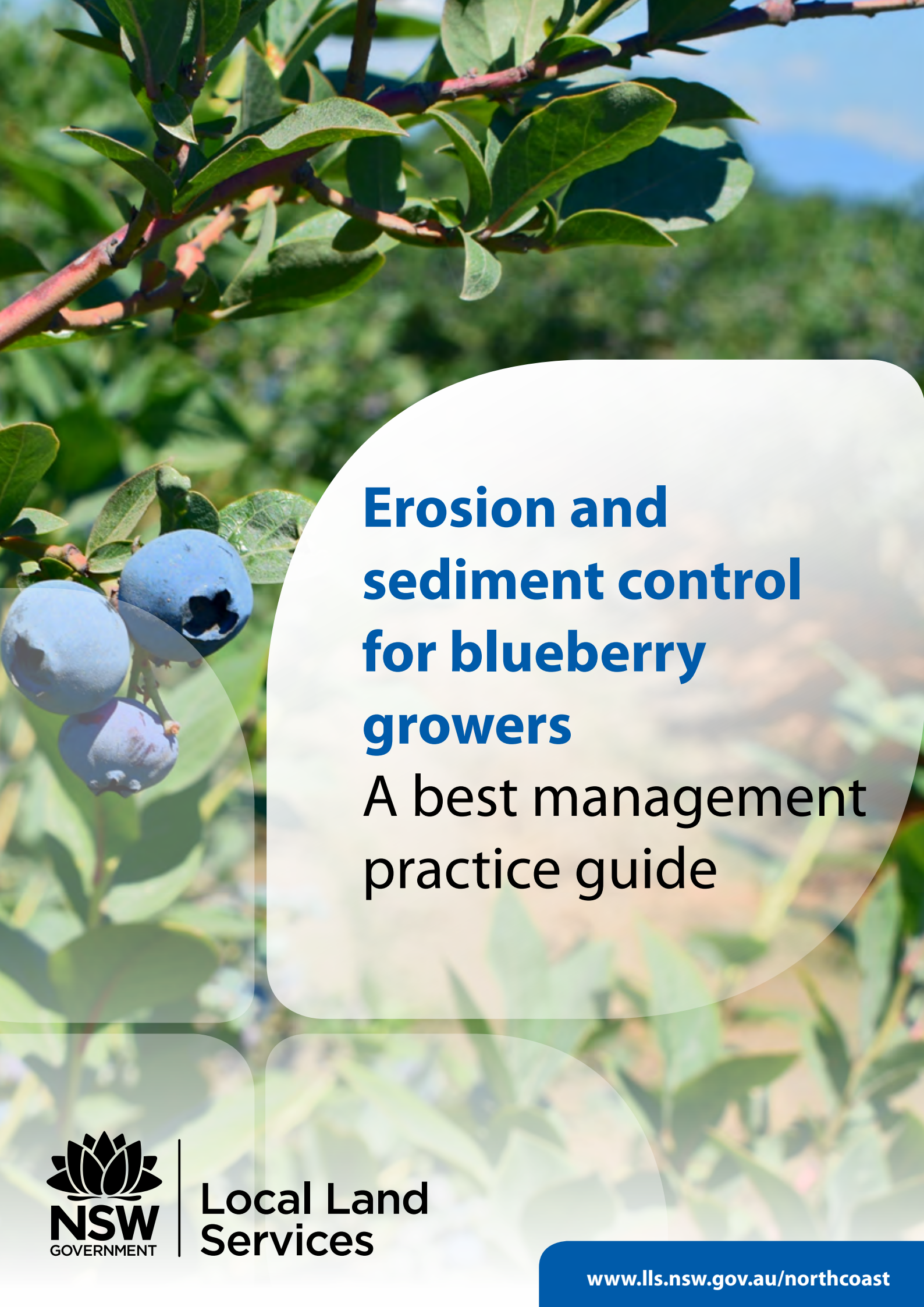


# Erosion and sediment control for blueberry growers

## A best management practice guide

NSW GOVERNMENT | Local Land Services

www.lls.nsw.gov.au/northcoast


**Acknowledgements**

This document is an updated version of the document Wilk,P and Ireland,G (2008) Soil and Water Management Practice for Blueberry growers in Northern NSW. It has been updated by Local Land Services in consultation with NSW DPI, Soil Conservation Service NSW and Berries Australia.
Author: J Dart (Local Land Services).
Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing June 2020. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of Local Land Services or the user's independent adviser.

# Contents

# Introduction

The Erosion and Sediment Control for Blueberry Growers Best Management Practice (BMP) guide has been developed for the blueberry industry on the north coast of NSW, where high intensity rainfall is common, and blueberries are often grown on steep land.

Adopting good soil conservation practices is essential if soil erosion is to be avoided.

Soil erosion has been recognised as a serious land degradation problem in Australia for many years. Some movement of soil through the landscape is natural, but high rates of soil loss from agriculture and development is not.

Unfortunately, erosion rates of more than 20 tonnes of soil per hectare a year occur easily on steep slopes, if management practices are not ideal.

Erosion control practices will reduce off-site impacts such as polluting water with sediment and nutrients. By controlling erosion and sediment on the farm you can help keep your farm dams clean and reduce the risk of algal blooms.

By following the BMPs in this guide, businesses can develop and operate blueberry orchards that have fewer erosion problems, which won't adversely affect downstream neighbours or the environment.

Management practices described in this guide can be applied in other growing regions.

**Sediment is soil and other material that has been picked up and carried to another location in water. It is important to minimise sediment loss from the farm.**

**Soil erosion results in lost production, loss of access to land (from washouts) and increased cost of fertilizers to replace lost nutrients.**

# Background

## The Australian Blueberry Growers' Association Code of Conduct

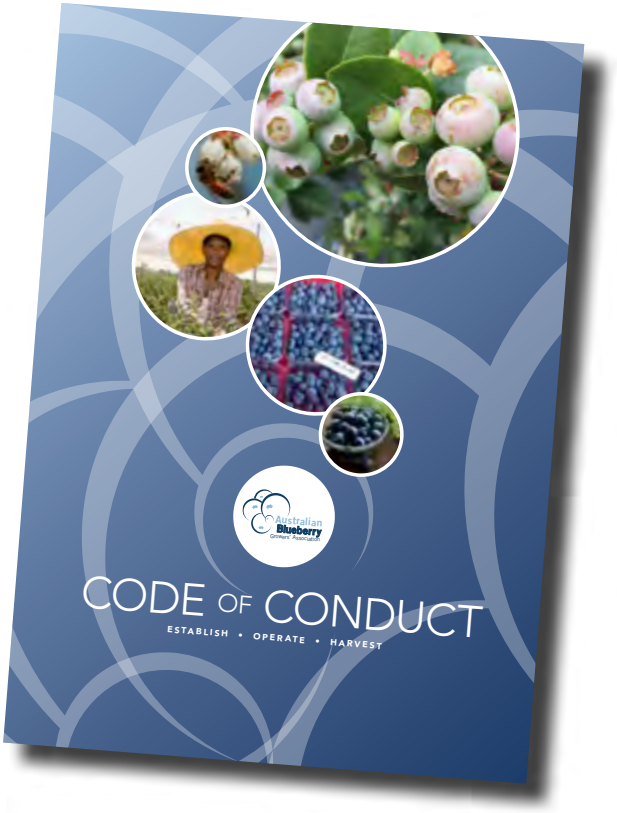
In 2018 the Australian Blueberry Growers' Association (ABGA) published an industry code of conduct (the Code) which intended to promote good practice operations across Australia.[1]

The Code includes references to erosion and sediment control planning, the implementation of soil conservation works, and the need to maintain any structures over the life of the orchard.

The Code provides a checklist to assist growers keep track of their progress against various recommended practices.

The pre-establishment checklist includes two erosion and sediment control items:

- Do I have suitable erosion and sediment control plans in place for the construction phase of development?
- Will my development include long term measures to control erosion?




## A growers' duty of care and the application of due diligence

The BMP guide has been designed to help growers meet the erosion and sediment control recommendations in The Code to satisfy legal duty of care and due diligence under environmental legislation.

Using the practices will reduce pollution, so water leaving the property meets water quality guidelines and standards.

There are several NSW laws (legislation) that relate to soil erosion. These aim to prevent harm being caused to the environment and to people as a result of excessive soil loss.

If a creek is polluted with soil, fertilisers or other chemicals washed from a property, this could lead to prosecution under the *Protection of the Environment Operations Act (1997)*.

*Left: Double Crossing Creek flows into Hearne's Lake and during low flows the water quality is good. Right: After heavy rain the creek has a high load of sediment from the upstream catchment. Source- Shane White, Southern Cross University.*

### How can a grower meet their legal obligations in terms of minimising soil erosion?

Two terms are often used when discussing a landholder's responsibility with respect to environmental law:

- duty of care
- due diligence.

A duty of care is a legal duty to take reasonable care not to cause harm that is reasonably foreseeable to another person. It is sometimes called the neighbourhood principle because it is based on the idea that in order to live in a healthy and functioning community, we all have to take responsibility not to harm those around us.[2]

The idea of due diligence has a more formal legal meaning:

Due diligence is recognised in most jurisdictions of Australia as a defence to director prosecutions following a breach by a company of environmental law.[3]

## Protecting catchment and marine water quality

Every landholder should ensure that water flowing off their property is at least the same quality, or cleaner as the water that entered it. Doing this will help maintain water quality in the catchment for all users and keep the environment healthy.

A recent study into the threats faced by the marine estate in NSW (which includes all coastal waters, estuaries and coastal wetlands) found that sediment and fertilizer pollution from agricultural runoff was one of the top three risks to the marine estate.

Algal blooms occur in water when nitrogen and phosphorus levels are high. With sunlight and warm temperatures algae can grow rapidly. Nitrogen is dissolved in water, and phosphorus attaches to soil particles in muddy water.

Algae problems occur both on farm and in the natural environment. It can be avoided by controlling farm runoff and taking care with fertilizers.

# Minimising soil erosion and nutrient runoff from your property

The BMP recommends eight practices to control soil erosion and nutrient runoff. The following key points are important:

- The practices in this guide apply to both existing blueberry farms and new developments.
- Many practices are suitable to adapt for other perennial fruit crops grown on raised beds.
- The BMPs are best used with a formal erosion and sediment control plan which will identify the exact requirements of your property.

It is highly recommended that professional assistance be sought to develop an erosion and sediment control plan, which includes the design and implementation of on-ground soil conservation works.

## 1 SLOPE

Determine which areas of the property are suitable for berry production, and which areas are not (based on the slope of the land).

## 2 MAINTAIN MAXIMUM GROUND COVER

Ensure that there is no bare soil in the orchard by using mulch and living groundcover in the orchards.

## 3 RUN-ON WATER

Manage run-on water for each area developed for berry production.

## 4 RUNOFF WATER

Manage runoff from irrigation and rain falling within the orchard to minimise sediment and nutrient loads.

## 5 SEDIMENT MANAGEMENT

Minimise sediment (dirty water) movement within the orchard, and on the farm, by implementing sediment management practices.

## 6 SAFE DISPOSAL

Water diverted from, or collected in the orchard, is delivered to a stable receiving area without causing more erosion.

## 7 RIPARIAN ZONES

Protect native vegetation along waterways and rehabilitate to protect streams from erosion and improve water quality.

## 8 MONITOR AND MAINTAIN

Regularly check and maintain sediment control structures and continue practices to ensure they are effective and operating as intended.

BMP 1

# Determine the slope

## Why consider land slope?

Land with a slope of 18 degrees (°) or more should not be developed for blueberries, or other intensive horticulture crops requiring cultivation or regular use of tractors and machinery. This includes steep land previously used for bananas. Blueberries should be grown on land with a slope of less than 15°. Soil erosion and general management problems become worse when land is steep (with 18° being considered the absolute maximum).

## Measuring slope

The slope of your land is the most important aspect to consider when planning to develop your property for blueberry production. Which areas can be developed, and the soil erosion control works that will be required, depends on the slope. The slope is the relationship between the rise (vertical distance) and the run (horizontal distance). It can be confusing when talking about slope measurements as it can be expressed in different ways.

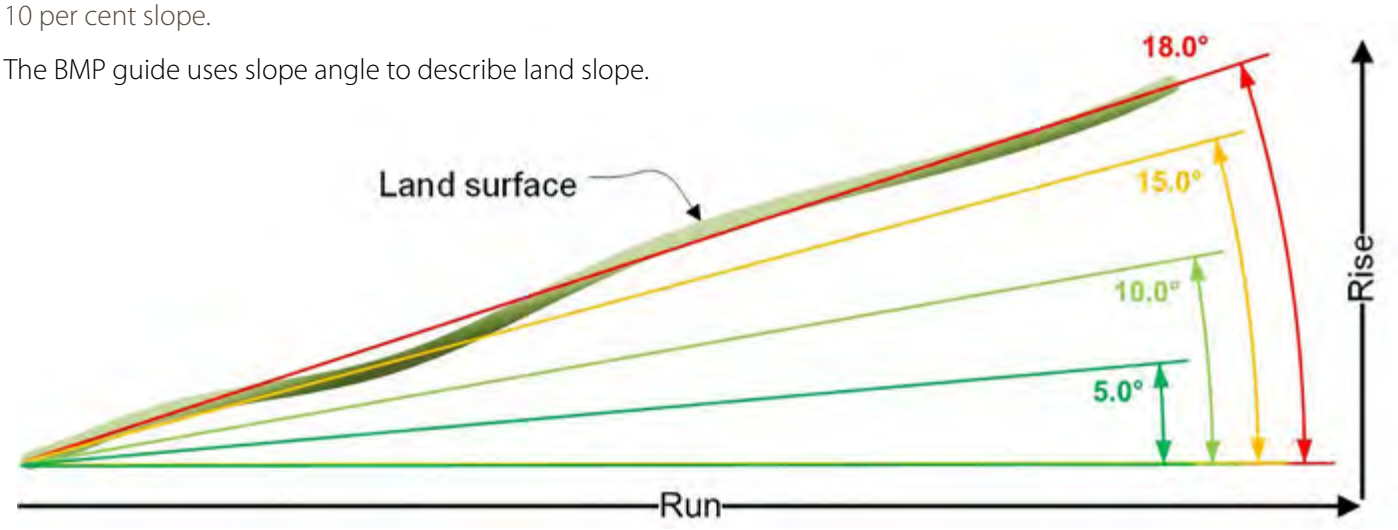
The typical measurements are:

**Angle:** The internal angle (in degrees) at the lower corner of a triangle formed by a line drawn through the land's surface and the horizontal run (see figure below).

**Ratio:** The rise in relationship to the run e.g. a hill that rises 1m over a horizontal distance of 10 m would be expressed as a 1 in 10 slope, which is typically written 1:10.

**Grade (percentage):** The ratio expressed as a percentage, e.g. a slope with a rise of 1m over a 10 m run has a 10 per cent slope.

The BMP guide uses slope angle to describe land slope.




| Angle (°) | 5 | 10 | 15 | 18 | >18 |
|---|---|---|---|---|---|
| Ratio (1 in xx) | 1:1 | 1:6 | 1:4 | 1:3 | No orchard development |
| Grade (%) | 9 | 18 | 27 | 33 | |
| Orchard development desirability | ✓✓✓✓ | ✓✓✓ | ✓✓ | ✓ | × |

*Slope is the relationship between elevation (rise) and distance (run). The conversion table presents slope angles in three formats. In the slope diagram the slope is expressed as degrees.*

## Assessing slope on your property

Slope measurements can be grouped into slope classes. The BMP guide uses the following:

- flat to gentle
- moderate
- steep
- too steep/vulnerable land.

### Direct measurement

The Direct measurement of a slope is usually carried out using an instrument called a clinometer. There are now smart-phone applications that can do the same thing.

On long uniform slopes taking a number of readings and averaging the results will improve accuracy. The results can be recorded on a property plan.

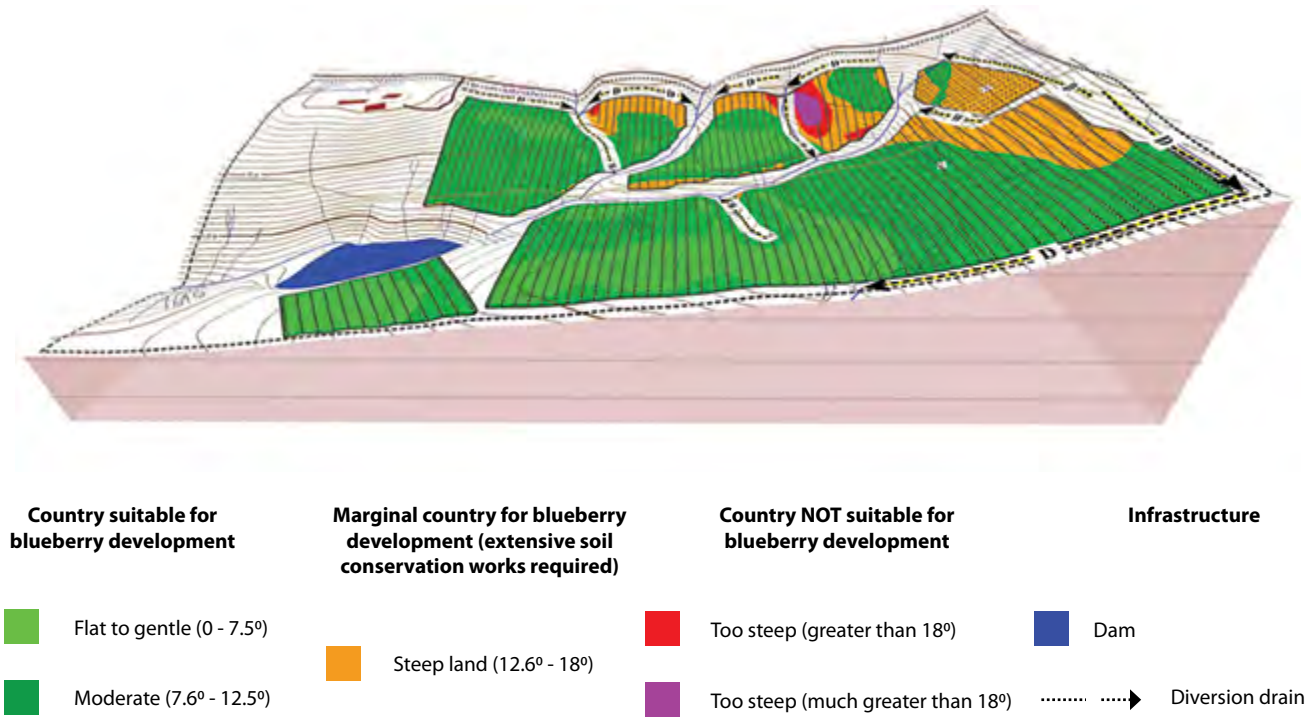
### Mapping

The slope of land can be calculated from topographic maps, or for large areas a remote-sensing technique called LiDAR (light detection and ranging) can be used to produce detailed slope maps.

Contractors are available who can use this technique to map your property at reasonable cost.

Slope mapping can also be used with mathematical models to calculate rates of soil erosion on the farm and help you decide on effective management strategies.

An example of a 3D map produced using the LiDAR technique is presented below.




*A slope map made from LiDAR data. Detailed maps can be produced using computer modelling. Contractors are available who can map your property and help design sediment and erosion control plans. Source: Bob Howard, GES Mapping.*

## Selecting land that is suitable for blueberry production

The following is a guide to land use limitations and other commercial considerations for blueberries based on slope class:

### Flat to gentle (0 – 7.5°)

- Flat to gently sloping land is ideal for blueberries and is a good choice for development in areas not susceptible to frost, flooding or water logging.
- The performance of drip irrigation systems, as well as the ease of growing and harvesting operations, are best on flat to gentle slopes.
- Even on gently sloping country, soil erosion can occur on bare ground and when soil is cultivated. Soil conservation practices still need to be observed.

### Moderate (7.6 – 12.5°)

- Moderately sloping land is often suitable for horticulture. The slope can assist with drainage and is at lower risk of frost damage, as cold air drains to lower areas.
- Permanent erosion control measures may be required on land within this slope class, for the lifespan of the orchard.
- Irrigation systems must be designed by a qualified irrigation professional for good performance and even water distribution on moderate slopes. Extra components such as drainage control valves may be required in the system to overcome pressure issues caused by slope.

### Steep land (12.6 – 18°)

- There are blueberries grown on steep land in the north coast region and these are usually re-developed banana plantations or grazing land.
- The management of berries in rows running up and down slopes is very different to bananas, which are planted on the contour and require minimal machinery use.

**It is important to seek advice from a CPESC certified, erosion and sediment control practitioner before undertaking blueberry development on steep land.**

**Soil conservation earthworks and other permanent erosion control measures will need to be implemented to avoid problems farming on steep land.**

**An erosion and sediment control plan should be developed when farming on steep land.**

## Problems with irrigation and chemical application on steep country

**It is hard to achieve best practice irrigation and chemical application on steep country. The following problems are commonly encountered:**

- Orchard rows must run up and down slopes for tractor safety, which greatly increases soil erosion risk between rows.
- There is a higher risk of machinery accidents (slippage and run overs) on steep slopes.
- Erosion of any bare soil is highly likely making orchard establishment or redevelopment risky.
- Maintaining 90 per cent - 100 per cent groundcover for the life of the orchard is essential to stabilise soil.
- Gully erosion can occur at the lower ends of blueberry rows. Badly eroded areas become un-trafficable.
- Wash-outs of unsealed farm tracks are common.
- Good irrigation performance is difficult to achieve with uneven watering patterns due to pressure changes on slopes. Professional irrigation design is essential.
- Water logging can occur at the bottom of rows due to gravity drainage from irrigation lines.
- There is an increased risk of workers having slips and falls on steep slopes.
- Walking up and down steep slopes is hard work. Picking is slower and less attractive for pickers on piece-rates.

## Too steep or vulnerable land (slope greater than 18 degrees)

In NSW, many local government areas classify land with a slope of 18° or more as vulnerable or highly erodible land in their development control plans, which include maps of affected land.

These plans and maps should be considered as well as the land use zone maps found in each local councils local environment plan.

Land with a history of agriculture and a rural zoning (RU1, RU2) may still contain steep areas that are separately mapped as vulnerable land.

This land may have previously grown bananas with few problems, or grazed livestock. It should not be used for blueberries, or any other crops that are not able to be safely grown on the contour, with full groundcover.

Vulnerable Land has more restrictions on land clearing and new development, such as earthworks and buildings.

There are maps available that identify these areas which are held by your local council and the Land Management Unit of Local Land Services. Contact your local council or Local Land Services office for advice.

### Rehabilitation of unsuitable areas

Most properties will have areas that are unsuitable for orchards e.g. steep slopes, wet areas (including natural wetlands) and along creeks.

Rehabilitating these areas by increasing groundcover, carrying out bush regeneration, planting native vegetation and controlling weeds can have many benefits, including:

- improved orchard pollination by local bees
- control of pests by natural predators
- limiting spray drift (buffer zones)
- vegetation operating as wind breaks
- habitat for wildlife
- assisting erosion control by trapping sediment.

*The above image is an example of land in the too steep category. The long rows and extreme slope (26 degrees) would have eroded severely during summer storms. The site was converted back to pasture on advice from a soil conservation professional. Seek advice before development to avoid costly mistakes. Source: J Dart, Local Land Services.*

# Erosion and sediment control plans

Erosion and sediment control plans (ESCPs) are an important part of the planning process in the construction industry where they are typically a legal requirement where more than 250 $m^2$ of non-rural land is to be disturbed.

Landcom (4th edition,2004), Managing Urban Stormwater, soils and construction, volume 1 is used as the main guiding reference[9].

Erosion and sediment control plans can easily be adapted for use when developing a property for blueberry production to properly consider any likely problem areas and make good planning decisions.

Developing a plan for a property with existing orchards is also useful, as this will help highlight any issues that might have been overlooked at planting and provide options for retrofitting existing structures if required. Having a plan is useful if you are considering a redevelopment or replanting in the future.

For a rural property, ESCPs are often developed using an aerial photograph as the base layer. Many key features can be found on high-resolution digital photography which is often available today. The following layers of information are then added to the aerial photograph:

- the property boundary
- key infrastructure such as powerlines, roads, farm tracks, buildings
- easements and exclusion areas
- detailed contour lines so the slope and slope length can be determined
- natural drainage lines, such as gullies and creeks
- catchment areas, including those that contribute run-on water from up-slope off the property
- any existing drainage infrastructure, including dams
- existing and proposed orchard areas.

Computer mapping software can be used to combine and present these layers of information.

This software can also manage and display LiDAR data to produce a detailed topographic picture of your property.

When this information is mapped, problem areas can be identified and solutions developed to prevent and reduce erosion.

Mapping can help identify where erosion control structures should be located for both effectiveness and orchard efficiency. Structures can then be designed by a professional to suit your farm.

BMP 2

# Maintain maximum groundcover at all times

Groundcover protects the soil from raindrop impact and loss of soil particles as well as slowing the movement of water across the grounds surface. The roughness of the surface slows down water flow and encourages any suspended soil particles to drop out of the water.

Living groundcover should be reasonably dense and cover at least 90 per cent of the soil surface. On moderate to steep slopes aim for 100 per cent cover. Ultimately, there should be no bare soil on the farm.

## Suggested groundcover

| *Area* | *Groundcover suggestions* |
|---|---|
| **Blueberry mounds** | Weed mat or weed suppressing mulch |
| **Inter rows** | Perennial grasses or herbs, with a mix of species to ensure year-round growth (both tropical and temperate grasses). |
| **Farm tracks** | Grass cover on minor tracks.<br>Gravel or concrete on farm roads and tracks where grass does not grow well. |

*Maintaining at least 90 per cent groundcover is an essential first step to preventing soil erosion. At nearly 100 per cent cover, this photo represents the ideal cover for steep slopes.*

*Erosion channels have formed in wheel ruts on exposed subsoil. Maintaining groundcover is critical on steep slopes. The notebook is A4 size for scale. Source: J Dart, Local Land Services.*

## Established orchards

On established farms there may be areas where the groundcover doesn't grow well.

### Spray zones along mound edges

Herbicide strips along the edges of blueberry mounds should be as narrow as possible, with the aim to control grass runners only. Aim to maintain grass cover as close to the mound edge as possible, and control with mowing.

Herbicide dead zones along weed mats are prone to gully erosion.

### Access tracks

Over time the use of vehicles compacts the soil and makes it difficult for groundcover plant roots to grow. Avoid using heavy equipment when soils are wet to prevent compaction.

In dry conditions plants in the compacted area are the first to die from water stress. This leads to bare patches developing which are at risk of erosion.

Establishing properly formed dish-drains as outlined under BMP 3 will also help prevent erosion in this area, as the middle row becomes the lowest point to capture water flow.

# Development or renewal

**Where groundcover has been removed for development, or needs improvement, the following steps should be completed:**

### Timing of works

Establishing orchards or carrying out any other work that will involve the loss of groundcover, should be undertaken when heavy rainfall (summer storms) is least likely. On the north coast this is typically between June and September.

### Staged development

When development will expose soil to erosion, consider staging the work so smaller areas of soil are exposed at any given time. Once the work is completed in the area, re-establish groundcover on the site quickly before moving onto the next stage of the project.

Erosion control methods that divert water around the work site and capture any sediment must be used where groundcover has been removed.

### Stockpile topsoil

When earthworks are required (such as drain construction), the topsoil should be removed first and stockpiled separately. Once the works are completed the topsoil can be put back in place. The topsoil has the required consistency and nutrients to assist with rapid regrowth of groundcover.

### Improve soil between blueberry mounds

Usually the topsoil is scraped up and mounded into blueberry beds. This leaves very little to no topsoil in between the rows.

On the north coast, soil types often have very acidic, heavy clay subsoils with a compacted structure. These soils have poor aeration and a slow water infiltration rate, which increases runoff. Plants will struggle to grow in subsoil unless it is improved.

Acidic soils with a pH (water) below 4.5 can have toxic levels of aluminium and manganese that interfere with root growth. Lime can be mixed into the soil to bring it back to an acceptable pH, of 5.0 or more.

Light cultivation can be used to aerate the soil. Gypsum (calcium sulphate) can be added to help break up heavy clay to improve aeration and assist water penetration. Adding compost will increase organic matter. Organic matter maintains aeration and holds moisture and nutrients.

### Establish groundcover as soon as possible

Direct seeding with fast growing species, or laying turf rolls, should be carried out to re-establish groundcover as soon as possible. On moderate to steep slopes, jute mesh or matting is useful to hold loose soil and seeds in place. A higher seed rate should be used when broadcasting seed to account for seedling loss from poor soil contact.

Land managers can buy bags of seed mix which have been specifically formulated for this purpose. They may include fast-growing annuals such as rye grass and millet. Ideally, they will include a mix of perennial summer and winter growing species to provide ongoing groundcover.

Timing is important as there are minimum temperatures that are required for germination and establishment. Sowing seed is usually most successful in autumn and spring when temperatures are mild.

Turf rolls, although more expensive, are useful on areas that are prone to erosion. If needed, they can be held in place with temporary pegs. Top dressing can be used to fill in gaps and maintain moisture on the edges of turf rolls. Both turf and direct seeded areas will require follow up watering for the best results.

BMP 3

# Run-on water

*A diversion drain lined with jute mesh and seeded with grass was made to prevent erosion from run-on water on the exposed soil downslope. Ideally erosion control works should be installed before major earthworks begin. Source: C Colmer, Soil Conservation Service.*

## Why manage run-on water?

Water coming on to an orchard area from upslope is referred to as run-on water. Diverting this water away from the orchard with a diversion drain at the top of the slope reduces the amount of runoff water that you then have to deal with in production areas.

If the land above the orchard is native bushland or has good vegetation cover, the run-on water may be reasonably clean and can be diverted to local drainage lines without the need for further treatment.

Diverting run-on water can prevent water-borne pests, diseases and weeds from neighbouring farms entering the orchard. Water must not be diverted onto a neighbour's land .

## Run on water and development

It is important to control the flow of run-on water when planning for development. Erosion of bare soil can be greatly minimised when run-on water is diverted around the work site.

## Run-on water assessment and treatment

Assess the whole area above the orchard i.e. not just on your property, so the following questions can be answered:

1. What is the total catchment area above the orchard?
2. What is the slope immediately above the orchard?
3. Is there concentrated flow from road culverts or roadside drains that enter the orchard?

Soil conservation earthworks (diversion drains), will be required[5] if the length of the slope above the orchard is greater than:

| ***Slope angle (degrees)*** | ***Slope length*** |
|---|---|
| 0-3 | 100 m |
| 3.1-7.5 | 75 m |
| Greater than 7.5 | 50 m |
| Or anywhere water flow entering the farm is concentrated from a drain or culvert | |

Seek advice from a qualified person to assess the requirements of your farm and to design any diversion drains that may be required for the property. It is strongly recommended that the design and construction is carried out by a contractor with expertise in soil conservation works.

The International Erosion Control Association (Australia) has resources available including a directory of certified soil conservation professionals. www.austieca.com.au

BMP 4

# Runoff water

## Why manage runoff water?

Irrigation and rainwater within an orchard area must drain off without causing soil erosion. This is critical during development work when there are large areas of exposed soil.

Once established, orchards with rows running downslope are naturally erosion prone as the inter-rows concentrate water flow.

Depending on the efficiency of the orchard irrigation and fertigation system, there is also the risk of nutrient loss in the runoff water.

## Inter-row dish drains

Blueberry orchards with mounded beds running downslope naturally drain water down the inter-row spaces.

It is recommended that these inter-rows are shaped to create a shallow dish drain in the middle (figure below). For new developments, this should be undertaken at the same time as the planting mounds are created.

If the dish shape is not created, stormwater will find the lowest ground level. This is often a wheel rut or bed edge that then concentrates water flow and can become an erosion hot spot.

Maintain at least 90 per cent groundcover within the inter-row to minimise soil movement. For a small orchard that is established on gently sloping ground, this may be all the management of runoff water that is required.

## Managing runoff water on steep country

There are limits to the amount of runoff water that can be moved in the inter-rows of blueberries before erosion develops.

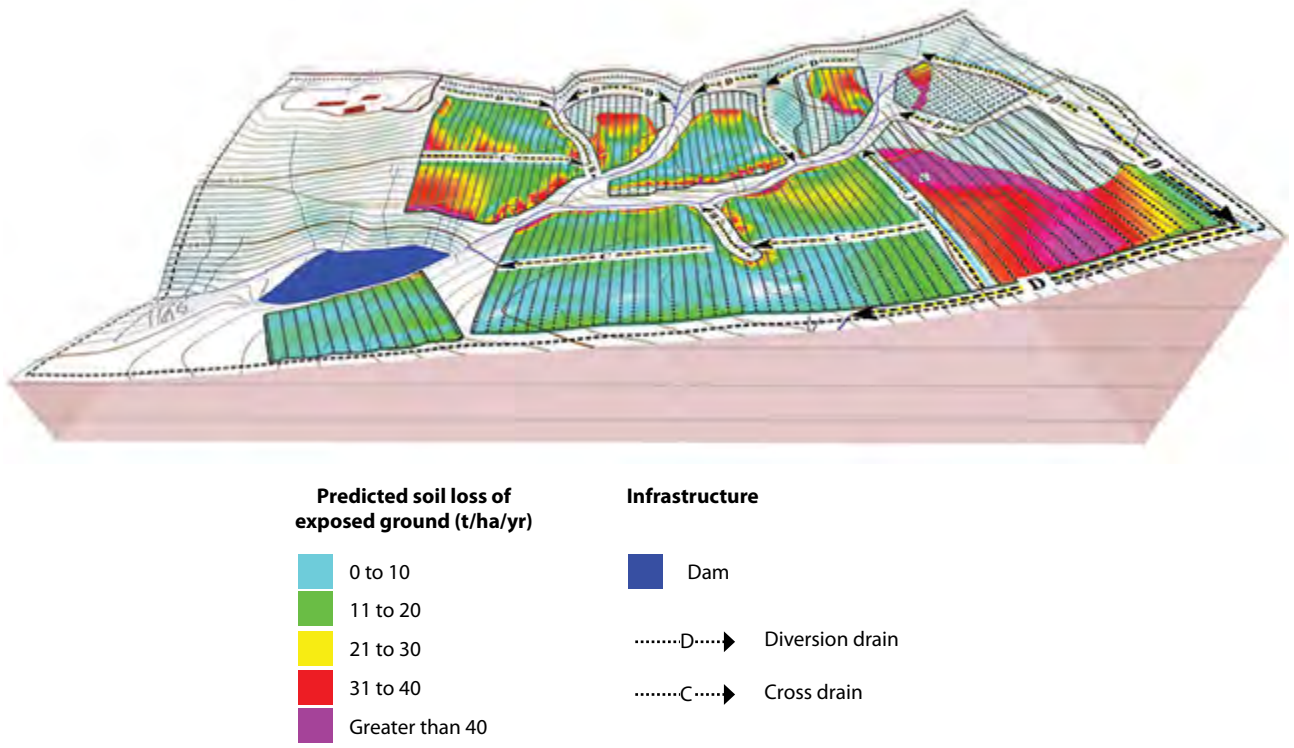
Two key factors to consider are slope and distance.

On a relatively gentle slope, long rows can collect enough water down-hill to start causing problems. Deep water, even when moving relatively slowly, can have considerable erosive force.

Short rows on steep country can have erosion issues because even a small volume of water can move quickly enough to scour into the soil surface.

Long rows on steep country will always be prone to erosion, from both water speed and quantity, especially on bare soil.

*Jute mesh is used to line this cross-drain. Grass will grow through and the mesh will break down afterwards.*
*Source: C Colmer, Soil Conservation Service.*




*Digital mapping can be used to simulate cross drain positioning to see the likely effect on reducing sheet erosion. The aim is to find the solution that delivers effective erosion reduction with minimum drain construction. Source: Bob Howard, GES Mapping.*

## Cross drains

To reduce erosion, water from inter-rows can be captured and moved sideways across the slope in a cross-drain to a suitable receiving area.

The number of cross drains required depends on local conditions, such as the orchard's slope, row length, expected rainfall and soil type. The simple rule-of-thumb is that the steeper the slope, the closer the cross drains will need to be together (see table 1 below).

Installing cross drains is a significant investment that can also impact how an orchard operates. Land managers should seek professional advice to develop a property plan for drainage so the most efficient and practical layout can be developed.

Any runoff water collected in cross-drains will need to be delivered to a safe receiving area on the property (see BMP 5 for details). Water collected in drains must not be discharged on to a neighbour's land.

*Table 1: Maximum distances between cross drains according to slope.*

| ***Slope class*** | ***Distance between cross drains (maximum crop row length)*** |
|---|---|
| Gentle (less than 7.5°) | 60 m |
| Moderate (7.6° to 12.5°) | 40 m |
| Steep (12.6° to 18°) | 30 m |
| Greater than 18° | Not suitable for development |

## Drain design considerations

Although the basic design of cross and diversion drains is relatively simple, getting the exact specification correct is essential if the drain is to function properly at any given location. The following are some of the design considerations:

### Water volume

What volume of water will the drain have to deal with? These structures are typically designed around the type of rainfall event that can be expected to occur, on average, at least once in every ten years.

### Catchment area

When considering run-on water, the upslope catchment also needs to be considered. Rainfall over an undisturbed section of native bushland will tend to soak in and be released downslope fairly gently over a period of time. If however, the upslope catchment is a cleared paddock that has been heavily grazed then the soil is likely to be compacted and most of the water will runoff immediately.

### Soil type

The type of soil found on site needs to be identified. Some soil types are naturally highly erosion prone and carrying out earthworks in these areas needs to be approached with caution.

### Drain slope

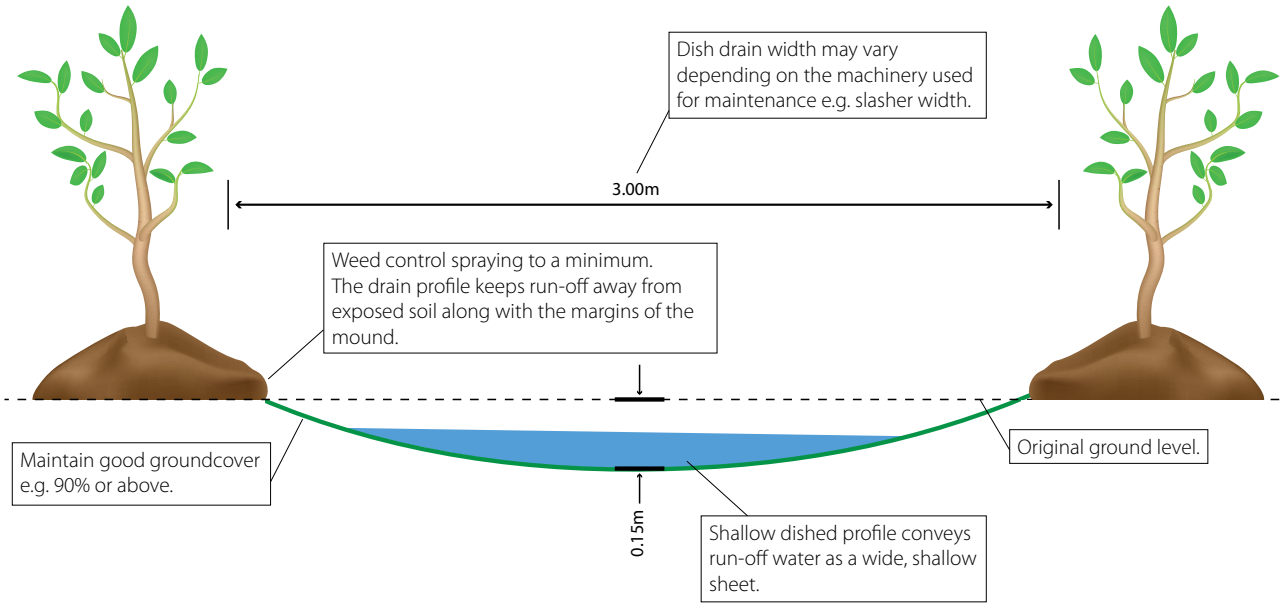
The slope of the drain needs to be carefully considered. The steeper the slope of the drain, the greater the risk that the drain itself will start to erode. Steeper drains require different design components to cope with the higher energy flows, for example, sections may have to be lined with crushed rock.

### Maintenance

The long-term maintenance of the drain also needs to be considered. If the drain, including the bank that lines the downslope side of the channel, is to be grassed and regularly mowed then the whole profile of the structure must be designed to accommodate this.

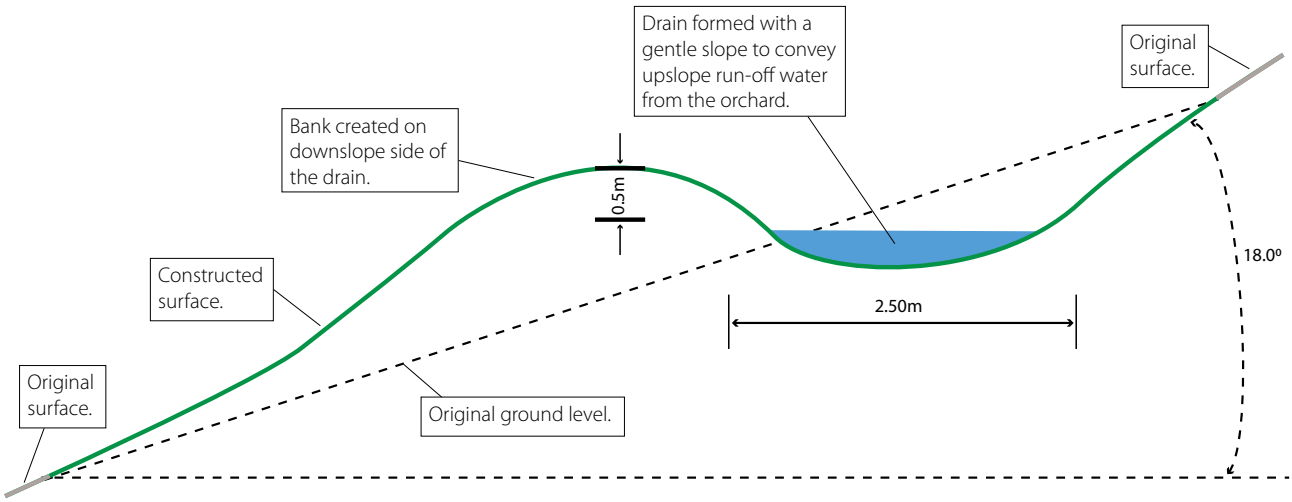
*Figure x: A cross drain installed on a newly developed blueberry block. Further irrigation work is required to enable access for maintenance. Cross drains can be a good location for irrigation sub-mains. Source: Saving Soil book, NSW DPI.*

## Inter-row dish drain standard detail




*Dish drains convey water downhill between blueberry mounds. The shallow profile encourages water to flow down the centre of the drain, without concentrating the flow. A shallow profile allows mowing of the groundcover. Width and depth of the drains will depend on site conditions and the width of farm machinery.*

## Cross drain standard detail




*Cross drains and diversion drains are similar in shape, with diversion drains designed to cope with more water. The cross-sectional profile of cross drains is designed to allow for machinery access. Drains need to be designed to suit farm conditions and landholder requirements. Design by a qualified soil conservation contractor is recommended.*

BMP 5

# Trap sediment on farm

When soil particles are dislodged by moving water and taken into suspension, the soil in the water is referred to as sediment.

Losing soil from your property as sediment should be avoided as the soil is an important farm resource. The muddy water will also include nutrients, either attached to the sediment or dissolved in the water. If this moves off the property it can pollute downstream water bodies.

By following sediment control principles, soil loss during orchard establishment can be minimised. In established orchards, sediment loss will be minimised if suitable soil conservation measures are maintained.

*The old saying "prevention is better than the cure" applies when managing sediment movement on your property. Stopping soil from getting into the water that runs off your property is always going to be easier that trying to remove the sediment from the water once the process starts.*

*Unsealed roads and orchard tracks can be a significant source of sediment. Gravel sheeting and careful design of drainage can prevent pollution of waterways.*

## Unsealed roads and farm access tracks

Unsealed roads are well known for polluting creeks with sediment. Their dirt surfaces are exposed and continuously broken up by traffic during dry times. During the next downpour the dusty surface washes off into to the nearest creek if drains are not well designed.

However, with good drainage, most of the sediment can be trapped on farm. Many of the techniques outlined in the next section can be applied to roadside drainage, but probably the most important point is to have orchard access roads constructed by a qualified contractor with soil conservation experience.

This will ensure that:

- The road is designed and built in such a way that there is minimal erosion of the surface. Gravel sheeting is recommended on farm roads to prevent soil erosion, and reduce dust, which can cause fruit quality issues.
- Water is diverted away from the roadside and appropriately treated e.g. directed through a vegetated buffer strip that will trap most of the sediment before the water moves into a waterway.

*Check structures, like this one made from sandbags, slow the flow of water down a drain. Sediment then falls out of the water. Sediment will need to be removed at regular intervals for the trap to be effective. Source: Saving Soil book, NSW DPI.*

## Trapping sediment

Preventing sediment movement can be difficult, particularly during orchard establishment work. Taking steps to trap sediment is good practice. Use temporary structures during earth works and permanent structures and vegetation afterwards to ensure water leaving the property has low sediment loads over the long term.

### Temporary sediment traps

In the construction industry managing sediment loss from a work site is usually a legal requirement. Structures such as sediment fencing and hay bale sediment traps are common techniques used to limit the movement of sediment off construction sites. Such techniques are also effective on blueberry orchards when soil is exposed. These are only temporary structures intended to manage the risk of encountering heavy rain during construction.

### Permanent sediment traps

When establishing orchards near existing watercourses and farm dams, leaving a wide grass buffer strip between the areas of disturbed ground and the channel has been shown[6] to be effective at trapping sediment.

Vegetation buffer strips are very effective at trapping sediment being transported by overland flow, such as water moving as a wide sheet, rather than in a defined channel. Grass needs to be 15 cm long to trap sediment, so regular mowing is not encouraged in buffer strips.

Along most watercourses, there's usually a combination of runoff moving as channelised flow and overland flow so careful observation is required to ensure that an effective combination of sediment trapping methods are used.

Grass buffer strips can be combined with sediment traps or check structures to deal with the more channelised flow. Vegetated buffer strips will vary in width depending on a number of factors. Widths can vary from only a few meters to 30 m or more.

Things to consider include:

#### Water volume

How much water will be passing through the buffer strip, and how heavily polluted will the water be i.e. how much sediment will it be carrying?

#### Slope

Gently sloping buffer strips are more effective as it's easier for sediment to drop out of slow-moving water. The steeper the buffer strip is, the wider it will have to be in order to be effective.

#### Soil type

Consider the soil in the upslope landscape, is it likely to erode easily? Soils that are naturally resistant to erosion such as heavy clays, will tend to produce less sediment and require smaller buffer areas .

#### What to plant?

The best buffer strips near creeks have a combination of grass and native trees and shrubs. The outer section (farthest away from the creek) should be a dense cover of mat-forming grass, which is left to grow to a height of at least 10–15 cm. Closer to the creek, native trees and shrubs will help absorb nutrients and prevent creek bank erosion.

*Sediment basins are usually located on a natural drainage depression down slope. They are not a replacement for other sediment control measures and are the last stage of the sediment management process. Source: Saving Soil book, NSW DPI.*

### Within-drain check structures

Check structures are low-level obstructions placed at right-angles across the floor of a drain to check (i.e. slow or restrain) the progress of sediment down the drain. These can be built with a variety of materials, such as rock, sandbags, coir logs, hay bales or silt fencing, depending on whether the intention is for them to be permanent or temporary. These drain obstructions are typically less than 30 cm in height and are lower in the middle then at the sides, so to encourage the flow to remain in the centre of the channel. The pool created behind the structure slows water down which encourages sediment deposition.

### Sediment retention basins

A sediment retention basin is a type of dam, designed to receive sediment-laden runoff and capture a proportion of the sediment before releasing cleaner water downstream. All dams trap sediment over time because the slow moving, or still pooled water, is no longer able to hold the entrained sediment in suspension.

Unlike a typical farm dam where sediment build-up is seen as a nuisance, sediment retention basins have design features that are specifically aimed at getting the sediment to drop out of the incoming water. For example, they are constructed with a minimum length to width ratio of 3:1 as this long narrow plan layout encourages sedimentation.

These structures are typically the last line of defence against sediment loss from orchards, as they are commonly located on a natural drainage depression at the downstream end of the property. Sediment retention basins should be designed with clearing of silt build-up in mind.

If the volume of water to be retained in the sediment basin is, in combination with any other dams you have on the property, within the harvestable right then no licence will be required (the harvestable right is set at 10 per cent of the average regional runoff calculated for your property area). If you are unsure, contact the Natural Resources Access Regulator to check if a licence is required.

BMP 6

# Safe disposal

## Why safe disposal is important

*You've installed a diversion drain to keep run-on water out of your orchard and the dish drains you've formed between the rows of blueberries deliver runoff downslope to cross drains. This system is successfully preventing erosion within the orchard, but what do you do with all this water that you've collected?*

When water is concentrated into a channel its erosive power can increase. If you have used the services of a soil conservation consultant to construct your property drainage, they will have designed the various channels very carefully so the water that flows along them doesn't start eroding the channel itself.

Eventually, all collected water needs to be safely delivered to the natural drainage systems that run through your property e.g. a local creek.

Safe disposal is all about making sure the water collected from your property enters the natural drainage network without causing erosion, either at the end of the drain or within the receiving watercourse.

Safe disposal is ensuring you don't solve one problem (preventing erosion in your orchard) but end up creating another one somewhere else (erosion at the drain discharge point).

### Stable watercourses

All areas where water flows need to be resistant to erosion. All constructed drains and natural flow lines in orchard areas must have good groundcover. To reduce erosion, and encourage any sediment to drop out, flow lines should have a wide and shallow profile.

Revegetating creek banks that have no, or limited, cover is a good idea even if there are no signs of erosion. It's important this work is carried out using native plants that would naturally occur along creek lines as these species will be adapted to withstand flood flows. (See BMP 7).

Creek bank revegetation can also be incorporated as part of a buffer strip where overland flow enters the channel. If there are existing erosion issues within your waterways such as bank or channel erosion, seek professional advice about the best course of action.

## Sediment basins and spillway design

Where a sediment basin has been installed the discharge point from the basin requires careful attention. A sediment basin is essentially a specialised dam. The term spillway is used to describe the channel that leads from a low point on the dam wall down to the natural watercourse below the dam.

Spillways are very prone to erosion and sometimes require the inclusion of an energy dissipation structure known as a rock ramp. As the name suggests, a rock ramp is a steep section of rock lined channel that assists with lowering water from the dam to the downstream channel.

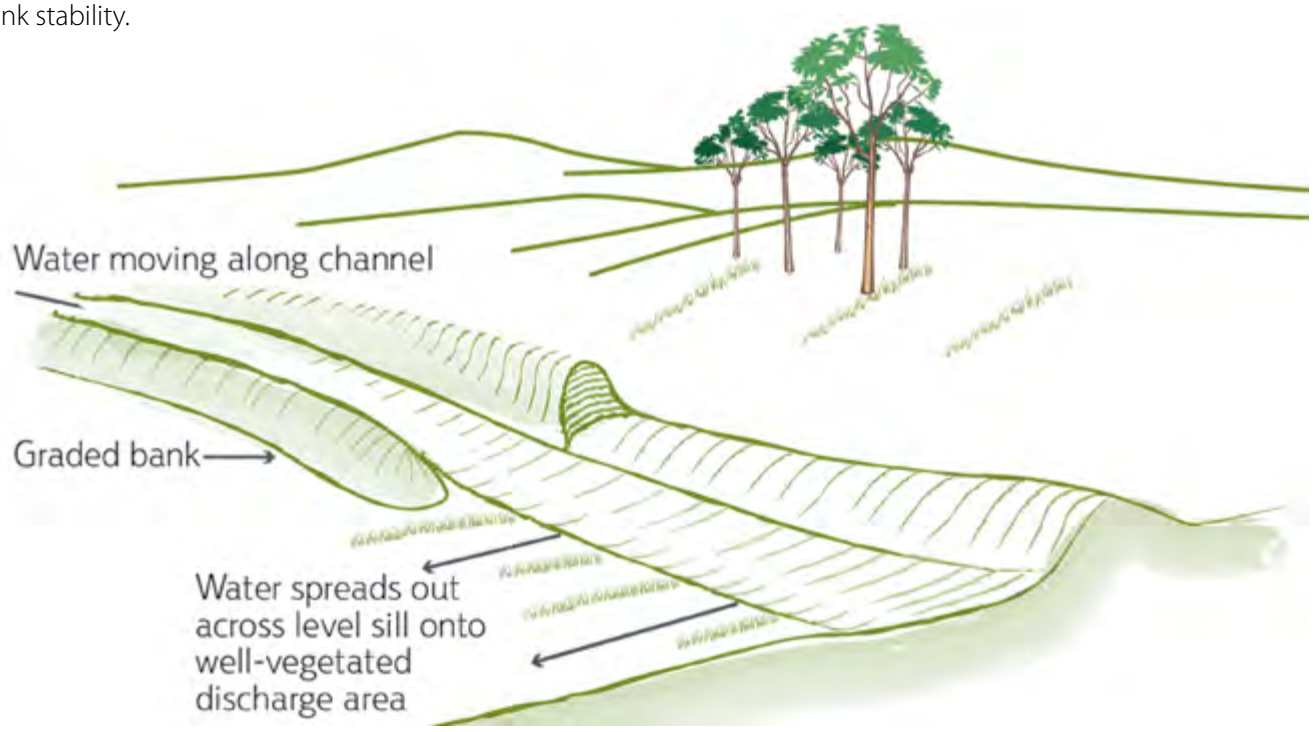
The rough rock surface creates turbulent flow that slows the water down, hence dissipating energy, and at the same time provides a protective layer to stop erosion of the channel itself.

*Getting overflow water from a dam to another location without causing erosion is difficult. Rock lining sections of the outlet channel is often required as the rough surface both slows the flow and protects the channel from damage.*

## Spreading sill

One of the easiest ways to safely discharge concentrated drain water is to allow it to spread out again into a slow moving, shallow sheet of water. This can be achieved by creating a spreading sill at the end of the drain that discharges water onto a selected, well vegetated section of ground. From here, the water can move across the surface to nearby watercourses in much the same way that all rainfall runoff moves across the landscape.

Care should be taken to ensure that the banks of the receiving waterway have a good cover of vegetation to ensure bank stability.




*Installing a spreading sill at the end of a drain is a good way to convert concentrated flow into a sheet of shallow, slow moving water with low erosion potential. Careful thought must be given to the discharge area and to the location at which the water will eventually find its way into any nearby watercourses. Good groundcover and bank vegetation along the watercourse are essential to stop sediment transport and erosion. Source: Saving Soil book, NSW DPI.*

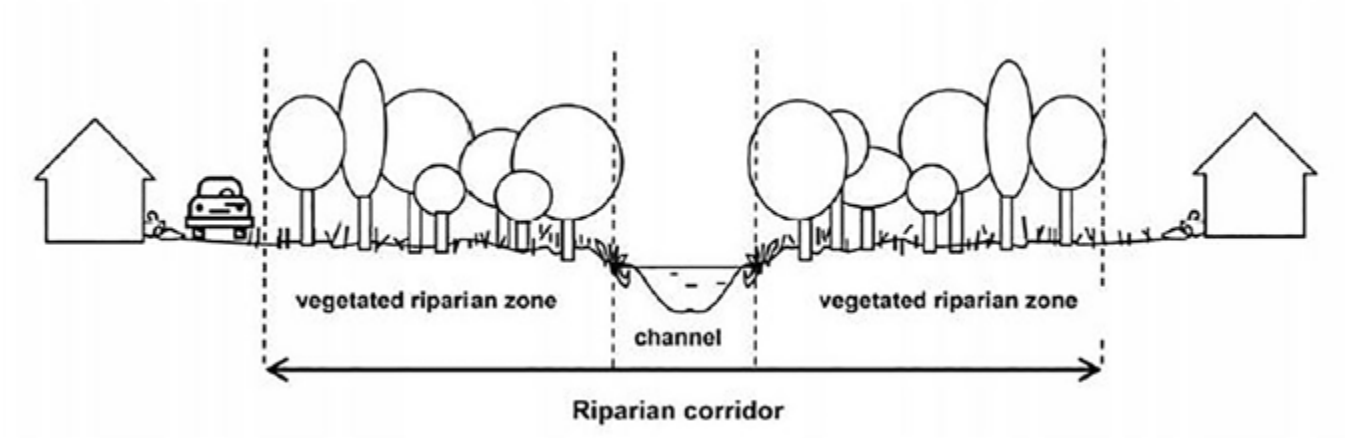
BMP 7

# Well managed riparian areas and buffer strips

Maintaining creeks and streams in good condition is an important factor in maintaining water quality for the environment and other water users. The vegetation along waterways plays an important role in protecting stream banks from erosion, trapping sediment and maintaining water quality. It is also important to consider the value of vegetation around farm dams.

The best approach is to not remove native trees, shrubs and grasses growing near watercourses when first developing a property. A buffer zone of good quality riparian vegetation is the last line of defence to maintain water quality from farms.

Where vegetation has previously been removed, rehabilitation and replanting to local native species is encouraged. There should be a minimum of 90 per cent stable groundcover. Ideally a mix of locally native trees, shrubs, grasses and other groundcovers should be used. Your local Landcare network may have a list of locally suitable species.




*A diagram of a riparian corridor. Source: NRAR fact sheet: Guidelines for controlled activities of waterfront land, riparian corridors[7].*

## What is a riparian corridor?

A riparian corridor includes the bed and banks of the watercourse and the vegetated riparian zone on both sides of the channel.

Riparian corridors are important in the following ways:

- providing stream bed and bank stability and reducing bank and channel erosion
- protecting water quality by trapping sediment, nutrients and other contaminants from runoff entering waterways
- providing habitat for terrestrial, riparian and aquatic plants (flora) and animals (fauna)
- providing connectivity between wildlife habitats
- providing space for flood flows and helping control the direction of flood flows
- providing a buffer between development and waterways.

The width of your riparian corridor will depend on the type of watercourse present. You can use the Strahler stream order classification system to determine the order of the stream. Small, often dry upstream tributaries (first order streams) join together to form a larger stream (second order) and so on. Topographic maps and aerial images can be used to determine stream order.

# Best management practices for riparian corridors

- determine if there is a watercourse present, and its stream order (seek advice)
- determine the appropriate riparian corridor width
- seek to maintain or improve the vegetated area with a mix of native trees, shrubs and grasses
- minimise soil disturbance in the corridor area
- minimise the number of creek crossings
- locate services and infrastructure outside the riparian corridor whenever possible
- treat runoff water before it enters a riparian area.

*Table 2- Best practice riparian corridor and vegetated zone widths.*

| ***Watercourse type*** | ***Vegetated riparian zone width (each side of watercourse)*** | ***Total riparian corridor width*** |
|---|---|---|
| First order | 10 m | 20 m + channel width |
| Second order | 20 m | 40 m + channel width |
| Third order | 30 m | 60 m + channel width |
| Fourth order | 40 m | 80 m + channel width |

## Development Approval

### Waterfront Land

In NSW, *The Water Management Act (2000)* applies to waterfront land. This includes the bed or bank of any river, lake or estuary and all land within 40 m of the highest bank of a river, lake or estuary.

A Controlled Activity Approval from the Natural Resources Access Regulator (NRAR) is required before clearing or other development takes place in riparian corridors on most watercourses. This includes building erosion control works. You must seek advice from the department before starting work.

Refer to fact sheet: Guidelines for controlled activities of waterfront land, riparian corridors[7].

### Land Zoning

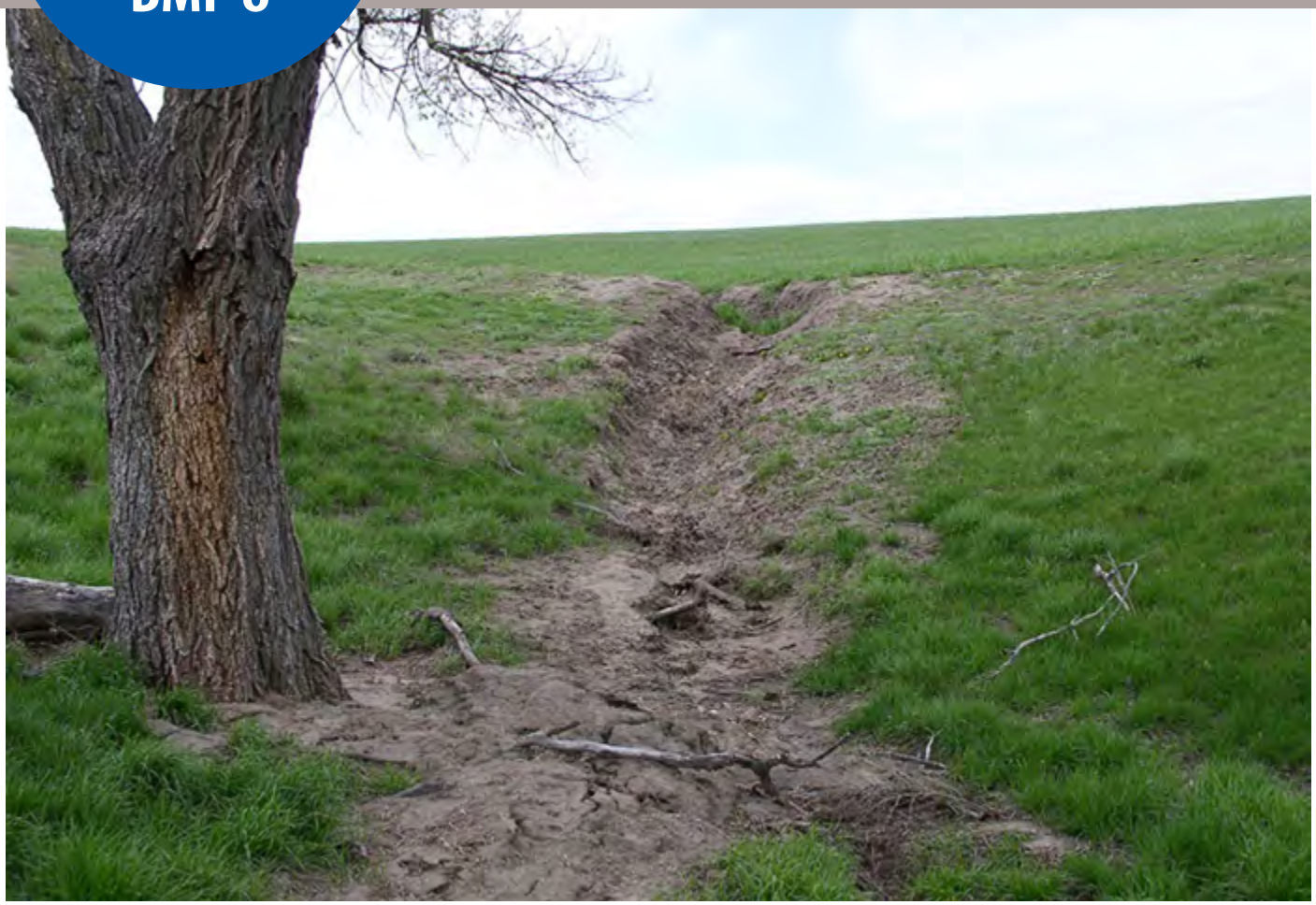
Many local government areas include the riparian corridors of higher order streams in their local environment plan as waterways (W1& W2) or environmental zones (E2 & E3).

Different development rules apply to this land compared to that zoned rural (RU1 & RU2).

Seek advice from your local council when planning development. Intensive plant agriculture may not be permitted in environmental and waterways zones.

BMP 8

# Monitor and maintain



*If left untreated this erosion can quickly expand into a big problem. Regular monitoring of erosion control drains and associated structures is important, especially when they are first installed and there hasn't been time for sufficient groundcover to establish.*

Your sediment control works will need regular monitoring. Groundcover will still be establishing and initially some soil movement can be expected.

Any erosion should be dealt with immediately, as small problems are easier to fix. It can be more difficult and expensive to repair if problems are ignored and allowed to get worse.

It can be useful to walk over the property during heavy rain and see where the water is flowing. Check on any control works.

Ask yourself the following questions:

- Overall, is the system operating as expected?
- What's working well?
- What's not working so well?
- Are there any specific issues of concern, such as obvious scouring in the bed of a drain?

Sediment control structures will need maintenance, especially when they are new.

Sediment traps will require the removal of sediment build-up so that they can continue to work well.

The removed sediment can simply be spread out on the ground surface somewhere on the property that is not subject to wash following rainfall, for example a grassed, flat area away from watercourses.

# More information

## Key resource

For more information on soil management in the north coast region, the 2009 Saving soil booklet is an invaluable resource. Copies can be downloaded from: www.dpi.nsw.gov.au/agriculture/soils/erosion/saving-soil

## Other useful publications

The following publications are useful resources for blueberry growers that can be downloaded from the NSW DPI website: www.dpi.nsw.gov.au/agriculture/horticulture/berries

- Primefact 1388 - Who to consult when planning for blueberry development.
- Primefact 827 - Irrigation and moisture monitoring in blueberries.
- The second edition of the Berry plant protection guide.

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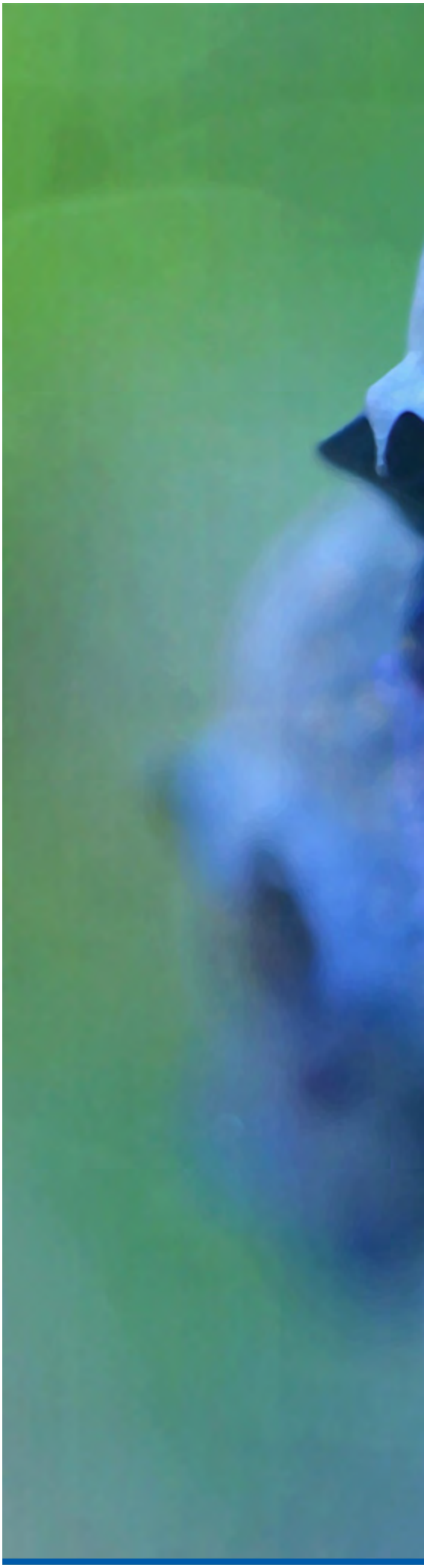

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