FarmPlan21 manual

Develop a whole farm plan

State Government Victoria

FarmPlan21

DEPARTMENT OF PRIMARY INDUSTRIES | farm services

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Foreword

Welcome to *FarmPlan21* and the opportunity to develop your whole farm plan for a sustainable and productive farming future.

Over the past decade farmers have faced a range of new and difficult challenges. Unpredictable weather conditions and changes in agricultural economics have affected many farming families and communities. Many farmers are looking for new ways to approach their farm design and business to ensure long-term viability.

FarmPlan21 'Develop a whole farm plan' course is a leading farm planning program that combines production goals with social and ecological values. Whether your farm business is on a large or small scale this program will build your knowledge and skills to support the complex decisions you face regarding your property's soils, water resources, biodiversity and risk management.

Delivered in collaboration with an extensive public and private network of service providers, the course uses the latest technology and best-practice information. The delivery aligns to the DPI's *Better Services to Farmers* strategy, accounting for landholder and catchment needs across all industry sectors such as dairy, beef and sheep, grains, horticulture and farm forestry.

FarmPlan21 'Develop a whole farm plan' is an accredited course (RTE 5516A) within the Australian Qualification Training Framework (AQTF). This course manual and the supplementary material (relevant to your region and production sector) serve as a reference tool to assist you through the core components, discussions, worksheets, exercises and assessment tasks. Not only does the manual provide important information for completing the course, it can also be used for the ongoing implementation of your whole farm plan.

The course meets Nationally Accredited Training standards, so on successful completion all participants will be recognised with a certificate. We hope you enjoy your experience with *FarmPlan21* and that your whole farm benefits!

Assessments

The FarmPlan21 Manual follows an order of Elements and Performance Criteria set out by the Australian Qualification Training Framework (AQTF) guidelines. Each Element has a number of Performance Criteria that need to be met. Exercises and Assessment Tasks are presented to enable you to meet these criteria. As you work through them you will be demonstrating your ability to meet all the AQTF requirements.

Only the Assessment Tasks (on pale yellow pages within the manual) need to be handed in to your facilitator. Once you have completed and submitted each of these please check them off below.

Assessment Tasks for submission

Page number	Task number	Description	Date submitted
15 & 16	1.2 & 1.3	SWOT analysis and strategies	
49	2.3	Land class description	
103	4.1.2	Project action plan	
125	4.3.1	Total farm water balance	
145	5.1	Verbal presentation – Farm Plan (review)	

Contents

Introduction

What is whole farm planning?

Whole farm planning is a process of planning, property design and management based on ecological and economic factors. A Whole Farm Plan develops short- and long-term goals based on the aims of the farming family or operation. The plan aims to simplify management, improve productivity and include biodiversity and ecological issues in the decisions you make for your farm. It takes into account livelihood, lifestyle and landscape to ensure sustainability of all three.

Benefits of whole farm planning

Before embarking on whole farm planning, you should first consider your farm goals:

- Are you looking at any major enterprise changes, such as a shift from cropping to grazing?
- Could your farm management be made easier?
- Are you farming within your landscape's capability?
- Have you considered the ecological potential for your farm?
- Are you prepared for climatic extremes such as drought, wet periods and fire?
- What are your goals? 'Leave the land in better condition', 'make a profit', 'leave something for the kids' or simply 'establish windbreaks'.

Whole farm planning may benefit your business through addressing the following changes:

- Declining terms of trade where income is not keeping pace with increasing costs
- Climate change with rainfall likely to be more variable
- Fertiliser requirement decreasing or increasing
- Soil health decreasing or increasing
- Waterway health declining from nutrient and sediment inflow
- Community expectations for improved environmental outcomes from farmland management.

Whole farm planning with a focus on improved management and production, increasing soil health and biodiversity offers a way of meeting these challenges through:

Workability
A well designed and constructed farm layout can improve efficiencies in time and labour. Well-placed paddocks and track systems allow for faster and easier movement of stock, personnel and equipment across the farm. Stock can be moved and pastures grazed when and as required with reduced damage.

Productivity
A farm layout with paddocks of an optimum size and fenced according to soil and topographical capabilities contributes to greater farm productivity without increased inputs. With land largely of the same capability in the one paddock, better management and more efficient use of pasture is possible. Windbreaks and tree areas can be best sited to reduce animal and pasture stress.

Sustainability
The increased farm efficiency and productivity from whole farm planning will improve and contribute to the long-term economic viability of the farm business. Sensitive and other at-risk land types can be identified and appropriate treatment implemented. By treating land according to its capability and risk, land degradation can be arrested and often restored leading to an environmentally sustainable farm.

Whole farm planning: what you will need

A farm map

Farm management is about looking at your property's overall structure, health and performance. Your farm management system should involve all aspects of your farm. This not only includes farm production and the environment, but also your finances, family and community.

A basic tool used in the planning stage is an aerial photograph. The aerial image gives you the chance to view your property as a single unit rather than a series of separate paddocks. Getting this overall perspective is vital to farm management. We will provide a recent aerial photograph of your farm and introduce you to electronic mapping using one of the agricultural programs available.

For those who have already completed a farm plan for your property, the FarmPlan21 program gives you an opportunity to revisit and renew your plan. Agriculture has changed in the last decade and a review will allow you to address old and new farming-enterprise goals. Your farm size may have also changed and an electronic map will allow new land to be included in your farm plans.

Figure 1 Electronic mapping at work

Continuous improvement approach

Making decisions using the 'continuous improvement process' is straightforward. Instead of heading for the 'do' phase consider the reasons 'why' you are doing the work and 'how' to do the work most effectively.

Plan

The plan phase is about identifying the necessary stages. It is about describing what it is you want to do, why it needs to be done, what you want to achieve and how you want to achieve your goals. It allows you to make objective and informed decisions. Decisions made with sound planning give you the best chance for success.

Do

Doing the work is generally the most enjoyable and satisfying part of the management process. It is easy to get wrapped up with the 'doing' part of the job. However, without considering why the work needs to be done, it can be just as easy to spend time, resources and money and achieve far less than intended.

Check

When the work is done, how will you know that you achieved what you wanted to achieve or only got part of the way there? At some stage you will need to pause, go back and consider what you have done. You can then gather that information and check whether it matches up with your goals.

Review

To make the most of our actions we all need to make time to 'have a good look at ourselves'. In the review stage you reconsider your plans, actions and monitoring. The question to ask is 'has my work actually achieved what I set out to do and how can I be sure?'

Element 1

1. Determine long-term directions for your business

Performance criteria

1.1 Long-term directions and purposes of the business are established through identification and analysis of the values, expectations and personal opinions of the people involved.

1.2 Business and personal strengths, weaknesses, opportunities and threats are identified.

1.3 Strategies to address the SWOT analysis are developed consistent with the business vision.

Farm plans have been part of farming enterprises in Australia for many years. Before the 1980s however they mainly focused on specific farm issues or general productivity improvements. In recent years, with the greater need to farm in a more sustainable and environmentally-friendly manner, 'whole farm plans' have a much broader focus. A useful plan today is one that takes a holistic approach, considering economic issues while also addressing the social and environmental impacts on the farm. To achieve this you need to know what you bring to your whole farm plan.

1.1 Values, expectations and opinions

Your vision, values and purpose are the source of your motivation. They provide you with the reason to get out of bed in the morning. They are also the starting point for developing your plan and management system. When discussing and setting out the vision and goals of your farm, it is important to include your family, business partners and advisers in discussions. You should be prepared to come back regularly and review your vision, values and purpose because they will change as you and your farm change.

It is important for you to set goals for your farm before you complete a plan or do any work. The vision, purpose and goals you believe in give you motivation, enjoyment and satisfaction.

Vision

A 'vision' is a statement or diagram that describes the situation you want to create. A vision sets a strategic direction for managing your property and establishes what is important to you and why. It provides overall direction and context for setting realistic goals.

Values

Your values are the main principles that describe how you intend to operate your farm. If your desire is to gain financial stability and economic security then finances will drive your enterprise. If, on the other hand, your values lay in the environment or working with others, this is what your vision should reflect. Remember, financial gain and the environment can be linked – it is up to you. Your values may include:

- Protection and enhancement of farm biodiversity
- Minimising or eliminating chemicals in the farming system
- Protecting the health of you, your family and your community.

Purpose
Your purpose represents the reasons why you are farming. Why do you want to farm? What do you want to farm? What do you want from farming? Some of these may be:

- To make money
- To improve the asset for your children
- For the freedom of being your own boss
- For the love of your farm environment.

A value assessment

List the values and purposes that are important to you, your family and your farm.

Values	Purpose

The values you have listed can make up an overall 'Value Assessment' for your farm.

My family and I value the following in our farm enterprise.

Further definition of your Value Assessment can be gained from looking at different sectors of your farming life.

Please jot down your ideas for both the Value and Purpose under each heading.

	Value (to me and to the farm)	**Purpose**
Production		
Environment		
Finance		
People and social		
The farm for future generations		
Your life after the farm		
Family members' roles with each other and to the farm		

This Value Assessment can be used to write a 'Vision Statement' for your farm. A good farm vision will contain your values, purpose and aspirations.

Your vision statement

Defining your values and purpose clarifies your vision for your farm.

Please jot down your vision.

Key indicators your vision is going off-track:

- Others involved in the vision do not want the same thing as you
- Others involved in the vision are not happy
- Illness to a key member of the vision
- Not achieving progress toward critical short and long term goals
- Not following the timeline set out in the vision
- Motivation to achieve the vision wanes.

Tools for re-energising your vision:

- Re-visit your vision every three months
- Discuss your vision regularly with family members and employees
- Always remember your vision and your role in the vision
- Be open to slight changes to the vision
- Maintain motivation by focusing on positives of the future.

Setting goals

A critical component of the whole farm planning process is the development of short- and long-term strategies that meet the aims and aspirations of the farming family or entity. Most farms aim to meet production goals and provide sufficient income to sustain a moderate standard of living. However, considerations such as lifestyle or providing a healthy environment for children may be just as important or more important for some families.

Numerous other aspects may be considered in defining the family's aims for the farm:

- Land/soil maintenance or improvement
- Capital improvement
- Labour efficiency
- Lifestyle
- Vegetation diversity
- Wildlife conservation
- Off-farm investment
- Marketing innovation
- Improved access and communication.

For the purpose of this course, your plan will be looking at directions you wish to take over the next ten years.

To help establish the long-term directions and purposes for your business, begin by answering the following questions.

How long have you been on the property?	
What size is the property?	
What are the current land uses on the property?	
What would you like to see happen on your property in the future?	

The following 'View from the Verandah' exercise is a useful one to complete, as it further defines your goals and aspirations.

What will be my view from the verandah in the short and longer term?

	1 year	5 years	10 years
Time What would you like to be doing with your time? How much time do you want to spend on/off the farm?			
View What would you like the view from your verandah to be? What would you like to see?			
Legacy What do you want others to remember about you or be remembered for?			

Landholders often look at their property and feel confined by what is already there, e.g. fencing, shedding, rocks. Some aspects cannot be changed but there are many that can be altered with the right motivation and setting of priorities.

This is to be completed in consultation with your family or business partners and is an exercise in looking at different scenarios and management options.

Exercise 1.1 – Design the 'perfect farm'

Aim

As a small group design a management plan for part of a seriously degraded property in hill country and present the results to the other course participants.

Background

A local landholder has recently purchased a 100 ha property. The owner has asked the Department of Primary Industries staff to assist with preparing a whole farm plan. As part of this process your group has been asked to provide specific advice on how the erosion on the property can be controlled and what sort of cost may be involved.

Resources

Figure 2 property plan and coloured marking pens.

Outcome

After reading the information below, discuss the following questions and then use the coloured pens to show the following on your plan:

- Where would you place land class fences?
- What assets and threats can be identified on the property?
- What enterprise may be appropriate?
- What future actions would you recommend e.g. tree planting, erosion control etc?
- Present a final plan on Figure 2.

Additional information on this property

Topography

Undulating to hilly with slopes ranging from 20:1 (5%) to 4:1 (25%).

Soils

Weakly structured red/yellow duplex soils, with very shallow topsoil. Large areas of rock outcrops on steeper hills.

Rainfall

500 mm/year.

Degradation

Gully erosion, tunnel erosion, sheet erosion, compaction, and rabbits.

Vegetation

Scattered trees consisting of Yellow Box, Red Stringybark, Messmate and Long-leaf Box, some understorey species including heaths and acacias. Degraded native pastures consisting of Kangaroo Grass, Wallaby Grass and Weeping Grass.

Gully erosion

Main gully head is approximately 5 m deep and is moving upstream rapidly. The sides and floor are quite unstable. Near the road, the gully is only about 0.5 m deep and has numerous rock bars. The bed and banks are relatively stable.

Funding
The local Catchment Management Authority has identified this catchment as a high priority in its Waterway Action Plan. As a result, it will meet the full cost of all soil conservation works. Associated catchment improvement works such as fencing and tree planting will also receive a generous level of assistance. The budget for this project is virtually unlimited.

Concepts
Sustainable land management, enhancing biodiversity values, land rehabilitation, erosion control, improving financial returns.

Techniques
Gully-head and grade-control structures, diversion banks; gully battering, gully edging, gully-plug dams, ripping, revegetation, and fencing.

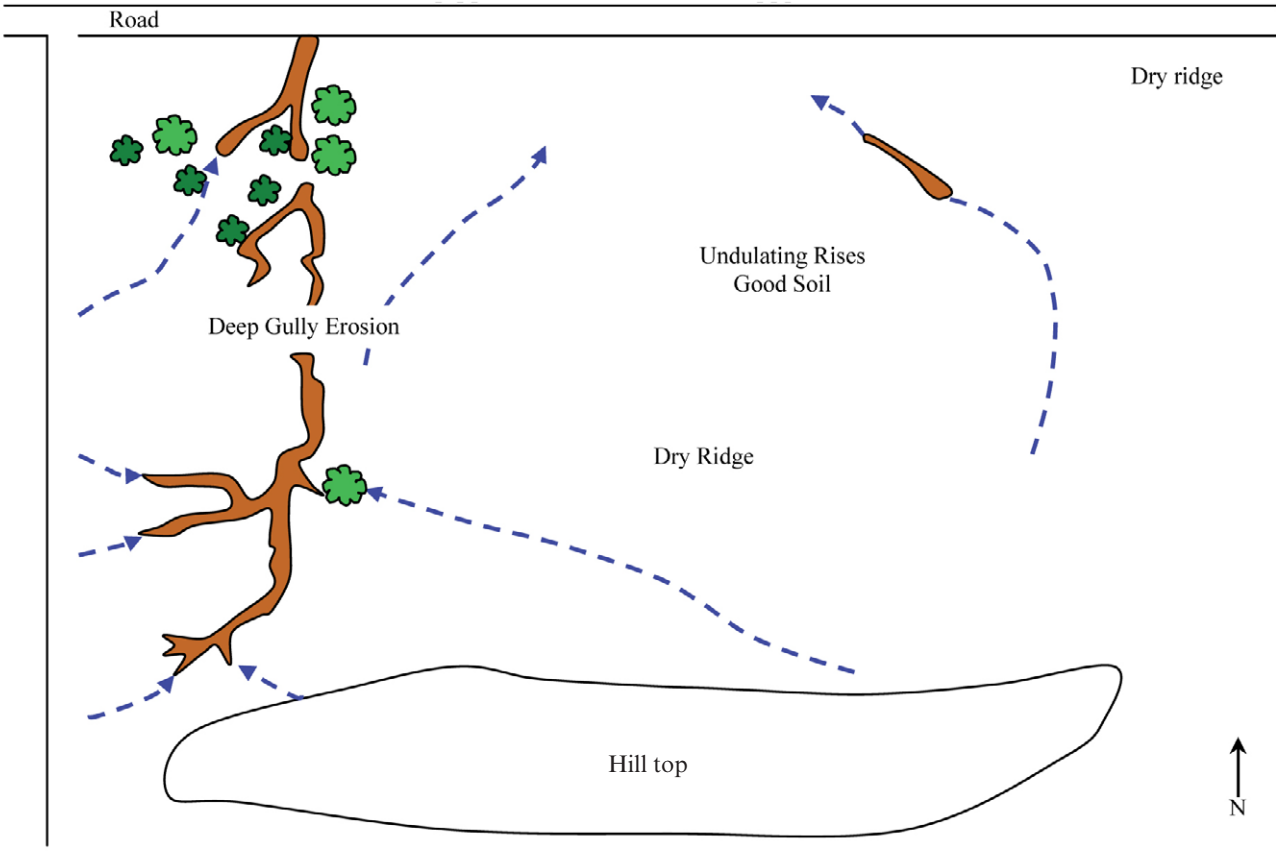


Figure 2 Designing the 'perfect farm'

1.2 Strengths weaknesses, opportunities and threats

When you approach a new plan for your property, you generally have a main enterprise already operating or have one in mind. An existing enterprise is often there because it's been suited to the region in the past and has been profitable over the long term. A new plan needs to account for the economic, environmental and social factors that are all important in providing a lifestyle you value.

A SWOT analysis

An analysis of your current enterprises can be done in comparison with other enterprise possibilities. Regardless of whether your farm is on a small lifestyle block or a large commercial property with multiple enterprises, an analysis of your Strengths, Weaknesses, Opportunities and Threats (SWOT) can be a useful decision-making tool. A SWOT analysis applied to a business, an enterprise, a piece of land or just about anything we do can be enormously helpful. It creates a clearer picture of a situation for then making more informed management decisions.

Your SWOT analysis will involve looking at some aspect of your business, farming or lifestyle that you wish to evaluate. Some people choose their overall business as their focus. Others may choose a particular problem they are trying to deal with such as marketing of products, grazing regime, fodder conservation or a specific pest.

A SWOT analysis consists of the following four elements:

Strengths

- What do you do well?
- What relevant resources do you have access to?
- What advantages do you have?
- What are the strengths of your property?
- Do you have access to more labour?

Weaknesses

- What could you improve?
- What aspects of your management are detrimental to the business?
- Should you seek help for some issues or operations?

Opportunities

- What opportunities do you see for you?
- What opportunities do you see for your farm?
- What are some of the interesting trends you have seen?
- Is changing technology providing opportunity?

Threats

- What obstacles do you face?
- Do you have a cash-flow problem that hinders development?
- How are you coping with change?
- Is your age or health a threat?
- What are concessions and expectations of the farm?

A SWOT analysis of your property's water could resemble Table 1.

Table 1 A SWOT example

Strengths	**Weaknesses**
Good rainfall Dams Good water quality Underground bores, soaks, springs	Poor rainfall/drought Poor soil Dams unable to hold water Nutrient runoff from stock camp above dam, poor water quality, blue-green algae
Opportunities	**Threats**
Improve utilization of water by using troughs, fence off dams, pipe water giving better quality, less waste. Do a water budget to find out how much you have compared with how much you use. Address seepage and evaporation issues	Drought Poor storage areas Contamination Underground water reliability

Please fill out the SWOT analysis and strategies on the following pages for your property. *These two Assessment Tasks are to be handed in to your facilitator.

Blank worksheet

*Assessment Task 1.2 – Complete a SWOT analysis of your farm

Choose an aspect of your farm life or business and complete the following SWOT analysis sheet. *Please hand in to your facilitator when completed.

SWOT analysis of	

Strengths	Weaknesses
Opportunities	Threats

*Assessment Task 1.3 – Strategies to address your SWOT analysis

Develop some strategies to address problems that emerged in your SWOT analysis. Make these strategies consistent with your overall goals for your farm. *Please hand in to your facilitator when completed.

Ways to build on strengths	
Ways to take advantage of opportunities	
Ways to reduce the effects of weaknesses	
Ways to deflect or reduce the effects of threats	

1.3 Strategies to achieve your business vision

Take another look at the goals and dreams that may have surfaced during your group discussion around 'The perfect farm' exercise. Now consider your SWOT analysis. Next you can develop some strategies to address problems that emerged in your SWOT analysis that will be consistent with your overall goals for your farm. You may wish to change your response to this assessment task as you progress through the course. You can return to it and update it at any time.

Learning outcomes

At the completion of Element 1 you will be able to:

- Determine the long-term directions and purposes of the farm business
- Identify and analyse the values, expectations and personal opinions of those involved in the farm business
- Identify your business and personal strengths, weaknesses, opportunities and threats
- Develop strategies to address the SWOT analysis that are consistent with the farm business vision.

Element 2

2. Audit the natural resources of your property

Performance Criteria

2.1 Physical characteristics of the soil are identified and recorded.

2.2 Soil map of property is drawn and land classes are recorded using a standard classification system.

2.3 Land capability is determined and land management options for each land class identified.

2.4 Natural property features and infrastructure are shown on the property map.

2.5 Areas at risk of soil degradation are identified.

2.6 Native vegetation is classified and condition is assessed.

2.7 Rare or threatened species and communities are identified.

2.8 Other natural resource issues are identified as appropriate to the property.

Gaining a detailed understanding of your farm's natural resources is critical to achieving your farm business goals. Soil type and health is the basis for production in most farming enterprises and managing your farm to its land capability makes the best business sense. It is important to identify and maintain the native vegetation and associated species of your property for the longer-term viability of your land and the wider landscape.

2.1 Soil characteristics

In order to make sound decisions about best practice on your farm, it's important to know your soil. To gain competency 2.1, you will take samples of soils from different areas of your property and learn how to conduct a range of tests on the samples. You will then record and report on your findings. Complete the required reading and work through the assessment tasks. If you require further information or explanation, your facilitator can help you.

Soil is a mixture of solid, liquid and gas components:

- solid = mineral particles
- liquid = water
- gas = air.

The solid components are minerals derived originally from weathering of rocks, and organic materials derived from plants and micro-organisms.

The weathered material is distributed across the landscape through the action of water and wind. For example, on the plains areas (part of the Riverine Plain of southeastern Australia) much of the mineral elements of the soil have been transported to the area by the action of water and distributed via prior streams or rivers. These prior streams are no longer active, but once dominated the landscape. The finer particles of clay have also been blown in by the wind.

The liquid component of soil is made up of water and there are varying amounts of nutrients and other soluble substances dissolved in it. The water and nutrients are essential to support plant growth. Water is added to the soil by rainfall, runoff from overland flow and from irrigation. Water is lost from the soil through evaporation, drainage deeper in the soil profile and through transpiration where water is also drawn out of the soil by plants and released into the atmosphere.

The gas component of the soil refers to the air contained in the soil. Soil is generally porous, containing many air spaces. Oxygen in the soil is required for the growth of most plants. When the soil becomes saturated with water, with no air left in the pores, the soil is termed water-logged.

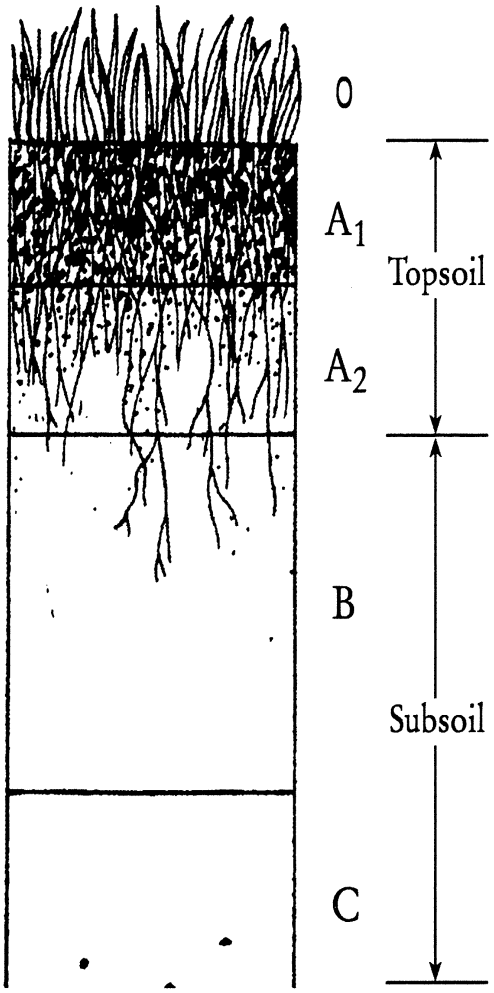
Describing soils

When we describe soils, we do so in terms of the soils physical, chemical and biological properties. To fully understand our soil we'll be looking at all three properties. The physical element is divided into soil texture and soil structure. Soil texture is related to the mineral components of the soil, while soil structure is related to how the mineral components combine together and how this affects the distribution of pores and the stability of the soil. When we talk about soil chemistry we mean the nutrients contained in the soil as well as other characteristics such as soil pH (acidity or alkalinity levels) and salinity. Soil chemistry can also have a significant effect on the soil stability. Soil biology refers to the groups of organisms living in the soil that influence nutrient availability and soil structure. A good place to start learning about soils is by looking at the soil profile.

Soil profile

A soil profile is a vertical section of the soil that shows the layers of the soil from the surface soil down to the rock or sediments from which the soil was formed (parent material).

The layers in the soil are called horizons (refer Figure 3). These horizons are obvious in some soils where change in soil appearance is abrupt. However in many other soils the change is more gradual and horizons are hard to distinguish.



0 horizon (surface organic litter)

This is the layer of organic matter sitting on top of the soil.

A 1 horizon (topsoil)

This is the surface soil, referred to as topsoil. It has the most organic matter and biological activity of any of the horizons. The decayed organic matter (humus) darkens the soil colour

A 2 horizon (topsoil)

This layer is not present in all profiles. It frequently has a pale bleached appearance and is poorly structured.

B horizon (subsoil)

This horizon often has more clay than the topsoil. A soil that has a heavy clay content won't have as big a difference between the A and B horizons as you'll find in other soils, such as the red-brown earth.

C horizon (weathering rock)

This layer is not present in most Riverina soils.

Figure 3 A soil profile

Physical properties of soil

Soil structure

Soil structure refers to the arrangement of sand, silt and clay particles and organic matter, as well as the spaces between them. Individual soil particles and organic matter usually stick together to form aggregates, leaving air spaces or pores between the aggregates.

A well-structured soil has many small aggregates. It has ample space within and between aggregates to allow good penetration of water, air and plant roots (transmission pores), yet also has adequate small pores to store water for use by plants (water storage pores).

Individual soil aggregates may have differing shapes. Some aggregate shapes indicate better soil structure from a plant growth point of view:

- **Crumb** type aggregates allow good plant growth due to good water and air movement. Soils with crumb structure allow good root growth since the soil is less compact than other structure types.
- **Blocky** structure is also generally favourable to plant growth.
- **Platey** structure is likely to restrict air and water movement and thus reduce plant growth.

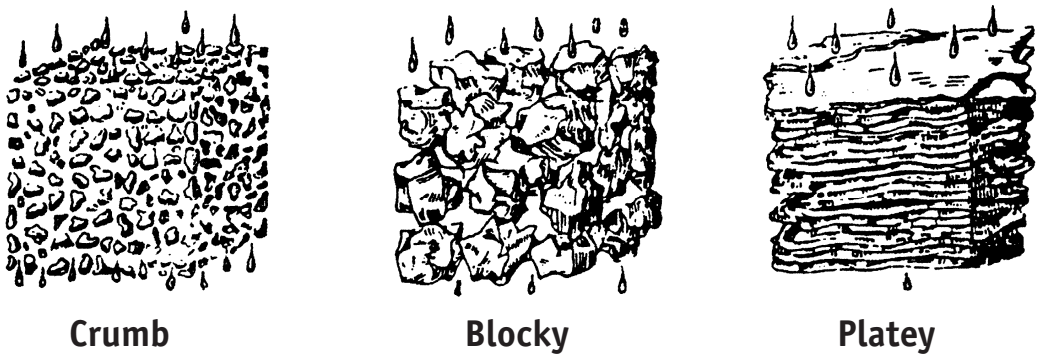


Figure 4 Soil structure types

Assessing the health of your soil

The best time to assess the health of your soil is during autumn or spring. It's a good idea to wait two days after the last rainfall as this is the best time to sample. To make this job easier, spend some time establishing where soil types are likely to change on your farm first. A significant change in slope, aspect, landform type or vegetation cover can indicate a change in soil type. On flat land, waterlogging or drying out, changes in weed species or differences in colour on an aerial map of the farm can indicate changes in soil type.

When choosing an area to sample, avoid areas around gateways, troughs, headlands, trees or dams as these will not accurately reflect the health of your soil.

These next three assessment tasks will help you assess the physical characteristics of your soil.

Exercise 2.1.1 – Determine your soil structure

To determine the structure of your soil, try this simple test called aggregate size and sorting. Then describe your soil structure.

Dig out a spadeful of surface soil (10 cm deep) and place on a large tray, board or tarpaulin. Use gentle force to separate the soil mass into natural aggregates. Separate into three size fractions: >60 mm, 20-60 mm and <20 mm. If all material falls into the <20 mm size class then do a further check for material <2.0 mm.

A high proportion of soil material in the >60 mm is an indicator of cloddiness and poor physical condition. Or all material <20 mm is an indicator of soil with potentially weak macro-aggregation. Even smaller fractions can indicate vulnerability to wind and water erosion. This is a quick technique for comparing differences between paddocks or areas within a paddock that may relate to soil aeration and infiltration.

Describe your soil structure.

Soil texture

Soil texture is determined by the proportions of sand, silt and clay in the soil.

Texture affects all physical properties of soil, particularly storage of air and water, the organic matter level, the movement of and availability of water and nutrients, ease of root growth as well as its workability and resistance to erosion.

Texture varies from place to place. Many paddocks are not uniform and it is wise to check texture in several places within a paddock. Texture variation may help to explain the difference in plant growth between parts of a paddock or between different paddocks. Compare a sample of soil from one sampling place with soil from another place, to help you gauge relative differences in texture. Gauging relative differences in texture is easier if two soil samples are assessed at the same time, one in each hand. Soil texture may also vary between the A horizon and the B horizon.

Soil particles are grouped into 5 main size ranges: gravel, coarse sand, fine sand, silt and clay. A soil with a relatively even mix of particle sizes is called a 'loam'.

Soil texture is assessed by the behaviour of a small handful of soil when moistened and kneaded into a ball and then pressed out between thumb and forefinger (ribboning technique).

Exercise 2.1.2 – Determine your soil texture

You are going to examine the texture of your soil. You will need a sample of soil sufficient to fit into the palm of your hand.

If it contains gravel, try to remove the larger pieces. Moisten the soil with a little water, and knead it until the ball of soil no longer sticks to your fingers. This is when its water content is approximately 'field capacity.' Add more soil or water if necessary. Usually the ball of soil will be ready for you to assess its texture after one or two minutes of kneading or working. Do not knead the ball too long as it may dry out.

Now follow the 'Texture-by-feel analysis' shown in Figure 5 to make your assessment.

The following terms are often used to describe soil texture:

- **Coherent** the ball holds together.
- **Sandy** feels gritty, and coarser sand grains can be seen. Very fine sand grains make a grating sound as the soil is rubbed between fingers and thumb.
- **Spongy** typical of loams; high organic matter also creates a spongy feel.
- **Silky** the smooth soapy or slippery feel of silt.
- **Plastic** the ball can be deformed and holds its new shape strongly, typical of clays.

Resistance to shearing: how firm the soil feels as you form a ribbon. Place the ball between your thumb and forefinger and squeeze, sliding your thumb across the soil. Try to make a thin continuous ribbon about 2 mm thick. A light clay is easy to ribbon and shear while a medium clay is firm and stiff, and a heavy clay is very stiff (usually takes two hands to form a ribbon).

Now describe your soil using any relevant terms from above. Which category from the diagram best describes your soil?

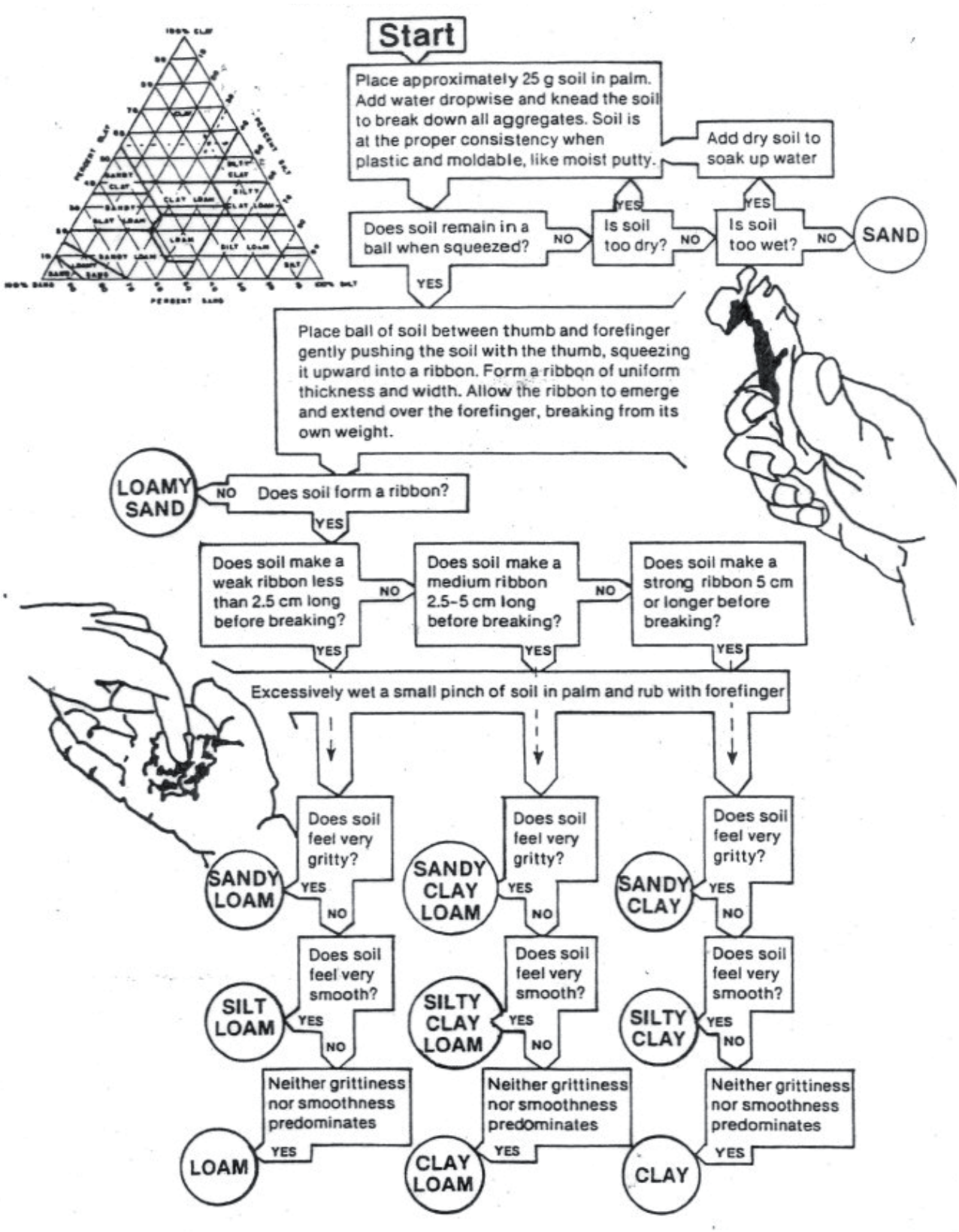


Figure 5 Examining soil texture

Aggregate stability

Soil structure is dynamic and generally it is much easier to destroy soil structure than it is to improve it. Declining soil structure, as a result of water being applied, is seen when the soil aggregates appear to 'melt' or break down. This process results in the original soil aggregates disintegrating into smaller fragments. These very small aggregates are often referred to as micro-aggregates. This process is common in most soils.

Two common features of surface soil structure decline are crusting and hard-setting soils. Surface crusting is a thin layer (usually less than 10 mm thick) on the surface when soil dries. It forms when unstable soil is exposed to sudden wetting or raindrop impact. Hard setting, by contrast, tends to effect the entire soil horizon which can be the plough layer in highly cultivated soils.

Soil slaking

Soils that are low in organic matter are likely to slake excessively. Slaking occurs when intense rain hits dry soil and the surface of porous aggregates rapidly absorbs the water and traps air internally. With further wetting, the force of the air escaping can cause weak aggregates to disintegrate. This process of aggregates breaking into small particles is called slaking and can block up pore spaces. When the soil surface dries, a crust will form. Slaking can occur within minutes and can cause water infiltration and seedling-emergence problems.

A simple way to distinguish slaking from sodic, or dispersive, soils is to take two or three pea-sized samples of soil and place them in a shallow container of rainwater. If the soil is sodic, a cloudy suspension will develop in the water around the soil. Generally the quicker this happens, the more sodic the soil. If prone to slaking, when the soil sample is placed into the shallow dish of water, it will crumble. No cloudiness of water occurs with slaking.

Tests and scoring systems for slaking and dispersion are described below. Both tests can be done on the same air-dried sample of soil. Follow the steps and record your findings. The test result for slaking will be recorded within 10 minutes but to assess dispersion, you will need to return to the sample to observe it again after 2 hours.

Take soil samples and allow to air dry for 1 to 5 days, depending on how wet the soil is when sampled.

Exercise 2.1.3 – Test your soil for slaking

Follow the steps and record your findings.

Take at least three small (3-5 mm) crumbs of dry soil and place them in a dish or saucer of rainwater or distilled water. The water must be deep enough to completely cover the clods. Do not disturb the dish and keep it out of the wind.

After five minutes, assess the slaking score (0-4):

- **Score 0** if the lump remains intact. This means the soil is stable
- **Score 1** if the lump collapses around the edges but remains mainly intact
- **Score 2** if the lump collapses into angular pieces
- **Score 3** if the lump collapses into small (less than 2 mm) rounded pieces, forming a cone
- **Score 4** if the lump collapses into single grains (you can see sand grains).

Interpretation of slaking scores and management options

Score 0-1 This soil is stable to wetting. This is typical of a soil under several years of pasture. No action is needed.

Score 2 The crumbs form a loose, granular surface layer, with perhaps a thin, fragile crust. This is typical of self mulching clays. If the soil does not disperse no action is necessary.

Score 3 This score suggests that the surface may form a crust. It is a problem in non-swelling topsoils (sands, loams and some clay loams). Reduced cultivation and stubble retention can overcome this problem. Sometimes the application of gypsum will improve the soil structure.

Score 4 This soil is very likely to crust and hard-set (sands and loams). Reduced cultivation, stubble retention, and more frequent irrigations may be necessary on these soils.

Slaking score	

Is any action needed? If so, what form could it take?

Soil dispersion

When water is applied to soils with high sodium contents and low soluble salts the aggregates may break down into individual particles. This is called dispersion.

Dispersion is the process following slaking, in which soil micro-aggregates break down further into their component particles (sand, silt and clay) on the application of water. Dispersive soils are generally poorly structured.

Clay dispersion mainly occurs due to high levels of sodicity, i.e. high amounts of sodium bound to clay particles and low levels of soluble salts. Dispersion increases when sodicity is high and organic matter levels are low. Additionally, working soils when too wet will increase dispersion.

Gypsum is often applied to sodic clay soils. It acts by increasing the level of soluble salts and replacing sodium with calcium. The combination of these two factors reduces swelling and prevents dispersion and therefore helps to maintain soil structure. Organic matter that helps to bond soil particles together can assist in reducing dispersion.

Exercise 2.1.4 – Test your soil for dispersion

The test and scoring system for dispersion is described below. This allows comparisons between soils. The 'dispersion on wetting' method requires you to assess the degree of dispersion after two hours.

Follow the steps and record your findings.

Place air-dry clods (3-5 mm diameter) in a dish and cover them with rainwater or distilled water.

The degree of dispersion is assessed on a scoring scale of 0 to 3 using the following criteria:

- **Score 0** indicates no dispersion. Your soil is stable
- **Score 1** is moderate dispersion with obvious milkiness
- **Score 3** is complete dispersion leaving only sand grains in a cloud of clay

Dispersion score	

What does this score tell you about your soil? If your dispersion score is high, how could you lower it?

Soil water

The ability of a soil to hold water is related to soil texture and structure. This affects the range of uses that are suitable for your soil.

When all the soil pores are filled with water then the soil is said to be water-logged. When this happens, most of the air has been displaced from the soil pores and this starves the plant and other soil life forms of much needed oxygen. If no further water is added, the water in the soil will drain away until the only water left is that held in the pores by the soil particles against the force of gravity. At this stage the soil is said to be at field capacity.

The soil continues to dry through evaporation and transpiration. When the soil water gets to the point where the plant roots are unable to effectively extract any more water, the soil moisture is said to be at the permanent wilting point. At this stage any soil water is tightly held in very small micro pores in the soil.

Free drainage water is the excess water that drains from a saturated soil until the water content has become relatively stable. Available water is the volume of water a plant can access that is stored between the upper and lower storage limits. The upper storage limit is the maximum water content that can be stored under rainfall or irrigation, after free drainage has occurred. The lower storage limit is the lower limit from which a plant can extract water from the soil.

Loamy soils have more available water than clays and sandy soils have even less. This means that sandy soils take less water to sustain plant growth but can dry out quicker.

Infiltration and permeability

Infiltration refers to the entry of water into the soil. A soil with low infiltration is one in which water does not enter very quickly and a shallow wetted zone may result. Permeability is the soil characteristic that governs the rate of air and water movement through it.

Permeability and infiltration rates are influenced by the size and distribution of pores in the soil. The more porous a soil the higher its permeability and infiltration tends to be. The low permeability of more clayey soils limits the entry of water deeper into the soil profile. Waterlogging may result and cause plant growth restrictions.

Exercise 2.1.5 Test your soil permeability

A simple test can give you some information on the infiltration rate and permeability of your soil.

Fill a 250ml cup of water and pour it from waist height on to your soil. Watch what happens. Does it run straight off? Does it spread? How far? Did some run off but some soak in? How long did it take to soak in? Did it soak in rapidly and make a hole?

Record your observations.

Carry out this test in several locations such as along fence lines and around gateways to observe extremes. If the water soaks in quickly, it can indicate good soil health while water that ponds or runs off can indicate poor soil health.

This test can also indicate rain and irrigation water infiltration, compaction and hard setting. For a more detailed assessment, follow the steps in Figure 6.

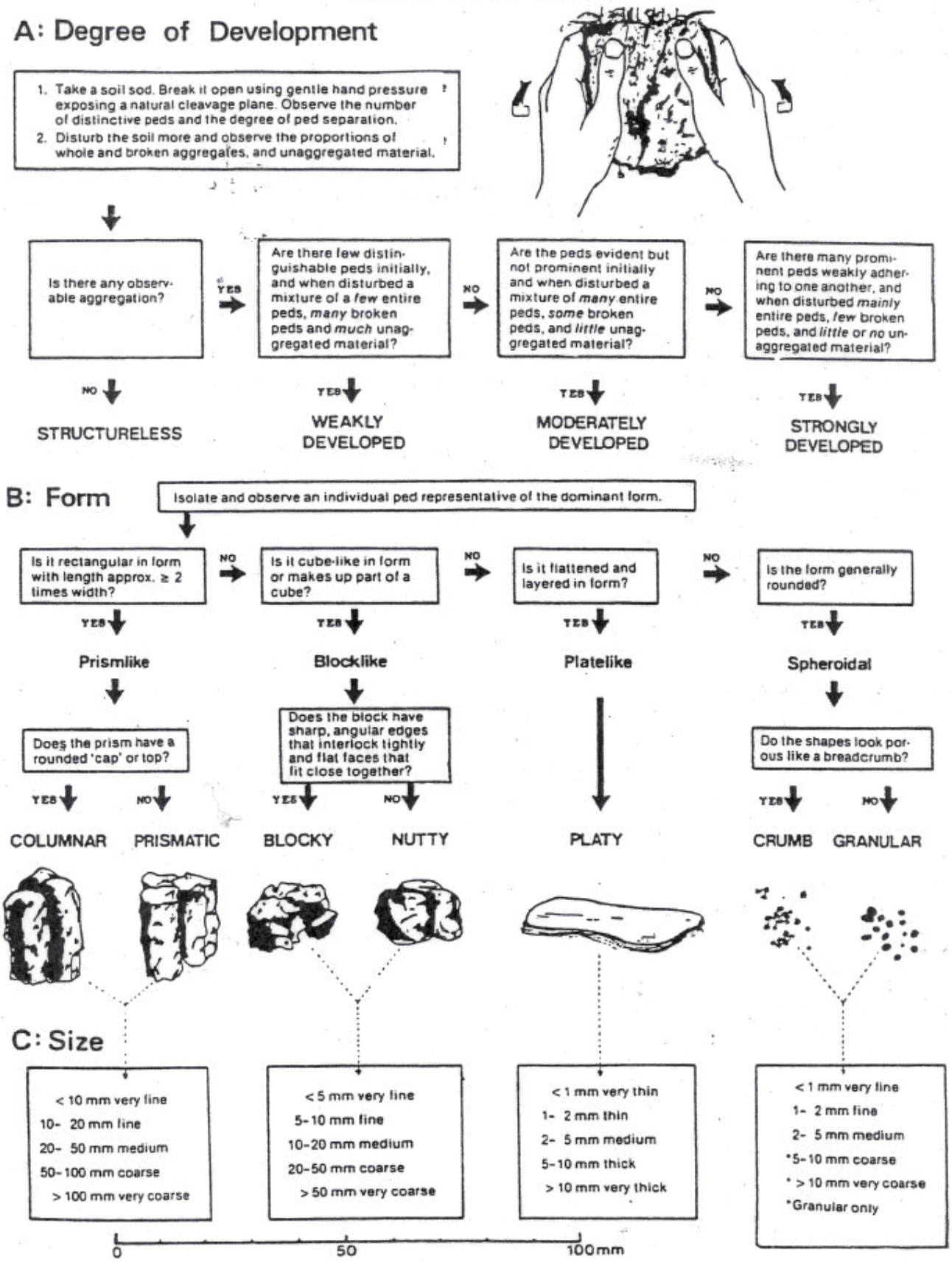


Figure 6 Assessing soil structure

Soil colour

Soil colour can indicate certain conditions of your soil such as the amount of organic matter, drainage status, presence of iron oxides and position in the landscape. For example, we know that when iron is exposed to oxygen, it rusts. The same happens to iron in soil, so a soil that is oxygenated is generally well drained and reddish in colour. At the other end of the scale is a mottled/ bleached soil.

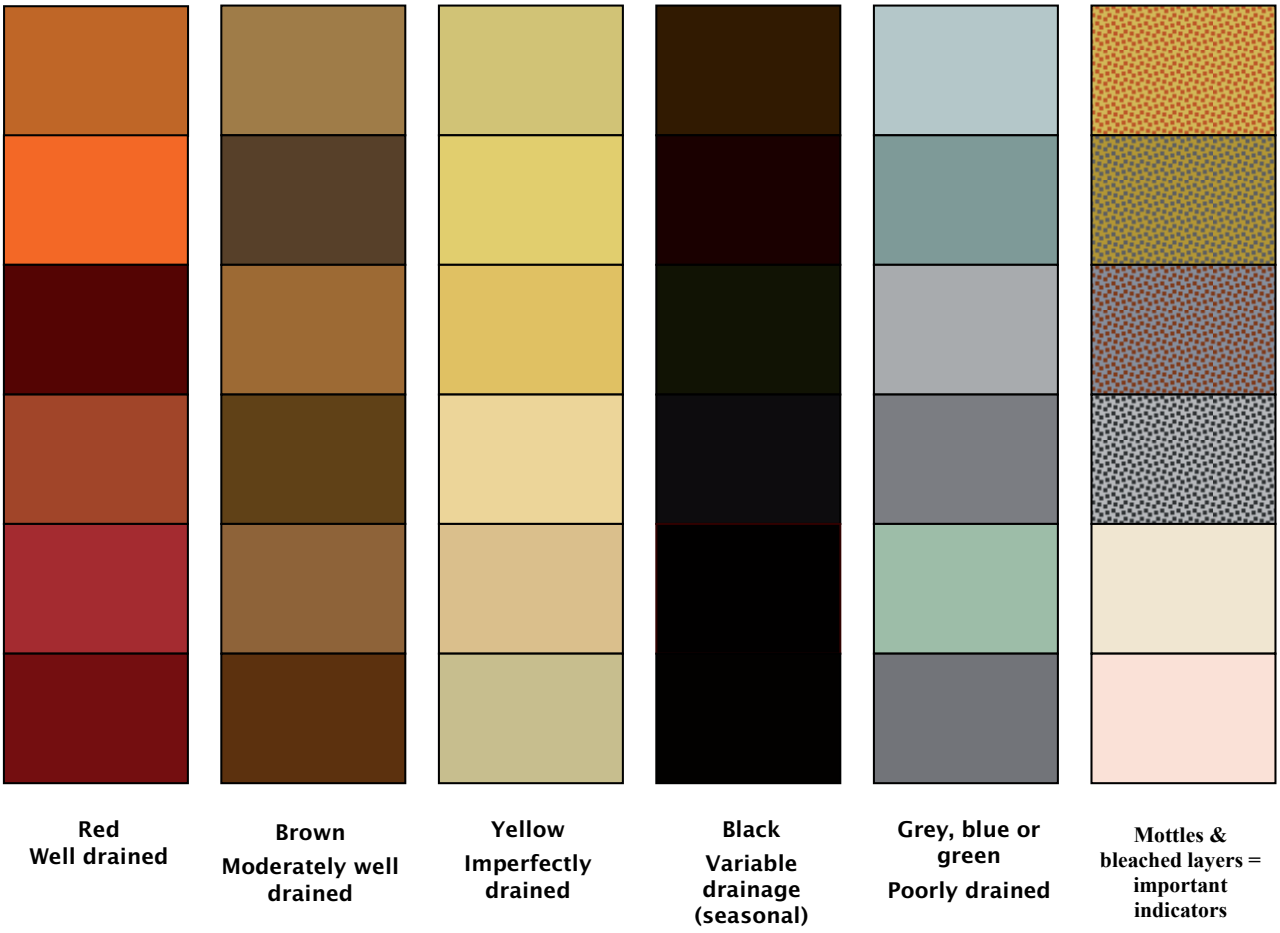


Figure 7 Soil colour

Reddy brown mottling indicates periodic water-logging while pale or grey mottles mean more permanent saturation. The greater the mottling, the more significant the problem. However, the deeper it occurs from the soil surface, the less impact it will have on plant growth.

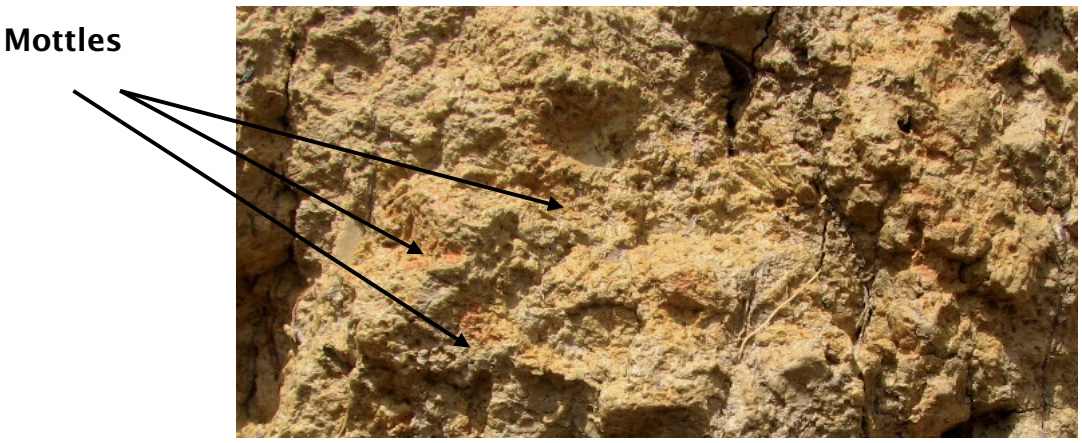


Figure 8 Soil with mottling

Exercise 2.1.6 – Assess your soil colour

What colours have you observed in your soil? There may be an area where the soil profile is exposed or you may need to use an auger to obtain a sample from the topsoil down to the subsoil.

Record the colours you can readily observe on your property and briefly describe where they appear. What does this tell you about your soil's drainage?

Soil smell

The smell of soil is another indicator of the health of your soil. A healthy soil should smell fresh, earthy and sweet. A poor soil will have a sour or chemical smell due to the bacteria that grow as hyphae (like fungi) in the soil.

Exercise 2.1.7 – Describe your soil smell

Using a fresh handful of soil, record the smell of your soil.

Soil chemistry

Acid or alkaline soils

Another important factor influencing the potential of your soil is a chemical characteristic, its pH level, a measure of the acidity or alkalinity of the soil.

The pH of soil indicates the strength of acidity or alkalinity in the soil. Soil is neutral when pH is 7. It is acid when pH is less than 7 and alkaline when it is greater than 7. The pH scale is logarithmic, so a difference of a unit is a tenfold difference in acidity or alkalinity (e.g. pH 5 is ten times more acid than pH 6):

$$pH = -\log_{10} [H+]$$

A number of Victoria's soils are naturally acid while others are naturally alkaline. This is due to the effect of natural processes (e.g. leaching, erosion, deposition) occurring over hundreds to thousands of years on the soil parent material. Consequently, areas of higher rainfall such as those on the coast or near the mountain ranges have more acidic soil compared to drier areas in northwestern Victoria due to the more intense leaching in wetter climates.

In an undisturbed system this is not a major problem. Plants and other soil biota naturally adapt to the circumstances and create a viable balanced ecosystem. Problems arise when the balance is disturbed, as it has been by the widespread use of farming techniques not well suited to the existing soil condition.

Measuring soil pH

Many crops and soil organisms have a preferred pH range. For example, Triticale can grow well within a range of 4.5–8.5 yet Lucerne prefers a pH of 6. So knowing the pH range of your soil gives a good indication of what you can grow.

You can conduct a simple pH test on your soil by purchasing a pH test kit from your local nursery or hardware outlet. It will come with directions and a colour chart. This method is accurate to 0.5 of a unit scale and is a very useful tool for developing an understanding of soil pH on your property. A small sample of soil is placed on a white tile and indicator solution is added until a smooth paste is obtained. The colour produced is highlighted by lightly dusting the paste with a white powder (barium sulphate). The colour is compared to a reference chart that shows pH to within half a unit. However, ensure that the indicator solution is not beyond its expiry date - old indicator is likely to give misleading pH results.

The colour chart below is a typical way of measuring pH. Some chemicals change colour according the pH level of the solution they are in; we use these as indicators of acidity.

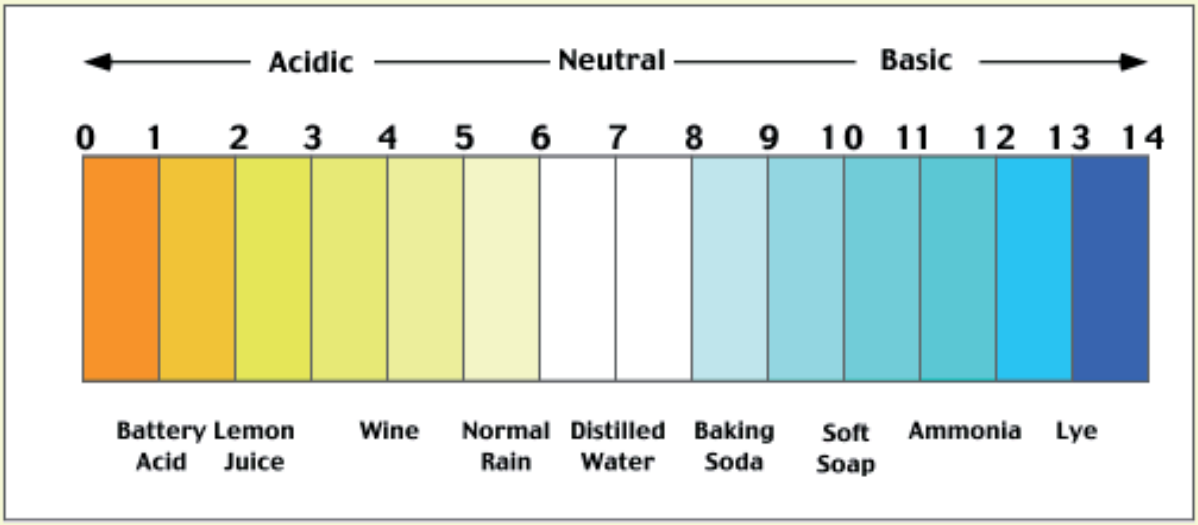


Figure 9 Measuring soil pH

If your pH test shows your soil is acidic, you should send a sample for testing in a laboratory. Soil pH is measured in the laboratory by inserting a pH electrode into a suspension of one part soil and five parts water (1:5). This test has been carried out traditionally and is known as a pH test in water.

The calcium chloride method has been used in more recent times to measure soil pH where a weak calcium chloride solution is used in place of water. It's a more robust method of measuring pH as it's less affected by soil salts. On most soil tests carried out by laboratories both methods are used. This newer method gives a lower reading by up to 1.3 pH units. It's important therefore to understand which method has been used when assessing pH.

Exercise 2.1.8 – Test your soil pH

Use your pH test kit to measure your soil's pH.

What is your soil's pH?	

The desirable pH (CaCl) range for plant production is 5 to 7.

Soil pH problems

The major causes of acidification are:

- loss of buffering capacity in the soil i.e. the natural capacity of the soil to absorb the H+ ions
- formation of Nitrate and leaching from legume pasture plants
- product removal through grazing, harvesting and hay cutting because plant products tend to be alkaline in composition.

In southeast Australia, soil acidity is affecting agricultural production across more than 10 million ha. These are mainly dryland farming areas which use legume based pasture. Soil acidity is a major problem in northeast Victoria where most soils in the hill country are described as acid to very acid. Soil pH levels of 5 or less are very common.

As soils become progressively more acid, the availability of nutrients and chemicals in the soil changes. Aluminium and manganese toxicities and molybdenum and phosphorus deficiencies are probable causes of poor production in many strongly acid soils.

In contrast, alkalinization has also occurred in some soils. Specifically, irrigation with alkaline bore water and fertilising with nitrate fertilisers will increase soil pH. Movement of an alkaline water table will also alkalinize soil, as will applying lime. Lime application on alkaline soils can induce zinc and iron deficiencies.

Managing acid soils

There are very few options for managing acid soils. We can live with the problem using acid tolerant species, but this does not solve it.

The most effective way to increase soil pH is to apply lime (calcium carbonate). The actual rate at which it needs to be applied to be effective depends on the starting pH, the level of exchangeable aluminium present in the soil and soil texture. The following table indicates the amount of lime needed to neutralise acidification caused by produce removal.

Table 2 Amount of lime needed to neutralise acidification caused by produce removal

Produce removed	Lime requirement (kg/t of produce)
Grass hay	25-40
20% clover, annual grass	15
40% clover, annual grass	30
60% clover, annual grass	40
80% clover/medic, annual grass (clover hay)	50/60
Cereal hay	22
Perennial pasture hay (phalaris, cocksfoot)	30
Lucerne hay	60-70
Maize silage	40
Wheat grain	5-10
Barley grain	5-10
Lupins	20
Meat*	17
Wool*	14
Milk (1000L)*	4

* With set stocking rates and manure concentrated at stock camps, the remainder of the property requires an estimated 25kg/ lime/ha/yr to neutralise acidification effect.

When liming soil, it is a common aim to increase the pH to at least 5.2 in water. However, soil texture and your whole farm plan should be taken into account when establishing the lime application rate. The usual recommended rate may not be necessary for what you aim to achieve on your land. Base the decision on calibrated soil tests and professional advice that is specific to your needs.

A faster and more effective change in pH will occur if the lime is incorporated into the soil rather than broadcast.

Types of liming or acidity-reduction materials:

- **Agricultural lime: Calcium carbonate** This is a common liming material. It consists of limestone crushed to a fine powder and is usually the cheapest material for correcting soil acidity. Good quality lime includes 37 to 40 percent calcium.
- **Burnt lime: Calcium oxide** Also known as quicklime, burnt lime is derived by heating limestone to drive off carbon dioxide. It is more concentrated and caustic than agricultural lime and unpleasant to handle. It is rarely used in agriculture.
- **Hydrated lime: Calcium hydroxide** This is made by treating burnt lime with water, and is used mainly in mortar and concrete. It is more expensive than agricultural lime.

- **Dolomite:** Dolomite is a naturally occurring rock containing calcium carbonate and magnesium carbonate. Good quality dolomite has a neutralising values (NV) of 95-98, and contains 22 percent calcium and 12 percent magnesium. It is good for acidic soils where supplies of calcium, and magnesium are low, but if used constantly can cause nutrient imbalance. This is because the mix is two parts calcium and one part magnesium, 2:1, whereas the soil ratio should be around 5:1.
- **Gypsum: Calcium sulphate** Gypsum is not considered a liming material because it does not reduce soil acidity. It is used mainly to improve the structure of sodic clay soils.

Table 3 General effect of soil pH (water) on some plant nutrients

	Soil pH						
Plant nutrient	**Strongly acid** 4.0-5.0	**Medium acid** 5.0-6.0	**Slightly acid** 6.0-6.5	**Neutral** 6.5-7.5	**Slightly alkaline** 7.5-8.0	**Medium alkaline** 8.0-8.5	**Strongly alkaline** 8.5-10.0
Nitrogen	⇩	⇩	⇔	⇔	⇔	⇩	⇩
Phosphorous	⇩	⇩	⇔	⇔	⇩	⇩	⇧
Aluminium	⇧	⇧	⇧	⇔	⇔	⇩	⇩
Molybdenum	⇩	⇩	⇩	⇔	⇔	⇔	⇔
Sulphur	⇩	⇩	⇔	⇔	⇔	⇔	⇔

⇩ indicates decreasing nutrient availability

⇔ indicates equal nutrient availability

⇧ indicates increasing nutrient availability

Table 4 Preferred soil pH (water) ranges for a number of common crop and pasture species

Crop or Pasture	**pH range**
Wheat	5.5 - 9.0
Barley	6.0 – 9.0
Oats	4.5 – 8.5
Triticale	4.5 - 8.5
Lupins	5.0 – 6.5
Peas	6.0 – 8.0
Canola	6.0 – 7.5
Ryegrass	5.5 - 7.0
Phalaris	6.0 – 8.0
Cocksfoot	5.0 – 7.5
Lucerne	6.0 – 8.0

Baxter and Williamson *Know your soils* Centre for Land Protection Research, 2001.

Soil organic matter

The soil is composed of approximately 90-98% minerals and only 2-10% organic matter. Soil organic matter (SOM) is everything in or on the soil that is of biological origin, alive or dead. Organic matter is the remains of living things or products of living things in the soil. Organic matter tends to be concentrated in the upper part of the topsoil, since this is where plant production takes place.

Although SOM is only a small percentage of the soil, SOM plays a key role in soil health through biological, physical and chemical functions. Organic matter on the soil surface such a wheat stubble residue protects the surface from the action of raindrops, reducing surface compaction and hard-setting. Organic matter also helps to bind sandy and silty soils and improves water infiltration through the soil. Organic matter also acts as a buffer against compaction.

Soil organic matter has a role in all key soil functions and is responsible for the darker layer of topsoil, or humus, in many soils. A soil rich in organic matter is also home to earthworms which aerate and nourish soil by recycling nutrients.

For more information on organic matter, refer:
www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soilhealth_organic and www. csiro.au/resources/soil-organic-matter.html

For more information on identifying earthworms see the booklet *Worm wise II – a pictorial guide to the paddock earthworms of South Eastern Australia* by Pauline Mele and Carole Hollier of the Rutherglen Research Institute or www.dpi.gov.au/dpi/vrosite.nsf/pages/soil_biology_worms

Soil carbon

Depending upon the residue type, carbon makes up about 50% of the molecules in organic matter. As organic matter breaks down the amount of carbon that ends up in soil depends on a range of factors, and reflects the balance between accumulation and breakdown. The main factors are:

- **Climate** For similar soils under similar management, carbon is greater in areas of higher rainfall, and lower in areas of higher temperature. The rate of decomposition doubles for every eight or nine degrees Celsius increase in mean annual temperature.
- **Soil type** Clay helps protect organic matter from breaking down, either by binding organic matter strongly or by forming a physical barrier that limits microbial access. Clay soils in the same area under similar management will tend to retain more carbon than sandy soils.
- **Vegetative growth** The more vegetative production the greater are the inputs of carbon. Also, the more woody this vegetation is (greater C:N ratio), the slower it will break down. So, the crop system can strongly affect carbon concentrations.
- **Topography** Soils at the bottom of slopes generally have higher carbon because these areas are generally wetter and have higher clay content. Poorly drained areas have much slower rates of carbon breakdown.
- **Tillage** Tillage will increase carbon breakdown. However, the impact of tillage is generally outweighed by the effect of management on the amount of carbon grown and returned to the soil. An exception to this is where tillage leads to increased erosion.

As carbon is broken down by microbial activity, its physical and chemical properties change. The soluble and particulate organic carbon fractions ('labile' carbon) are readily broken down and are the main energy source for microbes which are part of the soil biota. Recalcitrant organic carbon (e.g. charcoal) decomposes very slowly and has no nutritional value for microbes but can provide beneficial physical and chemical properties. Due to their varying reactivity, the turnover times for these different carbon fractions varies from a few months to tens of thousands of years.

For more information on soil carbon, refer: www.csiro.au/resources/soil-carbon.html

Soil biology

Soil biology is the study of four groups of organisms (soil biota) living in the soil and the interactions between them and their surrounds. The soil biota covers an enormous diversity and some reports suggest there may be greater than 15,000 different species per gram of soil. With such diversity it can be expected soil biota has a large range of functions that impact on the health and productivity of a farm.

The soil biota are grouped according to their size and some examples from smallest to largest are:

- Microflora (bacteria, fungi, viruses)
- Microfauna (nematodes, protozoa)
- Mesofauna (mites, collembola)
- Macrofauna (earthworms, insects).

Soil carbon levels in the form of plant residues and animal manures provide the energy source for soil biota which in turn impact on nutrient availability and soil structure.

Favourable conditions are required for active soil biology with regard to water, air supply, temperature and an absence of toxicities such as salt and heavy metals. It is critical to consider soil biology in the management of your property through:

- No till, stubble retention and direct drilling
- Crop rotations
- Minimising chemical inputs
- Caution with inoculants and biological products.

Soil fertility

Soil fertility depends on many of the factors that have already been discussed: texture, structure, pH, organic matter, carbon and soil biology. Soil fertility determines how well plants will grow. There are three important considerations when thinking about soil fertility:

- What nutrients are present in the soil?
- What nutrients are available in the soil?
- What am I trying to produce from the soil?

In the case of the first two it is important to understand that nutrients such as phosphorous, nitrogen, iron, sulphur and many others occur in different forms in the soils. Some forms are more soluble than others and the form that the different nutrients take depends on the presence of other nutrients but particularly on the soil pH. For example, all other things being equal, a soil of pH 7 will have more available iron than one of pH 4.

Tests for soil fertility can be done directly on the soil, or in the case of high value crops, in combination with plant tissue testing. Plant tissue testing is a valuable way of identifying which nutrients in the soil are available to the plant and whether the balance is right or not.

Below and on the following page is an example of the results of a soil test.

Table 5 Example of soil test results with interpretation

Pasture soil	Analysis report example
Customer no	123456
Sample no	000123
Sample taken	12.08.08
Reported	15.08.08
Order no	
Phone	03 123 124
Fax	03 123 125
Email:	example @soiltesting.com

Paddock name:	Big Hill	Size:	10ha
Sample name:	2	Paddock location:	Benalla

Test	Result	Very low	Marginal	Optimal	High	Excess	Optimal range
Phosphorus – olsen (P)	8 mg/kg	###					20-30
Available Potassium (K)	59 mg/kg	###					200-350
Available Sulphur KCI (S)	5.9 mg/kg		###				10-25
Electrical Conductivity (EC)	0.06dS/m			###			<0.2
EC of saturated extract (ECe)	0.60 dS/m			###			<1.9
Organic carbon (OC)	2.30%			###			1.7–2.6
Phosphorus – Colwell (P)	18 mg/kg						20-35
P buffer index (PBI)	110	moderate					
pH water	5.20	highly acidic					5.8-7.0
pH CaCl2	4.50	highly acidic					5.0–6.2
Soil texture	loam						
Soil colour	brown						
Total cation exchange capacity	3.70 meg/100gm						
Aluminium (Al)	0.86 23%				#	##	<5%
Calcium (Ca)	2.25 61%			###			60-85%
Magnesium (Mg)	0.31 8%			###			6-18%
Sodium (Na)	0.17 4%			###			<6%
Potassium (K)	0.12 4%	###					0.5-0.9 meq
Calcium to magnesium ratio	7.31			#	##		2-6
Potassium to magnesium ratio	0.39		###				0.5-1

Enterprise	Beef/sheep
Expected stocking rate/yield	10.0 dse/ha
Average annual rainfall	650 mm
Irrigation	No
Paddock use this year	Existing pasture
Lequme % in pasture	
Method of sowing	
Paddock history	
Lime applied	n/a
Gypsum applied	n/a

2.2 Soil map and land classes
and
2.3 Land capability and land management options

We have combined Performance Criteria 2.2 and 2.3 because land classes are usually closely linked to soil types. While soil type is not the only factor that determines land class, it's often the most dominant factor. Different soil types can usually be identified by changes in surface colour, structure or texture of the soil or their position in the landscape.

Land classification and capability

We classify the land in order to understand what it is capable of producing. All of your planning should be based on using the land according to its capability. Land Classification is a standard descriptive ranking of land. From these standard descriptions you can work out what your land is capable of, taking into account limiting factors such as soil, slope, elevation, aspect, climate and the presence of degradation and remnant vegetation types. These are all used to categorise the land's capability.

Knowledge of the total area of each land class on the property will help decide the best management practice to adopt for the property. This information is also very useful when you plan new projects and Landcare activities. The aim should always be to complement the natural potential of the land.

Land use history

The great dust bowl of the 1930s and 1940s in the grain belts of Australia and the USA highlighted the importance of appropriate land management. The newly developed tractor allowed farmers to plough land more quickly than was previously possible with horses. This opened the way for farmers to cultivate much more of their farms in preparation for crops to be planted.

The combination of dry years and vast areas of bare, cultivated land resulted in wind erosion on a catastrophic scale during this period. The vulnerability of the land to bare cultivation was all too apparent.

One of the outcomes from the research that resulted from the 'dust bowl era,' was the development of a system of classifying land based on its inherent risk of land degradation. The system uses land in a bare cultivated state, the most vulnerable state, as the basis for assessing the land.

The Standard Australian System, which we will use throughout this course, is based on the US Department of Agriculture eight-class system, with Land Class I having minor limitations or risk and Land Class VIII being unsuitable for agriculture. All other agricultural or horticultural lands fall between the two.

Capability: why classify land?

The whole farm planning process aims to optimise the productivity and profitability of the farm while maintaining or improving the land resource. This is achieved by identifying the risk of land degradation occurring on various parts of the farm and then managing it accordingly.

Livestock, for example, will be able to graze some areas but fencing other areas into smaller paddocks may be necessary to restrict the livestock causing degradation of land that is not capable of supporting it. Matching cultivation practice and crop choice to land capability is the critical factor on these properties. For example, a paddock ranging from a low slope to steep rocky slopes may have three different classifications. The lowest slopes could be classified IV and be considered best grazing. They may even be sown to pasture though too fragile for regular cropping. Further up the slope may be classified V and suitable for less intensive grazing. It will need specialised equipment for sowing and even then it may cause erosion if sown to pasture. Towards the top of the paddock may be classified VI and here the potential for erosion will mean more careful managing. This steep rocky hill will not be cultivated, and grazing will need to be strictly controlled. Advisable management would be to fence along the land class boundaries and manage according to the assessed land capability.

By first recognising that all land on a farm is not the same, and then developing short- and long-term plans for its appropriate management, farm productivity and income can be optimised while sustaining the land resource.

Land capability

All farmed land is exposed to some risk of land degradation. The land capability is determined by any factors that will limit long-term cultivation and production. These could be soil type, slope, salinity, flooding, etc. It should be noted that the land capability relates to the inherent risk of the farm management practice and not necessarily to the productivity that can be achieved from that land. Productivity is largely dependent on management. In many cases, production can be higher on a more limiting land class where management is appropriate than land with fewer limitations and inappropriate management.

The native vegetation of an area can often be used as an indicator of the land capability. The Red Gum flats along streams and rivers indicate good soils with the potential for a range of uses. However, Box-Ironbark forests are usually associated with poor, shallow soils that are easily eroded. With much of the vegetation removed off farms, roadside remnants may provide a clue to the local vegetation.

Land classification

The benefits of classifying land are:

- improved land management suitable to the land class
- improved grazing management
- optimisation of productivity through targeted fertilizer use
- reduced land degradation through appropriate land use

Whole farm planning is based on mapping the property according to the presence and severity of limitations. Different areas of the property are placed into one of the eight classes described below according to the Standard Australian System. These range from Class I (very minor or no limitations) to Classes V-VII (non-arable) and Class VIII (non-agricultural).

While land capability classification relies on some understanding of the soil type and its characteristics, the system is much simpler than soil classification. Most people with a very basic understanding of soils will be able to classify land for its capability.

It is general convention to indicate the land capability in Roman Numerals – this differentiates these figures from other information.

Remember, this eight class system of classifying land is based on the inherent risk of land when it is in a bare cultivated state.

Arable (Agricultural land)

Class I Land that is able to support a wide range of uses with very minimal risk of degradation — suitable for cultivation on a permanent basis. These are usually the best cropping soils without problems or special needs. Usually flat land that is highly fertile and is able to be cropped continuously, examples include market gardening areas.

Class II Land with some risk of degradation but still able to support a wide range of uses. Low slope with little erosion potential and good soil types. Techniques such as crop rotations and conservation farming will ensure long term sustainability of the farm environment. Some conservation practices required if used for cropping (e.g. broad rotations, conservation tillage or application of gypsum).

Semi-arable

Class III Land with severe risk of degradation. Sloping cropping country that could wash and erode when ploughed. The land is also quite fertile cropping land but erosion control earthworks, like contour banks, may be necessary due to the length of slope and type of soil. Conservation tillage techniques are recommended for Class III soils.

Class IV Land where cropping constitutes an unacceptable risk. Best Grazing country but too fragile for regular crops — up to 2 crops in 10 years with direct drilling or minimum tillage (tyned implements recommended). Preferable to keep pastures taller than 5 cm. The land may be undulating with the main limitations being slope, rockiness, fertility of soil and/or susceptibility to soil structure decline. Improving pasture by applying fertiliser and controlling grazing will maintain adequate ground cover.

Non-arable (Pastoral land)

Class V Land with little risk of degradation but unsuitable for cropping because of soil, topography, water-logging or salting. Suitable for grazing, and pasture renovation can be carried out with tyned implements. Soils are as for Class IV but less capable. Some limitations are more significant because of existing or potential erosion and the degree of slope may require erosion control earthworks (especially if the topsoil is exposed during cultivation). Control of vermin, broadcasting of seed or aerial fertiliser application may also be necessary.

Class VI Land with severe risk of degradation. Suitable for grazing but good management is needed to preserve vegetation cover because of soils, slope, rocks, wind or water erosion. Specialised equipment is necessary for establishment of improved pasture. Requires good management such as controlled grazing or broadcast pasture improvement (often by air) for improved carrying capacity.

Class VII Land with a very severe risk of degradation. Suitable for controlled grazing only. Good vegetation cover is essential for the protection of the land. Not suitable for agriculture. Keep trees for seed and honey. Land best left under green timber or undisturbed ground cover. The area could be a high salinity recharge area.

Class VIII Land incapable of sustaining agricultural production (e.g. cliffs, lakes, swamps and quarries, non farming scenic woodland or wetland).

Mapping

The first consideration in assigning a class to a particular area of land is whether the area is arable (i.e. safe to plough and crop regularly without damaging the land) or non-arable (not suited to cultivation). The decision whether land is arable or not should be based on its ability to sustain cropping on an annual basis and not whether this is your chosen management option for the land. Non-arable Pastoral Land classes are those areas suited only to permanent cover by pastures. The final class is Non Agricultural, where land is unsuitable for agriculture but may have other values as conservation areas, quarries etc.

When classing an area where a confusing intermingling of different land classes occurs and each is too small to be fenced off, we class it according to the poorest land in the area unless it is of insignificant size, then we class according to the land that takes up the greatest proportion. A valley that isn't sufficiently wide or large enough to be given its own classification can be included in the neighbouring class.

Exercise 2.2.1 – Classify your land

You are going to classify your land according to the classification descriptions I to VIII above. You can use the knowledge you have gained in studying soils in Element 2.1 and land capability in Elements 2.2 and 2.3.

Mark in the borders between the different classifications on your farm map and label them with Roman Numerals.

Exercise 2.2.2 – Match your soil type to land class

Using the knowledge you have gained about your soils, you are going to mark soil types on your farm map. In most cases these will roughly follow your land class borders.

The easiest way to do this is to observe the soil that is typical of each land class area and write a descriptor in your legend. Descriptors may be based on colour and/or texture (e.g. sandy, rocky, clay, loam).

For further information on soils go to: www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/vrohome

*Assessment Task 2.3 – Assess your land capability

Having classified your land, it is now time to use this information to look at its limitations and assess its capability.

Choose one classification area and complete the following classification sheet for that area. *This is an Assessment Task that needs to be handed in to your facilitator.

Land class description
(One sheet for each different land class)

Land class	Common name	Area (ha)	% of farm

Brief description of the soil (e.g. waterlogging problem most years in winter)

Native vegetation that occurs on the land (e.g. Red Gum, Blackwood etc.)

Landform (e.g. mainly flat, undulating)	Slope (e.g. 3-5%)

Soil description

Depth	Colour (e.g. grey)	Texture (e.g. clay)	Structure (e.g. sodic)	pH (e.g. 5.5)	Salt EC	Other (e.g. gravel layer)
Top soil (0-10 cm)						
Upper subsoil (10-25 cm)						
Lower subsoil (25-60 cm)						

Following on from identifying the capability of one of your land classes, you can now note some of the main features for management under the following headings. *This is the second part of Assessment Task 2.3 and is also to be handed in to your facilitator.

Main land degradation risks

(e.g. subsoils clays are sodic and land is of risk to erosion by water)

Main production limitations
(e.g. waterlogging of crops/pastures in winter/early spring, pugging problems if grazed by cattle)

Main activity
(e.g. good pasture production in autumn following break and holds good feed into late spring most seasons)

Appropriate management practice
(this should include the main use, management and special precautions)

Suitable rotation
(essential decision if land is considered for cropping)

Land care activities
(e.g. increase tree coverage to at least 12% of land area and fence off 3 hectare swamp to re-establish a wetland habitat)

2.4 Natural property features and infrastructure

To make good decisions for the future it's important to know what you have to work with. This is why you need to mark all the natural features and infrastructure that already exist on your property, on to your farm map.

Exercise 2.4 – Record the natural features and infrastructure

You are going to mark the natural features and infrastructure on your farm map. These will include a wide range of features from wetlands and ridges to rocks and weeds. A check list is provided for you to tick off features. Write N/A against features that are not found on your property.

You may want to revisit this section after completing performance criteria 2.6 and 2.7 as these will give you more insight into native vegetation and wildlife species on your land. Indicate the following:

Natural features

Drainage lines and ridge lines

Remnant vegetation and plantations (including those adjacent to your property)

Native grassland

Large old paddock trees

Areas of natural regeneration (would be less than 10 years old)

Wildlife habitats

Historical or archaeological sites

Wetlands (swamps, springs)

Infrastructure

(mainly features that are man-made)

Dams

Bores

Water troughs

Buildings

Sheds

Fencing

Stockyards

Pipelines (including septic lines)

Powerlines/Underground electricity supply

Telephone cable

Easements

Road reserves

Gas pipelines

2.5 Areas at risk of soil degradation

Land degradation

Most of the land degradation problems experienced on agricultural land today are a direct result of unsustainable farming practices and enterprises that have exceeded the land's capability.

Europeans who colonised Australia came from agricultural lands that had soils that were younger, deeper and more fertile than the soils in Australia. There was a lack of understanding about how to treat the land here and a perception of never-ending land and trees. The land was cleared rapidly and European agricultural practices followed which were unsuitable for the older and less fertile soils.

Technological improvements at the end of the 19th Century such as mechanisation and irrigation enabled vast areas to be brought into production. A lack of knowledge of climate, geology and soils has meant water from our rivers and ground water supplies has been over-used and vast problems with rising salinity have occurred.

Symptoms of land degradation were recognised earlier last century and whole farm planning is part of the spread of knowledge and establishment of practices that address degradation issues and aim to prevent future degradation.

Ecosystems have not had time to adapt to the changes humans have made to the environment. This has led to the deterioration of the environment, loss of biodiversity and agricultural productivity, and increased costs to society for the repair of ecosystems.

Soils are fundamental to productivity but have been severely damaged over time.

Soil structure decline

Soil is made up of soil particles that form aggregates (peds) with spaces between, called pores. These contain air and water that are available to the plants.

When the soil is compacted, the ratio of pores to peds declines and the soil increases in density. This results in a decline in the soil water and air that is available to the plant. This affects the nutrients and the ability of vegetation to grow. This decline in soil structure leads to surface crusting, making it harder for moisture to penetrate and harder for air and soil biota activity to keep the soil from compacting. Soil crusting also increases runoff that may lead to greater soil erosion.

Soils most vulnerable to soil structure decline are sandy loams, sandy clay loams, and sodic duplex soils. These soils in the cropping areas are particularly vulnerable as the soil is disturbed more frequently.

Subsoils are also vulnerable to compaction with the size of soil pores reduced. This can lead to the formation of an impenetrable layer, where roots, water and air can't penetrate and waterlogging of the upper soil profile follows.

Soils with structural decline lack the formation of soil aggregates (peds).

Recognition of soil degradation

Soil compaction refers to the compression of a soil into a hard mass after continuous passage of heavy machinery, implements or animals. Bulk density is a measure of the degree of soil compaction. Soil compaction is recognisable by poor plant growth, lack of organic matter and the presence of soil crusting.

Surface crusting occurs in some soils, which exhibit cement-like features in the surface layers. Crusting results from excessive cultivation which may be combined with exposure to wetness and baking and also may be low in organic content. Soil crusting is recognisable as a smooth surface effect with finer soil particles forming a crust and coarser soil particles standing isolated within the crust surface. This is particularly apparent after rainfall.

Some areas are afflicted with hardpans. These are impervious or slowly pervious horizontal layers in the soil, anywhere from 150 mm to 600 mm below the surface: A hardpan is formed by the cementing together of soil particles by iron oxide, silica or calcium carbonate (limestone) into a hard, stone-like mass.

The impervious nature of these hard pans commonly results in a perched water table, turning surface soil into 'soup' for long periods after rain has fallen. It may be necessary to dig a soil pit to investigate further. Look for roots growing horizontally that are unable to penetrate a hardpan.

Exercise 2.5.1 – Record degradation issues

Have you observed any areas on your property affected by the following? Please tick.

Compaction	
Surface crusting	
Water-logging	

Acidification

Soil pH can vary greatly between farming districts and even on the one farm where differing soil types occur due to topography, weathering processes over a long period and vegetation history.

Soils that are strongly alkaline can cause some limitations to plant growth. However it is the strongly acidic soils that reduce plant growth and development.

Soil acidification usually refers to our farm management practices that over time cause the soil to become even more acidic. The use of improved pastures, the removal of agricultural products and excessive nitrogen application particularly in high rainfall regions can all contribute to further lowering of soil pH.

Low soil pH reduces the availability of phosphorous, calcium, molybdenum and magnesium to plants, and the elements aluminium and manganese may become toxic. These all affect crop and pasture establishment and growth.

Exercise 2.5.2 – Describe areas at risk of acidification

Are there any areas on your property that are at risk of acidification? Describe them.

Fertility decline

Most Australian soils are naturally low or deficient in phosphorous and nitrogen although the use of fertilisers, especially superphosphate and legumes in pastures, has substantially improved the fertility of agricultural soils. Soil fertility decline is due to poor management of soil nutrients.

Agricultural production uses soil nutrients that are removed from the system as products and sold off farm. These nutrients need to be replaced to keep a balanced system or the result is lower soil fertility and eventually, lowered production as pasture and crop yields are reduced and weed invasion occurs. Increased soil acidity, explained above, also affects the toxicity and availability of some elements.

Biota decline

Soil biota decline is associated with loss of soil structure. This is caused by overworking the soil that causes breaking down of the soil peds and reducing the soil pore size (see soil structure decline).

Compaction of the soil and overgrazing are also likely to lead to a reduction in soil biota. The reduced soil aeration and moisture penetration leads to a loss of conditions that favour organic matter breakdown and a reduction in health and numbers of soil biota.

Exercise 2.5.3 – Mark soil degradation areas

Mark on your farm map any areas where the soil is already degraded or is at risk of degradation given current management practices. Soil degradation is a threat and should be marked on the threats layer.

2.6 Native vegetation type and condition

and

2.7 Rare or threatened species and communities

Since understanding that many of our current problems are the result of inappropriate farming practices, we now see the need to increase plantings of native vegetation on farms, and regenerate bushland that is in a poor state of health. To do this it's helpful to know what species of trees, shrubs, herbs and native grasses once dominated the area.

Many indigenous species and communities are now considered rare or threatened. Threatened categories may range from less common through to vulnerable or even endangered. Habitat reduction through clearing or cultivation is a major cause of biodiversity loss. Competition with or predation by pest plants and animals has also contributed to the decline. An essential component of whole farm planning is to consider the rare or threatened species on your farm and in your landscape.

Knowledge of indigenous species gives an indication of what once grew well in the area and also provides an opportunity to encourage native wildlife back into the area. This is the reason most environmental grants and management plans include plantings of indigenous species.

In Victoria, information on indigenous flora and fauna and their preferred habitat is available from the Department of Sustainability and Environment (DSE) and your local Catchment Management Authority. Other sources of information are 'Landcare' groups, local amateur naturalists, local remnant vegetation sites, 'Bushcare' and 'Trust for Nature' facilitators.

Useful links include:
Victorian Resources Online: www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/regionalprofile

Australian National Botanic Gardens site: www.anbg.gov.au/anbg/index.html

DSE Conservation and Environment Home Page: www.dse.vic.gov.au/dse/nrenpa.nsf/

Exercise 2.6.1 – Record your flora, fauna and habitat

You are going to try to identify native vegetation and habitat on your property.

List flora and fauna species that inhabit your property under the following categories. Write N/A if the category can't be found on your property.

Patches of bush (large or small)	
Scattered paddock trees	
Wetlands, swamps, dams, bogs	
Rocky outcrops	
Native grasses/pastures (unimproved areas of land that have had little fertiliser application)	
Rivers/streams/drainage lines/gullies	
Regenerating vegetation	

Talk to local Landcare groups and check websites to find out what other species are found in your region. Record your findings along with any benefits you think they may have for your property.

Biodiversity in whole farm planning

Biodiversity is simply the variety and interactions of living things including plants, animals, fungi, bacteria, etc.

The main threats to biodiversity on our farms are habitat loss and degradation. This is much more than the removal of trees. It includes removal of fallen timber (firewood collection or 'cleaning up') and ground litter, such as leaves, twigs and the organic layer. Another major threat is the introduction of pest plants and animals which have had, and continue to have, a significant impact on our native flora and fauna.

Biodiversity is important because our water, air, food and quality of life are all founded on a wide variety of living systems which produce clean air and water. Biodiversity benefits us and our use of the land in a variety of ways. Some examples are:

- 100 Straw-necked Ibis consume up to 25,000 insects per day
- Magpies will consume up to 40 scarab larvae per day
- Sugar Gliders have been estimated to eat 3.25 kilograms of insects per year
- Sheltered pastures lose 12 mm of water less than open pastures during the spring growing season
- Without shelter belts cold stress reduces live weight gain in cattle by 31% over several weeks
- Gross value of pasture output is at its highest level when the proportion of tree cover area (natural remnants) on a farm is at 34%.

To encourage the benefits of native wildlife on your property, you need to ensure habitats are protected and patches of vegetation are well connected to other areas of vegetation. This may mean looking outside your property boundary to see where the good patches of vegetation are and how you could link in with them.

Practical ways to maintain biodiversity

There are three important rules to take into account in the planning of your farm. In order of importance they are:

- Protect existing habitats
- Enhance the condition of the existing vegetation
- Revegetate to create buffers, extend remnant areas and link remnant stands of vegetation (refer Element 4.3).

Protect existing habitats

We should aim to protect habitat diversity and the biggest patches of remnant vegetation. The most valuable patches are the largest ones and those that include the most variety of structural layers of vegetation, from ground cover through to shrubs (understorey) and taller vegetation (overstorey). Ideally they will be relatively free of disturbance and contain logs and ground litter. These should be protected as a priority.

Larger remnants are more likely to have a variety of habitats and be home to larger populations of plants and animals. Vegetation that exists in small patches has a lot of edges relative to their area. Edges, where vegetation meets open country, create increases in temperature, wind velocity and weed invasion into that patch. These effects are known as 'edge effects'. Larger, wider remnants have fewer edge effects. A long narrow strip along a roadside is almost all 'edge effect.'

It's important to protect a wide variety of habitats on your property, even if they are small patches of vegetation or isolated trees. Bogs or springs, rocky outcrops, native grasses are all resources for a wide array of native species. The more diverse the habitats, the greater the diversity of species you will have on your property. This greater complexity improves the likelihood of finding predators for pest insects, nutrient turn-over in the soil, and nature keeping check on plague outbreaks of individual species.

Protecting a range of vegetation types

Not only is it important to protect a range of habitats, it's also important to protect a range of vegetation types. Native vegetation changes as you travel through the landscape. These changes are driven by things like topography, soil type, geology, climate and aspect. To capture these vegetation changes in the landscape the term Ecological Vegetation Class (EVC) is used. The EVCs are a computer-derived model that reflects the different vegetation types in the landscape. It's based on the factors listed above that drive vegetation change (aspect, topography etc) as well as survey data of native vegetation sites. Because it is a model, it is able to tell us what the original cover of the vegetation was in the landscape before the arrival of Europeans (pre-750 EVCs).

Conservation Status of EVCs

Once the pre-1750 EVC layer has been determined, we can then overlay this with a satellite image of the current vegetation layer and work out how much of each EVC remains. The landscape hasn't been cleared evenly. We have extensively cleared the more fertile areas but large swathes of bush, usually public land, remain. Because of this, EVCs have differing 'Conservation Status' based on the amount that has been cleared.

The Department of Sustainability and Environment's website allows you to determine the EVCs of your property and their associated Conservation Status. Simply follow these steps:

- Go to www.dse.vic.gov.au
- Click on 'Interactive Maps'
- Click on 'Biodiversity Interactive Map'
- To locate your property click on 'Find location', one of the tab buttons located in the top part of the screen. This gives you a number of different options. Click on either 'place name', 'local government area' or 'postcode' to locate your property. You can use the Hand symbol to move around the area and the 'Zoom In' tool (magnifying glass) to zoom to your property
- Click on 'Layers', another tab in the top part of the screen
- Click on the 'Vegetation' folder, and then tick the box next to '1750s EVCs'
- Click on 'Refresh Map' to enable these features to be viewed
- To identify the EVCs, click on the 'i' icon next to the 1750EVC. When selected, it changes from grey to black
- Go up to the tabs at the top of the screen and look for the same 'i' icon. Click on this. Then click the mouse pointer on a coloured patch of vegetation
- An 'Identify Results' box will be revealed on the right of the screen. This produces a detailed analysis of the vegetation you have selected.

For the Conservation Status of EVCs, repeat the same process as above, but within the Vegetation Folder, select 'Bioregional Conservation Status' and then 'Refresh Map'. Note the Conservation Status layer here only applies to existing vegetation.

Exercise 2.6.2 – List your EVCs

List the EVCs occurring on your property, as well as their Conservation Status.

Enhance the condition of the existing vegetation

To enhance the existing vegetation you first need to find out what is missing from your patch. Is it ground cover, shrubs or overstorey? When you have identified what is missing then your aim should be to recreate the missing layers.

To find out what elements are missing from your vegetation, a Rapid Habitat Assessment form has been developed. This form lists the parameters within a patch of vegetation that denotes 'benchmark' quality, that is, what we should be aiming to have represented in a healthy patch of vegetation. The form also allocates a score next to each of these parameters. When the form is completed for a given patch of vegetation, the scores give a general indication of which parameters are at benchmark quality, and which ones show a need for improvement. The condition of the patch of vegetation can be improved dramatically if action is undertaken that will increase the low scoring parameters.

A more detailed tool for assessing Vegetation Quality is the habitat hectares method (refer DSE website). This method relates site-based habitat and landscape components to the appropriate EVC benchmark, which is part of an approach to calculate gains in native vegetation and revegetation of formerly cleared areas.

Ideally, we aim to establish linked patches of vegetation in preference to long narrow bands of vegetation. As already mentioned, larger patches have fewer edge effects and offer a range of habitats from the edges through to the 'heart' of the stand.

Other threats to habitat quality are pest weeds, animals and removing fallen timber. Identifying and managing the control of such threats is very important to the condition of remnant vegetation.

Exercise 2.6.3 – Determine your habitat quality

Undertake a Habitat Quality Assessment in one of your patches of native vegetation. List the actions that you would undertake to improve your score.

To help you do this a Rapid Habitat Assessment form is provided below.

You will need to refer back to this Rapid Habitat Assessment form as a basis for completing Performance Criteria 4.3 where you develop management strategies for your vegetation and habitat.

Rapid Habitat Assessment form

	Target	Quality ranking	Weight	Value
Large trees (over 50 cms) Apply to living and dead	10-15/ha in woodlands 20/ha in forests	No large trees	0	
		Present but not common Woodlands, up to 7/ha Forests, up to 12/ha	1	
		Common Woodlands, more than 7/ha Forests, more than 12/ha	2	
Canopy cover (use all trees over 80% of their mature height)	10-20% in woodlands 20-50% in forests	Very substantially reduced (<25% of benchmark)	0	
		Significantly reduced (25-50% of benchmark)	0.5	
		Comparable to benchmark, although it may be reduced (>50% of benchmark)	1	
Understorey include shrubs, grasses, herbs and young regenerating trees	**Cover** of native species – 90-100% in woodlands and forests; **Diversity** of lifeforms - 25-35 species in woodlands and forests.	Absent or virtually so (<10% total expected cover)	0	
		Native cover greatly reduced (10-25% total expected cover)	2	
		Native cover somewhat reduced, **low** diversity (25%-75% total expected cover, < 50% diversity)	3	
		Native cover somewhat reduced, **high** diversity (25% - 75% total expected cover, >50% diversity)	4	
		Native cover little reduced, high diversity (>75% total expected cover, >50% diversity)	5	

Weeds	% cover	Dominated by exotic species (>50% cover)	0	
		Exotic species common but not dominant (25 – 50% cover)	1	
		Exotic species present but not common (5 – 25% cover)	2	
		Exotic species absent or very rare (<5% cover)	3	
Recruitment	Include all components - trees, shrubs, grasses and herbs.	Recruitment absent or, if present then only for a minority of species (<30% of species)	0	
		Recruitment common but not for all species (30-70%)	1	
		Very common for most life forms (>70% of species)	2	
Organic litter	20% cover in woodlands	Organic litter absent or significantly reduced from benchmark level (< 50%)	0	
		Organic litter present and not significantly reduced from benchmark level (>50%)	1	
Logs m/ha	100 m in woodlands, 150 m in forests	Logs and/or cut stumps absent or significantly reduced from benchmark (< 25%)	0	
		Logs and/or cut stumps common but reduced from benchmark (25 – 50%)	0.5	
		Logs and/or cut stumps present and not significantly reduced from benchmark (>50%)	1	
Size	Area	< 2 ha	0	
		2 – 10 ha	1	
		> 10 ha	2	
Neighbourhood	Within 1 km radius, % area covered by indigenous vegetation	< 10% cover	0	
		20 – 60% cover	1	
		> 60% cover	2	
Distance to the nearest 'core area'	'Core area' is a block of native vegetation > 50 Ha	> 1 km from 'core area'	0	
		< 1 km from 'core area'	1	
			Total	

General indication of level of habitat quality:
High – 12-20 Medium – 7-11 Low – 0-6

Exercise 2.7 – Identify your rare or threatened species and communities

You may know of rare or threatened species and communities that occur in your region, but do you know if any reside in or move through your property? Check with your local Landcare group and view the DSE website under native plants and animals for detailed locality information.

List any rare or threatened species and communities on your farm?

2.8 Other natural resource issues

A natural resource issue is any physical or biological process brought about by human activity that degrades the natural assets of the catchment or farm.

Most of the land degradation problems experienced on agricultural land today are a direct result of unsustainable farming practices and enterprises which have exceeded the land's capability.

Europeans who colonised Australia came from agricultural lands where soils were younger, deeper and more fertile than the soils in Australia. There was a lack of understanding about how to treat the land here and a perception of never-ending land and trees.

The land was cleared rapidly and the European agricultural practices that followed were unsuitable to the older and less fertile soils.

Symptoms of land degradation were recognised earlier last century and the Department of Agriculture in various States began to address these while gradually increasing our understanding of the Australian environment.

Whole farm planning is part of the spread of knowledge that is helping to establish practices that address degradation issues and aim to prevent future degradation.

Exercise 2.8.1 – Identify other natural resource issues

To complete Performance Criterion 2.8, you need to identify what other natural resource issues are occurring on your property.

Read the following descriptions of some of the natural resource issues that occur across our landscape and then answer the questions in the boxes.

Soil erosion

Soil erosion is the removal of soil particles from one area to another by water or by wind. Soil erodes naturally, but the intervention of mankind has increased the ratio of soil eroded to soil formed, leading to a net loss of soil. Major factors affecting soil erosion include vegetative cover, slope and length of slope, soil type, rainfall intensity and wind velocity.

The loss of soil through water and wind erosion leads to many problems for land and marine environments. These problems can include deterioration in water quality, loss of biodiversity and reduced production from agricultural land.

Problems can also include silting of dams, flooding damage to rivers and human structures. Damage to the marine environment (coral reefs and coastlines) through excess silt deposition from rivers, and loss of topsoil leading to desertification of agricultural land.

Recognition of soil erosion is the first step in the prevention process. Physical changes in the landscape are indicators of an erosion problem and these are accompanied by a decline in production as valuable topsoil and arable land is lost.

A useful resource providing further research and information is the 'Property Management Planning Manual' by Peter Dixon pp 83-95.

Streamside erosion

Streamside erosion represents one form of soil erosion. It can be recognised as increased cutting away of the stream bank with a loss of vegetation along the banks which, in turn, increases stream flow and sediment load in the water.

Can you identify any examples of streamside erosion on your property? Are there any areas that could be at risk if stock is introduced?

Wind erosion

Wind removes the topsoil from land in dry conditions leaving behind the heavier particles and is more easily recognised when clouds of dust fill the air. The land left behind has thinner topsoil layers with noticeably larger soil particles and a scoured look. The dust and sand blown by the wind then accumulates on man made structures such as fences, roads and railway lines.

Wind erosion occurs where the wind has direct access to bare soil. Soil particles are moved by wind in three ways:

- Finer particles are moved by suspension as in a dust storm
- Medium sized particles (0.1-0.5 mm) are moved by 'saltation', the bouncing movement of sand grains across the surface. They rarely rise above 50 cm and as they land they knock more fine particles into suspension
- Coarse sized particles roll or slide along the surface.

Wind erosion can move large quantities of topsoil and cause clouds of dust in the atmosphere as the topsoil, nutrients and pasture seeds blow away. This later settles out elsewhere and may result in coverage of roads, buildings and water channels with sand and dust.

Can you identify any examples of wind erosion of the soils on your property? Describe their location.

Water erosion

The intensity of raindrops falling on bare soil influences the rate of soil erosion. High intensity raindrops break down surface soil structure and reduce infiltration. Vegetative cover breaks the fall of raindrops and their impact on the soil surface. Hence removing vegetation from the land increases the impact of rainfall and the velocity of water moving across the landscape.

The slope of the land and the length of slope will affect the velocity of water moving across the landscape and its removal of soil particles. The impact of water and wind on the landscape will also be influenced by the size of soil particles, the way they are held together and their vulnerability to being moved.

Rill erosion

Rill erosion is the removal of topsoil from an area by water, leaving small channels of less than 300 mm deep across the soil surface. These can still be removed using normal tillage techniques although valuable nutrients and topsoil will have been lost leaving the area less fertile.

Are there any examples of rill erosion on your property?

Sheet erosion

Sheet erosion is the removal of a reasonably uniform layer of topsoil particles from an area. It is similar to rill erosion, but areas of the total layer of topsoil are removed rather than channels forming. Sheet erosion is the result of runoff or raindrops on vulnerable soil that is bare.

Can you identify any areas where sheet erosion has occurred on your property?

Gully erosion

Gully erosion is the removal of soil by water as it moves across the landscape leaving channels greater than 500 mm deep and 300 mm wide. These cannot be removed by normal tillage.

Gully erosion may develop from a concentration of water moving across the land, rill erosion or collapsed tunnel erosion. They have steep sides and are generally actively eroding at the head as well as losing soil from the steep sides.

The head of the gully could erode very actively (50 m/year) or slowly (only centimetres/year). Apart from the loss of soil from the farm, gully erosion can cause water quality problems downstream and dissection of the farm and associated access problems. These gullies can also harbour vermin and reduce the value of the farm.

Can you identify examples of gully erosion on your property? Are there any areas at risk of developing it in the future?

Tunnel erosion

Tunnel erosion is the removal of the subsoil by water while the surface soil is left. This can occur when the subsoil is easily dispersible but the topsoil is more stable, and rainwater follows down cracks, rabbit burrows and root channels.

Tunnel erosion is first evident as a fan of fine silt appearing at the opening of a hole that has water gushing out during rain events. It generally occurs in areas that have been cleared of large trees (providing the root channels), where there is rabbit infestation and where dispersive or sodic soils are found.

Figure 10 Dispersible soil emerging from tunnel erosion

Can you identify any areas on your property affected by tunnel erosion? Do you have any areas at risk?

Land slips

Landslips are the mass movement of soil down slope due to the effect of gravity on surface soil materials. It can occur on a moderate to steep slope where the topsoil layers or soil horizons become fully saturated during the winter. The topsoil then fails to bind well with the soil layer below that could consist of a heavy clay.

Is there any evidence of landslips on your property? Are any areas at risk?

Salinity

Soil salinity is regarded as one of the most important threats to sustainable agriculture in many areas of Australia. Large areas in many States have been rendered unproductive as a result of salinity and will require a great deal of effort and financial commitment to reverse the adverse effects we are experiencing today.

Soil salinity may begin with irrigation water entering the groundwater causing it to rise, bringing salts to the surface. As the ground water gets within two metres of the surface, it comes to the surface through capillary action and deposits salts.

Where irrigation is continued, the salts can be leached below the root zone only to cause problems on adjacent land. Groundwater that flows into streams and rivers carries salts, resulting in a further decline in stream water quality.

Dryland salinity is classified as 'primary' when it occurs naturally or 'secondary' when it is due to rising ground water caused by human intervention. Clearing the land of trees and other deep rooted perennial species and replacing them with a range of annual crops and pastures has caused increased infiltration of water through to the water table.

The result is salinity appearing at the break of slope or along lower contours of the landscape. Hydrological studies are increasing the knowledge of the Australian landscape and ground water movement, and thus improving the targeted treatment of dryland salinity within catchments.

There are several ways to confirm whether you have a salinity problem on the property. Salinity will generally occur in the low parts of the farm. These areas need to be inspected. During Spring look for pale green areas that don't have the vigorous growth that you would normally expect; salinity may be the cause.

Look at what plant species are growing in low-lying areas or areas with poor growth. Plant species present indicate the level of soil salinity. An excellent booklet available to assist you is 'Spotting soil salinity – A Victorian field guide to salt indicator plants'.

Currently there are three major approaches to on-farm salinity control and management:

- recharge management using vegetative controls
- recharge management using engineering controls
- management of salt-affected land.

Further research and information on these and the following topics can be found on the DPI website: www.dpi.gov.au/notes

Weeds and pest animals

Weed identification

A weed is a plant that is growing out of place. It is essential that weeds be correctly identified to avoid confusion with a native plants. Furthermore correct identification of the weeds on your property is essential before you decide on a control plan because the success of the plan will depend on the life cycle of the particular weed.

Patersons Curse, for example, is an annual which will seed and die within the year so control will aim at preventing reseeding or germination. Biennials like some thistles will need to be controlled in their first year of life before they set seed. Blackberries are an example of a perennial and these are controlled by depleting their root reserves so that no new shoots emerge.

Landcare notes on identifying and controlling the weeds in your region are available from your local DPI or DSE office or their websites. If you suspect a plant is a weed you can send a photo to your nearest DPI office or local government office. There are also weed identification books available at libraries.

Pest animal control

Pest animals such as rabbits, foxes and wild dogs have a negative impact on the environment and production. For more information on pest animals check www.dpi.vic.gov.au/notes

Identify and record the names of any problem weeds and pest animals you have found on your property.

Exercise 2.8.2 – Map areas of significant degradation

Mark on your aerial farm map any areas of significant degradation and label them.

Any that are significant threats to your property should also be marked on the threats layer.

Tick the relevant boxes below to record the areas you have mapped and to note other natural resource issues you have observed on your property.

- ☐ Erosion (gully erosion, land slips)
- ☐ Salinity (recharge, discharge)
- ☐ Access problems (stock, vehicles)
- ☐ Areas of bushfire risk
- ☐ Invasive plants and animals (rabbit burrows, fox dens or harbour, weeds)
- ☐ Biodiversity decline (loss of trees and other habitat)
- ☐ Animal health issues (lack of shelter, areas with disease issues)
- ☐ Water supply issues (quality, capacity, management)
- ☐ Soil issues (compaction due to stock camps, pH extremes, surface crusting / hardsetting)
- ☐ Nutrient loss
- ☐ Pasture or crop issues (run-down pasture, low ground cover, stem rust)

Blank worksheet

Learning outcome

By the end of this session you will be able to:

- Identify and record the physical soil characteristics
- Create a soil map of your property and record land classes
- Determine land capability and land management options for each land class identified
- Map your property's natural features and infrastructure
- Identify areas at risk of soil degradation
- Classify the native vegetation on your property and assess its condition
- Identify threatened species and communities present on your property
- Identify and map other natural resource issues on your property.


invasive garden plants
what you can do
In your garden, replace invasive garden plants with safer alternatives.
Dispose of garden waste and aquarium or pond contents responsibly.
The nursery and garden industry, the horticultural media and the Victorian Government are all working together to help gardeners understand the invasive garden plant issue.
Weeds are everyone's property
invasive garden plant
ILLEGAL AQUATIC PLANTS
invasive garden plants
what
Weed
Alert!
New weed threats

Element 3

3. Monitor legal requirements impacting on your property

Performance criteria

3.1 Current knowledge of relevant Acts and regulations impacting on the property is maintained.

3.2 Legal requirements are addressed through management plans.

As a landowner you have many responsibilities and obligations under the law. If you're looking to buy land in a rural zone you need to know how to manage your land in a responsible way and keep it free of vermin and noxious weeds. So let's look at a number of the most important laws that ensure you, your neighbours and the environment are protected.

Most of the following information comes from the Rural Law Online website and this is only a sample of the legislation affecting landholders. If in doubt you should always seek an opinion from a qualified legal practitioner.

3.1 Relevant Acts and regulations

and

3.2 Legal requirements and management plans

Pollution

Under the *Environment Protection Act 1970* (the EP Act) landholders cannot 'release any matter into the water, air or soil that harms or puts at risk, the health or survival of any plant or animal living within it.' The Act covers the management and disposal of hard waste, nutrients, effluent, airborne fumes and odours.

The pollution of waterways is seen as a particularly serious matter. The more common examples of pollution of waterways are:

- Dumping hard waste or using natural depressions as waste dumps
- Dumping dead stock into waterways or burying them too close to waterways
- Failing to follow label advice on the correct use and disposal of chemicals and fertilisers
- Allowing wastewater and sewage from domestic water systems or stock containment areas to leak into waterways

With regard to pollution within the EP Act, the definition of water covers 'reservoirs, tanks, billabongs, lakes, springs, swamps, natural and artificial watercourses, coastal waters and ground water as well as the bed and subsoil beneath those waters and the air lying above those waters and drains.'

If you are unsure whether your activities are polluting, contact the Environmental Protection Authority (EPA) information centre on (03) 9695 2722 or your regional EPA office. Further information may be found at: www.epa.vic.gov.au

Also refer to the following EPA publications located on the EPA website:

- Waste Management on Farms
- What to do with Farm Wastes.

Dealing with a pollution problem

Any breach of the EP Act may result in you being penalised or sued as a consequence of your actions. In more serious cases, you may be charged with a criminal offence. You may be required to pay compensation and to bear the costs of cleaning up the damage.

Water and your rights

Water is defined in the EP Act as:

- rivers, streams, creeks or watercourses
- water flowing through a natural channel, either continuously or discontinuously
- a channel formed by the alteration of a waterway
- lakes, lagoons, swamps or marshes.

You do not need a licence to use water for stock and domestic purposes. This includes household use and watering of a domestic vegetable or flower garden.

Outside of stock and domestic uses, you require a licence to take water from a waterway, bore, spring, soak or dam. There is an exemption to needing a licence where a dam is for re-use purposes and is less than a prescribed size.

You need a licence to:

- take water for irrigation and other commercial use from an on-farm waterway and bore (ground water)
- take water for domestic and stock use where there is a crown reserve or other land between your land and the waterway
- take water from off-farm streams for irrigation and other commercial purposes
- access to the Regional Water Authority systems and urban and industrial systems supplied by Urban Water Authorities
- purchase waste water from Urban Water Authorities
- construct bores or dams on waterways.

You also need to be aware of prohibitions on pumping water to dams during summer and volume limits on the amount you can pump. For further information contact your local water authority.

Exercise 3.1.1 – Identify your farm water resources

Identify the water resources on your farm and describe the various ways you can use them.

Farm dams

If you intend to construct a farm dam you have responsibilities under the *Water Act 1996* and the *Planning and Environment Act 1987*. In each case you may require approvals and a licence for construction of the dam and you could incur an on-going fee to continue to use the dam. The Act defines where you can take water from, what sort of dam you construct and when you take water.

It is your responsibility to ensure that the dam does not fail or cause harm to other people or stock. This applies whether the dam is in use or not. For further information refer to the Rural Law Online website or the Department of Primary Industry website: www.dpi.vic.gov.au

Exercise 3.1.2 – Identify your farm water resources and legal constraints

Identify the water resources on the your farm and describe your legal responsibilities regarding their use. Describe the limitations on its different uses?

Native vegetation

Native vegetation refers to the plants that grow naturally in Victoria and were present before European arrival. The category includes trees, shrubs, herbs and grasses. Indigenous native vegetation refers to the native vegetation specific to an area, i.e. does not come from other areas of the State or country.

Legislation relevant to native vegetation includes the *Flora and Fauna Guarantee Act 1988* (the FFG Act), the *Planning and Environment Act 1987* (the PE Act) and the *Catchment and Land Protection Act 1994* (the CaLP Act).

If you intend to import or export native plants or import plants that could harm native animals, you need to be aware of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the EPBC Act, you must seek approval for any actions that could affect areas that have been declared World Heritage Property, Ramsar Wetlands or have listed communities of threatened species.

For more information on the EPBC Act go to www.deh.gov.au

Catchment and land protection

The *Catchment and Land Protection Act 1994* (CaLP Act) covers the management and protection of soils, water, vegetation and fauna on land. It describes the actions and obligations of landholders to protect other landholders and businesses from suffering damage through inappropriate land management. Areas of major concern are:

- Soil conservation
- Soil and water contamination
- Declining water quality and aquatic habitat

The CaLP Act, along with the *Extractive Industries Development Act 1995*, controls any mining activities on your property. This is most likely to be relevant to landholders conducting small-scale extractive work on their property.

Under the CaLP Act landholders have to take all reasonable steps to:

- avoid causing or contributing to land degradation which causes or may cause damage to another landholder
- conserve soil
- protect water resources.

A land management notice may be served on a landholder who fails to comply with these duties. It is an offence under the CaLP Act to disobey a land management notice and penalties may apply.

Catchment management officers

Authorised officers have the power to enter and search land without a warrant when investigating the trade and possession of pest animals. Generally, they only do this with the consent of the occupier of that land unless the situation is deemed an emergency. It is an offence under the CaLP Act to obstruct, interfere with or provide false or misleading information to an authorised officer.

Flora and fauna

The *Flora and Fauna Guarantee Act* 1988 (FFG Act) governs the conservation of threatened species and communities. The FFG Act lists species of 'protected' flora and provides conservation and control measures for the management of potentially threatening processes.

Protected flora

Protected flora refers to native plants or communities of native plants that have legal protection under the FFG Act. View the current protected flora list at www.dse.vic.gov.au

The protected flora list includes plants that are:

- listed as threatened under the FFG Act
- belong to communities that are listed as threatened under the FFG Act
- not threatened but require protection.

You require a permit or licence to possess, trade, move or process protected flora. This applies to both living and non-living plant material. If you wish to collect protected native plants or undertake activities on public land that could disturb, injure or kill protected native plants, you can be prosecuted if you do not have a permit.

For further information on whether a licence/permit will be required for your activity and to obtain application forms, contact the Department of Sustainability and Environment (DSE) on 136 186.

Powers of authorised officers

Under the FFG Act, authorised officers do not need a warrant to investigate compliance with the Flora and Fauna Guarantee Act. They have the power to enter and search any land, inspect equipment, stop moving vehicles, ask questions, and seize and examine relevant documentation.

Collection of seed or propagation material

If you intend to collect native plant seed from public or private land, you may need a permit from the DSE. To check this, contact the DSE or your local council.

To collect protected flora material (e.g. stem cuttings, rhizomes) from public land, you will require a permit from the DSE. You may also require an additional permit for collection from State Forests, parks or conservation reserves managed by Parks Victoria, or any land controlled by your local council, VicRoads or the Public Transport Corporation.

For more information on whether you require a permit and to obtain a permit application form, contact the DSE on 136 186.

Native vegetation permits

Under Victorian law it is illegal, with some exceptions, to clear native vegetation without a permit from your local council. Every planning scheme requires farmers to obtain permits if they intend to clear land for pasture development or cropping. Similarly, a permit is required to crop or re-sow paddocks containing native grass more than 10 years old.

To check whether you will require a planning permit, contact your local council. Local zoning laws and overlays may impose additional controls and requirements that can override some of the exemptions.

A copy of the 'Native Vegetation Management Framework – A Framework for Action' is available at www.dpi.vic.gov.au

Exercise 3.1.3 – Identify your native vegetation responsibilities

Look at the changes you intend to make on your farm layout and identify what responsibilities you have towards native vegetation.

Property vegetation plans

A Property Vegetation Plan (PVP) is a voluntary agreement between a landholder and the DSE that considers how all the vegetation on a property will be managed over the next 10 years.

A PVP that is approved by DSE may be used as a basis for an application for a planning permit to remove native vegetation. If a permit is granted in accordance with a PVP, the permit will be valid for 10 years, rather than the usual two years.

Duty of care and the right to farm

Farmers and their urban neighbours

The relocation of people from urban areas to rural areas can lead to conflicts and misunderstandings, particularly when new residents have a poor appreciation or understanding of the realities of farming and farming activities. It is an offence to take action that unreasonably interferes with another person's use or enjoyment of their land or causes them an injury. Neighbours who are affected by things like odours, loud noise, excess water being diverted on to their land, or trees and branches falling onto their fences may have grounds for complaint and action under common law.

Informing prospective buyers

If you are selling your property, you are obliged to make the buyer aware of any agricultural practices and processes on adjacent properties that may impact on the value of the property. If you are buying property you should make yourself aware of the activities carried out on adjoining properties in case they could have a negative impact in the future.

Negligence and duty of care

All citizens have a duty of care to other members of the public. 'Negligence' is a failure to exercise a duty of care resulting in damage or injury. We all owe a duty of care to anyone who could be affected by our actions if we don't carry them out carefully.

Duty implies that for every action we take, we should be considering its effect on our 'legal neighbours'. We should aim to ensure that they do not suffer personal, property or financial loss or damage as a result of our actions.

Local Government

The planning scheme

Under the *Planning and Environment Act 1987*, the planning scheme regulates the use and the development of land.

Every parcel of private land in Victoria is subject to a planning scheme and is included in a zone. Each zone lists the types of land uses and dwellings that:

- can proceed without a permit (Section 1 Uses. Landholders do not need the permission of the local council to use land for a Section 1 Use)
- can only proceed with a permit (Section 2 Uses and must not be commenced until the local council grants a permit)
- are prohibited (Section 3 Uses. The local council is not legally allowed to grant a permit for these uses).

For more detail about planning law in Victoria, see the DSE publication 'Using Victoria's planning system'.

Overlays

As well as being within a zone, parcels of land may also be subject to another type of planning control called an overlay. Overlays usually exist to protect a particular and important aspect of land that requires a permit. Examples include vegetation, landscape character, water quality, and heritage issues.

Overlays and zones specify types of development. Examples include building works, excavation works, removal of vegetation and subdivision of land.

Your local council can inform you of the zone and any overlays that apply to your land. You can also get this information by searching your address at the Land Victoria website: services.land.vic.gov.au/landchannel. Planning schemes (which comprise maps and text) can be inspected online at www.dse.vic.gov.au/planningschemes

Exercise 3.1.4 – List zones and overlays on your farm

List the relevant zoning and any overlays pertaining to your property.

Animal welfare

As a stock owner, you are expected to avoid inflicting pain and duress on pets and livestock. There are laws controlling the export and import of animals as well as an industry self regulation especially in areas such as animal husbandry and the control of breeding standards.

Cruelty to animals is unacceptable and subject to legal action under the *Prevention of Cruelty to Animals Act 1986* (Vic) and *Prevention of Cruelty to Animals Regulations 1997* (Vic).

Unfortunately cruelty to animals is all too common, with most cases involving pet animals. You must take all steps to ensure that stock in your care are properly housed, fed, watered, protected from extreme weather conditions and provided with adequate room for exercise. Prevention of cruelty to animals requires that you regularly check the welfare of your animals, either directly or through a neighbour. You must plan for times of feed shortages or extreme weather events.

The Act and the Regulations can be viewed at www.dms.dpc.vic.gov.au (select 'Victorian Law Today ') or through AUSTLII at www.austlii.edu.au.

Exercise 3.1.5 – Steps you take for animal welfare

What steps have you taken to preserve the welfare of stock and/or pets for which you are responsible?

Chemicals and fertiliser

The inappropriate or illegal use of chemicals can lead to poisoning, pollution, chemical residues, damage to native flora or fauna (including beneficial insects) and resistance in target pests.

Control and use of agricultural chemicals in Australia

You need to familiarise yourself with the laws on the use of various Agricultural and Veterinary (agvet) chemicals and products. These cover the type, frequency and method of use of chemicals as well as who is legally authorised to use certain chemicals and under what conditions.

Agricultural chemical user permit

You need to hold an Agricultural Chemical User Permit (ACUP) or be under the direct supervision of an ACUP holder if you wish to use the following agricultural chemicals:

- those classified as poison schedule 7 (e.g. aldicarb, aluminium phosphide, chloropicrin, methyl bromide* and parathion) – this does not include animal health products or veterinary preparations
- atrazine
- metham sodium
- the ester formulations of MCPA or 2,4-D or 2,4-DB or triclopyr.

You cannot use these agricultural chemicals for a purpose not specifically mentioned on the label unless you have a permit issued by the DPI.

To qualify for an ACUP you need to complete a Farm Chemical Users Course (FCUC) or a recognised equivalent. Regional Chemical Standards Officers or the Chemical Information Service at the DPI (phone (03) 9210 9379) will provide further information. The ACUP is valid for ten years. An application form can be downloaded from www.dpi.vic.gov.au

To purchase and use 1080 you must complete a 1080 endorsement course (half-day training). To find your nearest 1080 endorsement course go to the ChemCert website www.chemcertvic.org.au and follow the '1080' link.

Prohibition and restrictions on chemical usage

It is important that you check that the chemicals, fertilizer or food stock you intend to use are permitted, as well as the ways you intend to use them. There are some chemicals that are either prohibited or can only be used in specific ways and then only with authorisation.

Prohibited chemicals and chemical uses are subject to change, so it's important that you keep up-to-date with any changes by visiting the 'rules and regulations' section of the DPI website www.dpi.vic.gov.au

Agricultural spraying

The safe use of chemicals has to be uppermost in your mind when using, transporting and storing chemicals.

When spraying chemicals you are responsible for spray drift that may affect the environment or your neighbours welfare and crops. This means you need to be aware of spray conditions (relative humidity, wind speed, wind direction, temperature) as well as the correct maintenance and operation of your spray equipment. In some cases, you are also required to keep detailed and accurate records for certain chemicals. Always check your responsibilities and obligations with the DPI or the person selling you the chemicals.

You cannot apply chemicals to any agricultural produce without the express permission of the owner of that produce.

The code of good practice for farm chemical spray application (available from the DPI website www.dpi.vic.gov.au) provides a voluntary standard for the safe and effective application of farm chemicals. It highlights the user's responsibility to ensure that spray and farm chemicals do not move beyond the target area. The code deals only with ground-based spraying.

Transporting chemicals

When transporting chemicals you must ensure they are kept in a separate, locked compartment, away from passengers and the driver.

The car boot is not a separate compartment. It is good practice to ask your supplier to deliver agvet chemicals to your property rather than pick them up yourself. Containers carried in utilities, trucks or trailers must be securely chained to the vehicle. Transport vehicles must be locked when unattended. You also need to display the appropriate dangerous goods hazard symbols or class labels and hazchem signs. Safety equipment and protective clothing must be carried separately, as must food and drink.

Storage

When storing chemicals, they need to be kept in a secure, dry and well-ventilated area, away from direct sunlight. Avoid storing chemicals with fertilisers, seeds, stock food and personal protective equipment. You should check containers frequently for leaks or signs of deterioration.

It is illegal to possess chlordane and heptachlor for agricultural purposes. If you have another reason for keeping them, then they must be stored on premises which are licensed under the *Environment Protection Act 1970* (Vic) and in a way that ensures they will not contaminate stock, agricultural produce, land or water.

Withholding periods

Many chemicals you use will have a withholding period. In general you cannot trade or use stock or produce that has been treated with an agvet chemical for which the withholding period has not expired.

If you are selling or buying goods that are subject to a withholding period, the seller is obliged to tell the buyer of the withholding period. As standard good practice and to avoid penalties and liability, if the withholding period has not expired you should fully disclose (in writing) to buyers of your agricultural produce and stock.

Exercise 3.1.6 – Do you need chemical user permits?

Do you need to acquire an Agricultural Chemical Users Permit and/or a 1080 endorsement?

Purchase, storage and use of Ammonium Nitrate

Since January 2006, anyone wishing to import, export, store, transport, sell, supply, purchase, acquire, use or dispose of Security Sensitive Ammonium Nitrate (SSAN) has required a Worksafe Victoria licence. Licences are only available to those who can demonstrate a legitimate need for SSAN. Legitimate uses can include commercial and agricultural use by primary producers. For more information, contact Workcover at www.workcover.vic.gov.au

You can also contact the Dangerous Goods Unit of WorkSafe Victoria on (03) 9641 1444

Disposing of farm chemicals safely

Waste-holders wishing to dispose of unwanted chemicals should register a notification of their products to the Chem Clear program (phone 1800 008 182) or online at www.chemclear.com.au

Exercise 3.1.7 – List the chemicals on your property

List the chemicals on your property

Describe your chemical storage area. Is it dry? Is it locked? Are other things like fertiliser stored in the same location as chemicals? Describe how you will store your chemicals.

Control and use of veterinary chemicals

Non-prescription registered veterinary products such as vaccines, drenches and dips for use on cattle, sheep, pigs, or chickens must be used in strict accordance with the label. This must include which animals the drugs can be used on unless you have the written authorisation of a Veterinary Surgeon.

You will require a permit issued by the DPI if you want to:

- Use a registered agricultural chemical product on an animal, unless the use is performed by a Vet, or in accordance with a Vet's written instructions
- Use a registered veterinary chemical product on a plant, place or thing

The Chemical Standards Branch of the DPI provides a free Chemical Information Service to assist agricultural and horticultural industries to improve farm chemical use. The service provides accurate information about registered agricultural and veterinary products and the uses for which they are approved in Victoria.

The service operates during business hours from Monday to Friday. All calls are answered by trained operators. Contact details:

- phone (03) 9210 9379
- fax (03) 9210 9298
- Chemical Standards Branch on the DPI website

Aboriginal cultural heritage

Victoria has a rich and diverse Aboriginal cultural heritage that provides a link for contemporary Aboriginal people with their culture and their past. Cultural places and objects are of great interest and significance to Aboriginal people and form an important part of the heritage of all Australians.

Aboriginal cultural heritage in Victoria is protected by a nationally unique combination of State and Commonwealth legislation. Anyone who plans activities that may damage Aboriginal cultural places or objects should be aware of their obligations under the legislation.

For further information relating to this topic including the most recent legislation go to the Aboriginal Affairs Victoria website: www.aboriginalaffairs.vic.gov.au

New legislation

Commencing on May 28 2007, the new *Aboriginal Heritage Act 2006* (Vic) replaced the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Comm.) and the *Archaeological and Aboriginal Relics Preservation Act 1972* (Vic.)

Key features of the Aboriginal Heritage Act 2006 include:

- the creation of the Aboriginal Heritage Council, with membership of traditional owners who will advise on the protection of Aboriginal heritage
- the use of cultural heritage management plans for certain development plans or activities
- the ability for registered Aboriginal parties to evaluate management plans, advise on permit applications, enter into cultural heritage agreements and negotiate the repatriation of Aboriginal human remains
- alternative dispute resolution procedures.

Bushfire risk management

The Country Fire Authority (CFA) shares the main responsibility for bushfire prevention with the Department of Sustainability and Environment (DSE). The *Emergency Management Act 1986* sets requirements for the coordination of services. For rural private land in Victoria, fire legislation is covered by the *Country Fire Authority Act 1958* (Vic) and the *Summary Offences Act 1966* (Vic), while state forests, parks and other public land is covered by the fire provisions of the *Forests Act 1958* (Vic).

These laws clarify when you can light fires in the open air and your obligations if a fire spreads out of control. During the summer fire season under declared fire regulations, it is an offence to light a fire, or allow a fire to remain alight unless you have a permit. It is also an offence to leave a fire, or fail to report or take action to suppress or report a fire where there is a danger of it spreading.

In some areas of the Victoria, the Forests Act introduced fire prevention and fire suppression requirements for state forests, national parks and protected public land managed by the DSE. This covers about 33 percent of Victoria. During summer, certain powers under the Forests Act are extended 1.5 kilometres over adjoining private land.

Under the Summary Offences Act landholders must also take care with lighting fires outside the declared fire danger period in country Victoria.

Weed and pest animal infestations

Noxious weed identification

Noxious weeds are plants that cause environmental or economic harm or have the potential to cause such harm. Under the *Catchment and Land Protection Act 1994* (Vic) noxious weeds may be declared under one of four categories:

- state prohibited weeds
- regionally prohibited weeds
- regionally controlled weeds
- restricted weeds.

How a particular weed is categorised varies from region to region so a weed that is controlled in one region may be prohibited in another. The regions correspond to the 10 Catchment Management Regions in Victoria.

Aquatic plants may be declared as Noxious Aquatic Species under the *Fisheries Act 1995* (Vic) and such declarations may apply to all of Victoria or a specified part. Noxious aquatic weeds pose a serious threat to fisheries, the aquatic environment or to human health. It is an offence under the Fisheries Act to bring, keep, possess, sell, transport or release in Victoria any noxious aquatic species declared under the Fisheries Act unless you have a permit. Weeds currently declared noxious aquatic weeds are: Ricegrass (also known as Common Cordgrass), Wakame Seaweed and Caulerpa.

A complete list of every noxious weed (including aquatic weeds) and its declared category in each Victorian region is available on the weeds page of the DPI website at www.dpi.vic.gov.au or the DSE website pest plants page at www.dse.vic.gov.au

Noxious weeds on your property

As a land manager, you are responsible for the management of weeds on your land. You are required under the CaLP Act to take all reasonable steps to:

- eradicate regionally prohibited weeds on your land
- prevent the growth and spread of regionally controlled weeds on your land
- prevent the spread of regionally controlled weeds on roadsides that adjoin your land.

The DPI and DSE weed pages on their websites also present the responsibilities landholders have for specific noxious weeds as well as details on how to manage them,

If you intend to control weeds on roadsides near you property, talk it over with the local council officers and make sure you follow the correct safety procedures for working on roads. What constitutes the roadside depends on whether it is sealed or on Crown land. Check with the DPI or look up the Rural Law online site to determine your own circumstances.

Exercise 3.1.8 – Describe noxious weeds on your farm

Describe noxious weeds on your property. Are they regionally controlled? Regionally prohibited?

Describe what action you are required to take for each weed (eradication or control).

Other weed restrictions

Under the CaLP Act, the DSE can restrict the movement of grain, fodder, equipment or animals likely to spread noxious weeds. This includes vehicles and trailers used for transporting hay, grain, fodder or livestock and machinery or equipment used for building or maintaining roads, roadsides or infrastructure. You need to ensure that your machinery or equipment is free from noxious weed material that is capable of growing.

You require a permit from the DSE to:

- import into Victoria or transport within Victoria the seeds or any other part of a noxious weed
- deposit a noxious weed or its seeds on land
- buy or sell (or offer to buy or sell) noxious weeds, seeds or any part of a noxious weed capable of growing

- remove or sell soil, sand, gravel or stone which contains or is likely to contain any part of a noxious weed or that comes from land on which noxious weeds grow
- remove or sell fodder or grain containing seeds or any other part of a noxious weed capable of growing
- sell or hire a substance or machine for use in primary production that contains the seeds or other parts of a noxious weed capable of growing
- sell an animal carrying seeds of a noxious weed, except directly to an approved meat processing facility.

Weed management obligations

If you don't meet your obligations under the law for noxious weeds, you can be issued with a land management notice. It will direct you to take specific action to control the weeds for which you are responsible. Further action can be taken if you don't respond and this is often an expensive option.

Pest animals on your property

Landowners are responsible for managing pest animals on their land under the Catchment and Land Protection Act. Landholders are required to take all reasonable steps to prevent the spread of pest animals and, where possible, eradicate them. Landholders are also required to take all reasonable steps to prevent the spread of these animals on any roadside adjoining their land.

Pest animals are classified as prohibited, controlled, regulated and established. Your responsibilities concerning importing, keeping and selling pest animals depends on pest classification.

For more information on the management of foxes, rabbits, sheep lice, European wasps, wild dogs and other pests, visit the websites of the DSE at www.dse.vic.gov.au and the DPI at www.dpi.vic.gov.au

Hunting and shooting pest animals

You do not need a game licence to hunt pest animals in Victoria, but you must hold a current firearms licence if you hunt with a firearm. There are no bag limits and no seasonal restrictions. Pest animals may also be hunted at night with spotlights, although it is often wise to inform your neighbours of this activity. Further restrictions may apply on Crown Land.

Further information is available from:

- The DSE Customer Service Centre on 136 186 or the Parks Victoria Information Line on 13 19 63
- Stuart Lardner and Keith Larner (DSE), 'A guide for the control over the possession, trade and movement of declared pest animals', LC0303, DPI, Melbourne, June 1998, updated March 2007 at www.dpi.vic.gov.au/notes
- Alan Roberts, 'Managing risk when controlling vermin' AG1213, DPI, Bendigo, July 2005, reviewed September 2008 at www.dpi.vic.gov.au/notes.

Occupational health and safety: Farming is a dangerous job

The following information is from the website: www.betterhealth.vic.gov.au

The most dangerous workplaces in Australia are farms. Farms make up 10% of workplaces but account for 25% of all work-related deaths. Children under 15 and adults over 65 are most at risk of injury or death. It is your responsibility to maintain equipment and machinery, and operate it in a safe manner. You are also responsible for ensuring your family members, farm workers and visitors are aware of potential dangers and are properly trained in the use of the machinery and equipment.

Common hazards

Some common hazards found on farms are:

- animals including injuries inflicted by the animal such as bites or kicks, manual handling injuries and transmissible diseases
- chemicals including pesticides and herbicides which can cause injuries such as burns or poisoning
- confined spaces including silos, water tanks and manure pits that may contain unsafe atmospheres
- electricity including faulty switches or cords or overhead power lines
- heights including ladders, rooftops, silos and windmills
- machinery including tractors without roll-over protection, and any machinery with unguarded moving parts
- noise pollution including noise from livestock and machinery
- vehicles including falls from motorbikes, tractors and horses
- water bodies including dams, lakes, ponds, rivers and creeks which pose the risk of drowning to young children
- weather exposure including sunburn and heat stroke

Exercise 3.1.9 – List safety risks on your farm

Based on the information above, list 10 safety risks you've found on your farm.

	Safety risks on your farm
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

A safer workplace

Ways of making your farm a safer place include:

- consult with farm safety advisors from the Victorian Work Cover Authority
- create a safe and contained play area for young children close to the house
- make sure everyone working on the farm is properly trained
- keep all equipment in good repair
- store dangerous items like machinery and chemicals, behind locked doors
- regularly walk around your farm and assess potential dangers
- devise ways to improve safety, such as fitting roll-over protection (ROPS) and seatbelts to tractors, or replacing dangerous chemicals with less toxic varieties
- keep a log of injuries and near-misses to pinpoint areas for improvement
- consult with other workers and family members on how to improve safety
- write a safety plan together that includes ways to identify the hazards and minimise potential risks
- always use appropriate safety equipment such as goggles or breathing apparatus
- make sure everyone, including children, understands and uses safety procedures.

An emergency plan is vital. Draw up an emergency plan that includes:

- ensure easy access to a suitable First-Aid kit
- make sure at least one person on the farm is trained in First Aid
- keep emergency numbers next to the telephone
- plan routes to the nearest hospital
- regularly talk through your emergency plan
- make sure your children understand what to do
- professional health and safety services.

There are many organisations that can offer valuable advice on improving health and safety on your farm:

- the Victorian WorkCover Authority has farm safety advisors and a comprehensive collection of publications covering health, safety and compensation issues
- the Victorian Farm Safety Training Centre at the University of Ballarat runs a 'Managing Farm Safety' course
- Victorian Farms Alliance offers information on safe operation of tractors and other farm machinery
- FarmSafe Australia and the DSE also offer information and advice on safe machinery operation.

Where to get help:

- Victorian WorkCover Authority Ph. (03) 9641 1555
- Victorian Farm Safety Alliance Ph. (03) 9207 5513
- Victorian Farm Safety Training Centre Ph. (03) 5334 3510
- Department of Sustainability and Environment Ph. (03) 9637 8000
- FarmSafe Australia Ph. (02) 6752 8210.

In an emergency, always call 000 for an ambulance.

The following pages within the www.betterhealth.vic.gov.au website may also be useful:

Farm safety – children, handling animals, handling chemicals, machinery, sheep and shearing.

Exercise 3.2 – Actions to address farm safety risks

Look again at the risks you listed for Assessment Task 3.1.9. Using the information above and your own research into relevant areas, describe the action or steps you intend to take to rectify these situations. Include the date by which you aim to complete these steps.

Learning outcome

By the end of this session you will be able to:

- Gain current knowledge of the relevant Acts and regulations impacting your property
- Develop a management plan to address any legal requirements.

Element 4

4. Develop management strategies for your natural resource issues

Performance criteria

4.1 Property improvement plans to assist natural resource management are developed, costed and prioritised.

4.2 Plans to repair land degradation are developed.

4.3 Plans and strategies to address water supply and water management, vegetation and revegetation management, and wildlife management are prepared as appropriate to the property.

4.4 Strategies for weed and pest management are developed.

4.5 Plans to address fire/risk management are developed as appropriate.

Managing your farm's natural resource issues requires complex planning. Some projects will be more urgent than others because of their impact on production or the risks they pose if not addressed. Each project needs to be prioritised and costed, whether it be related to erosion repair, water supplies, biodiversity protection or pest plant and animal treatments. Best-practice strategies can then be developed to improve your property.

4.1 Property improvement plans

Completing Performance Criteria 4.1 will be easier after working through criteria 4.2 to 4.4. By completing the Assessment Tasks to meet those criteria you will have developed strategies and plans to deal with the issues you identified while working through Element 2. You can then return to criterion 4.1 and prioritise and cost the relevant management issues.

Now that you've made plans for developing your farm, it's important to divide these plans into separate projects and list them in order of priority. Some projects may be deemed urgent, while other projects may be on the long term 'wish list' if sufficient cash flow surpluses or Landcare funding becomes available.

Implementing the new whole farm plan may take many years, especially if limited capital is available. It should also be recognised that the plan should not be 'set in concrete' and should be adaptable to change as new technology and farm practices change. Projects should be costed and implemented in order of priority but opportunity and necessity will generally have the most influence on what gets done and when.

Budgeting for new developments or projects is also an important part of the whole farm planning process. If the project falls into a category where Landcare funds may be available as support, then costing the project can be part of an application for grant and government funding.

Listing projects

An action plan will allow you to break down what might appear to be unreachable goals into many smaller achievable actions. In doing so, you can ensure that over time, action by action, you will achieve your goals.

A well-considered strategic action plan will increase your chances of success. It will also help you manage risks that could lead to ineffective or failed actions or jobs.

An action plan forms the path from the current assessment to the future assessment. This does not mean that a single action plan will allow you to achieve your visions. An action plan to improve a particular area might include many actions running parallel and sequentially over a period of time, perhaps years. Actions dealing with complicated issues might involve many steps and each must be carefully considered to minimise risk of wasting time and money.

It is also important to remember that no plan is permanent. If at any stage the monitoring or review process shows outcomes different from the desired plan, then there is an 'issue' with the plan. Following the continuous improvement cycle, you need to go back to your plan, assess it, determine the areas of failure and develop an improved plan.

On completing the ideal plan for the property, taking into consideration personal aspirations, farm business plans and environmental needs, you will have identified a number of developments or changes necessary for the property.

It is important to separate these developments into individual projects where they can be listed on a work sheet and even given project names. For example:

- new laneway to link paddocks 3 and 4
- new dam in paddock 2 and associated pipes and troughs to service paddocks 1, 3 and 4
- new tree shelter belt along western boundary of paddock 5
- farm woodlot (1 ha) established in paddock 1
- fence off erosion gully in paddock 4
- fence out swamp in paddock 6 and create wetland reserve
- realign fence between paddocks 3 and 4 to match land class boundary
- new tree shelter belt along southern boundary of paddock 2.

No limit need be applied to the number of nominated projects in developing a new ideal whole farm plan and neither must they relate to new subdivisions, land degradation, water supply or trees. If you wish, projects could include such aspects as pasture renovation, crop management and new buildings. The types of plans and projects should not be restricted by financial circumstances at the time as a 'dream plan' can some day, become reality.

The next crucial step in the planning process is setting priorities for the projects you have identified in your new plan. It is highly unlikely that finances will allow all projects to be completed in one or even two years hence the need to develop a realistic timetable to achieve the bulk of the desired improvements.

Setting priorities

After developing the ideal plan, there is usually a number of proposed projects or changes that are identified. While many of these are small and easily achieved, others are large and require more effort and capital.

It is never easy deciding how to order the projects you want to implement so it's a good idea to have an Implementation or Action Plan. This is achieved by scoring each change under a range of different criteria. The outcome of this process is more balanced than simply carrying out changes on the basis of one factor such as return or cost.

Table 6 below provides an example of how to rate the effects of a range of factors applicable to Assessment Task 4.1.1. Each individual change is listed in the table. It may also be desirable for the Assessment Task to prepare a separate set of notes detailing each of these changes.

Firstly the cost of the proposed change is estimated and this is placed in the cost column. The proposed change is then scored for each of the different headings. A score of 0 should be given if the change has no value, 1 for low, 2 for medium and 3 for high value. The individual scores are added and placed in the total column.

Table 6 Example of prioritising ideas for change in the farm plan

Proposed change	Extend lane	Holding yards	Fence off creek	Shelter belt	Chemical storage shed
Cost					
Benefit to land/soil					
Living environment					
Land value					
Amount of labour required					
Long term production					
Total points					

Exercise 4.1.1 – Prioritise changes in your farm plan

Prepare a table like the example shown in Table 6 for your property. Study your map to remind you of the range of works. You may also need to return to the Vegetation Quality Assessment form you completed for Element 2 and the plans you made in Element 4.3 to remind you of the actions that could be taken to increase the habitat potential of your property.

Now list the proposed changes in order by ranking the highest scoring change (3) through to the lowest (0). This becomes your implementation list.

Proposed change					

It may be that the highest scoring item on the top of the list is beyond the scope of your present budget and needs to be included in your long-term planning. Other changes with a lower priority may be immediately achievable. These changes can be carried out and removed from the list. While this will allow changes from a lower ranking the list to move up, the priority order of the changes remains the same. This list will serve as a reminder of the changes that you consider the most important to your property.

Implementation

The next step is the implementation stage. A realistic timetable should be established to see the project through. This requires a genuine commitment and a belief that a particular project is affordable and achievable. The timetable could take the form of a calendar extending over the next five to 15 years and each year designated with one or more projects according to priority.

Budgeting

Each project should be thoroughly costed out to ensure adequate funds are available to complete it. Allowances for time, labour and ongoing maintenance are sometimes overlooked. To make budgeting easier, a simple project worksheet will be useful. You'll give the project a name, calculate anticipated costs as accurately as possible and rank the priority of the project.

Forward planning in preparing budgets for individual projects has several additional benefits. First, cost estimates can be factored into annual farm budgets that can give such projects a priority weighting in the overall farm management plan. A second benefit is Landcare grant applications. With costing estimates for a particular project already completed, much of the work in preparing a submission for a Landcare grant has been done. Another aspect of planning and budgeting to implement a project is to seek the most cost-effective design or method as a means of getting more work done for less.

A project worksheet should include the following:

- Project title
- Brief description including benefits
- List of materials
- Cost of materials
- Cost of labour
- Prerequisites to the implementation of the project
- Priority ranking of the project
- Timeline.

*Assessment Task 4.1.2 – Prepare an action plan of your priority projects

Prepare an action plan and costing of one of your high priority projects. You may use the table provided or devise your own project worksheet. *Please hand this in to your facilitator.

	Example	Project 1	Project 2
Issue and location	Tunnel erosion on hillside identified as E1 on WFP		
Course of action	Deep rip, plant perennial grasses, fencing (land class)		
Who else do I need to consult (contractors, DPI, etc)**?**	Liase with DPI or contractor with regards to specific details of works		
Timeframes	When conditions allow: earthworks in drier months; sow in Autumn/ Spring		

Risks associated with actions	Storm events after earthworks/ sowing; quality of operator		
Cost	$100/hr earthworks; $150/ha perennial pasture establishment		
Date completed			

4.2 Land degradation

Land degradation describes the degradation of soil and water resources due to human intervention. Some degradation occurs naturally, but it is a slow process and is associated with natural change from parent rock material to soil formation.

Human intervention has resulted in a speeding up of the process, which does not give ecosystems time to adapt and results in a deterioration of the environment, loss of biodiversity, loss of agricultural productivity and increased costs to society to pay for the repair of ecosystems.

Soil structure

We can improve soil structure by minimising soil disturbance and improving the organic matter levels of the soil. This can be achieved by using Precision Agriculture (PA) in cropping systems which include minimum or no-tillage or direct drilling of crops, retaining stubble and management zoning. The use of manures and other organic wastes are being trialled for improving organic levels in the soil for improved structure. Long-term pasture paddocks can improve organic matter levels, especially with efficient grazing practices.

If we have a problem with surface sodic soils, we can add gypsum which alters the soil chemistry and encourages the formation of peds within the soil.

Subsoil compaction is another problem that can be avoided by minimising heavy vehicle traffic and pugging by cattle, particularly during wet periods when soils are vulnerable. Encouraging increased levels of organic matter, which improve soil structure, can help by encouraging particles to bind together into larger and more stable aggregates. Deep ripping and adding gypsum can also help.

Soil erosion

For further information on the types of soil erosion summarised below go to: www.dpi.vic.gov.au/notes

Wind erosion

Wind is a prime cause of soil erosion in dry conditions where there is little vegetation cover. Wind velocity affects the size of soil particles that can be lifted and moved from their original position. Groundcover vegetation will affect the wind speed at ground level while taller trees will have a regional affect on the wind speed.

To reduce the likelihood of wind erosion, it is necessary to keep the amount of bare soil to a minimum. This is achieved by retaining vegetation or crop stubble over the dry season.

Rill and sheet erosion

Rill and sheet erosion can be remedied relatively easily by reworking the land and revegetating. If slopes are at risk of rill erosion due to potentially intense rainfall, establishing contour banks at regular intervals down the slope may be a better long-term solution.

However, the area may lack fertility as there is an unrecoverable loss of topsoil during the process and this will take time to rebuild. Future agricultural production from the area should also encourage development of organic matter to replenish the topsoil.

Gully erosion

As gully erosion is caused by the removal of vegetation, it is prevented by retaining vegetation and minimising soil disturbance in vulnerable areas. We can prevent gully erosion by directly drilling crops into stubble or pasture and maintaining good vegetation cover throughout the catchment.

When gully erosion has started, it may be necessary to divert water from the gully, slow down the water velocity using engineering structures and stabilise the gully and catchment using revegetation. An engineering solution may be necessary to take water from the upper level to the lower level of the gully to remove energy from the water and reduce erosion. Planting trees and allowing grasses to re-establish will stabilize gully erosion.

Tunnel erosion

Areas affected by tunnel erosion are dangerous if driving over on tractors or other heavy vehicles as the surface can collapse under the weight.

The tunnel often collapses in on itself over time and progresses to form gully erosion. Tunnel erosion needs major work to break down the current water drainage system. We do this by deep ripping, consolidating the area and revegetating the drainage line with grasses. The wider catchment may need engineering work to divert water from the area and revegetating with trees to reduce water saturation of the catchment. Gypsum may be beneficial in reducing the dispersive soil.

Land slips

Landslips occur due to a combination of the topography, removal of vegetation that increases soil moisture, agricultural activities such as overgrazing, a breakdown in soil structure and additional loads and change in lateral support of the area.

We prevent landslips by minimizing soil disturbance and maintaining deep-rooted vegetation within the catchment to reduce changes in hydrology. Once landslips have occurred they may need engineering work to divert water flow from the area. The problem area may be stabilised through the use of fencing to remove stock, and revegetation of the catchment to reduce water infiltration.

Exercise 4.2.1 – Steps to improve your erosion issues

Refer to the areas you identified in Elements 2.4 and 2.8 as degraded or at risk of degradation through erosion on your property. Describe the steps to make improvements.

Other soil changes

Acidification

Soil acidification usually refers to our farm management practices that over time cause the soil to become even more acidic. Improving pastures, removing agricultural products and applying excessive nitrogen particularly in high rainfall regions can all contribute to a further lowering of soil pH.

Control of soil acidity is achieved by adding lime to raise the soil pH. A fertiliser management program that carefully assesses nitrogen needs ¬may also help to control further acidification. It is important to choose deep-rooted grass species to increase the nutrient cycling.

When liming soil, it is a common aim to increase the pH to at least 5.2. However, soil texture and your whole farm plan should be taken into account when establishing the lime application rate. The usual recommended rate may not be necessary for what you aim to achieve on your land (as shown in Table 2, Element 2). Base the decision on calibrated soil tests and professional advice that's specific to your needs. The most effective change in pH will occur if the lime is incorporated into the soil rather than broadcast.

Fertility decline

Most Australian soils are naturally low or deficient in phosphorous and nitrogen, although the use of fertilisers especially superphosphate and legumes in pastures has substantially improved the fertility of agricultural soils. Soil fertility decline is due to poor management of soil nutrients.

Agricultural production uses soil nutrients that are removed from the system as products are sold off farm. These nutrients need to be replaced to keep a balanced system or lower soil fertility will eventually lower production as pasture and crop yields are reduced and weed invasion occurs. Increased soil acidity or alkalinity also affects the toxicity and availability of some elements.

Biota decline

Soil biota decline is associated with loss of soil structure. Overworking the soil breaks down the soil peds and reduces the soil pore size (see soil structure decline). Compaction of the soil and overgrazing are also linked to a reduction in soil biota. The reduced soil aeration and moisture penetration leads to a loss of the conditions that favour organic matter breakdown and a reduction in health and numbers of soil biota.

The overuse of agricultural chemicals, particularly insecticides and fungicides, may also contribute to soil biota decline.

Exercise 4.2.2 – Rectify your other land degradation issues

Refer to Element 2.5. What other land degradation problems did you identify as occurring on your property? Research and describe what you can do to rectify them.

4.3 Water supply, vegetation and wildlife

Property water supply

Water is an essential resource for all properties, and the availability and quality of water can be a major determinant of the types of activities or enterprises conducted on a property as well as the productivity and profitability of those enterprises.

Many rural and rural residential properties do not have access to a mains water supply and rely on water from bores, watercourses or captured from runoff into dams or rain tanks. While some of these sources may provide a permanent and reliable source of water, others may only provide an intermittent supply which can be unreliable.

The period from 1996 to 2009 was the driest 13 year period in the rainfall record of Victoria so water became a critical issue for many properties with many once reliable supplies failing. In response farmers had to de-stock, change enterprises or seek alternative water sources.

Important considerations for planning any property's water needs are:

- What is water required for (e.g. house and garden, stock drinking, fire fighting, crop spraying, dairy shed, irrigation)
- For each use, the quantity required per year as well as quality
- What water sources are available (their reliability, quality and any restriction or limitations associated with them)
- How to harvest, store and distribute water around the property
- Any regulations relating to the harvesting or use of the water.

Farm water balance

A farm water balance helps to determine how much water is required on an annual basis and how much water is available, in order to identify options to meet that need and manage the water.

Where the water supply is from a continuous and reliable source (such as a bore or permanent watercourse) and no shortage is experienced, the farm water balance would be positive and show a water surplus.

A farm water balance is more applicable and useful where the water source is less reliable and discontinuous, such as from surface runoff or ephemeral (non permanent) watercourses. In these cases the farm water supply relies on capturing and storing water for later use, often in tanks or dams. It helps to identify if the amount of water storage available is sufficient to provide the amount required for usage.

Water requirements

Household and garden water

Household water consumption will depend upon the number of occupants, their lifestyles, and ages of the family members. For the average household, the daily consumption is often in the order of 120 to 180 litres per person. However additional allowances may need to be made for other uses such as evaporative air-conditioners or septic tanks.

Determine your household water requirements.

House name	Litres per year per person	Number of people	Water use (litres/year)
Total household water requirements			

The amount of water required for a garden depends upon the type of garden and its size, as well as the average rainfall (refer Table 9) and the type of watering system used. The watering allowance for gardens shown in Table 7 has been determined on rainfall zones and is supplementary to the amount of summer rainfall received. It is based on a watering or irrigation period of 105 days centred over summer (with no supplementary water use) for the remainder of the year.

Table 7 Garden water requirements to supplement rainfall

Garden type	**Average annual rainfall**		
	above 800 mm	Between 500 and 800 mm	less than 500 mm
Native garden (no lawn)	50	100	150
Lawn with shrubs	150	300	450
Vegetable garden	300	600	900

These figures are advisory only and may not be representative of all situations. If a more accurate estimate is required an individual audit should be conducted.

In drier areas, and for times such as the long period of below average rainfall from 1996 to 2009, some may need to adjust their estimated usage to allow for a longer watering period than the 105 days.

Determine your garden water requirements.

Garden	Area (m²)	Litres used (year/m²)	Water use (litres/year)
List each type of garden area (native, vegetable or lawn)	List the garden area (in metres squared)		
Total garden water requirements			

Stock water

For many rural properties stock water consumption will be one of the major water uses. Water availability and water quality for stock can be a major limitation for many grazing properties and affect the type or number of stock run.

Knowing how much stock drink on an annual basis can help to plan the property water requirements and the size of major storages while the peak summer daily requirement is useful for designing farm water reticulation systems.

The amount required by stock will depend upon a range of factors related to the type of animal and the environmental conditions.

Factors that can affect the drinking water requirement of an individual animal are:

- Class of animal (sheep, dairy cow, beef cow, horse, etc.)
- Type and condition of animal (weaner calf, dry cow or lactating cow, prime lamb, wether, dry or lactating ewe)
- Age and condition of animal
- Activity level of animal (distance to water, size of paddock, distance to dairy shed)
- Environmental conditions (regional location and seasonal temperatures such as hot and dry, warm and/or humid)
- Topography and landscape (hilly terrain, access to shade)
- Type of feed on offer (stock on lush green feed can obtain a significant proportion of water from the pasture, whereas dry feed contains very little moisture; lower quality feed or feeds containing higher amounts of salt will require a higher water intake to aid digestion)
- The quality of water on offer (stock consuming water with higher salt levels will require even more water)
- Type of farm production system.

The figures quoted in Table 8 have been collated from a wide literature search and should be treated as indicative only as they have often been determined under specific conditions.

Table 8 Stock drinking requirements

Livestock unit	**Daily average** (L/day)	**Summer daily average** (L/day)
Sheep		
Nursing ewes on dry feed	10	14
Prime lambs on dry pasture	4	5.6
Mature sheep on dry pasture	7	9.8
Prime lambs on irrigated pasture	1.1	1.5
Mature sheep on irrigated pasture	3.5	4.9
Cattle		
Dairy cow, dry	80	112
Dairy cow, milking	150	210
Beef cattle	70	98
Weaners (250-300 kg)	50	70
Horse		
Working	55	77
Grazing	35	49
Pig		
Brood sow	45	63
Mature pig	20	28
Grower (25 – 90 kg)	12	16.8
Poultry		
Laying hen	0.33	0.46
Pullet	0.18	0.25
Turkey	0.55	0.77
Alpaca (dry)	6	8.4
Deer (dry)	6	8.4
Goat		
Dry	4.5	6.3
Milking	6	8.4

These amounts should be treated as indicative only; you may need to adjust for your particular circumstances.

Determine your stock water requirements.

Stock type	Number of animals	Litres per year per animal	Water use (litres/year)
List each type and class of animal run on property	List maximum potential stock numbers per year		
Total stock water requirements			

Fire-fighting water

Different parts of the state have different requirements for water to be stored for fire-fighting purposes. These can range between 10,000 and 45,000 litres. Some councils require a dam for fire-fighting purposes. If using a tank make sure the fittings are compatible with CFA equipment. Investigate your local council's requirement.

How much water should you aim to store for fire-fighting purposes?

Fire-fighting storage points	Water store (litres)
Total fire-fighting store	

Other uses

Although stock drinking may be the main water use on many properties, water can be required for many other uses such as:

- crop spraying
- dipping of livestock
- washing and cleaning or cooling milk in a dairy
- processing fruit and vegetables or other produce.

Some of these uses could constitute a commercial use of water and if so a licence is required from the appropriate water authority.

Determine your other water use requirements.

Miscellaneous	Water use (litres)
List other uses of water (e.g. spraying and cleaning)	
Total other uses of water	

Water sources and water availability

Rain water supply

On many rural and rural residential properties, water used within the house or for domestic purposes is usually sourced from rainwater collected from roofed areas and stored in tanks (Table 9 indicates the variability in average annual rainfall across Victoria). Rainwater provides high quality water for drinking, hot water services, household cleaning and various veterinary purposes.

Tanks come in a wide range of sizes, and are constructed from a variety of materials (plastic, fibreglass, concrete, galvanised iron). Careful consideration should be given to your purchase. For example, a tank that will service your fire sprinkler system would need to be concrete rather than plastic.

Table 9 Annual average rainfall at Victorian locations

Location	**Rainfall** (mm)	**Location**	**Rainfall** (mm)
Alexandra	703	Hamilton	687
Ararat	590	Horsham	444
Bacchus Marsh	505	Kerang	372
Bairnsdale	716	Maryborough	523
Benalla	668	Mildura	261
Bendigo	550	Seymour	594
Charlton	431	Shepparton	413
Corowa	537	Swan Hill	349
Echuca	426	Wangaratta	638

Roof yield

The total amount of runoff available for storage will depend on roof area and rainfall (refer Table 9 above for your average annual rainfall) and can be calculated from the following relationship:

$$Y_R = R \times A \times F$$

where

- Y_R = annual yield from roof (litre)
- R = annual rainfall (millimetre)
- A = area of roof (square metre)
- F = factor to account for evaporation and splashing

However not all of the rain that falls is actually captured in the tank, as some is lost to evaporation from the roof surface at commencement of the rain event or some very light events may not generate runoff. Some water may also be lost due to overflowing of gutters during heavy events.

An allowance of 5% is made for these losses, reducing the total yield to 95% of annual rainfall. For example, as shown in Table 10, if the average annual rainfall is 600 millimetres and the roof area is 250 square metres (m^2) then:

$$Y_R = 600 \times 250 \times 0.95 = 142{,}500 \text{ litres.}$$

Table 10 Amount of runoff from roof area

	Roof area			
Annual rainfall (mm)	**150 m²**	**200 m²**	**250 m²**	**300 m²**
100	14,250	19,000	23,750	28,500
400	57,000	76,000	95,000	114,000
600	85,500	140,000	142,500	171,000
800	114,000	152,000	190,000	228,000
1000	142,500	190,000	237,500	285,000

As rainfall occurs on a relatively frequent basis and the majority falling on roofed areas runs off for capture, rainfall tanks are replenished (or refilled) on a regular basis. As water is drawn from the tank for use also on a regular basis, this provides storage capacity and makes it possible for more water to be used over a year than the actual tank capacity.

To determine the optimum size tank to match the likely yield from your available roof area and the amount of water used, it is useful to do a water budget (i.e. calculate the input into the tank and the output or use of water from the tank) on a monthly basis.

Determine how much water you can store in rainwater tanks.

Storage tank name	Height (m)	Diameter (m)	Total storage volume (litres)
			List the tank volume (if known or calculate)
Total tank storage			

Catchment yield (runoff into a dam)

Catchment yield is the volume of water that can be expected to run off from the catchment serving the dam site. The catchment yield will depend on:

- rainfall
- area providing runoff to the dam
- soil type
- gradient of slope
- vegetation cover and type
- land use
- proportion of hard surfaced areas within the catchment.

For a given rainfall and area, a catchment with shallow soil and poor vegetation cover will have more runoff and generate a greater yield compared to one with deep soils and intact vegetative cover.

Given the range of factors that can affect how much water actually runs off and how these factors can vary within a particular catchment, accurate prediction of catchment yield is difficult. Predicting future yield is also difficult due to the inherent variability of rainfall from year to year. While the long-term average annual rainfall can be used, consideration may need to be given to the declining rainfall trend experienced since the 1970s and in particular that experienced since 1996.

There are complex methods for predicting catchment yield that provide a greater degree of accuracy, however the following simple rule of thumb has been developed to estimate the yield for small catchments.

Determining catchment yield is a two-step process. First, the yield per hectare generated as a function of annual rainfall is determined from Figure 11. Then to determine the total catchment yield for small, relatively uniform catchments the yield per hectare is multiplied by the area of the catchment and factors for soil type, land use (groundcover) and location.

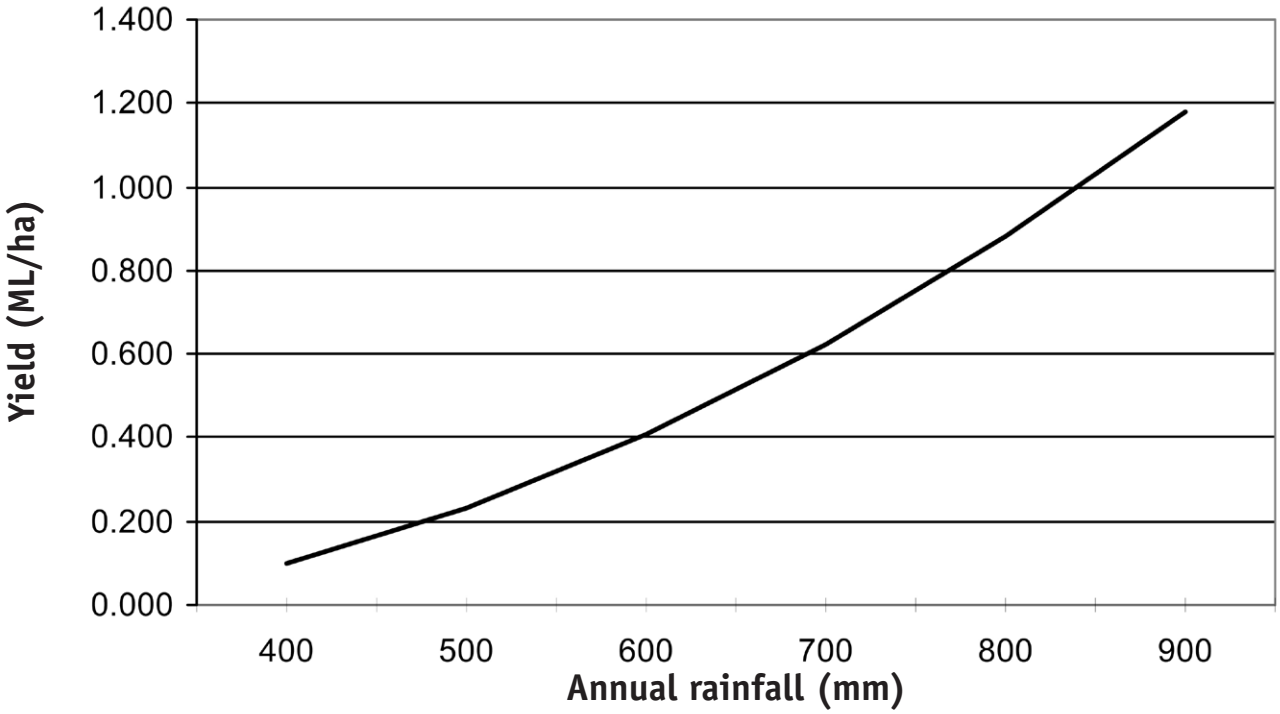


Figure 11 Relationship between yield per hectare and annual rainfall

The total yield from a small catchment is calculated as follows:

Total small catchment yield (megalitres) = Y x A x Sf x Gf x Lf

where

- Y = yield generated (ML/ha from Figure 11)
- A = catchment area (hectares)
- Sf = soil factor

highly permeable	(sandy)	x 0.3
permeable	(loamy)	x 0.6
medium textured	(clay loam – light clay)	x 1.0
heavy textured	(medium – heavy clay)	x 1.3

- Gf = groundcover factor

annual pasture	x 1.0
improved pasture	x 0.5
timbered or forested	x 0.5

- Lf = location of catchment area factor

south of the divide	x 1.1
on the divide	x 1.0
north of the divide	x 0.9

Water storage

Many rural properties that do not have a permanent and continuous water supply, such as a bore or mains supply, rely on storage of water in dams and/or tanks. Due to the inherent variability of rainfall from season to season and even year to year these storages need to be sufficient to last until the next expected refilling of the storage.

Farm dams

Farm dams are a commonly used and quite economical means of storing water for later usage. They can be filled either by direct capture of runoff from the catchment area feeding them or by pumping from a water course or bore.

The suitability of a particular site for a dam will depend primarily upon the soil type and topography of the land as well as the ability to fill it. Not all soil types are suitable for dam construction and some sites can be better suited to the construction of a dam than others whereby they give a better storage to earthworks ratio (how much water is stored per cubic metre of earthworks required to construct the dam).

The site and topography will determine what sort of dam is best suited. Dams can be gully dams, hillside storages, ring tanks or turkey nests. Gully dams may have a ratio of 2 to 1 possibly up to 5 to 1, whereas hillside storages may be 1.5 to 1 or 2 to 1; both can be filled by direct capture of runoff. As gully dams are often located on a watercourse or waterway they need to be designed to have spillways (to allow for the passage of runoff from large storm events without damaging the dam wall structure) and may require licences from relevant authorities. Ring tanks or turkey nests can have high storage to earthworks ratios, up to 20 to 1, but require water to be pumped into them.

Owners of dams are responsible for and accountable for the safety of their dams in relation to hazard to life and property. Consequently owners need to ensure that any dam is designed and constructed to adequate standards to ensure it does not fail. Legislation and regulations apply to particular dams that can be defined as 'hazardous dams'. Ensure you are aware of the responsibilities associated with hazardous dams.

A new dam may require a permit or approval from the local council or water authority before you can proceed with its construction. If the water in the dam is to be used for a commercial use then the dam will require registration with the local water authority.

When planning a new dam, or for assessing the supply of water from existing dams, it is useful to begin with calculations of the expected catchment yield and to make an allowance for losses due to evaporation and seepage.

The size of the dams you need will depend on the catchment yield, the amount of water required for various uses supplied by the dam and the amount of water lost from the dam due to seepage and evaporation losses. A major consideration for sizing a dam is the period for which the dam may need to store and supply water until refilling, termed the replenishment period.

Planning a farm dam

The following checklist will help to ensure you have considered all the factors before constructing your new dam:

- Decide what you want to use the water for
- Calculate the estimated annual requirements for each usage that the dam is to supply and obtain a total
- Determine the replenishment period for the area, and decide upon a drought management strategy
- Multiply replenishment period by annual requirements to determine approximate dam size volume
- Consider possible locations for the dam taking into account:
  - location of dam in regard to legislation and regulations from water authorities
  - potential catchment yield
  - suitability of the dam site regarding:
    - soils, topography
    - how you will fill the dam (direct runoff or pumping)
    - type of dam (gully, hillside, turkey's nest, ring tank)
    - potential storage to earthworks ratio
  - potential size of dam that can fit the site
  - water quality from the catchment and its suitability for proposed uses
- Discuss potential dam sites with relevant water authorities
- Determine approximate dimensions of dam to satisfy volume required and dam site
- Calculate losses due to evaporation and seepage
- Calculate volume required to act as a dam health reserve
- Calculate final design volume
- Determine freeboard requirements and spillway sizing
- Finalise dam design.

Replenishment period for farm water storages

The replenishment period is the time for which the storage must be able to supply water between refilling events, or the frequency on which it could be expected to refill.

The replenishment period is related to rainfall. The lower the rainfall, the less frequently a storage is likely to refill. For dams the replenishment period is usually in years or months. However for tanks the replenishment period may only be months or even weeks due the higher proportion of runoff generated from a shed roof compared to a catchment.

In high rainfall areas it may be sufficient that a dam or dams need only store water to meet one year's water requirements, with a replenishment period of one year. However, in lower rainfall areas where rainfall is more variable or unreliable, a dam may need to store two or even three years water supply. The replenishment period will also be affected by other drought management strategies for the property.

Table 11 Recommended replenishment period for farm dams

Annual rainfall (mm)	**Replenishment period** (months)
Over 800	12
500 to 800	18
Under 500	24-30

Farm dam losses

A significant proportion of water stored in a dam can be lost due to evaporation from the water surface and seepage through the base and sides of the dam. This can be minimised by constructing dams that are deeper and have less surface area exposed to evaporation. Having fewer large dams rather than many small shallow dams can also reduce losses. Table 12 provides a rule of thumb for minimum depths of key (or critical) farm dams, assuming normal seepage and evaporation losses, to minimise these losses.

Table 12 Recommendations for minimum dam depth

Annual rainfall (mm)	**Minimum water depth over 25% of the surface area** (metre)
> 1250	2.5
1,000-1,250	3.0
800-1,000	3.5
500-800	4.0
300-500	4.5
< 300	5.0

Evaporation

Evaporation of water from the surface of a dam can result in the loss of a significant proportion of water contained in the dam. It should be allowed for when planning and designing the dam.

How much water is actually lost from a particular dam due to evaporation is dependent upon the climatic zone (see Table 13), time of the year and period for which water is stored, the surface area of the dam as well as the topography surrounding the dam. Accurate determination of the evaporative loss is very difficult and expensive although it can be estimated by using the Class A pan evaporation data available from the Bureau of Meteorology.

Annual evaporation loss can be calculated from the following relationship:

$$LE = 0.67\ E \times AF$$

where

- LE = evaporative loss (litre)
- E = local annual evaporation (millimetre)
- AF = surface area of the dam at full supply level (square metre).

Table 13 Annual evaporation at Victorian locations

Location	**Evaporation** (mm)	**Location**	**Evaporation** (mm)
Alexandra	915	Hamilton	984
Ararat	1059	Horsham	1173
Bacchus Marsh	1074	Kerang	1401
Bairnsdale	862	Kooweerup	600
Benalla	1158	Maryborough	1143
Bendigo	1212	Mildura	1488
Broadford	1053	Shepparton	1302
Charlton	1275	Swan Hill	1380
Cobram	1323	Tallangatta	1068
Corowa	1218	Wangaratta	1158
Echuca	1350		

For example a dam with a surface area of 5000 square metres (0.5 hectare) at Benalla will lose the following amount of water through evaporation:

$$0.67 \times 1158 \times 5000 = 3{,}879{,}300 \text{ litres}$$

Evaporation also varies considerably throughout the year. During the summer months it is usually about twice that of either spring or autumn months, hence the three summer months account for about one half of the yearly total. This variation will need to be allowed for if estimating evaporations for other than full-year periods.

Seepage

Seepage through the base and sides of a dam can result in loss of water from the dam and some allowance should be made for this. How much a particular dam loses due to seepage will depend primarily upon soil type and construction techniques.

Dispersive clays can very effectively form an impermeable dam with little to no seepage loss. However soils such as red Krasnozems derived from volcanic basalt are very permeable and extremely difficult to make watertight. The presence of rocky or sandy layers can also cause seepage losses and should be avoided when locating or constructing the dam.

The actual loss due to seepage is very difficult to accurately quantify, so an assumed minimum seepage loss of 10% of the total storage volume is allowed for.

Capacity of a farm dam

Knowing the capacity of storages available helps to plan how to meet the water requirements for a property.

There are various formulas for calculating the capacity of a farm dam depending upon the shape and type of the dam. The total capacity of any dam comprises two components: the capacity due to storage above the original natural surface level created by the dam walls (natural storage capacity) and the capacity due to excavation of material for the dam wall that is sourced from below the full supply level (excavated capacity).

Square or rectangular dams

Square or rectangular dams (sometimes termed tanks) are fully excavated storages with no natural capacity and all storage due to the excavation of material. This gives them a 1 to 1 storage to earthworks ratio.

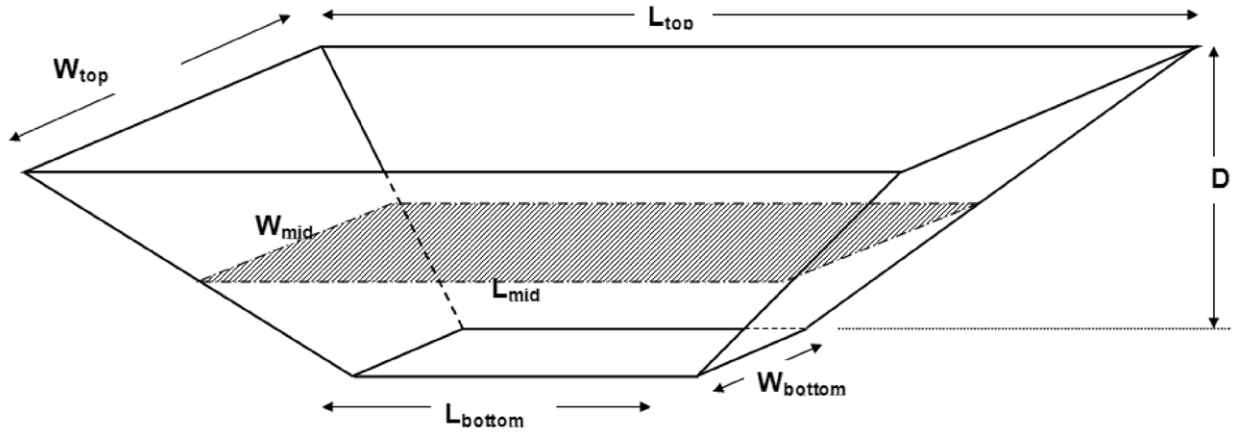


Figure 12 Rectangular dam capacity

The following formula is commonly used in engineering for calculating earthworks and is the most accurate. It requires measurements of the length and width of the water surface when the dam is full, the depth of water when full, and either the length and width of the base (bottom of the dam) or the slope of the batters.

$$C \text{ (cubic metres)} = \frac{D \times (At + 4 \times Am + Ab)}{6}$$

where

- C = capacity
- D = depth at full water level
- At = area of surface when full
- Am = area at mid depth
- Ab = area of base or bottom of dam

Hillside dams

Hillside dams are constructed on sloping ground with the material for the dam embankments usually coming from within the dam storage area (i.e below full supply level). As a result a hillside dam will have a total capacity (C_t) that is the sum of the natural capacity (C_n) and any excavation (C_e) below full supply level:

$$C_t = C_n + C_e$$

The natural capacity can be calculated by using either the prismoidal formula (as for the square or rectangular dam) or the following formula which provides a reasonable estimation (within 20%) depending upon the dimensions of the dam:

$$C_n = A \times D/3$$

where

- A = area of water surface when full
- D = maximum depth of water.

The excavated capacity, providing this is all sourced from below full supply level, will be as follows:

C_e = volume of earthworks in dam wall

Gully dams

The total capacity of gully dams is dependent on the shape of the gully. While formulas exist to approximate their capacity these can significantly over or underestimate the actual capacity, depending upon the actual shape of the gully. As for hillside dams, the storage capacity of a gully dam comprises the natural storage and the contribution from the excavated area:

$$C_t = C_n + C_e$$

where

- C_t = total storage capacity of the dam
- C_n = volume of storage provided above the natural surface
- C_e = volume of storage due to excavation.

The natural storage capacity (C_n) of a small gully dam can be estimated using the following formula (for a wedge):

$$C_n \text{ (cubic metres)} = \frac{(D \times L) \times (2B + W)}{6}$$

where

- L = length or reach of water when full
- W = width of water when full
- D = maximum depth or height of water
- B = width or breadth of gully floor at the base of the dam wall.

Regarding the excavated capacity (C_e), if the dam is empty and the excavated area can be measured its contribution can be determined using the prismoidal formula. Alternatively the excavated capacity would be similar to the volume of the dam walls, providing all the material for the walls had been sourced from below the full supply level. Similarly the volume of the dam walls can be determined using the prismoidal formula.

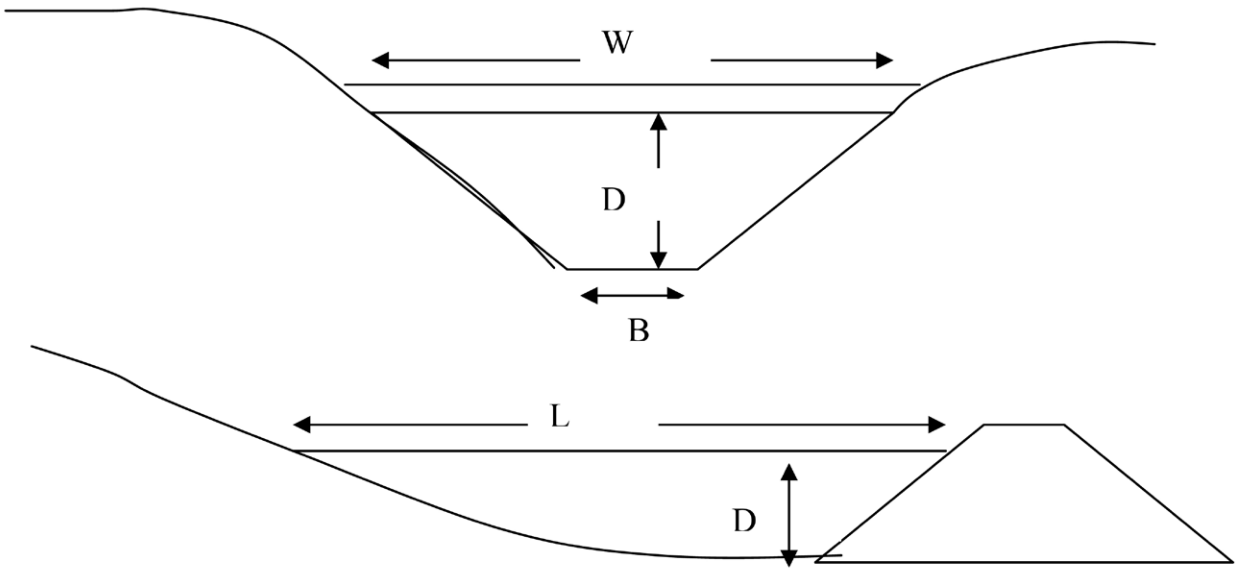


Figure 13 Hillside dam capacity

Dam health reserve

As water levels in a dam get low it is important it does not dry out completely. If it does dry out, the wall, base and sides can crack, and may result in leakage. This is particularly relevant to gully dams built with dispersive soils as small cracks in the wall can lead to tunnel erosion potentially resulting in collapse and failure of the dam.

To prevent this, a minimum amount of water should be maintained in the bottom of the dam to keep it damp. This water can also provide an important habitat for fish, plants and other organisms that contribute to a healthy ecosystem and good water quality. If the dam water is naturally even slightly saline, the minimum amount may not be suitable for use as evaporation can cause an increase in salinity levels.

There are no absolute values, but it is recommended that about a 1.5 to 2.0 metre depth should be maintained. This will also allow for some additional loss due to evaporation and ensure most of the issues will be avoided.

Calculate the volume available from your farm dams after evaporative and seepage losses.

The amount available from a storage for use will be:

$$V_a = C - V_{ev} - V_s - V_h$$

where

- V_a = volume available
- C = capacity of storage
- V_{ev} = volume lost due to evaporation
- V_s = volume lost due to seepage
- V_h = dam health reserve.

Dam name / identification	Total storage volume (litres)
(Do not list dams that fail in 5 or more years out of 10 as they are considered unreliable	List the dam volume (if known or calculate)
Total dam storage	

*Assessment Task 4.3.1 – Determine your farm water balance

Use your calculations above to fill in your total farm water balance sheet. *Please hand this in to your facilitator.

	Total Farm Water Balance		
Part A. How much water do you need per year?			
Stock type	*Litres per Year per animal*	*No of Animals*	*Total water use*
eg beef cattle	*25,500*	*10*	*255,000*
House	*Litres per Year per person*	*No of people*	*Total water use*
eg House 1	*120L x 365 days = 43,800L*	*3*	*131,400*
Garden	*Litres used per year*	*Area (sq. m)*	*Total water use*
Native			
Lawn & Shrubs			
Vegetable			
Miscellaneous	*Volume of water per year*		*Total Water Use*
eg Fire fighting	*45000 litres*		*45,000*
System Losses	*Water source*	*Leakage/evaporation loss factor*	*Total water use*
eg Evaporation	*Dam surface*		
	Overall Total Water Use Part A =		

Part B. How much water can you collect?

Water Source	Flow rate	Daily use		Total Water
eg Stream or bore				

Roof type	Annual Rainfall	Roof area (ha)	Runoff factor	Total Water Collected
10m x 20m	600 mm Rainfall	200m²	0.95	114,000

Catchment name	Annual Rainfall	Catchment area (ha)	Runoff factor	Total Water Collected
	Overall Total Water Use Part B =			

Part C. How much water can you store?

Storage Name (dam or tank)	Storage Type	Dimensions	Total Storage Volume
Dam 1	Rectangle dam	20m x 15m x 3m; 2:1 batterslope	410, 000
	Overall Total Water Use Part C =		

Total Farm Water Balance

Total D =

Water surplus/negative D = C - A

How does Total Farm Water Balance (D) compare with storage (C)?

Property water balance

The water balance is an estimate comparing the annual water requirements for a property to the volume of storage available and in certain cases a more detailed budget may be required.

Where the water balance shows a **surplus** (i.e. the volume of storage available exceeds the annual amount of water required for the property) it is assumed the property's yearly water requirements are met. However in low rainfall areas where runoff and the likelihood of filling (or replenishing) the storages is much lower and more infrequent, it is often desirable to have sufficient storage available to provide water supply for up to two years or longer.

Should the water balance indicate a water **deficit** (i.e. the annual water requirements exceed the volume of storage available) the following aspects need to be considered:

- Does the water source provide replenishment or refilling of the storage of such a frequency that the property does not experience an actual water shortage in most years
- There is sufficient water available in some years but not others and the property occasionally runs out of water
- The property regularly runs short of water on an almost annual basis.

Addressing a water deficit

There are a number of ways to address a water deficit:

- Improve the reliability of supply by seeking alternative water supplies such as groundwater, community pipeline schemes from a secure supply or enhancing catchment runoff by the use of roaded catchments or diversion drains into dams
- One of the cheapest and easiest alternatives is to become more efficient and reduce the amount required, such as providing shade for stock which can significantly reduce their drinking water requirement in hot weather or by installing drip watering systems for gardens
- Reduce the amount of water lost from dams due to evaporation and/or seepage by reducing the number of smaller, shallower dams and having less though larger and deeper dams
- Increase the replenishment period of the dam and hence the storage capacity to carry water over from wetter years to use in drier years, noting that careful consideration needs to be given to the ability of the catchment or watercourse to fill these
- Adjust the enterprise mix or farming system to cope with reduced water availability.

Water quality

Water quality is a key influence on what water can be used for and it can limit or restrict the types of enterprises conducted on a property.

Water quality takes into account a range of parameters, such as salinity, pH, the levels of iron or particular ions such as chloride, calcium and magnesium, the hardness of the water, or the concentration of particular nutrients such as nitrogen or phosphorous. The presence of sediments (as turbidity), odours, bacteria or algae can also influence the suitability of water for certain uses, particularly domestic usage.

High levels of nutrients (phosphorous and nitrogen) can cause algal growth in dams. Algae can cause problems such as unpleasant odours or blockage of pumps. The combination of high nutrient levels and certain environmental conditions can cause excessive growth (blooms) of blue-green algae, which can potentially be toxic if consumed or contacted by humans or stock.

Salinity is often the major water quality issue for farms as water sourced from particular bores, water courses or catchments may be naturally saline. Salinity levels can change over time and should be monitored, particularly if it is known to be an issue. As water levels in dams decline or flows in water courses reduce, salts may become more concentrated and salinity levels increase.

Salinity can be easily measured with a meter and the different levels of salinity that various types of stock can tolerate are provided in Table 14.

Table 14 Salinity tolerance levels for stock drinking water

	*** Production decline begins**		**** Maximum allowable**	
	EC (µS/cm)	mg/l (or ppm)	EC (µS/cm)	mg/l (or ppm)
Lactating ewes, weaners	6000	3800	10000	6400
Sheep (dry feed)	9300	6000	21800	14000
Beef cattle	6250	4000	15600	10000
Dairy cattle	4700	3000	9300	6000
Horses	6250	4000	10900	7000
Pigs	3100	2000	6250	4000
Poultry	3100	2000	6250	4000

*Desirable maximum salt concentration for healthy growth.

**Maximum salt concentration that may be safe for limited periods.

Water reticulation systems

For properties that depend on farm dams in paddocks, their location and reliability is often a major restriction for pasture and grazing management. Water reticulation systems enable water to be transferred around the property from a key water source to troughs in the paddocks. This allows greater flexibility in the location of the watering points (i.e. troughs) and better grazing management which can lead to improved productivity and profitability.

Reticulated water is often of a better and more consistent quality and supply to paddocks is more reliable compared to water from dams and watercourses. Integral to the design of a reticulation system will be the flow rates required to satisfy stock water requirements in a timely manner on a hot summers day, which will exceed average daily demands. On hot days, the peak daily water demand will need to be met over a relatively short time period, often 2 to 4 hours.

The reticulation design will need to account for the location of watering points, the desired flow rates to the watering points and any head losses (i.e due to elevation change and pipe friction loss). These considerations are essential to determine the correct pipes (diameter and pressure rating) and pump required for the job.

Effects of climate change

Across southeastern Australia rainfall for the 13 year period between 1996 to 2009 was the lowest in the historical record (1900 to 2009), with the rainfall deficit being 45% greater than the previous lowest 13 year rainfall (1933 to 1945). This is part of a declining rainfall trend that commenced in the 1970s and from 2000 to 2009 the annual rainfall for each year has been below the long-term historical average.

Unlike previous droughts that were linked to sea surface temperatures, approximately 80% of the recent rainfall deficit is attributable to an intensification of the sub-tropical ridge and accelerated climate change.

The declining rainfall trend is expected to continue, however given the inherent variability of the climate and rainfall there will continue to be some years of above average rainfall. It is predicted there will more years to come of below average rainfall and drought and possibly less frequent but more intense rainfall events. This will have a significant impact upon the type and productivity of farm enterprises and farm water supplies.

As a rough rule of thumb a 10% decline in rainfall results in a 30% reduction in runoff. Such reductions should be considered when planning a farm water supply as they will affect farm water availability and reliability, and potentially necessitate a shift in enterprise mix.

Farm water planning

When planning for farm water supplies it is worthwhile to also consider any potential future changes. This should take into account any changes to the enterprise (e.g. from set stocking to rotational grazing or from sheep to cattle) or type of enterprises (e.g. the proportion of cropping and stock carried) that may be conducted on the property as well as water availability under future climatic conditions.

Vegetation, revegetation and wildlife management

Planning for biodiversity conservation is fundamental to a successful outcome whether you want to create wildlife corridors or habitat blocks. When completing a whole farm plan, it's important to consider where, what, when and how actions to conserve biodiversity will take place. It's easier to be prepared if you prioritise actions on the initial plan.

Action to conserve biodiversity does not simply mean planting trees. Often other actions such as leaving fallen timber on the ground, fencing any remnant vegetation from stock or doing weed control work to allow for natural regeneration will have a greater benefit to the flora and fauna on your property than any revegetation works.

A good management strategy for your property will enhance existing vegetation by recreating missing layers. For Exercise 2.6.3 you prepared a habitat quality assessment. You will use this as the basis for developing a management strategy.

Corridors and stepping stones

When thinking about the layout of your farm and how you can make best use of the existing vegetation it's best to consider the vegetation in terms of corridors of vegetation and stepping stones as links for the movement of animals and plant material through the landscape.

Wider corridors are more effective. Where possible make use of the existing roadside vegetation to build wider corridors; a zone of about 40 metres is desirable.

Vegetation does not have to be connected to provide valuable habitat. If remnants are of a suitable size and close enough together, they can still provide the necessary shelter and diversity for different species of plants and animals.

You can add layers of vegetation to enhance existing remnants and fence them off from grazing stock. By fencing and joining 'islands' of vegetation, you can create stepping stones to maximise the opportunities for native birds and animals.

For more information check the DSE website, refer to the 2002 DNRE publication by Steve Platt, *How to plan wildlife landscapes: a guide for community organisations* or contact your local DPI or CMA extension officer.

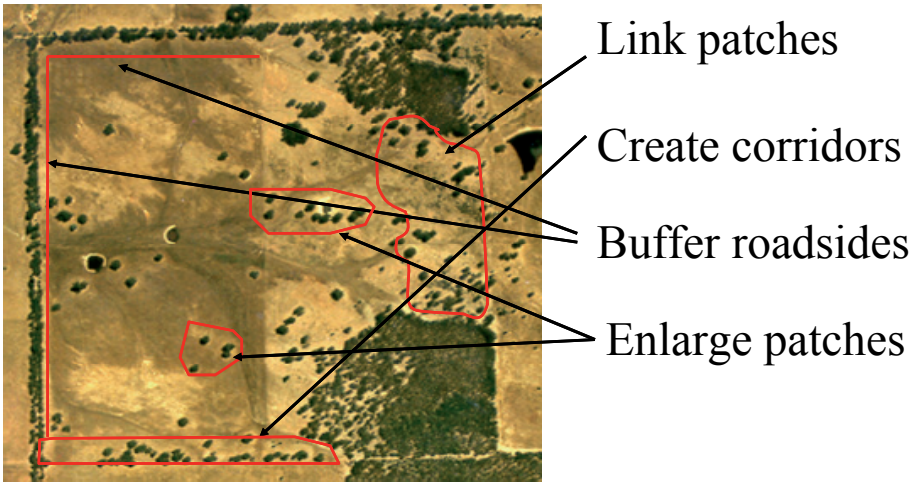


Figure 14 Example of planning for biodiversity

Exercise 4.3.2 – Improve your vegetation quality

Refer to the Rapid Habitat Assessment form you completed for Exercise 2.6.3 to meet Performance Criteria 2.6 and 2.7. You scored a section of your property against a number of components and benchmarks.

Choose one of your lowest scoring components/benchmarks. Now describe what you could do to improve your score. For example, if your score for logs was low, you may decide to retain older and dying trees rather than clean them up, and establish woodlots instead to meet your firewood requirements.

Component/benchmark	
Score	
Strategies to improve score	

For detailed information on strategies refer to the DSE booklet 'Environmental management in agriculture', Worksheet 7.

Revegetation

If you are planning revegetation works, you will need to allow time to order seed or seedlings, prepare the site and erect fencing in order to ensure the seed or seedlings go in the ground at the right time of year. If applying for grants, there may be an 18 month lead time between planning, application, receipt and actual planting. Good site preparation is the key to successful revegetation projects so it pays to be prepared and to be patient!

For the latest information on revegetation strategies and government grants go to your local Catchment Management Authority website.

Exercise 4.3.3 – Record future works for your farm map

You are now going to record your plans for future works regarding water, vegetation, revegetation and wildlife management on your aerial photograph. Take into account what you know about your property and ask yourself what management improvements you could make. Remember to start with what you already have and build on that. Don't allow cost to be a factor at this stage because, depending on future policies and grants, what may seem unattainable now might well be accessible in the future.

Record your plans for future works in the following categories.

Wildlife refuges and corridors	
Wetlands enhancement	
Vegetation management	
Fencing	
Water supply	
Plantations	
Other	

4.4 Weeds and pests

Managing weeds

For Performance Criterion 2.8 you identified weed infestations on your property. You are now going to develop a plan to manage those weeds. Remember controlling weeds is not a one-off event but a regular annual commitment.

There are a number of methods for treating weeds. These include:

- Biological control which uses one organism to attack and control another
- Pasture and grazing management that aims to minimise infestations with sowing and soil aeration programs and by using stock to keep down weeds. This is achieved by grazing at a range of different stocking rates
- Chemical control that uses a range of chemical herbicides specific to certain weeds. These must be used strictly in accordance with the directions on the label
- Prevention that depends on knowing the weed's method of dispersal. Weeds can be spread by stock feed, new stock, machinery, wind and water. Once you know their dispersal mechanism, you can take preventative measures like confining new stock and cleaning up machinery that has been used in a weed infested area
- Plant competition where weeds are unable to spread due to a good, healthy cover of vegetation
- Cultivation using implements like disc ploughs, harrows and deep rippers that can be effective on annuals, however this method must be used with consideration for the potential effect on soil structure and erosion
- Mulching which covers the weeds with a layer of material that denies them light and prevents germination
- Burning which has specific applications and requires specialist knowledge
- Using a combination of the above methods is an effective way of managing weeds.

Table 14 Description and timing of weed control works (check regional variations)

Month	**Weed**			
	Patterson's Curse	St John's Wort	Blackberry	Pasture improvement^
January	Patrol	Spray	Spray	
February	Patrol	Spray	Spray	
March	Spray	Spray	Spray	
April	Spray			
May	Spray			
June	Spray			
July	Patrol#			
August	Patrol		Mechanical control	
September	Patrol		Mechanical control	
October	Patrol			
November	Patrol	Spray		
December	Patrol	Spray	Spray	

*Description = planning, or chemical, or mechanical or biological control methods (chemical control includes soil treatments)

undertake control activities (spray or dig out) if necessary

^ Pasture improvement/fertiliser application is an important part of weed control

As discussed earlier, the most appropriate form of weed control will depend on the weed infestation and the capacity and use of your land. On marginal land that makes little difference to overall profit, it may make more sense to tolerate a certain weed level if it is in a low density and not escaping into the surrounding area.

Remember it is the landholder's responsibility to control weeds and in some areas it is an offence not to control certain weeds.

Exercise 4.4.1 – Develop a weed management plan

Having identified weeds on your property in Element 2 decide what you will do to control or if required eradicate them. Information can be found in Landcare Notes on the DPI website: www.dpi.vic.gov.au/notes

Complete your weed management plan, ensuring the timing of weed control works shown in Table 14 is relevant to your area.

Location of infestation (paddock name/ number)			
Severity (H/M/L)			
Area (Ha)			
Options available (chemical/ mechanical/ biological)			

Risks associated with option			
Most effective option			
Work plan (outlines plan of action)			
Timing (summer, autumn, winter, spring)			
Cost of works			

Pest animals

As a landholder, you owe it to yourself and your neighbours to control pest animals such as rabbits and foxes. Keep in mind that even native animals such as kangaroos may need controlling to prevent suffering and to reduce their impact on native bush and pastures. Talk to your local Department of Sustainability and Environment office about obtaining a wildlife permit. If you are a landholder who is relatively new to the area, talking to locals and joining your local Landcare group are good ways to learn about local conditions and pest control programs in the district.

Exercise 4.4.2 – Develop a pest animal management plan

Complete your pest animal management plan.

Location of infestation (paddock name/ number)			
Severity (H/M/L)			
Area (Ha)			
Options available (e.g. ripping, fumigating, shooting, ferreting, baiting)			

Risks associated with option			
Most effective option			
Work plan (outlines plan of action)			
Timing (summer, autumn, winter, spring)			
Cost of works			

4.5 Fire and risk management

Your farm is your home and your business, and an important part of developing a whole farm plan is your fire plan. According to the Country Fire Authority (CFA), there are a number of things you can do to reduce the chance of a fire starting on your property:

- Check that all your equipment and everyday farm practices are fire safe
- Store flammable materials safely
- Learn about fire and how it behaves
- Observe fire restrictions.

The CFA also gives advice on how to minimise the impact of a fire on or near your property:

- Have a fire plan
- Have a communication plan
- Prioritise your assets
- Undertake fuel reduction work such as strategic grazing and slashing, removing fuels and managing fuels around strategic assets
- Understand the ramifications of the current 'leave early or actively defend' strategies
- Make sure your whole family understands what to do in a fire emergency
- Be aware of what's happening on and around your property
- Have an appropriate fire fighting capacity that doesn't depend on an electric pump or plastic hoses
- Phone 000 early; don't wait for the fire to grow
- Have appropriate insurance cover
- Have clearly marked watering points.

If you do need the fire brigade it's important that they can access all areas of your property. Fire trucks have specific requirements to operate at their full capacity. They need a minimum height and width clearance of 3 metres – narrow gates and tight turns restrict access – and bridges need to be able to support at least 15 tonnes. They also need accessible water supplies with suitable fittings.

For the latest information:

- Go to www.cfa.vic.gov.au
- Contact the Victorian Bushfire Information Line on 1800 240 667
- Ask your local CFA Community Education Coordinator for information and brochures.

Exercise 4.5 – Consider your fire management strategies

Apply what you have learned to your own property and answer the following questions.

What will you do to minimise the chance of a fire starting on your property?	
What will you do to minimise the impact of a fire on your property?	

Learning outcomes

At the completion of Element 4 you will be able to:

- Develop, cost and prioritise property improvement plans to assist natural resource management on your property
- Develop plans to repair any land degradation on your property
- Plan strategies to address water supply and water management, vegetation and revegetation management, and wildlife management as are appropriate to your property
- Develop strategies for weed and pest management
- Plan strategies for fire and risk management.

Element 5

5. Review your whole farm plan

Performance criterion

5.1 Plans are reviewed and revised to meet changing circumstances.

5.1 A revised and renewed plan

The final step is to review your whole farm plan preferably in consultation with your business partner, family, other landholders or your local extension officer. Ideally, the plan should be reviewed on a regular basis depending on changes in priorities.

Assessment Task 5.1, on page 145, provides an opportunity to consolidate all that you have learned in the previous sections and adjust your farm plan as circumstances and needs change.

Learning outcome

At the completion of Element 5 you will be able to:

- Review and revise your plan to meet changing circumstances.

*Assessment Task 5.1 – Your property features and planned improvements

This Assessment Task is designed to help you in the review process. *Please complete and hand in to your facilitator.

What you have on your farm

Please use this sheet as a checklist to ensure you have identified all the land features on your property.

- ☐ Land classes and capability (see attached land class sheet Class I – Class VIII)
- ☐ Drainage lines and ridge lines
- ☐ Soil types (soil tests or at least soil pH tests)
- ☐ Remnant vegetation and plantations (including those adjacent to the property)
- ☐ Native grasslands
- ☐ Areas of natural regeneration (less than 10 years old)
- ☐ Historic or archaeological sites
- ☐ Wetlands
- ☐ Erosion (areas showing signs of erosion or that are susceptible)
- ☐ Salinity
- ☐ Tree decline
- ☐ Frost hollows
- ☐ Other problems
  - ☐ - waterlogging
  - ☐ - rocks
  - ☐ - recharge / discharge
  - ☐ - steep slopes
- ☐ Ecological Vegetation Classes (EVC's)
- ☐ Bioregion name

- [ ] Planning constraints
- [ ] - easements
- [ ] - power lines
- [ ] - road reserves
- [ ] - gas pipe lines
- [ ] - covenants
- [ ] Fire management plan
- [ ] Weed management plan
- [ ] Wildlife habitat
- [ ] Weeds
- [ ] Rabbits, vermin or wildlife
- [ ] Stock camps
- [ ] Access problems
- [ ] Run-down pasture
- [ ] Fencing
- [ ] Water supply
- [ ] Buildings
- [ ] Access and laneways
- [ ] Yards
- [ ] Pastures
- [ ] Shelter
- [ ] Fire plan works
- [ ] Investigate new farming techniques

What you plan to do

Taking into account what you know about your property, what improvements could you make for its best management? Use this sheet as a checklist to make sure you've marked on your map all the improvements you could make.

- ☐ Wildlife refuges and corridors
- ☐ Wetlands enhancement
- ☐ Vegetation management
- ☐ Fencing
- ☐ Water supply
- ☐ Buildings
- ☐ Access
- ☐ Yards
- ☐ Pastures
- ☐ Plantations
- ☐ Investigate new farming system

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