rather than being recycled through grazing or baling. If stubble can be effectively managed through grazing and baling, then burning is not recommended.
Avoiding excessive cultivation

Excessive cultivation results in a rapid decline in soil structure and soil organic matter levels. Biological activity also declines as a result of physical injury to beneficial soil organisms and soil organic matter decline. Therefore, minimal tillage practices are generally recommended. However, a more intensive level of cultivation may be required perhaps once in every 5 years to provide a break in disease, pest and weed cycles. See Section 2.4 for further information about choosing appropriate implements.
2.3 Manage a flexible grazing system

Guidelines

- Implement and monitor a flexible and effective grazing system to match stocking intensity with pasture production.
- For dry conditions, implement a well-managed combination of rotational grazing and set stocking.
- If most paddocks are not susceptible to pugging in wet conditions, implement a well-managed combination of rotational grazing and set stocking.
- If many paddocks are susceptible to pugging in wet conditions, implement a well-managed set stocking system.
- Rejuvenate damaged or sacrificed paddocks with a new pasture in the following season.

Soil structure and soil organic matter levels can be severely degraded through inappropriate grazing or over-grazing. Subsequently, stock performance declines and the risk of soil erosion is increased.

Poor management of set stocking also results in the transfer of nutrients away from the grazing areas. As a result of stock camping, these nutrients are deposited into small areas. Such concentrations result in poor nutrient recycling and increasing the risk of soil and water contamination.

Maintaining an effective grazing system

An effectively managed grazing system can improve pasture growth and thereby improve soil organic matter, soil structure and stock performance. Well-developed pasture cover and root growth increase productivity while also improving water and nutrient cycling. Improved management of grazing patterns reduces the opportunities for stock camping, thereby improving nutrient redistribution.

A grazing system is only effective if the stocking density is matched to the carrying capacity of each paddock. Planning and constant monitoring is essential to ensure that there is sufficient pasture in each paddock:
- before grazing to allow for pasture resilience during and after grazing;
- during grazing to maintain animal performance;
- after grazing to allow for rapid plant recovery.

To maintain animal and pasture performance, a grazing system needs to be flexible in accordance with different soil moisture conditions. Appropriate strategies during dry, wet and optimal conditions are described below. Detailed information about grazing systems is available from relevant agribusinesses and DPIWE.
Grazing in dry conditions

In dry conditions, pasture growth is slow and the ability of pasture to recover following grazing is low. Over-stocking in dry conditions may lead to degradation and exposure of soil through grazing and pulverisation of the soil surface.

A well-managed combination of rotational grazing and set stocking can avoid soil and pasture degradation in dry conditions. For the rotational grazing system, the pasture recovery period and the number of paddocks determine the grazing period in each paddock. Reducing the stock intensity can slow the rate of paddock rotation.

In conjunction with a rotational grazing system, sacrificing one or two paddocks with set stocking will help to maintain a sufficient pasture recovery period for the remaining paddocks. Sacrificed paddocks need to be rejuvenated with a new pasture in the following season.

Grazing in wet conditions

Poor grazing management in wet conditions may lead to pugging of soil. This results in soil compaction and pasture decline.

A rotational grazing system is not recommended if the majority of available paddocks are susceptible to pugging. In this situation, well-managed set stocking strategies can reduce the incidence of pugging.

If there are enough dry paddocks available, a well-managed combination of rotational grazing and set stocking can avoid soil and pasture degradation in wet conditions. The pasture recovery period and the number of paddocks determine the grazing period in each paddock.

Sacrificing one or two paddocks with set stocking helps to maintain a sufficient pasture recovery period for the remaining paddocks used for rotational grazing. Sacrificed paddocks need to be rejuvenated with a new pasture in the following season.

Some strategies to reduce the incidence of pugging include:
- using pug-prone paddocks early in the winter-feed plan;
- using the driest paddocks in the wettest period of winter;
- allocating lighter stock in wetter paddocks, and heavier stock in drier paddocks;
- reducing stock intensity to better match pasture production;
- improving drainage to reduce the incidence of waterlogging. See Section 2.5 for further information about managing soil moisture levels.

Further information about managing grazing in wet soils is available in the DPIWE leaflet “Managing wet soils on dairy farms”.

Grazing in optimal conditions

When soil is friable (not too wet and not too dry), pasture growth rates are potentially optimal. This may result in insufficient stocking densities to maintain frequent paddock rotations. High amounts of pasture can be managed through increased stocking densities and/or baling.
2.4 Use appropriate implements

Guidelines

- Choose implements that avoid excessive cultivation.
- Be aware that inappropriate use of powered implements and mouldboard ploughs will cause severe soil degradation.
- Combine cultivation practices to reduce the number of passes.
- Overcome machinery blockages by managing stubble and green manure crops.

Any form of tillage results in a decline in soil structure and soil organic matter. Excessive cultivation results in a rapid decline in soil organic matter and beneficial soil organisms. Therefore, use of implements appropriate to soil conditions is essential.

Appropriate implements loosen the surface soil without unnecessary soil shattering, soil smearing and exposure of soil organic matter. The choice of implements depends on the soil to be cultivated, the soil moisture content, the amount of stubble in the soil and the intended crop. Extensive information of the use of appropriate implements is compiled in the DPIWE booklet “Managing Tasmania’s Cropping Soils. The booklet is available from DPIWE and via the DPIWE website.

Effective management of stubble and green manure crops can allow for reduced machinery blockages and reduced power requirements during cultivation. See Section 2.2 for further information about incorporating stubble and green manure crops into soil.

Direct drilling

Direct drilling into crop residues improves soil organic matter levels and minimises the risk of erosion. Successful direct drilling requires skilled and attentive operators and specifically designed machinery.

For heavy soils, a combination of direct drilling and minimal surface tillage is necessary to allow for good plant growth. For lighter soils, surface tillage is unnecessary. Direct drilling is especially beneficial for duplex soils (to minimise disturbance of less fertile sub-soil) and deep sands (to maintain the fragile soil structure).

Increased temperatures promote biological activity in the soil, thereby playing a major role in the success of direct drilling. Compared to a spring sowing, an autumn sowing extends the length of the growing season and utilises the remaining warmth and friable soil conditions before the onset of winter conditions.

Where very wet winter conditions are prevalent, sowing in winter may result in reduced yields compared to yields produced through conventional tillage. Incidence of slugs and plant diseases can also increase in wet conditions.

Tined implements

Compared to powered implements, tined implements cause less disruption to soil structure. Changing tine configurations and reducing stubble length can allow easier flow of stubble through cultivation machinery.

Powered implements

The use of powered implements (such as rotary hoes and power harrows) tends to degrade soil structure and soil organic matter through pulverisation and smearing.

An exception to this general case applies to krasnozem (ferrosol) soils. For such soils that have a suitable moisture content and a high level of stubble, less soil compaction will result from effective use of powered implements (at a suitably low speed) compared to over-use of tined implements. In this instance, soil structure is better maintained from only one pass using powered implements, compared to the required two or more passes using tined implements.
Mouldboard ploughs

Mouldboard ploughing inverts surface soil and has the capacity to bury high amounts of residues. For soils with deep and friable topsoil such as krasnozems (ferrosols), mouldboard ploughing is quicker and more effective for maintaining soil structure and reducing the risk of erosion, compared to tines.

Severe soil degradation can occur if mouldboard ploughs are applied too deeply on shallow or sandy soil. This can result in the exposure of less fertile (and perhaps more erodible) sub-soil. For shallow duplex soils, no more than the upper 100 to 150 mm of topsoil should be inverted.

There are cases where the incorporation of the underlying clay sub-soil crust with the topsoil has improved wetting characteristics and thereby plant productivity. However, such practices have a high risk of failure and therefore prior professional advice is recommended.
2.5 Manage soil moisture levels

Guidelines

• Seek professional advice before implementing drainage or irrigation systems.
• Consider drainage systems that are easily incorporated into farming operations.
• Provide adequate drainage outlets that are directed away from neighbouring properties.
• Install appropriate surface and/or sub-surface drainage systems.
• If irrigating, monitor soil moisture levels so as to match water requirements of plants.
• Improve uniformity of spray applications by avoiding irrigation in windy conditions.
• Adjust nozzles to optimise spray droplet size.
• Use pressure-regulating devices to maintain a consistent sprinkler output.

Effective management of soil moisture can reduce the degree and extent of wet soil conditions in a paddock. A soil with appropriate moisture conditions offers improvements in plant growth, cultivation and vehicle access.

Drainage

Soil moisture levels can be managed through improved drainage systems. Extensive information for managing drainage is available from relevant agri-businesses and DPIWE.

Professional advice and surveying is recommended for the correct positioning and grading of major drainage systems. Consultation with relevant neighbours and local authorities is also recommended when planning drainage works. Redirection of water may need approval before commencing drainage work.

Where possible, it is recommended that drainage outflows are directed towards settling ponds, dams or buffer strips to minimise sediment and nutrient run-off flowing into streams. See Section 6.3 for further information about buffer strips.

Drains in dispersive soils can lead to soil instability and severe erosion. See Section 3.4 for further information about managing dispersive soils.

Grassed waterways are most applicable for crop and short-rotation pasture on sloping paddocks. Grassed waterways transport water along natural drainage lines. Grassed irrigator runs can help to transport water into grassed waterways. Graded (contour) drains help to transport water into grassed irrigator runs and grassed waterways. Refer to “Keeping your Soil on your farm” for further information about these drainage systems.

Cut-off drains, in conjunction with grassed waterways, effectively divert water flowing towards a paddock or a cultivated area. Installing cut-off drains located along farm tracks or fence lines minimise interference to farming operations. Refer to the DPIWE booklet “Managing Tasmania’s Cropping Soils” (available from DPIWE and via the DPIWE website) and “Keeping your Soil on your Farm” for further information about cut-off drains.

Hump and hollow drains are most applicable for pasture and crops on flat or poorly drained paddocks. The parallel ridges drain water to shallow waterways so that the root zone is elevated from the watertable. Refer the “Drainage Information Package” for further information. This package is available at DPIWE and via the DPIWE website.
Raised beds with adjoining furrow drains are most applicable in continuous cropping systems, where livestock are excluded from the cropping area and where the gradient is no greater than 3%. Shortening the length of beds can reduce the risk of erosion resulting from high volumes of water flowing along the furrows. Further information about raised beds is available from DPIWE.

Sub-surface drains are most applicable for pasture and crops where soil is permeable. Refer to the “Drainage Information Package” for further information. This package is available from DPIWE and via the DPIWE website.

Irrigation

To avoid applying too little or too much irrigation water, applications need to be matched to plant requirements. Monitoring soil moisture conditions provides information about required application rates and application scheduling. See Section 4.2 for information about irrigating on saline soils.

Although useful indicators, tensiometers merely indicate when plants are water-stressed, rather than indicating the level of soil moisture. Electrical readings from capacitance probes can better indicate soil moisture levels. Irrigation scheduling services are available from a number of agricultural support businesses. Further information about monitoring and scheduling of irrigation is available through relevant agribusinesses or DPIWE.
2.6 Manage traffic and tillage, especially on wet soils

**Guidelines**

- Avoid excessive cultivation.
- Use appropriate cultivation equipment.
- Manage soil moisture conditions through improved drainage and irrigation systems.
- Use controlled traffic systems (such as raised beds) to restrict traffic to designated areas.
- Manage stock movement and stock grazing through an effective grazing system.
- Before cultivation, assess the risk of soil compaction.
- If tillage on wet soil is unavoidable, restrict operations as much as possible.
- When possible, postpone operations until the soil moisture level is appropriate.
- Reduce axle loads in conjunction with wider tyres and lower tyre pressure.

Excessive cultivation causes a decline of soil structure and soil organic matter levels. In wet conditions, the risk of compaction increases as a result of traffic and tillage. In very dry conditions, soil aggregates can be pulverised as a result of cultivation.

Effective management of soil moisture conditions can reduce the degree and extent of wet soil conditions in a paddock. See Section 2.5 for further information about managing soil moisture levels through improved drainage and irrigation systems.

**Restricting the impact of traffic**

Controlled traffic systems (such as raised beds) restrict all heavy traffic to the same permanent wheel tracks. Subsequent benefits include:

- reduced incidence of wet soil conditions, thereby increasing opportunities to cultivate at the appropriate soil moisture;
- elimination of soil compaction in the cropped area, allowing for improved yields per hectare despite the loss of cropping land from permanent wheel tracks;
- reduced tractor power requirements as a result of improved soil structure;
- increased precision of operations, so that each operation is done in exact relation to a previous or future operation. Automated guidance and steering systems further enhance precision;
- reduced seeding, fertiliser and spray overlap.

Raised bed systems with adjoining furrow drains are an advanced application of controlled traffic principles. This system is most effective in continuous cropping systems, where livestock are excluded from the cropping area and where the gradient is no greater than 3%.

Shortening the length of beds can reduce the risk of erosion resulting from high volumes of water flowing...
along the furrows. Cut-off drains incorporated within raised bed systems can divert drainage before accumulating along the furrows. Further information about raised beds is available from DPIWE.

Cropping with raised beds.

The simplest controlled traffic system involves the restriction of traffic to tracks and designated headlands. Managing stock movement can further reduce the impact of grazing. See Section 2.3 for further information about managing a flexible grazing system.

Minimising the impact of tillage

For non-sandy soils, the appropriate soil moisture content for cultivation is indicated when the soil contains enough water to be friable but not so much as to be plastic. Moist lumps of soil break off easily by hand when the soil is in this ideal friable state for safe cultivation.

The ‘hand-roll’ test for soil workability (also known as the ‘soil-wire’ test) is a simple check to determine the risk of compaction during cultivation. The test does not apply to sandy soils.

The hand-roll test involves the following procedure:

- digging to the depth of the cultivation layer;
- taking a handful of soil from different levels;
- working the soil to an even consistency;
- attempting to form a sausage about 3 mm round by rolling the sample between your palms.

When the soil is too wet for tillage, a 3mm thick rod will easily form. This indicates that operations need to be delayed to avoid soil compaction. At the optimum moisture content the soil rod will crack and break into short lengths. If the sample crumbles the soil conditions are still suitable for cultivation. However, power requirements and soil shatter will be high.

The DPIWE booklet “Managing Tasmania’s Cropping Soils” provides a detailed diagnosis of the risk of soil compaction for a range of Tasmanian soil types. The booklet is available from DPIWE and via the DPIWE website.

In conjunction with the hand-roll test, a risk of soil compaction can be indicated if boots leave a tread in the soil. Another indication may be soil adhering to wheels and equipment. However, significant compaction might occur before this indicator is apparent.

Choice of implements appropriate to the soil moisture conditions is essential. See Section 2.4 for further information about using appropriate implements.
2.7 Repair soil that is already compacted

Guidelines

- Recognise signs of compaction, and determine its extent and depth.
- Only rip if the operation effectively shatters a compacted layer and improves drainage.
- Don’t repeat ripping if earlier ripping is ineffective.
- Immediately following ripping, stabilise rip lines.

Compacted soil is characterised by the presence of layers in the profile with fewer pores, fewer individual aggregates and fewer plant roots and earthworm channels. Soil that is not compacted has a more friable soil structure.

Compaction may not be obvious at the surface as it can develop below the plough layer. Indications of a sub-surface compaction layer can include:
- reduced plant growth resulting from restricted root growth, poor drainage and poor aeration;
- prolonged rainwater ponding on the soil surface;
- increased difficulty in cultivating.

Examination of an exposed profile can help to identify signs of compaction and the depth at which compaction may occur.

Effective deep ripping

It is recommended that farmers read the DPIWE leaflet “Guidelines for Deep Ripping Soils” before proceeding with deep ripping. This leaflet is available from DPIWE and via the DPIWE website.

Deep ripping is defined as the ripping of soil, deeply, with a tine or similar tool primarily to loosen compacted soil. Deep ripping is not a surface tillage operation and therefore should not bring sub-soil to the surface. Ripping operations are most effective with the use of correctly spaced winged tines.

In grazed paddocks, deep ripping is often only required in clearly compacted areas, such as headlands, tracks, and gateways — rather than the whole paddock. Compared to grazed paddocks, cropped paddocks may require more widespread ripping because traffic compaction tends to be more evenly distributed.

The depth of the compaction layer determines the depth of a ripping operation. Ripping to a depth greater than 300 mm is only beneficial in deep sandy soils where wheel traffic has produced a deep compaction layer.

Compaction layers in clays tend to occur at much shallower depths. Ripping between a depth of 200 and 250 mm is recommended for such soils.

As the tines move through the soil, soil shattering occurs above a critical depth, while smearing and compaction occurs below this critical depth. Therefore, ripping below the compacted layer (but not below the critical depth) is required to effectively shatter the soil. As the level is largely determined by soil moisture content, critical depth is constantly changing.

Effective ripping also requires that soil conditions are friable (not too wet or too dry). Ripping wet soil can be ineffective due to inadequate shattering of the compacted layer. Ripping dry soil requires a higher power input to effectively shatter the compacted layer. See Section 2.6 for information about assessing the risk of soil compaction.

Stabilising rip lines

Rip lines can be stabilised by avoiding traffic directly above the fractured soil. Vigorous root growth can also help to stabilise rip lines. See Section 2.1 for further information about maintaining vigorous root growth.

For dispersive sub-soil, gypsum (calcium sulphate) applied into rip lines can help to reduce the level of dispersion. See Section 3.4 for further information about managing dispersive soils.
Cultivated soil with poor structure

Cultivated soil with good structure

Winged ripper tines.
This chapter discusses recommendations to reduce the risks of soil erosion by water and wind. The following practices are recommended:

- control run-on and run-off
- minimise wind erosion, sheet erosion and rill erosion
- treat tunnel erosion, gully erosion and mass movement
- manage dispersive soils

Soil on steep paddocks has a high potential to erode. A millimetre of soil eroded is the same as trucking 10 to 15 tonnes per hectare and dumping it elsewhere.

The rate of soil erosion depends on climate (precipitation and wind), topography (angle and length of slope), soil properties (soil texture, soil structure and organic matter), vegetation cover and management. Climate, slope angle and certain physical characteristics of the soil cannot be directly controlled. However, their effects may be modified indirectly through improved management practices.

Dispersive soil refers to soils affected by an excess of sodium ions attached to clay particles. When dispersive soils are wet, clay particles repel each other and this causes the soil to disperse and become extremely susceptible to erosion.
3.1 Control run-on and run-off

Guidelines

- To intercept run-on, install cut-off drains across the top of each paddock.
- To manage run-off, install systems that drain surface water flowing across each paddock.
- Provide adequate drainage outlets that are directed away from neighbouring properties.
- Assess the potential risks of erosion from a drainage system.
- Consider drainage systems that are easily incorporated into farming operations.
- Seek professional advice to determine the correct positioning of drainage systems.

Run-on is the flow of surface water from up-slope onto a paddock that can lead to erosion. Run-on usually originates from roads, culverts, yards and adjacent paddocks.

Run-off is the flow of surface water over a paddock that can lead to erosion. The risk of erosion is increased when volumes of surface water accumulate across a paddock.

Effective drainage systems minimise the potential for erosion by collecting and discharging surface water in an appropriate manner. Where possible, it is recommended that drainage outflows are directed towards settling ponds, dams or buffer strips to minimise sediment and nutrient run-off flowing into streams. See Section 6.3 for further information about buffer strips.

Seeking advice

Professional advice and surveying is recommended for the correct positioning and grading of major drainage systems, as overly steep or narrow drains increase the risk of scouring the drain itself. Extensive information for managing drainage is available from relevant agribusinesses and DPIWE.

Consultation with relevant neighbours and local authorities is also recommended when planning drainage works. Redirection of water may need approval before commencing any drainage work.

Drains in dispersive soils can lead to soil instability and severe erosion. See Section 3.4 for further information about managing dispersive soils.

Controlling run-on with cut-off drains

Cut-off drains, in conjunction with grassed waterways, effectively divert water flowing towards a paddock or a cultivated area. Installing cut-off drains located along farm tracks or fence lines will help to minimise interference to farming operations.

Refer to the DPIWE booklet “Managing Tasmania’s Cropping Soils (available from DPIWE and via the DPIWE website)” and “Keeping your Soil on your Farm” for further information about cut-off drains.

Managing run-off with mulched-rip lines

Mulched-rip lines are most applicable for annual crops on sloping paddocks. Rather than draining run-off, this system allows for increased infiltration of water into the soil, thereby improving sub-soil moisture levels and reducing the need for other surface drains.

Single rip lines installed at regular intervals along contours slow surface run-off and reduce the length of slope. The application of cereal straw along the top of each rip line further improves infiltration and reduces run-off speed.

Mulched-rip lines offer minimal restrictions to farming operations, and are cheaply and readily installed. Contact DPIWE for further information about mulched-rip lines.
Managing run-off with grassed waterways

Grassed waterways are most applicable for crop and short-rotation pasture on sloping paddocks. Grassed waterways transport water along natural drainage lines.

Grassed irrigator runs and cut-off drains can help to transport water into grassed waterways. Graded (contour) drains can help to transport water into grassed irrigator runs and grassed waterways.

Broad and shallow drains are more easily incorporated into farm operations as they are easily slashed, easy to cross with machinery, and less susceptible to erosion. Refer to “Keeping your Soil on your farm” for further information about these drainage systems.

Managing run-off with raised beds

Raised beds with adjoining furrow drains are most applicable for continuous cropping systems, where livestock are excluded from the cropping area and where the gradient is no greater than 3%.

Shortening the length of beds can reduce the risk of erosion resulting from high volumes of water flowing along the furrows. Cut-off drains incorporated within raised bed systems can divert drainage before accumulating along the furrows. Further information about raised beds is available from DPIWE.

Managing run-off with hump and hollow drains

Hump and hollow drains are most applicable for pasture on flat or poorly drained paddocks. The parallel ridges drain water to shallow waterways, so that root zones are elevated from the watertable.

Refer the Drainage Information Package for further information. This package is available at DPIWE and via the DPIWE website.
3.2 Minimise wind erosion, sheet erosion and rill erosion

Guidelines

- Avoid excessive cultivation.
- Protect soil by maintaining stubble or vegetation cover.
- Use appropriate implements (such as direct drills) to maintain stubble protection.
- For long term soil protection, maintain perennial pasture.
- Match stocking intensity to the requirement for vigorous pasture growth.
- Between cropping phases, sow green manure crops.
- Use cover crops to protect establishing cash crops.
- Establish windbreaks in strategic locations to reduce wind speeds.
- Try to avoid cultivation in very dry conditions to minimise wind erosion.
- Maintain surface roughness (through discing or ridged rollers) to minimise wind erosion.

- Control run-on and run-off.

Wind erosion occurs on dry and exposed soils. The resultant air-borne soil particles may cause physical injury to pastures and crops in a process known as sandblasting.

Sheet erosion is the removal of a uniform thin layer of soil resulting from flowing water. Rill erosion occurs from concentrations of flowing water forming rills in the surface soil.

Wind, sheet, and rill erosion is collectively referred to in this section as “erosion”. More specific terminology is used where necessary.

Careful cultivation

Any form of tillage can result in erosion. Excessive cultivation increases the chances of erosion, as well as degrading soil structure and soil organic matter levels.

Appropriate implements can help to minimise erosion by loosening the surface soil (without unnecessary soil shattering) and retaining organic residues (such as stubble). The choice of implements depends on the soil to be cultivated, the soil moisture content, the amount of stubble in the soil, and the intended crop.

Stubble cover

Cereal stubble can protect soil (before and after sowing) from erosion. Effective stubble management requires appropriate implements, such as direct drills. Drills specifically designed to handle stubble interference can reduce the incidence of machinery blockages. To further overcome machinery blockages, stubble can be chopped into shorter lengths. See Section 2.4 for further information about direct drills and other implements.

Vegetation cover

Vegetation can lower the risk of erosion by providing protection and resistance to surface water flows, winds at ground level and rainfall splash. Through vigorous root growth, vegetation can improve the rate of surface water infiltration into the soil and rapidly utilise this ground-water recharge. Improved water infiltration also means reduced amounts of run-on and run-off.

Vigorous vegetation cover may require adequate drainage and appropriate fertiliser applications. For further information, see Section 2.5 about appropriate drainage and Section 5.1 about managing fertiliser applications.
Perennial pasture with vigorous root growth is a long-term approach for protection from soil erosion. The potential benefits are greatest when the pasture phase exceeds 2 years. To avoid over-grazing, stocking intensity needs to be matched with pasture production. See Section 2.3 for further information about managing a flexible grazing system. Grazing is not recommended where the risk of erosion increases as a result.

Green manure crops can provide soil protection between cropping phases. Green manure crops that produce rapid root growth include short rotation ryegrass and oats. Lupins and tick beans are also useful for producing organic matter that is high in nitrogen. Further information is available in the DPIWE leaflet “Green Manure Crops — a Powerful Soil Management Tool”.

Cover crops can provide soil protection at the beginning of a cropping phase. Cover crops also provide protection to the cash crop from wind damage and sandblasting.

Competition (for soil moisture, nutrients and light) between the cash crop and the cover crop inevitably increases as both crops become established. It is therefore essential to spray the cover crop with a selective herbicide shortly after sowing to allow the cash crop to maintain vigorous growth.

Where moisture and nutrients are inherently low in the soil, the cover crop may require herbicide spraying before (or a few days after) sowing the cash crop. A cover crop sprayed with herbicide continues to provide soil protection while it gradually withers and dies.

Consult DPIWE and refer to the DPIWE booklet “Managing Tasmania’s Cropping Soils” (also available via the DPIWE website) for further information about cover crops.

Windbreak shelter

Windbreaks, commonly trees, can significantly lower wind speeds on the leeward side for a distance of approximately 10 times the tree height. This shelter effect:
• protects crops and pastures from wind damage;
• reduces evaporation rates of plants and soil;
• protects stock from cold winds;
• shades stock from excessive heat radiation.

The extent of the shelter depends on windbreak permeability and windbreak positioning in the landscape. Windbreak orientation is determined using local knowledge of the general prevailing wind directions.

Correct choice of species, preparation and planting techniques and on-going maintenance are essential for successful tree establishment. Trees require fencing from stock. Contact DPIWE or local Landcare groups for further information.
3.3 Treat tunnel erosion, gully erosion and mass movement

Guidelines
- Fence and exclude grazing.
- Where possible, maintain vigorous deep-rooted perennial vegetation.
- Where erosion is unlikely to be managed by vegetation alone, implement structural operations prior to revegetation.
- Seek professional advice before attempting to prevent or treat erosion.

Gully erosion is the result of deep channels being formed from concentrations of flowing water.

Tunnel erosion occurs when water moves along cracks in dispersive sub-soils, underneath a more stable surface layer (dispersive soil refers to soils affected by an excess of sodium ions attached to clay particles). The tunnels may enlarge and cause the topsoil to collapse, forming pot-holes and eventually a gully. Tunnel erosion most often occurs in duplex soils.

Mass movement (also known as landslides or soil creep) occurs if the weight of the water-soaked soil becomes greater than the ability of the sub-soil to hold it. Landslips tend to occur on steep slopes that have a distinct slip plane with high moisture levels. Signs of historical landslips include cracks and terracing across slopes, bent tree trunks on steep slopes, and bulges of soil on foot slopes.

Tunnel erosion, gully erosion and mass movement is collectively referred to in this section as “erosion”. More specific terminology is used where necessary.

The occurrence of erosion can often result in:
- total loss of production in the affected area;
- damage to fences, roads, buildings and adjacent paddocks;
- hazards to stock and to machinery operations;
- prevention of access.

Vegetation cover
Prevention of erosion is the cheapest and most effective form of management. Prevention is possible by identifying areas at risk of erosion, and then managing appropriately.

Vigorous and permanent vegetation can anchor soil into place and lower soil moisture levels through utilisation of ground water recharge. Recommended vegetation includes deep-rooting perennial grasses, shrubs and trees. Further information about revegetation is available from DPIWE.

Fertiliser applications need to match the requirements for vigorous plant growth. See Section 5.1 for further information about managing fertiliser applications.

Where erosion is unlikely to be managed by vegetation alone, structural operations may be required prior to revegetation. Seek professional advice before attempting treatment.

An example of gully erosion.
3.4 Manage dispersive soils

Guidelines
- Assess the level of dispersion by conducting simple field tests or including a dispersion test as part of a routine soil analysis.
- Seek professional advice before considering any drainage or tillage operations.
- Only consider drainage and tillage if such operations do not risk the exposure of dispersive sub-soil.
- Maintain vigorous vegetation cover.

Dispersive soil refers to soils affected by an excess of sodium ions attached to clay particles. Sodicity refers to a soil that is highly dispersive; where more than 10 to 15% of the clay's negative charge is dominated by sodium ions. Most sodic soils in Tasmania are dispersive only in the sub-soil. Such soils are usually duplex soils or black cracking clays.

When exposed dispersive soils are dry, a crust develops that prevents seedlings emerging through the surface. When dispersive soils are wet, clay particles repel each other and this causes the soil to disperse. Exposed dispersive soil is therefore extremely susceptible to erosion by water.

Dispersive sub-soils are best managed by maintaining the protective non-dispersive surface soil. Where erosion has already occurred, refer to Section 3.3 for treatment recommendations. Further information about the following practices is available from DPIWE.

Drainage and tillage
Inappropriate tillage and drainage systems can expose dispersive sub-soil and lead to soil instability and severe erosion. Where there is a risk of exposing dispersive sub-soil layers, tillage or drainage systems are generally not recommended.

Shallow surface drains are only suitable provided that the drainage system does not expose the dispersive sub-soil. Prior to commencement of drainage operations, seeking professional advice and arranging laboratory soil tests is recommended.

Gypsum applications applied into rip lines or around sub-surface drains can stabilise exposed dispersive soil by replacing sodium ions with calcium ions. Surface gypsum applications are of little value for unexposed dispersive sub-soils.

If minimal tillage practices are deemed appropriate, careful usage of tines or direct drills are recommended to avoid exposure of dispersive sub-soil. See Section 2.4 for further information about using appropriate implements. Mouldboard ploughs and powered implements are unsuitable for such areas.

Vegetation cover
Stabilisation of areas with dispersive sub-soils requires permanent vegetation cover, such as perennial pasture, shrubs and trees. Grazing is not recommended if the protective vegetation is susceptible to over-grazing. Such areas require fencing and permanent exclusion from stock.

Where grazing continues to occur, grazing systems and fertiliser applications need to match the requirements for vigorous pasture growth. See Section 2.3 for further information about managing an effective grazing system.
This chapter discusses requirements to manage soil salinity. The following practices are recommended:

- assess the situation
- avoid salt accumulation when irrigating
- improve drainage
- increase vegetation cover

Salinity problems in Tasmania are presently not as severe or extensive as in other parts of Australia. However, there is a potential for future increases in soil salinity. The National Land and Water Audit has reported that about 3% of agricultural land in Tasmania is salt affected. The Midlands, north-east Tasmania and the Furneaux Group contain 80% of the salt affected land in Tasmania.

When surface soils become saturated and excess water can access groundwater, it can cause a watertable to rise closer to the root zone. Once a watertable reaches approximately 2 metres below the soil surface, evaporation at the soil surface draws water upwards from the sub-soil in a process known as capillary rise. If salts are mobilised and carried to the soil surface through this process, salt concentrates near the root zone. These salt concentrations may affect plant productivity.

The process of salinisation worsens with poorly managed drainage and irrigation practices and when deep-rooted native vegetation is replaced with shallow rooted pastures and annual crops.

Electrical conductivity (EC) is the potential of a material to conduct electricity. The ease with which an electrical current passes through water is proportional to the salt concentration in the water. Therefore, EC is an indirect measure of soil salinity. EC is commonly expressed as deciSiemens per metre (dS/m). A standardised method of measuring salinity is called “Electrical Conductivity in a Saturated Extract (Esat)”. Soil salinity can be rated as moderate (Where Esat is 4 to 8 dS/m), very high (8 to 16 dS/m) and extreme (>16 dS/m).
4.1 Assess the situation

Guidelines
- Check for salinity indicator species.
- Assess soil and water salinity levels (with field kits such as Saltpak).
- Hire consultants to rapidly measure apparent salt storage distributions.
- Install shallow observation bores to monitor groundwater levels.

Indicators of salinity
Changes in botanical composition and plant growth are a reflection of soil salinity. Low to moderate salinity can be indicated by reductions in pasture and crop yield. High salinity is characterised by the presence of sea barley grass and buck’s horn plantain. The presence of water buttons and patches of bare soil indicate severe salinity.

Assessing salinity
The DPIWE Saltpak is a simple field test kit that can help farmers to identify, assess and manage saline soils and water. The kit consists of a handheld conductivity meter and other equipment. The readings obtained from the conductivity meter can be applied to the tolerance tables provided to determine the most suitable crop and pasture species for the observed salinity conditions.

Although Saltpak provides a valuable field test for salinity, more accurate results might be required from laboratory facilities. Improved accuracy of salinity readings is especially important for the assessment and management of irrigation on saline soils. Contact DPIWE for further information about Saltpak and other options for salinity testing.

Monitoring groundwater levels
The presence and movement of groundwater is the primary vehicle for transporting salts to the soil surface. A better understanding of groundwater levels allows for improved management decisions.

Installation of shallow observation bores is the simplest and cheapest means of monitoring groundwater. Contact DPIWE for further information about installing bores.

Mapping of apparent salt storage across a paddock. The ‘cooler’ colours represent areas of lower salinity levels. The ‘hotter’ colours represent areas of higher salinity levels.
4.2 Avoid salt accumulation when irrigating

Guidelines

- Seek professional advice before developing an irrigation system.
- Avoid irrigation where natural drainage is insufficient to leach salts from the root zone.
- When salts in the root zone are insufficient to affect plant productivity, uniformly apply water at the precise level that matches plant requirements.
- In regards to the previous recommendation, only apply a higher level of irrigation to when salts have accumulated in the root zone and need to be flushed away.
- Regularly monitor soil moisture and salt levels and the level of salt in irrigation water.
- Avoid irrigation if the salinity level in the water exceeds 0.8 dS/m.

Avoiding excessive irrigation applications

To avoid an excessive accumulation of salt in the root zone as a consequence of irrigation, salts must be leached further down the soil profile by water percolation. An event whereby water percolates down a soil profile is termed a leaching fraction.

Excessive leaching fractions can worsen the process of salinisation by causing the saline watertable to rise closer to the root zone. Ideal leaching fractions provide enough water to leach salts away from the root zone, but not enough water to raise the watertable.

When rainfall provides a sufficient leaching fraction to leach salts away from the root zone, irrigation water can be applied at a level that is sufficient for crop requirements but insufficient to produce further leaching fractions. A heavier irrigation is only necessary if salts accumulate in the root zone to a level that affects crop productivity.

By monitoring the level of soil moisture, the level of water applied can be better matched to crop requirements while avoiding excessive leaching. Although tensiometers are useful indicators, they merely indicate when plants are water-stressed rather than indicating the level of soil moisture. Electrical readings from capacitance probes can better indicate soil moisture levels.

Irrigation scheduling services are provided by a number of agricultural support businesses. Further information about monitoring and scheduling of irrigation is available through relevant agribusinesses and DPIWE.

Monitoring salt levels in irrigation water.

The consequences of applying saline irrigation water on land can be severe. A megalitre of irrigation water that has a salinity level of 1 dS/m will deposit 640 kg of salt. Therefore, it is important to know the amount of salt being applied through irrigation applications. Prior to application, testing irrigation water for conductivity is recommended. See Section 4.1 for further information about monitoring salt levels.

Improved drainage can improve leaching rates. See Section 4.3 for further information about improving drainage in saline areas.

Irrigation with saline water is not recommended on clay sub-soils where drainage is insufficient to allow salts to leach away from the root zone.
4.3 Improve drainage

Guidelines

- Seek professional advice before positioning and grading drains.
- Avoid draining naturally occurring wetlands.
- Use cut-off drains to divert and remove surface water.
- Use raised beds to improve surface drainage and salt leaching.
- Use sub-surface drains to reduce waterlogging.
- Provide adequate drainage outlets that are directed away from neighbouring properties.
- Stabilise surface drains with fencing and vegetation cover.

In areas where salinity has been identified, adequate drainage is essential to divert or remove any excess water from waterlogged areas. Diversion or removal of excess water can allow for successful leaching of salt from the root zone to lower levels in the soil profile.

Consultation with relevant neighbours and local authorities is recommended when planning drainage works. Redirection of water may need approval before commencing any drainage work.

Some shallow wetlands in eastern and central Tasmania are naturally saline. Such wetlands may be listed under the Ramsar Convention as internationally important wetlands. The “Directory of Important Wetlands in Australia” database identifies such wetlands in Tasmania. Further information can be obtained from DPIWE or via the Environment Australia website (www.ea.gov.au/water).

Detailed information about managing drainage in saline areas is available from relevant agribusinesses, DPIWE and the “Drainage Information Package” (available via the DPIWE website).

Drains in dispersive soils can lead to soil instability and severe erosion. See Section 3.4 for further information.

Cut-off drains

Cut-off drains can divert and remove surface water that would otherwise become groundwater recharge. Refer to the DPIWE booklet “Managing Tasmania’s Cropping Soils” (available from DPIWE and via the DPIWE website) and “Keeping your Soil on your Farm” for further information about cut-off drains.

Drainage lines in saline areas can be stabilised and maintained with fencing and vegetation cover. See Section 4.4 for further information about establishing and maintaining appropriate vegetation cover.

Raised beds

Raised beds with adjoining furrow drains can improve surface drainage and salt leaching. Raised beds are most applicable for continuous cropping systems where the gradient is no greater than 3%.

Reducing the length of beds reduces the risk of erosion that can result from high volumes of water flowing along the furrows. Cut-off drains incorporated within raised bed systems can divert drainage before accumulating along the furrows. Further information about raised beds is available from DPIWE.

Sub-surface drains

Sub-surface drains can reduce waterlogging and increase the leaching of salt. These drains consist of a network of perforated pipes buried about 1 metre below the soil surface. The spacing of sub-surface drains depends on soil permeability and amount of drainage required.

Use of subsurface drainage in saline and dispersive soils may cause soil instability problems. Use of gypsum before installing subsurface drainage may prevent this. Seek advice before proceeding.
4.4 Increase vegetation cover

Guidelines

- Reduce the risk of salinity occurring in the first place by maintaining vigorous growth of perennial pasture and tree species.
- Improve protection of remnant native vegetation.
- Treat saline discharge areas by establishing perennial pasture and tree species that are tolerant to salinity and waterlogging.
- Further treat salinity by maintaining vigorous growth of perennial pasture and tree species in recharge areas.
- Apply effective vegetation establishment and maintenance techniques.
- Exclude stock during the establishment phase.

Water percolating into the sub-soil can cause the watertable (and possibly salts) to rise towards the soil surface. Vegetation cover can reduce the amount of water entering the watertable by utilising available soil water and surface water. Establishing appropriate vegetation cover requires knowledge of discharge and recharge areas on a property level.

Recharge areas occur where surface water soaks through the soil surface. Following rainfall, all land has the potential to act as a recharge area. Vegetation that can utilise large amounts of rain where it falls can prevent excess water soaking through the soil surface. Vigorous perennial pasture and/or deep rooting lucerne and trees is recommended.

Discharge areas occur where the watertable is close enough to the soil surface to evaporate, allowing for salts to accumulate. It also occurs when groundwater flows out onto the soil surface as springs or seepages. These areas are generally located in depressions, drainage lines and saline seeps. The choice of ground cover for discharge sites is limited by those species that are tolerant of salinity and waterlogging.

A mixture of deep-rooted winter-active perennial species is recommended for discharge areas. Puccinellia and tall fescue can grow well in extremely saline conditions. Strawberry clover and ryegrass can grow well in low to moderately saline soils.

A flexible grazing system can help to avoid loss of vegetation cover through over-grazing. See Section 2.3 for further information about managing grazing.

Vigorous plant growth requires adequate drainage and appropriate fertiliser applications. For further information, see Section 4.3 about drainage options and Section 5.1 about managing fertiliser applications so as to avoid soil contamination.

Planting is recommended in spring. Winter rains will have washed away some of the salt and spring is when moisture and temperature levels allow for rapid growth. Contact DPIWE about further details for pasture and tree establishment and maintenance.
This chapter discusses requirements to avoid soil contamination and thereby help to maintain soil fertility. The following strategies are recommended for avoiding soil contamination:

- manage fertiliser and chemical applications
- minimise the impact of soil acidification
- prevent disease, pest and weed invasion

A contaminant has undesirable effects on soil and water quality if its concentration exceeds a certain threshold.
5.1 Manage fertiliser and chemical applications

Guidelines
- Become an accredited farm chemical user.
- Favour operators that are licenced farm chemical users.
- Apply the appropriate product at the appropriate rate and location.
- Conduct regular soil tests and seek professional interpretations.
- Avoid chemicals that may be toxic to a subsequent crop.
- Avoid mixing or using products near drainage lines, streams or rivers.
- Avoid applications in imminently windy or rainy conditions.
- Favour products that are target specific with minimal residue periods.
- Reduce applications of phosphate fertilisers containing cadmium impurities.
- Carefully manage the application of effluent and sewage sludge (biosolids).
- Ensure appropriate storage, usage and disposal of chemicals.

- Prepare emergency procedures in case of chemical leaks or spills.

Poor management of applications is economically wasteful and may deposit residues that take years to break down. Excessive applications can also lead to contamination through run-off and leaching into waterways.

Elements that are harmful to plants or reduce yields if they are present in high concentrations include zinc, copper, nickel, cadmium and arsenic. Elements that are potentially harmful to animals and people include lead, arsenic, cadmium, mercury, copper, fluorine, selenium and molybdenum.

By precisely matching appropriate applications to plant requirements, the risk of contamination is minimised. There are a number of documents that provide guidance for improved product management.

Accreditation

ChemCert Australia has developed an accreditation program for farm chemical users. The program provides training in integrated pest management, legislation, record keeping, product labels, farm chemical formulations, environmental and personal safety, application of crop protection products and veterinary products. Accreditation also allows farm chemical users to demonstrate their capacity to manage chemical applications safely and effectively.

ChemCert accreditation is based on endorsed industry competency standards conforming to the national industry training standard for chemical risk management. This ensures farm chemical users comply with the legislation requirements for chemical use, occupational health and safety and environmental protection. Re-accreditation is required every 5 years to keep up-to-date with chemical usage and safety issue.

To enrol for ChemCert (Tas) Inc. contact the Tasmanian Rural Industries Training Board.
The Australian Fertiliser Services Association (AFSA) has developed a code of practice and accreditation program (Fertcare) for its members. This program is a self-regulatory program within the fertiliser services industry to promote a more professional service from the fertiliser industry.

AFSA can be contacted by phone (03 5381 2870), fax (03 5383 3745), email (ekafsa@ netconnect.com.au) and the internet (www.afsa.net.au).

Guidelines and codes of practice

There are Codes of Practice that are endorsed and published in Tasmania by the Agricultural, Silvicultural and Veterinary Chemicals Council. The codes regard aerial spraying, ground spraying and the supply and use of veterinary chemical products. These publications are available at DPIWE and via the DPIWE website.

The DPIWE "Guidelines for Interpreting Labels" provides advice for the interpretation of agricultural chemical product labels. The DPIWE Chemcollect guidelines and Drum-muster guidelines provide information for appropriate storage, handling and disposal of chemical containers. Further information is available at DPIWE and via the DPIWE website.

Avoiding cadmium contamination

Cadmium accumulation in the soil can be minimised by avoiding phosphate fertilisers containing cadmium impurities. Soil organic matter reduces plant uptake of cadmium already occurring in the soil. Further information about cadmium contamination is available from DPIWE.

Managing biosolid and effluent applications

Biosolids that contain unacceptable quantities of potential contaminants are not suitable for application, regardless of any potential agricultural benefit.

The following publications are available at DPIWE or via the DPIWE website.

The “Tasmanian Biosolids Reuse Guidelines” provides advice for the safe, practical and beneficial use of biosolids arising from the treatment of municipal wastewater. These guidelines provide detailed information regarding:

- permitted levels of contaminants in biosolids;
- grading and monitoring of biosolids based on quality and proposed end use;
- restrictions on site suitability, such as buffer distances to waterways;
- determining safe application rates;
- withholding periods for the resumption of agricultural practices after application.

There are further DPIWE guidelines that provide advice to operators and regulators regarding emission limit guidelines. Documents include the “Wastewater Management Guidelines for Intensive Animal Husbandry Activities” and the “Wastewater Management Guidelines for Meat Premises and Pet Food Works”.

Codes of practice provide guidance for aerial spraying, ground spraying and the supply and use of veterinary chemical products.
5.2 Minimise the impact of soil acidification

Guidelines

- Get soil pH tested regularly (ie. 2 years for cropping, 5 years for pasture).
- Apply finely ground liming material (without over-liming) to counter any increase in acidity.
- Avoid excessive removal of alkaline product (especially baled lucerne) from the property.
- Apply slow-release nitrate fertilisers rather than acidifying ammonium fertilisers.
- Minimise fallow periods and (where possible) favour deep-rooted perennial species to maintain nitrogen cycling in the soil.

Acidification is a decline in soil pH. Soil pH is an index (on a scale of 1 to 14) of soil acidity, which is a measurement of the concentration of hydrogen ions in the soil.

Soils that become more acidic (pH lower than 7) have a reduced availability of some elements (such as phosphorus and molybdenum) while other elements (such as aluminium and manganese) may increase to toxic levels. This results in stunted and yellowing pasture or crops, weed invasion and a decline in animal production. Soils with a water pH below 4.8 can be particularly toxic and unproductive.

The rate of acidification depends on soil type and its starting pH and buffering capacity. Buffering capacity refers to capacity of the soil to maintain constant pH levels despite the addition of acids. Sandy loams have a lower buffer capacity compared to clay loams.

Practices that increase the impact of soil acidity

Some agricultural practices acidify soils. Such practices include:
- excessive removal of alkaline product and organic matter leading to a more acidic soil environment. As legumes (especially lucerne) can be highly alkaline, removal through cutting and baling can cause soil acidification;
- frequent applications of nitrogen fertiliser (such as ammonium fertiliser or urea). These fertilisers break down into nitrate and hydrogen ions. The nitrate can then be leached, leading to an accumulation of hydrogen ions in the soil and a decrease in pH;
- having extended fallow periods. Nitrates are subsequently at risk of being leached during fallow periods, leading to an accumulation of hydrogen ions in the top-soil.

Countering inherently acidic soil

Most Tasmanian soils are naturally acid due to the effects of leaching under high rainfall. Therefore, lime applications are sometimes required to counter acidity and improve pasture and crop growth. For example, 110 kg ground limestone is generally recommended per 100 kg application of ammonium sulphate.

Mixing finely ground limestone or dolomite into the soil is better than surface applications that may take many years to dissolve. Over-liming soils may reduce the uptake of nutrients by plants, and this excess lime may take years to be eliminated from the soil.
5.3 Prevent disease, pest and weed invasion

Guidelines
- Monitor and control pest outbreaks.
- Ensure that equipment going to and from the farm is clean on arrival and departure.
- Clean equipment used in paddocks infected by pests.
- Use a suitable wash-down area for cleaning equipment.
- Harvest paddocks least affected by pests first.
- Restrict vehicles to tracks or headlands.
- Rotate crops and pastures to disrupt pest lifecycles.
- Work with neighbours and community groups to address pest problems on a local scale.
- Know the pest lifecycle to effectively target their most vulnerable stage.
- Use certified seed or feed to minimise the risk of weed contamination.
- Contact DPIWE for appropriate options for removing specific pests.

Weeds, soil-borne diseases, insects or other pests of plants and animals have been generally defined in this section as a “pest”. More specific terminology is used where necessary.

The cheapest and most effective form of pest management is prevention. Prevention reduces the need for chemical control measures and helps to secure markets that demand disease free produce.

Where pest invasion has already occurred, an integrated management approach is required so that pest populations remain below a threshold level. This is the level at which the pest may still be present — without being an economic threat.

Further weed management information is available from DPIWE and a number of DPIWE publications, including “Weed Plan”, “Integrated Pest Management” and a number of information sheets.

The Tamar Valley Weed Strategy’s web site (www.weeds.tassie.net.au) assists with weed identification and management.

DPIWE can also provide contact details for the following organisations:
- The Tasmanian Weed Society, which offers members with weed management information.
- Local Community Weed Management Strategies and Landcare groups, which operate in many parts of the State.

Signs inform visitors about farm hygiene standards.
This chapter discusses the practices to manage riparian land. The following practices are recommended:

- manage stock;
- manage native vegetation;
- minimise the impact of run-off into streams.

Riparian land occurs adjacent to streams, rivers, lakes and wetlands. It also occurs in gullies and depressions, where water only flows during wet periods. Such areas can vary in width from a few metres to well over 100 metres. Riparian zones are vital to sustainable land management, even though such zones occupy only a small percentage of a catchment landscape.

Poor riparian management increases bank erosion and flooding, decreases water quality and degrades productive land and riparian ecosystems. The width, vegetative composition and continuity of the riparian corridors are critical for effective riparian management.

If resources are limited for riparian vegetation management, the most suitable initial strategy might be to protect areas in good condition. This is a cost-effective strategy, as it is more expensive to restore a degraded area than to simply protect a healthy area.
6.1 Manage stock

Guidelines
- When possible, fence out stock from riparian land.
- If stock exclusion is not possible on riparian land, minimise the impact of grazing.
- Use fencing systems that effectively control stock.
- Use fencing systems that have minimal risk of damage during floods.
- Provide off-stream watering points.
- If on-stream watering is required, provide limited access points with stoned ramps.

Poorly managed stock on riparian land will result in overgrazing, trampling and soil compaction. Subsequently, the incidence of weed invasion and streambank erosion increases. Water quality is degraded as a result of increased erosion and increased direct inputs of stock manure and urine into streams.

Further information about managing stock on or near riparian land is available from DPIWE, catchment committees and farm advisers. Extensive details of fencing and watering options for stock are discussed in the DPIWE booklet “Managing Streamsides: Stock Control, Fencing and Watering Options”.

As riparian land is highly sensitive to grazing, stock exclusion in such areas is recommended. Any loss of grazing land due to fencing may be offset by less flood damage and reduced maintenance costs. River flats that are fenced off can be utilised for hay production.

If exclusion of stock is not possible, strategic management is recommended to minimise the impact of grazing:
- during the initial stage of the growing season to allow for adequate annual growth;
- during flowering and seed production to allow for reproduction of vegetation cover;
- following disturbance events (such as flooding) that provide triggers for mass germination;
- when there are signs of overgrazing, trampling or soil compaction.

Regular inspections are necessary to monitor the need to move stock. See Section 2.3 for further information about managing a flexible grazing system.

Fencing
Fencing enables strategic management of riparian lands. The type and location of fencing depends on:
- type of stock;
- size and shape of a stream channel;
- frequency and peaks of floods;
- intensity of use of fenced riparian land;

Fence life can be prolonged by positioning fences on higher ground or beyond the boundary of most floods. As the extent of potential flooding increases, a wider fenced zone is recommended. Where active streambank erosion is evident, a minimum width of 10 metres is recommended.

Fencing along streams
Plain wire fences are recommended as these offer less resistance during floods. Reduced resistance to flowing water and debris means a reduced risk of severe flood damage.

Electric fences (compared to standard fences that require more wires and posts) offer less resistance during floods, cost less to install and are easier to install and move. Fitting electrified wires can be an inexpensive way of upgrading a conventional fence.
Fencing across streams

Several fencing options are available where fences are required to cross the anticipated flow of floods.

**Minimal cost fences** consist of plain wires and as few posts as possible, thereby offering little resistance during floods. Financial loss is low if the fence is damaged or destroyed through flooding. Use of electrified wires further increase the effectiveness of this fencing type.

**Drop fences** are either manually lowered before a flood or automatically lowered from their anchor points under the pressure of floodwater. Following floods, these fences can be quickly erected. Drop fences can also be lowered to allow stock or vehicle movement without the need for expensive gateways.

**Suspended fences** are built across narrow streams to prevent stock wandering along the stream. The fences have hanging panels, planks or chains that lift upwards during floods and return to their normal position when flows subside. Panels damaged by flood debris can be cheaply repaired or replaced.

Supplying water

Following fencing of riparian land, water access points for stock may be required.

**Off-stream access watering** involves pumping water from a source to a trough or tank in a paddock. There is a range of cost-effective pumping systems available, including:

- stock operated pumps, whereby stock drinking from a pump push a lever to provide power to pump more water;
- water powered pumps, whereby the flow of water provides power to pump a small volume of water to a trough;
- electric, wind and solar powered pumps.

**Controlled access points** (also known as graded slopes) require sealing with compacted gravel or rock ramps to minimise erosion and pugging. Fences are required to extend into the water to prevent stock straying along the stream. Construction of stock access points in the bed or banks of a watercourse require approval from your local council.

The most appropriate locations for controlled access points is where streambank erosion is minimal. Streambank erosion tends to be minimal on the inside of a meandering river bend. The risk of erosion is highest in boggy areas and on the outside of streambanks.

Note that floods may damage fences and ramps leading to the water. Therefore, controlled access points may require repair or replacement when floods subside. The time and expenses required for developing controlled access points may be better spent on fencing off riparian areas and providing off-stream watering points for stock.

**Dams or tanks** with off-stream watering points or controlled access points. Contact a DPIWE Regional Water Management Officer about the potential requirement for a dam permit.
6.2 Manage native vegetation

Guidelines
- Use an effective fencing system to protect native riparian vegetation from stock.
- Regenerate or establish appropriate vegetation that is indigenous to the local area.
- Manage in-stream obstructions that may increase the risk of erosion.
- Seek advice from DPIWE for particularly unstable streambanks.

Dense vegetation reduces the risk of erosion by decreasing flow velocity and binding the soil along the bank.

Native vegetation can readily regenerate in riparian areas where there is adequate remnant vegetation to provide a seed source. Where native vegetation is absent or lacking in species diversity, planting may be necessary to successfully establish vegetation cover.

It is recommended to only establish riparian vegetation that is indigenous to the local area. Seeds collected from local areas will tend to be well adapted to the conditions into which they are being established. An exception is the sowing of annual grasses to assist in short-term soil stabilisation.

Establishment of riparian vegetation requires effective:
- weed management. See Section 5.3 for further information;
- exclusion or careful management of stock. See Section 6.1 for further information;
- prevention of browsing by possums, wallabies and rabbits with the use of tree guards or wallaby fencing.

At the toe of the bank, perennial grasses and sedges are recommended. Their flexible leaves and stems are better able to move with flowing water, compared to rigid plants that can break during peak flows. Their dense fibrous root systems are anchored into the soil during peak flows and thereby protect the soil from erosion. Recommended species include Sedge, Matt Rush, and Tussock Grass. A protective cover of woody debris or tea tree brush can help to stabilise establishing vegetation.

Higher up the bank, shrubs and trees with extensive and dense root systems are recommended. These bind and dry out the soil to a greater depth, compared to plants with less extensive root systems. The result is improved soil protection and soil moisture conditions.

To ensure consistent vegetation cover, shrubs and trees need to be planted in conjunction with grass and sedge species. Recommended species include Woolly Tea-tree, Black Tea-tree, Blackwood and Dogwood.

Further information about establishing and protecting vegetation on riparian land is available from DPIWE and in the “Kit 6 — Riparian Bush”, which is part of the Tasmanian Bushcare Toolkit.

Vegetation and woody debris within channels

Moderate occurrences of vegetation and large woody debris in channels can provide resistance to water. This reduces stream flow rates and thereby reduces the risk of erosion. However, thick stands of vegetation and woody debris within a channel can reduce stream flow rates to such an extent that blockages occur. This increases the risk of flooding and thereby streambank erosion.

Re-orientation (rather than removal) of such obstacles is sufficient to minimise the risk of flooding. Debris dragged back against banks at a 40 degree angle will minimise diversion of water onto banks. Only in very choked channels does the removal of vegetation and debris lead to improved flow capacities.

The removal of willow trees requires careful management. Further information is available in the DPIWE Willow Management Guidelines. Contact DPIWE before commencing willow management.
6.3 Minimise the impact of run-off into streams

Guidelines
- Use riparian buffer strips in conjunction with improved soil management practices on adjoining cultivated land.
- Strategically locate riparian buffer strips according to anticipated volumes of water and sediment.
- Develop a well-managed grazing system within grassed buffer strips.

Sediment and some nutrients (particularly phosphorus) can be carried to streams by surface flows from adjacent land. This sediment can contaminate water supplies and smother habitats for fish and other animals. Vegetation can slow the overland flow of water, causing sediment and nutrients to be deposited before reaching the stream.

Designing buffer strips
Water flows tend to become concentrated in natural drainage lines leading to a stream. Therefore, buffer strips only need to be located where water concentrates between cultivated land and streams. Buffer strips are ineffective filters when slopes exceed more than 10%, as run-off flows too rapidly for sediment to be trapped by grasses.

As a general guide, an effective buffer strip consists of a 10 metre wide grass buffer on the outside of a 10 metre wide natural vegetation strip that is adjacent to the stream. Wider buffer strips may be necessary where there is:
- poor vegetation cover;
- intense sources of contamination;
- high volumes of run-off;
- high levels of sediment movement.

Riparian buffer strips become ineffective if poor soil management practices occur elsewhere on the farm. Such practices can lead to high levels of soil erosion and contamination to an extent that cannot be filtered by riparian buffer strips. See Chapter 3 for further information about reducing soil erosion and Section 5.1 for further information about managing chemical and fertiliser applications.

Dams built within drainage lines can further reduce the flow of sediment into streams. If considering construction of a dam, contact a DPIWE Regional Water Management Officer about the potential requirement of a dam permit.

Maintaining buffer strips
To maintain a thick groundcover with a good height to trap sediment, a well-managed grazing system is required for grassed buffer strips. By rotating or excluding livestock with the use of temporary or permanent fencing, grazing pressure can be better matched to maintain pasture with adequate height. Regular inspections are necessary to monitor the need to move stock.

See Section 6.1 for further information about managing stock on riparian land. Further information about buffer strips is available from DPIWE.
Acidification
The process of making soil more acid.

Acid soil
A soil with a pH of 6.6 or less. There are more hydrogen ions than hydroxyl ions in an acid soil.

Alkaline soil
A soil with a pH of greater than about 7.3, or a high sodium content, or both.

Aggregate
Groups of soil particles that are clumped together to form the structure of the soil.

Annuals
Plants that complete their life cycle in 1 year or less.

Baling
Pressing hay or silage into square or round bales after cutting and drying the pasture material.

Biosolids
The solid proportion of organic waste that can be treated and used as an agricultural fertiliser.

Black cracking clays
Black, well-structured, swelling clay overlying a mottled brown to greyish-brown clay.

Bore
A drilled hole lined with tubing that allows underground water to flow in.

Catchment
A feature of the landscape which collects run-off.

Clay
Fine soil particles less than 0.002mm in diameter. A soil that contains more clay than silt or sand.

Compaction
Physical degradation through soil compression.

Contaminant
Produces undesirable effects on soil and water quality if its concentration exceeds a certain threshold.

Contour
An imaginary line on the soil surface connecting points of the same height above sea level.

Cover crop
A crop that is grown to reduce soil erosion and protect an establishing cash crop from wind damage.

Cressy soils
Dark grey-brown/brown loam/clay-loam topsoil overlying a red-brown/grey-brown clay.

Cultivation
Working the soil with implements in order to prepare it for sowing.

Deep sands
Deep uniform sands, with topsoils ranging from red-brown to grey-brown.

Dispersion
The separation of soil aggregates into particles, as a result of the presence of water.

Dispersive soil
A soil that is capable of dispersion.

Direct drill
Sowing with minimal cultivation.

Drainage line
A feature of a landscape down which water concentrates and flows.

Duplex soils
Soils having a distinct texture contrast between topsoil and sub-soil.

Ecosystem
The interacting biological and environmental parts of a particular habitat.

Fertiliser
A substance that is added to the soil to supply essential nutrients for plant growth.

Ferrosols
Krasnozems. Red-brown/red, strongly structured, gradational, clay-loam/clay soils that generally become darker, more acidic and higher in organic matter further inland.

Friable
A soil that crumbles easily or is easy to cultivate.

Grazier
A landholder managing grazing animals. Distinguished from a farmer who may cultivate land for cropping.

Green manure crop
A crop grown to improve soil structure and soil organic matter levels.

Groundwater
Water in the lower layers of the soil.

Herbicide
A material that will kill weeds.

Indigenous
Belonging to, or forming part of the natural biological diversity of a place.

Land Capability classes
A system of classifying land according to its productivity for agricultural use.

Leaching
The downward movement of nutrients or salts through the soil profile.
Legume
A plant, such as clover, peas and beans, that is able to fix (capture) nitrogen from the air by means of nodules on its roots.

Loam
A soil that contains moderate amounts of sand, silt and clay.

Mottled
Soil that contains more than one colour in a horizon, often indicating poor drainage.

Mulching
Development of a layer of organic material on the surface soil.

Nodule
A small lump on the roots of legumes in which rhizobia bacteria grows and fixes nitrogen from the air.

Organic matter
Carbon-based materials of either plant or animal origin.

Organism
A living thing.

Pasture
Grasses, legumes and other growing plant material suitable for grazing animals.

Perennials
Plants that live for more than 1 year.

pH
Potential Hydrogen. The measure of acidity. A pH lower than 7 is acid, higher is alkaline.

Pore space
The openings in a soil not filled with solid particles.

Porosity
The ability of a soil to allow water to move through it.

Pugging
A process of soil degradation as a result of compaction by animals during wet weather.

Quality assurance
Standards are set for a product or process that ensure that the end-product is of a predictable quality to improve its marketability.

Recharge
Rainfall or irrigation water that accumulates in the watertable.

Rhizobia
A bacterium that can infect legumes in a beneficial way. The bacterium takes nitrogen from the air and changes it into a form that the plant can use.

Riparian
The area close to a waterway, stream or river.

Ripping
An operation that loosens compacted soil.

Rotational grazing
A process of rotating stock across several paddocks.

Run-off
The flow of surface water over a paddock that can lead to erosion.

Run-on
The flow of surface water from up-slope onto a paddock that can lead to erosion.

Saline soil
A soil containing enough soluble salts to reduce plant productivity, but not containing an excess of sodium.

Set stocking
Fixed number of animals grazing a paddock for an extended period.

Slashing
Cutting pasture or grass with a machine to remove excess material or weeds from a paddock.

Soil profile
Description of each layer in the soil.

Soil structure
The arrangement or grouping of soil particles.

Soil texture
A measure of the proportions of different sized soil particles. The relative amounts of sand, silt and clay in a soil.

Soil type
A general term used to describe the features of particular soils in terms of fertility, colour, texture and parent material.

Stocking intensity
The number of stock in a given area.

Stubble
The dead plant material remaining after a crop has been harvested.

Sub-soil
Soil in the lower horizons of the soil profile.

Sustain
To meet the needs of the present while leaving equal or better opportunities for the future.

Tillage
Cultivation.

Topsoil
The part of the soil profile that contains the most fertile portion of the soil.

Watertable
The upper edge of free water. Water holding capacity The ability of soil to hold water.

Waterlogged
Soil that is saturated with water and where most of the pore space has been replaced by water.

Weed
A plant growing where it is not wanted.
REFERENCES


Glossary of Agricultural Terms. Brouwer D. 1999, NSW Agriculture —Tocal, Paterson NSW.


Keeping your Soil on your Farm. Kindred Landcare Group 1994, Department of Primary Industry and Fisheries, Tasmania, Australia.


Managing Tasmania’s Cropping Soils — a practical guide for farmers. Chilvers W.J. 1996, Department of Primary Industry and Fisheries, Tasmania, Australia.


CONTACTS

This document consists of basic guidelines and information. Further information and contact details pertinent to the document are available from the Department of Primary Industries, Water and Environment (DPIWE).

Within Tasmania, the general enquiry number for DPIWE is

1300 368 550

The DPIWE website is

www.dpiwe.tas.gov.au

Marine Board Building, Hobart
1 Franklin Wharf
GPO Box 44
HOBART TAS 7001
Telephone (03) 6233 8011
Fax (03) 6234 1335

Mt Pleasant Laboratories
165 Westbury Rd,
PROSPECT TAS 7249
Telephone (03) 6336 5444
Fax (03) 6336 5372

Prospect Offices
167 Westbury Rd
PROSPECT TAS 7249
Telephone (03) 6336 5444
Fax (03) 6336 5365

Lands Building, Hobart
134 Macquarie Street
GPO Box 44
HOBART TAS 7001
Telephone (03) 6233 8011
Fax (03) 6233 6655

New Town Laboratories
13 St Johns Avenue,
NEW TOWN TAS 7008
Telephone (03) 6233 6833
Fax (03) 6228 5123

Stoney Rise Centre
Rundle Road
DEVONPORT TAS 7310
Telephone (03) 6421 7601
Fax (03) 6424 5142