Horticulture™
New Zealand
Ahumāra Kai Aotearoa

Erosion and Sediment Control

Code of Practice

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This Code of Practice has been created to reduce the environmental impact of soil erosion and sediment entering waterways from horticultural production.

Soil is the most important resource to an outdoor grower. Soil loss through erosion not only deprives growers of this resource but it also does extensive damage to the environment. Damage to the environment from soil erosion chiefly comes from sediment entering waterways and damaging the freshwater ecosystem. Sediment contributes to increased water turbidity and often carries bound nutrients (predominantly nitrogen & phosphorus) leading to lower water quality.

Management practices to reduce the risk of erosion and soil loss focus on reducing the effect of erosive forces (water and wind) on the block, minimising the amount of erosion they cause and loss of sediment beyond the property boundaries.

This Code of Practice directs growers to assess the risk of erosion and sediment loss, and identify appropriate practices to manage this risk.

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Cover photo: Cross-contour oat strips in Pukekawa, Waikato.
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Erosion and Sediment Control Code of Practice

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Document control

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Summary of review changes since previous version (2014, v1.1)

Change	Reference
From Guideline to Code of Practice	Whole document
Addition of Nutrient and Erosion Management (NEM) workbook	Appendix A

This Code of Practice will be reviewed, as necessary, by Horticulture New Zealand Incorporated. Suggestions for alterations, deletions or additions to this code of practice, should be sent, together with reasons for the change, any relevant data and contact details of the person making the suggestion to info@hortnz.co.nz.

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1 Code of Practice overview

1.1 Introduction, purpose and scope

Protecting our soils

Soil is a critical resource for any commercial outdoor growing operation. While most practices in this code are relevant to cultivated growing systems, some are also relevant to permanent tree and vine cropping systems, depending on the level of erosion risk.

Natural soil characteristics such as water holding capacity, soil nutrients, soil structure and biological activity all contribute to the success of a growing operation. When soil moves within or off a block, there is a loss in productivity and profitability. This is caused by the loss of soil structure and fertility, the latter of which results in increased fertiliser costs, to replace the nutrients lost. In addition, soil moving off a grower's property creates sediment, which ends up on roads, in drains, streams, rivers and lakes, and the sea, generating significant negative impacts for the surrounding environment. These impacts and associated costs are borne by the whole community.

Therefore, retaining soil and its inherent characteristics through erosion and sediment control is important not only to the business of growing, but as part of our collective role in protecting our unique environment in Aotearoa. Maintaining soil health and retaining soil on farm is also critical to protecting the soil's life force (mauri) and conserving the soil's ability to produce food (mahinga kai) for future generations.

This Code of Practice

This Code of Practice has been built upon many years of grower and adviser experience, and industry research trials conducted during the Franklin Sustainability Project, as well as Holding it Together and Don't Muddy the Water projects. The Code of Practice also draws on Auckland Council's Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region (GD05), and its predecessor TP90, as well as TP223 Forestry Operations in the Auckland Region - A Guideline for Erosion & Sediment Control.

The recommended volumes and catchment areas for various sediment control devices differ from those in GD05[1], reflecting the difference in soil type and runoff factors from cultivated land, compared to earthwork sites. It was concluded, and accepted in submitted evidence to the Environment Court, that on cultivated land 0.5% storage is equivalent to or outperforms 2.0% storage on an earthworks site. The report *Justification of Silt Trap Capacity for Cultivated Land 0.5% vs. 2.0%* (Barber, 2012) describes this in more detail, along with the Don't Muddy the Water final project report. Copies are available from Horticulture New Zealand.

Table 1.1 outlines a range of control practices with estimated effectiveness and costs. The estimate of effectiveness was provided by John Dymond (Landcare Research). It assumes that the measures are used within their design limitations.

For example, a well-constructed vegetated buffer strip will have high effectiveness on low slope blocks, and a much lower effectiveness than shown in Table 1.1 on a steep block with channelised flow. There is no single silver bullet. Therefore, planning and implementation must include multiple complimentary control practices.

[1] 2023. Auckland Council. Erosion and sediment control guide for land disturbing activities in the Auckland region - Knowledge Auckland

Table 1.1. Cost and effectiveness of various management practices.

Pratices	Range in effectiveness (%)	Cost per hectare ($)*
Detailed erosion and sediment control plan	-	$200 - $250
Cover crop	90 - 99	$110
Uncultivated setback – 5 m		$90
Vegetated buffer strip – 5 m	50 - 80	$120 - $330
Stubble mulching	-	$100
Wheel track ripping or dyking	50 - 80	$50
Contour drains	30 - 70	$100
Benched headlands	50 - 80	$90
Super silt fence	80 - 95	$500
Decanting earth bund	80 - 95	$500 – 1,000
Sediment retention pond (SRP)	80 - 95	$1,000 - $1,500
SRP maintenance	-	$100/ha/year

* Estimated costs in 2025.

1.2 How to use this Code of Practice

This Code of Practice directs growers to complete an erosion risk assessment and conduct a block evaluation on each production block to assess the risk of soil erosion and sediment loss. It then provides growers with information on a range of practices to support sustainable land management.

The risk assessment and practices implemented to manage soil erosion and sediment loss are used to form an Erosion and Sediment Control Plan (ESCP), the recommended tool to manage soil erosion and sediment loss within a growing operation, especially outdoor cropping operations. The Excel-based Nutrient and Erosion Management workbook (Appendix A) has been created to support growers to prepare an ESCP. More information, including 'Steps to building and updating an ESCP' can be found in Section 1.5. On the next page, Figure 1.1 sets out how an ESCP, farm planning, risk assessments, and on-farm/orchard actions fit together, considering the overarching catchment context, which is discussed in Section 1.3.

Considerations for leased land

For leased and swapped land, which is typical in outdoor vegetable production rotation, implementing erosion and sediment control measures requires a conversation with the landowner. Because the installation of treatments and devices may involve physical works and changes to the land, it is ultimately at the landowner's discretion whether these measures are approved and maintained.

As a lessee, you are responsible for assessing erosion risk, undertaking a block evaluation, and implementing practices to manage erosion during your cropping cycle (e.g. cover cropping, wheel track ripping, cross contour drains).

However, the proposal and implementation of management practices requiring physical works or changes to the land will require agreement from the landowner. It is recommended that you engage with the landowner early in the process to discuss the benefits and requirements of erosion and sediment control and to explore practical solutions that meet both parties' needs. In some cases, these expectations may also be formalised in lease agreements.

For growers undertaking any major orchard development or contouring (i.e. large-scale soil movement), please note these guidelines apply to 'business as usual'. In these other cases, growers should contact their local authority to understand what additional requirements they may need to meet. Nevertheless, the practices described in this guide will provide a very good practical starting point.

Figure 1.1 sets out how farm planning, erosion risk assessment, and on-farm actions fit together.

The **catchment context** refers to the values and challenges for freshwater in the surrounding catchment. It influences whole farm planning and growers' operational activities and goal setting.

The **Farm Plan** considers the full range of activities being undertaken on the farm, from both a production and environmental perspective. The plan may include actions for freshwater, or biodiversity enhancement, as well as broader operational planning, like staff training.

The **Erosion and Sediment Control Plan** (ESCP) specifically focuses on minimising erosion and sediment loss within a growing operation. Key aspects of an ESCP include block risk assessments, practices, record keeping, and an action plan.

An **erosion risk assessment** includes both biophysical and management risks to understand your block-level erosion risk.

Management practices relate to the sustainable management of nutrients, whether at operation, block or crop scale. **Decision-support tools** further support practice implementation.

Figure 1.1. Erosion and sediment control planning within a wider farm/orchard context. Adapted from Edmeades et al. (2011)[2] and Foundation for Arable Research[3].

[2] Edmeades, D. C., Robson, M., & Dewes, A. (2011). Setting the standard for nutrient management plans. https://flrc.massey.ac.nz/workshops/11/Manuscripts/Edmeades_2011.pdf
[3] https://www.far.org.nz/resources/far-focus-6-nutrient-management-plans.

1.3 Catchment context

Growers need to consider the catchment's context in their freshwater farm plan. Regional Councils are responsible for collating and writing catchment context information for growers and other land users to refer to.

The catchment context can impact on a grower's Erosion and Sediment Control Plan. Catchment context refers to information about what's important in your local freshwater area – like its natural features, how people use the water, and water quality challenges from activities like farming[4].

Catchments can be sensitive or vulnerable to degradation. Regional councils may require growers in these catchments to have specific or extra erosion management practices in their farm plan.

There is a need for Council driven catchment-scale solutions to manage water quality alongside farm-scale actions. In some catchments, for example, with significantly modified drainage and landforms, councils should be responsible for a catchment plan.

Requirements from councils for growers may include the following:

1. Awareness of catchment context, regulatory requirements and any non- regulatory catchment plans. Regional Councils are responsible for making this information available.
2. Setting of short, medium, and long-term objectives in their farm plan (i.e. objectives related to the environmental impact of land-use activities on surrounding waterbodies).
3. Progress towards practices, with timeframes set for actions to be undertaken.

Farm plans may also include non-regulatory, collective actions that contribute to improved water quality outcomes at a catchment scale.

While these actions may extend beyond the farm gate, they reflect a proactive and collaborative approach to freshwater management that complements individual on-farm practices.

Recognising and documenting such efforts in farm plans demonstrates a commitment to broader environmental outcomes and alignment with community-led freshwater improvement goals.

1.4 Farm Plan

A farm plan contains important information about your operation, and how you identify, assess, and manage risks. Most growers have integrated Good Agricultural Practice (GAP) farm plans. GAP farm plan standards integrate risk management across food safety, environment, and employment law.

Farm planning drives outcomes for both growing operations and the environment. The New Zealand Good Agricultural Practice (NZGAP) Environment Management System (EMS) add-on is designed as a farm planning pathway for growers to demonstrate environmental performance and meet regulatory requirements to manage impacts to freshwater. It covers property mapping, soil and nutrients, water, and biodiversity, and mahinga kai.

The Freshwater Farm Plan Regulations, under Part 9A of the Resource Management Act 1991, apply nationally and focus on addressing adverse effects from agriculture on freshwater. Freshwater farm plans contain farm maps, risk assessments, action planning, and records. Collectively, freshwater farm plans support regional councils' plans to achieve catchment water quality outcomes.

This Code of Practice supports growers to develop an Erosion and Sediment Control Plan. Section 1.5 below introduces erosion and sediment control planning, and how this Code of Practice supports growers to build and maintain a plan for their operation, as part of their overall farm plan.

[4] https://www.horizons.govt.nz/managing-natural-resources/our-freshwater-future/freshwater-farm-plans/catchment-context,-challenges-and-values.

1.5 Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan (ESCP) outlines how erosion and sediment loss is managed on a horticultural operation. It forms part of the overall farm/orchard plan and ties specific practices to an assessed level of risk. They are living documents that evolve with new knowledge, practices, tools, and regulatory requirements.

Once erosion risk levels are assessed, practices proportionate to the level of risk can be applied.

Each ESCP is tailored to the farm or orchard, and is reviewed annually to reflect changing conditions, so that the plan stays relevant and practical. They include flexibility to manage uncertainty, such as extreme weather resulting in unexpected erosion and sediment loss. Using this approach, potential impacts can be minimised as much as practicable.

A well-communicated ESCP supports both performance and compliance. This Code of Practice helps growers develop a comprehensive ESCP that meets minimum expected industry practice and supports growers to address regulatory requirements. Knowing what rules apply to your farm or orchard helps build a plan that can both demonstrate compliance and become an asset to your business, to help achieve other goals, relating to finance, productivity, or soil health.

Criteria for a strong ESCP includes:

- **Clear goals and objectives**
- **List of blocks** and crops of commercial horticultural production
- **Erosion risk assessment** for each block (Section 2)
- **Practices to manage erosion and sediment losses** (Section 3)
- **Alignment with other management areas** in your wider farm plan, for example, irrigation management, and nutrient management
- **Comprehensive records** of practices, for example, maps, block evaluations, device design and implementation plans
- **Action plan** of all actions, responsibilities and timeframes, and
- **Review process** to track and adapt over time.

An Excel-based Nutrient and Erosion Management (NEM) workbook is available to support growers to develop an ESCP. This workbook is available in Appendix A, linked to HortNZ's website. Figure 1.2 on the next page steps growers through developing an ESCP using the workbook.

As part of the internal annual review of an ESCP, risk assessments may need to be updated to reflect any relevant changes, for example changes in location of your growing operation, or records of practices implemented.

Figure 1.2 illustrates the steps to build and update an Erosion and Sediment Control Plan (ESCP) using this Code of Practice and the Nutrient and Erosion Management (NEM) workbook (Appendix A).

1. Use the NEM workbook to assess erosion risk (Section 2.2) for each production block*. Alternatively, use the Don't Muddy the Water web app and record erosion results in the workbook.

↓

2. Assign each block to an erosion risk group based on the risk assessment. Use Table 2.1 to understand what Minimum and Additional practices apply.

↓

3. Complete a block evaluation and plan for each block to understand what practices would be most effective on each block.

↓

4. Based on the risk assessment results and block evaluation, implement practices to:

- **Manage water entering your block (Section 3.1)**
- **Reduce soil erosion (Section 3.2)**
- **Control sediment loss (Section 3.3)**

↓

5. Use the NEM workbook to track implementation of practices and develop an action plan. Keep comprehensive records.

↓

6. Review your Erosion and Sediment Control plan annually.

Figure 1.2: Steps to building and updating an Erosion and Sediment Control plan using this Code of Practice.

*The erosion risk assessment is also used to assess the risk of phosphorus loss in the Nutrient Management Code of Practice. If you have completed the block-level erosion risk assessment as part of your Nutrient Management Plan, it does not need to be repeated here. Results can be carried over to your Erosion and Sediment Control Plan. The block evaluation step still needs to be completed for each block.

2 Assessing erosion risk

2.1 Risk assessment approach

Risk assessment is a core part of an operation's Erosion and Sediment Control Plan (ESCP). Managing the risk of erosion and sediment loss through an ESCP supports production and environmental outcomes, as well as achieving compliance requirements.

This section contains an erosion risk assessment process, which includes the erosion risk assessment decision tree (Section 2.2) and a separate block evaluation (Section 2.4). These assessments are completed for every block in an operation where commercial horticultural production is occurring. A block definition is provided in the Glossary (Appendix C). The risk assessments are designed to assess the risk of uncontrolled erosion. The results inform the level of practice that a grower implements to effectively manage that risk over time. The outcome achieved, once relevant practices are implemented, is that the erosion risk, and therefore phosphorus loss risk, is considered well controlled for that operation.

Based on the risk assessment results, each block is assigned to an erosion risk group. These are groups of blocks with the same erosion risk profile (very low, green, amber or red), and the same level of management required. Each erosion risk group has a set of Minimum and Additional practices - see Table 2.1. Management practices are implemented at a range of scales, from operation-wide to block and crop scales.

As part of the annual review of the Erosion and Sediment Control Plan, risk assessments may need to be updated. For example, if you are adding or swapping production blocks, new blocks will need to be assessed, and relevant practices incorporated into your plan.

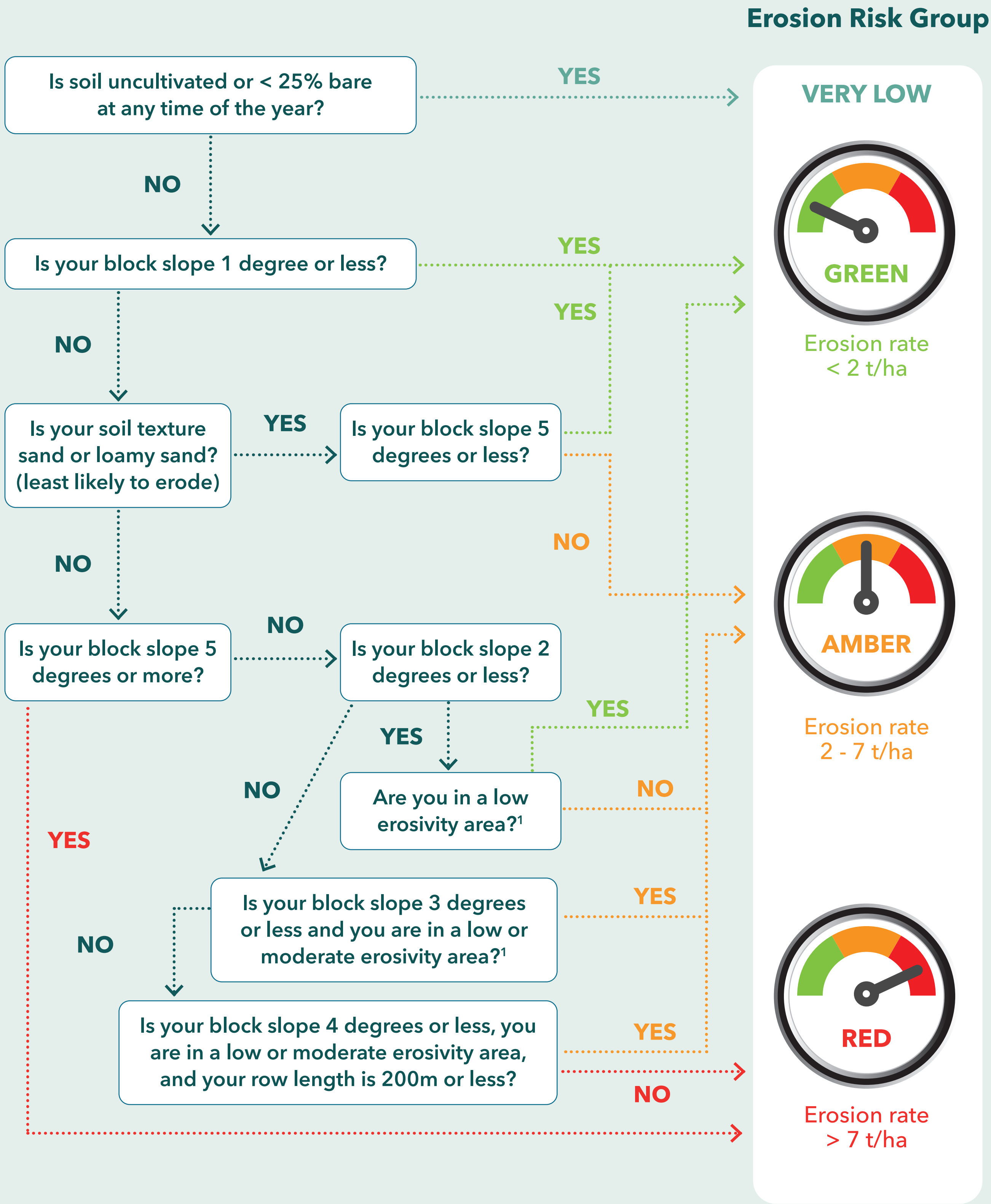
2.2 Erosion risk assessment

This risk assessment has been created for growers to easily assess the erosion risk of their blocks and identify relevant practices to manage that risk over time. The resulting erosion rates are based on cultivated land. Land that is predominantly in grass has significantly lower erosion rates and will generally be less than 2 t/ha (Very low or Green). For cultivated blocks, the DMTW web app (Section 4.1) can be used to provide the best estimate of erosion rates and model the effectiveness of practices to reduce erosion. The Nutrient and Erosion Management (NEM) workbook in Appendix A can be used to record erosion risk assessment results and DMTW web app results.

Note: if you have completed the erosion risk assessment for phosphorus as part of your Nutrient Management Plan using the Nutrient Management Code of Practice, it does not need to be repeated, and results can be carried over to your Erosion and Sediment Control Plan for those blocks. However, a block evaluation (Section 2.4) is still required for each production block.

To work out percentage slope from degrees, use the following formula: Degrees = $\tan^{-1}$ x (slope %) i.e. $\tan^{-1}$ x 0.176 = 10°. A 5-degree slope is equal to 8.7%, 2 degrees is equal to 3.5%.

As a reminder, when carrying out any assessments or practices, the health and safety of workers and the public must be an integral part of all activities, including the identification of hazards.



When cultivated rows are present, block slope should be assessed based on the direction of the rows, which should already be situated to reduce the risk of erosion. A slope of 1 degree is equivalent to a slope of 1.7%.

1. See the NZ erosivity map on page 55 (Klik et al., 2015). These regions generally have low rainfall erosivity. Use the DMTW web app to determine the best estimate of your erosion rate. Low erosivity R factor is <1,000; moderate is 1,000 to 1,500; high >1,500.

2.3 Minimum and Additional practices to manage erosion risk

To guide growers on what management practices to implement for soil and sediment loss, Table 2.1 marks practices included within this Code as Minimum or Additional for each erosion risk group.

Growers should work towards implementing all Minimum practices for blocks in an erosion risk group. These practices are designed to give growers a clear and practical starting point, or benchmark, for managing soil and sediment loss over time. Additional practices are other practices growers may decide to implement if appropriate. Growers can choose which combination of practices to implement based on what is most practical and effective for their production system and growing environment. This approach recognises the diversity of horticultural operations and production locations, and the need to retain flexibility for growers when making decisions.

All practices are included within the Nutrient and Erosion Management (NEM) workbook for growers to work through for all blocks, at each risk level, as part of their Erosion and Sediment Control Plan. If it isn't possible to do a Minimum practice, provide justification as to why and set out your alternative approach in the NEM workbook.

Other practices included in this Code, but not in Table 2.1, include silt fences (Section 3.3.5). Silt fences should only be used as a temporary solution.

Table 2.1. Minimum and Additional management practices for each erosion risk group.

COP reference	Management practices	VERY LOW	GREEN	AMBER	RED
2.4	A block evaluation is conducted on each block to note key features and plan practices to implement.	Minimum	Minimum	Minimum	Minimum
	Maintain good ground cover with dense vegetation or coarse mulch. Increase infiltration through higher soil organic matter and mechanical aeration.	Additional	N/A	N/A	N/A
3.1	Intercept overland flow: Use a combination of interception drains, diversion bunding, culverts, benched headlands, and grassed swales.	Additional	Minimum	Minimum	Minimum
3.3.1	Raise all accessways.	Additional	Minimum	Minimum	Minimum
3.3.3	Leave setbacks from rivers and drains.	Additional	Minimum	Minimum	Minimum
3.3.4	Install and maintain vegetated buffer strips at the edges of your block or orchard.	Additional	Minimum	Minimum	Additional
3.3.8	Follow Vehicle and Machinery Washdown Code of Practice to prevent soil moving off site.	Additional	Minimum	Minimum	Minimum
3.2.6, 3.2.7, 3.2.8 & 3.2.9	Follow practices for cultivation, harvest, compaction reduction and postharvest block management described in this Code of Practice.	N/A	Minimum	Minimum	Minimum
3.2.1	Use cover crops where possible in your operation to avoid bare or fallow soil, especially during winter.	N/A	Additional	Minimum	Minimum

COP reference	Management practices	VERY LOW	GREEN	AMBER	RED
3.2.2 & 3.2.3	Improve infiltration: Use wheel track ripping or wheel track dyking to increase infiltration on wheel tracks.	N/A	Additional	Minimum	Minimum
3.3.6 & 3.3.7	Control sediment loss: Install decanting earth bunds or sediment retention ponds to prevent uncontrolled runoff water.	N/A	Additional	Additional	Minimum
3.2.4 & 3.2.5	Manage the flow of water down rows: Reduce row length to < 200 m or manage using contour drains or in-row cross contour vegetative strips.	N/A	Additional	Additional	Additional

2.4 Block evaluation

This is a critical step and must be undertaken for every block you grow on.

The evaluation initially involves walking each block, mapping and identifying significant features (slope, drains, culverts, area, etc.). In particular, note overland flow paths, where water is coming from and going to, and the location and type of existing management practices. Knowing the block history is invaluable. This first block evaluation becomes the basis on which management practices are built, as well as future updates planned.

"When we first go into a new block, planning the layout revolves around the lay of the land…where drains logically must go…look at entry and exit points…what is happening around the block...history...row direction etc." Kevin Balle – Balle Bros

Block plan

Planning should be done on a block by block basis, building up to an Erosion and Sediment Control Plan, which sits within a wider farm plan. Erosion and sediment control practices will then be better integrated with your whole farm system to have maximum impact.

Start the planning process by walking around each block, particularly during or after heavy rain, and mark on a block map:

- Where water is coming from (e.g. roads, drains, buildings etc.)
- Where water is going or should go (e.g. any overland flow paths)
- Drains and bunds
- Any existing erosion or sediment control measures.

Also on the map:

- Note the block dimensions
- Mark the direction and steepness of the slope in different parts of the block
- Mark any streams and riparian strips.

Noting block slope is one of the most important parts of a block assessment. Slope has the single largest impact on erosion rates, with approximately 35 times the difference in unmanaged sediment loss on a 7 degree block, compared to a 1 degree block (see section on Vegetative Buffer Strips – Section 3.3.4).

A picture is worth a thousand words. It is a good idea to document your actions and keep a photographic record of where you started and what changes you have made.

Furthermore, many of the erosion control measures you might implement, such as cover crops and wheel track ripping, may only be visible for a few months. Documenting your use of these erosion control measures is invaluable.

This map and information will be used to plan the most efficient and effective set of erosion and sediment control measures. Maps can be simple hand drawn diagrams or based on electronic aerial photographs. Electronic maps are readily available from Google MyMaps, Google Earth, or the Councils' GIS systems. The advantage of using an electronic mapping system is that you can easily determine the catchment areas for your various sediment control options.

Figures 2.1 and 2.2 depict two block maps showing the types of features to note as part of the block evaluation.

Figure 2.1: A simple digital map with drawn features to show drains and flow of water.

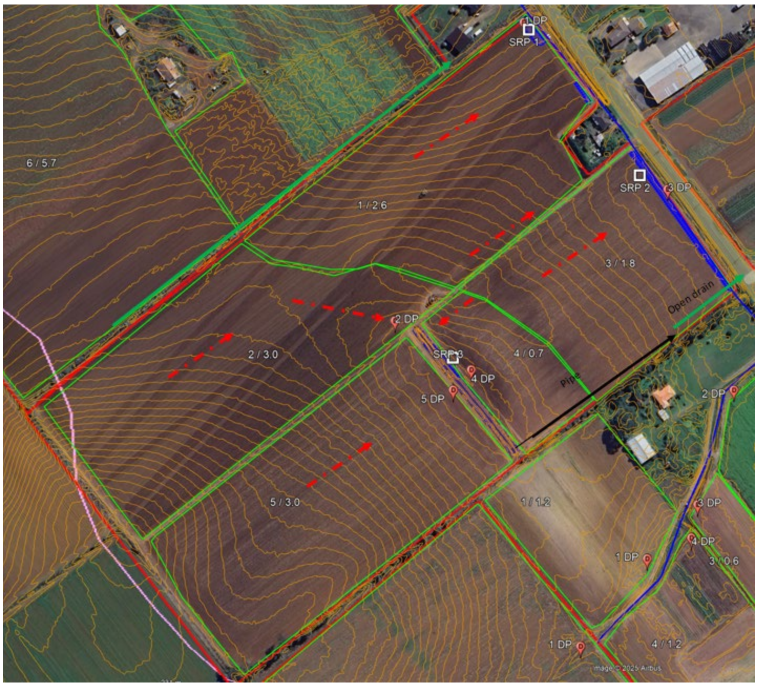


Figure 2.2: A digital block map showing contour lines (council provided) and location of sediment retention ponds (SRPs).

2.5 Managing steep and erosion-prone land

While most horticulture operations are situated on flat to sloped land, some growers may have areas of steep, erosion prone land they graze stock on, use for forestry, or have set aside as marginal land. These areas may be noted when walking around the property to conduct a block evaluation (if slips have occurred previously) or using erosion susceptibility mapping information. Steep, sloped land (generally > 25 degrees) is highly susceptible to erosion in storms, especially if more than 250 mm of rain falls over 2-3 days. The soil eroded in these types of events leads to significant sedimentation of streams, rivers, and coastal waters.

Growers with steep, sloped, and erosion-prone land should ensure management practices are in place to protect this land from erosion, in addition to their production blocks, the latter of which this Code of Practice addresses.

If the land is used for pasture and grazing:

- Maintain good pasture growth, using deep-rooted and productive cultivars
- Avoid high grazing pressure
- Consider spaced planting of species such as poplars to further protect soil. Poplars are fast-growing with a strong deep root system that prevents erosion.

If considering forestry:

- Find more information on the New Zealand Farm Forestry Association website for small forestry plantings and woodlots
- Retiring erosion-prone land and returning it back to native forestry helps to both stabilise land and support biodiversity. However, native species generally take longer to establish than exotic species.

Stream bank erosion

This refers to the natural erosion over time of streams and rivers. However, land use change, vegetation removal, and climate change (i.e. the potential for more intensive weather events) accelerates this process.

To manage stream bank erosion:

- Stabilise stream and riverbanks with plant species that have fibrous roots
- Fence and exclude stock from streams (if present) and build dedicated stock crossings.

Resources

The agriculture sector contains a range of resources on managing erosion prone land, which have been used as references for this section. Find more information here:

- NZ Landcare Trust: Soil erosion
- DairyNZ: Erosion control
- Plant & Food Research: Trees for the farm – A decision support tool for farmers

Photo credit: Woodhaven Gardens

3 Practices

In this section, management practices have been categorised by each of the steps to minimise erosion and sediment loss: controlling water entering blocks (Section 3.1); keeping soil on the block (Section 3.2); and managing water and suspended sediment moving off the block (Section 3.3).

3.1.1 Interception drains

Practices for stopping or controlling water entering the block

Identifying and then stopping or controlling water entering the block is crucial. Drains overtopping can be one of the biggest causes of erosion. In Pukekohe on the 21st January 1999, a short-duration high intensity storm struck. The most severe damage was caused where uncontrolled run-off entered blocks as a result of overflowing drains. In many places, inadequately sized culverts also caused drains to overflow. Keeping clean treated water off the block using interception drains wherever possible is crucial. Coordination of drains and erosion and sediment control practices between neighbours and council is essential to minimise soil loss. Meet on site with them to talk through and agree on what needs to be done.

Key points:

- Ensure all drains are linked
- Check that drains and culverts are large enough to cope with the volume of water
- Carry out regular drain maintenance
- Discuss with your neighbours linking the drainage systems and know the catchment sizes above you.

Keeping water off the block using interception drains or bunds wherever possible is crucial. Where this is not possible due to the contour, grassed swales through the otherwise cultivated block should be considered.

Interception drains need to be built large enough to cope with the flow of water from the catchment above. Where the drain has a steep gradient, **check dams** (energy dissipators) should be used to slow water flow and minimise drain scouring. Drains are most effective when both stabilised and vegetated to reduce the risk of scouring. Vegetated drains, compared to earth drains, more effectively filter out sediment (excepting extremely heavy rain events).

3.1.2 Culverts

Practices for stopping or controlling water entering the block

Culverts in drains are often undersized, which means they can easily become blocked with debris and rubbish, or simply cannot cope with large volumesof water, leading to overtopping. Like drains themselves, culverts need to be correctly sized and should have well-formed headwalls – in general, the bigger the better. The drain at the discharge end of the culvert should be protected with rock to prevent scouring. Table 3.1 gives an indication of the maximum catchment area for a range of culvert sizes for a 20% (1 in 5 year) and 5% (1 in 20 year) Annual Exceedance Probability (AEP) rainfall event.

The flow is based on having a 0.2m headwall above the top of the socket end culvert. The quantity of stormwater generated from a certain size catchment will vary depending on rainfall intensity, overland flow length, slope, and surface characteristics. The maximum catchment area given in Table 3.1 is a guide only and is based on a stormwater study conducted for the Bombay Hills. The area guide is likely to be conservative for most catchments as culverts in flatter catchments with less intense rainfall events could cope with larger catchment areas.

Table 3.1. Culvert size and associated flows and catchment area (ha) for 20% and 5% Annual Exceedance Probability (AEP) rainfall events.

Culvert size (mm)	Flow (L/sec)	Maximum catchment area (ha)	
		20% AEP	5% AEP
300	120	3.4	1.8
375	200	4.8	2.3
450	295	8.1	3.7
525	405	11.3	4.8
600	545	15.0	7.1
675	725	19.3	9.3
750	925	26.9	11.7
825	1100	35.9	14.8
900	1400	48.0	17.8
1050	2000	64.8	29.0
1200	2790	87.5	48.0
1350	3550	115.1	61.4

3.1.3 Benched headlands

Practices for stopping or controlling water entering the block

Modifying headlands is a simple and effective way of controlling and managing soil and water runoff from block rows, particularly wheel tracks (a major source of sediment). Often called 'benched' or 'contoured' headlands, the entire headland area is designed to direct water to the side of the block or to a drain within the block.

The headland slopes away from the rows, sloping towards an earth bund. The headland is still used in the normal manner for access to planting, spraying and harvesting operations.

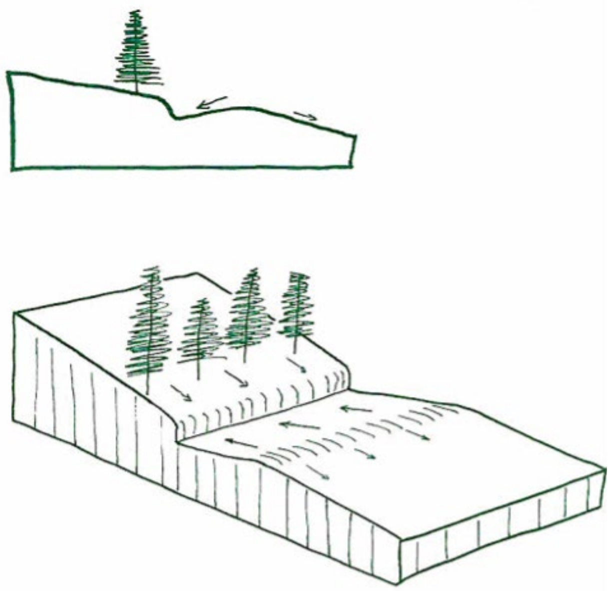
Grassing headlands will protect them from scouring and encourages silt to drop out before entering surface drains.

The easiest way to construct a benched headland is using a grader blade. Once in place, particularly if it is grassed, the only maintenance is to clear deposited soil and reshape in dry conditions or if major scouring occurs.

Benched headlands are used to good effect in breaking up the length of long block runs. If constructed to a broad shallow design, a tractor can be driven across the headland.

When constructing a benched headland, attention needs to be paid to:

- Where water from the benched headland is being directed, for example, to a permanent drain which will carry it off-site in an effective manner
- Where silt will be deposited in the benched headland, and further down the drainage system.



Benched headland

Scouring of benched headlands can occur if:

- Excessive water volumes flow into a headland. Use contour drains across the field to reduce this
- Soil in the headland has not been compacted
- The slope of the headland is too steep, creating high water speeds during rainfall. Take measures to reduce volumes reaching the headlands by diverting water to drains or vegetate the headland to cope with the high water speed.

Check what happens when the water reaches the end of a headland, making sure the headland connects with a suitable sediment control measure or stabilised discharge point.

3.1.4 Diversion bund

Practices for stopping or controlling water entering the block

Diversion (or earth) bunds are used to intercept water or run-off from another source, directing flow away from a potentially vulnerable block to a non-erodible outlet. Diversion bunding can be used as an alternative to interception drains. This practice both minimises the volume of water that can enter a block, thus reducing the risk of sediment loss, and reduces the need to potentially install a more significant sediment control practice at the bottom of the next block (as the bund reduces the catchment area).

Key considerations:

- If the water flow is clean (e.g. from a grassed block), the bund should divert the flow into a non-erodible clean drain or outlet
- If the water flow is dirty (e.g. run-off from another cultivated block), the bund should divert the flow into a treatment area (e.g. a decanting earth bund or sediment retention pond)
- The bund gradient should be uniform to avoid sediment dropping out early and building up along the bund
- The bund itself should be well-compacted and stabilised (top soil and vegetated) to reduce the risk of it breaching in high rainfall events
- Regular checks of the bunding are recommended, especially after heavy rain, to ensure no scouring or breaching has occurred.

Diversion bunding is also a recommended practice for managing sediment loss off a block. The same considerations apply but all water flow into the bund will be dirty.

3.1.5 Grassed swale

Practices for stopping or controlling water entering the block

A swale is a surface drain that is often shaped into a shallow saucer. Swales are used to ensure water flowing along natural overland flow paths through cultivated areas does not cause significant erosion. Clean water can be directed along the swale, following its natural course, to a stabilised discharge point. Once formed, the swale needs to be immediately stabilised with grass. The size is based on the catchment area above the block. As a minimum, the swale should be at least 3m wide. The swale should be shaped into a flat shallow saucer, about 0.3m deep, so it is easily driveable if it needs to intersect the cultivated rows.

A grassed swale may have prevented the damage shown in the photo (Figure 3.1). An interception drain or bund could not be used to cut this water off due to the contour. The water entering the block was clean so would not need any further treatment if it had passed over a grassed swale. Without the grassed swale, the volume required in the sediment control practices needs to account for the cultivated block as well as the catchment area above the block.

Figure 3.1: Damage caused by overland flow during a rain event flowing through a cropped block.

Photo credit: Provided by Bryan Hart from A.S. Wilcox & Sons

Erosion control practices to

3.2 Keep soil on the blocks

3.2.1 Cover crops

Practices for keeping the soil on the block

Implementing in-block erosion control measures to minimise soil movement will retain and even improve soil structure. Although eroded soil caught in a sediment control device (e.g. earth bund or sediment retention pond) can be redistributed back over the block, it is invariably in poor condition and no substitute for preventing soil from moving in the first place.

Green manure or cover crop describes any crop which is grown to be ploughed into the soil rather than harvested. This incorporation of a crop back into the soil is to improve soil quality and long-term production.

Benefits

The use of cover crops is beneficial in all long-term cropping situations for three main reasons:

1. To stabilise soil from erosion and improve water penetration and drainage
2. To produce dry matter, which improves organic matter and soil structure
3. To trap and cycle mobile nutrients from the previous crop.

Other benefits of using cover crops include:

- Smothering weeds (potentially reducing weed control costs)
- Improved soil fertility (improves productivity)
- Stimulating soil biological activity (e.g. earth worms) and assisting in breakdown of previous crop residues to reduce disease carry over and soil-borne diseases
- Providing a habitat for beneficial insects
- Fixation of nitrogen by some species.

3.2.2 Wheel track ripping

Practices for keeping the soil on the block

Compacted wheel tracks can act as drainage channels. Water flowing down the wheel tracks undermines the adjoining crop beds, leading to extensive crop and soil loss.

The shallow ripping of wheel tracks, to just below the cultivation compaction zone, allows water to percolate into the soil rather than flow down the wheel tracks. This reduces soil loss and prevents potential crop losses.

Wheel tracks in the rows used for spraying should not be ripped because the resultant loose track makes spraying difficult.

When any runoff reaches the bottom of the block, it needs to be dealt with by sediment control measures (e.g. decanting earth bunds or silt traps). The easiest and most effective way to deal with this problem is to minimise runoff in the first place. Ripped wheel tracks minimise runoff and reduces the pressure on any sediment control device.

Why rip wheel tracks?

Trials have found that wheel tracks are the key zones for initiation of surface runoff and erosion.

Reduction of water movement along wheel tracks is the key to reducing erosion rates. In a Franklin District trial, ripping wheel tracks increased the infiltration rate from 0.5 mm per hour to more than 60,000 mm per hour.

Table 3.2. Infiltration rate (mm/hour).

Treatment	June	October	January
Uncultivated wheel track	0.5	12.7	77.2
Cultivated wheel track	60,300	12,500	8,600
Onion beds	400	500	900

Table 3.3. Erosion rate (t/ha).

Treatment	Jun - Aug	Sept - Dec	TOTAL
Uncultivated wheel track	16.7	4.6	21.3
Cultivated wheel track	0.98	0.13	1.1

Because the infiltration rates are so high in both the ripped wheel tracks and onion beds, runoff would only be generated if the capacity for the soil to store water is exceeded.

As a word of caution, some growers attribute wheel track ripping to increased erosion. This underscores that no single measure will work for everyone in all situations. However, many growers and the research trials show that in most circumstances wheel track ripping will significantly reduce soil erosion.

How to rip wheel tracks?

Wheel tracking ripping in action (above).

Wheel track ripping is carried out as soon as possible after planting. A shallow tyned implement pulled behind a tractor is used for this purpose. It has double leg subsoiler shanks with small wing bases, mounted behind the wheels on a straight toolbar. Weights attached to the middle of the toolbar help with penetration of the implement.

Photo credit: K Makan.

3.2.3 Wheel track dyking

Practices for keeping the soil on the block

Dyking is a simple practice that creates a series of closely-spaced soil dams in wheel tracks (Figure 3.2). These dams capture water in what amounts to small indentations. Water can then soak into the profile, minimising runoff and any associated movement of soil and nutrients. As with wheel track ripping, dyking offers a practical solution to reduce soil erosion before it becomes a bigger issue.

Figure 3.2: Small indentations along the wheel track can be seen filled with water.

These small dams slow the water down and settle the suspended sediment. Water also has a longer duration to infiltrate into the soil.

Why dyke wheel tracks?

Trials in the Horowhenua and Hawke's Bay have shown that dyking wheel tracks can be extremely effective in reducing runoff and soil and nutrient loss. In low and high rainfall events dyking eliminated runoff compared to undyked (standard) wheel tracks (Figure 3.3). This largely reflects the longer retention time water has behind soil dykes.

Figure 3.3: Dyked (left) vs undyked (right) wheel tracks.

Creating these small dams along the wheel tracks can have clear production benefits too, through the minimisation of ponding. Reducing the risk of ponding is critical, given even short term ponding can significantly impact crop yield. Even where crops survive the initial ponding event, crop performance is still often affected.

How to create wheel track dykes?

Soil dykes are created by a propeller-like implement. A ripper shank works immediately in front of the propellers both to loosen the soil to create the small soil dams and to allow quick drainage (see the previous section). There are several different designs available, though most create soil dams about every 30 to 45 cm. The equipment itself is pulled behind a tractor and is mounted to a standard straight toolbar.

The best time to create the dams is when the soil has been recently worked. It is following this disturbance that soil is most at risk of moving. Soil dykes should be formed slightly below the top of the bed, so that if they overflow during extreme rainfall events the water will flow down the wheel track rather than across the bed. Don't work the wheel tracks if the soil is too wet – damage to soil structure is likely to outweigh any potential benefits.

In some situations there may be value in reforming dykes several times during the season, where in others once will suffice. Sowing oats at the same time the wheel tracks are dyked can increase the stability of the soil dams, but is not essential. Wheel tracks in the rows used for spraying should not be disturbed.

3.2.4 Contour drains

Practices for keeping the soil on the block

Photo credit: Wai Shing

Contour drains can be considered if the block is on a slope of 1°(1.7%) or more.

Contour drains are temporary drains used to collect runoff water. They effectively reduce the length of rows that runoff water can flow down by collecting water in shallow drains that run at a gentle gradient across the slope of the block. Water is then channelled into permanent drains or grassed alleyways. Contour drains also control the speed of runoff water when the correct gradient is used.

Contour drains must discharge into a permanent drain; otherwise the problem of erosion is simply shifted from within the block to the margins. The permanent drain must be capable of handling the volume of water discharged from the contour drains.

To work well, contour drains must be designed and constructed properly, taking the field's characteristics into account.

Contour drain spacing

The steeper the slope, the greater the number of contour drains needed. Table 3.4 provides appropriate drain spacing according to block slope.

Table 3.4. Contour drain spacing.

Block slope	Drain spacing
> 6° (10% i.e. 10m rise per 100m length)	20m
1.7° - 6° (3% - 10%)	30m
< 1.7° (3%)	50m

As a general rule, contour drains should never be more than 80m apart.

Getting the spacing of contour drains right is very important. Getting it wrong can actually create more problems than it solves. The golden rule is to avoid placing drains too far apart, as contour drains spaced too widely can overflow and cause erosion.

Contour drain slope

It is important that contour drains are sloped correctly. If too flat they can silt-up or overflow, if too steep they become gouged-out. The best way to get the slope right is to survey the block to get the right fall in the contour drains.

Trials in the Franklin District have found a slope of 1.0° - 1.5°(1.7 - 2.6%) is appropriate for clay loam soil.

The most common fault seen with contour drains is that they are too steep and too far apart. To compensate for this, they are often deeper than necessary and therefore become a hindrance to sprayers and other field equipment.

Contour drain length

For contour drains, shorter is better. The longer the drain, the more likely it is to overflow. As a guide, the Kindred Landcare Group in Tasmania recommends that contour drains be no longer than 50m.

Contour drain construction

A clinometer, two equal length poles, an assistant and marker pegs should be used to mark out the placement of contour drains.

1. Stand at the top of the block halfway between the vertical drains on either side of the block or at the far side of the block if there is only one vertical drain.
2. Send your assistant to the edge of the block, their pole held upright.
3. Set the clinometer to the required angle. Rest it on your pole and look through it.
4. Ask your assistant to move down the block until the top of the poles line up with the hairline on your clinometer.
5. Peg both your and your assistant's position. This is the line for the contour drain.
6. Both move down the block 20 - 80m, depending on the block's characteristics, and repeat steps 3 and 4 and 5.

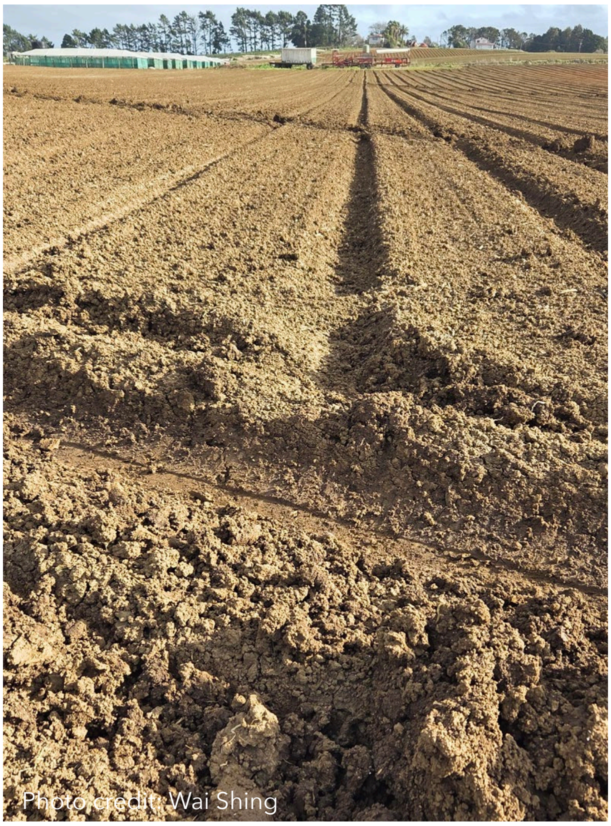


Photo credit: Wai Shing

Once pegged out, drains can be constructed with a blade set on an angle. Soil should be pushed to the downhill side. Drains may need to be finished off by hand.

Contour drains should be put in immediately after sowing the crop - not the next week. It may be too late or may not get done at all.

3.2.5 Block length

Practices for keeping the soil on the block

Row length is important if the block is on a slope of 2% (equivalent to about 1° degree) or more. In longer rows, erosion is often evident. This is because the cultivated rows act as channels, essentially a "race" for water and run off. In blocks with both slope and a long run length, water has the opportunity to build up more volume and velocity. This significantly increases the risk of scouring, as well as sediment loss to the surrounding environment. Scoured and eroded rows significantly impact crop productivity and profitability.

Measures to manage block length risk

- If rows are oriented up and down the slope, restricting row lengths to 200 m or less is recommended.
- Contour drains can help to break this length up to reduce the overall row length. See page 29 for a guide on installing contour drains.
- Some growers around Pukekohe use cross-contour vegetative strips to reduce in-block erosion caused by long run lengths (see Figure 3.4). Sown across rows before sowing or planting of the main crop, the strips help drop out sediment at intervals down the block during the growing season. This reduces both scouring in the block and the quantity of sediment that needs to be dug out of a sediment retention pond at the end of the season.
- Another method of reducing erosion in-row used by growers in Pukekohe has been to sow vegetative strips when wheel track ripping after planting (Figure 3.5).

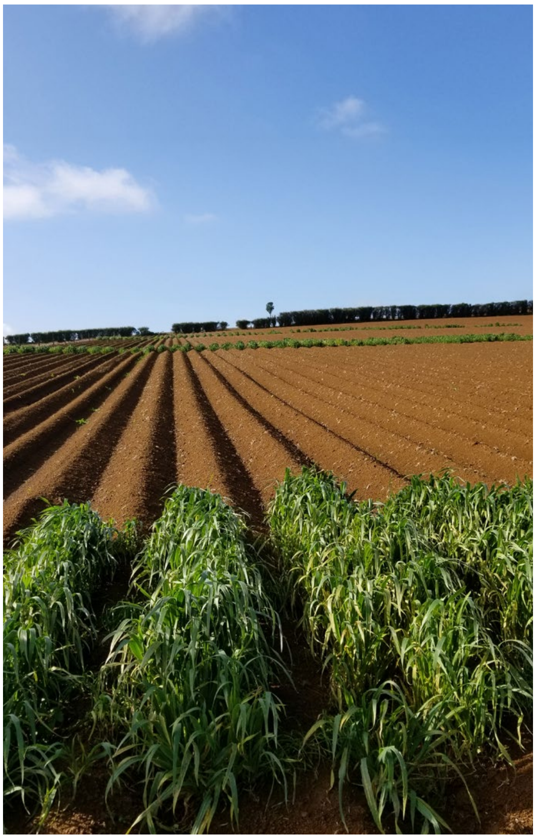


Figure 3.4: A grower's use of cross-contour oat strips on a steep block with a long run length. Used with permission.

Figure 3.5: A grower's use of in-furrow vegetative strips to reduce in-block erosion. Used with permission.

3.2.6 Cultivation practices

Practices for keeping the soil on the block

Cultivation reduces the stability of most cropping soils over time. The how, when and where cultivation is done can have a big impact on the erosion potential of your soil. Good cultivation techniques can increase productivity and conserve soil, keeping it in good condition for the future.

Protecting the soil resource is very important as it can take many years to rebuild once it is lost through erosion. Consideration should also be given to retiring or resting blocks where the soil structure has been degraded by excessive or poorly timed cultivation. Continuing to crop blocks with degraded soil structure will only intensify soil loss and erosion, for example, with an increased number of passes required to prepare blocks for planting.

Cultivation practice to reduce block erosion:

- Adopting minimum tillage approaches or minimising the number of cultivation passes can be an effective means to reducing soil erosion.
- Maintaining good soil structure can reduce the costs of cultivation, for example, by reducing the number of passes needed to achieve the desired seed bed. Good soil structure also protects the health of the soil by allowing better aeration and drainage.
- Excessive cultivation with rotary hoes should be avoided. The exposure of less fertile subsoils can require higher inputs of fertiliser (added cost) to maintain crop productivity.
- Where possible, blocks should be cultivated in alternating directions in successive years to avoid moving whole fields downhill.

Some dos and don'ts for soil cultivation

1. **DO** minimise the number of passes over the block wherever possible.

   Every cultivation pass results in the loss of organic matter through decomposition and can have a detrimental effect on soil structure.

2. **DO** build the organic matter level of your soils.

   Cultivation reduces organic matter. Building organic matter can be done with the use of cover crops (see the Section 3.2.1) or compost. Organic matter is critical for maintaining the stability of soil aggregates and reducing nitrate leaching. It also allows for easier preparation of seedbeds. The organic matter additions must form part of your nutrient budget (See Nutrient Management Code of Practice).

3. **DON'T** cultivate when the soil is too wet.

   The best way of reducing compaction and the formation of pans is to avoid being on the land when it is too wet. Compaction slows the infiltration of water into the soil and increases the risk of soil erosion.

3.2.7 Reduce soil compaction

Practices for keeping the soil on the block

Soil compaction significantly increases the risk of soil erosion. Compacted soils have reduced infiltration rates, leading to increased surface runoff and erosion, as water is unable to penetrate the soil and is instead carried away, taking soil particles with it. This also limits root growth and reduces plant cover, further exacerbating the problem.

Start by understanding the issue by measuring soil compaction using a penetrometer or simply digging a pit.

In cultivated horticulture compaction can be reduced with deep ripping. Wheel track ripping works by breaking up the compacted top layer in the wheel tracks and significantly increases infiltration rate.

In both permanent and cultivated horticulture, management practices to reduce compaction include:

1. Maintain and upgrade drainage systems.
2. Avoid traffic on wet soil.
3. Consider irrigation cycles and current soil conditions when scheduling machinery passes.
4. Avoid unnecessary machinery passes. Carefully consider the full cost-benefit of each machinery movement.
5. Reduce the weight of each pass, using tracked vehicles, extra or oversized tyres to spread the load and reduce downward pressure.
6. Create hard stands for loading and unloading operations, particularly around harvest activities.

In permanent horticulture, other practices could include:

1. Maintain year-round vegetative ground cover (orchard sward).
2. Drive in alternate rows where possible and use the same wheel tracks and travel direction in each row to limit the areas that become compacted and needs remediation.

3.2.8 Harvest management

Practices for keeping the soil on the block

At harvest, operations should be carried out in a manner that has the least adverse effect on soil and water resources.

Working blocks in wet conditions can lead to loss of soil structure, compaction, and increased sediment in the runoff. In addition, it can also increase wear and tear on plant and machinery, reduce labour efficiency, increase pressure on washing systems, and increase product reject levels. Additionally, mud left on the road can create a traffic hazard and result in public animosity toward land users.

However, timing of harvest operations can be dictated by the demands of markets or factory requirements (process vegetables). This makes it difficult for growers to always operate under good soil and climatic conditions.

All-weather facilities should be established for loading and marshalling areas to prevent severe compaction, breakdown of soil structure, or any limitation to access.

Where required, metal should be used in gateways and loading pads. Load out may occur in an adjacent block. Refer to 3.3.8 Vehicle and Machinery Washdown for more information on this topic.

3.2.9 Post-harvest management

Practices for keeping the soil on the block

Where a new crop is not going to be immediately sown following harvest, consideration needs to be given to block management to prevent soil erosion. Bare soil surfaces in blocks following harvest are vulnerable to erosion caused by wind and rainfall, with significant soil and sediment loss likely in heavy rainfall or storm events. Therefore, post-harvest block management should be planned before harvest to minimise this risk.

Establishing a cover crop soon after harvest can protect the soil and generate other advantages such as increased soil organic matter, preventing the breakdown of the soil structure, and providing a feed resource for grazing. With its fibrous root system, oats are an effective cover crop option. See Section 3.2.1 for a description on the use of cover crops.

Where a cover crop cannot be established following harvest, contour cultivation should be considered so that the soil surface is broken up and left in a condition that avoids erosion.

Contour cultivation (Figure 3.6 below) can provide a similar effect to contour drains. Because crop management no longer needs consideration, there should be greater choice on where such cultivation occurs and whether the whole area is given a breaking up pass or at regular intervals across the slope.

Returning blocks to pasture at regular intervals is an effective way of building up soil organic matter and avoids the build-up of pests, diseases, and weeds. When returning pasture blocks to cropping, take care not to undo all of the good work by over cultivating or working the ground in less than ideal conditions.

Rotation of crops is well recognised as a practice that replenishes different nutrients and organic matter, improves soil structure through varying root depths, and manages soil-borne disease pressures. The length of the rotation and cropping practices will influence the extent of soil damage that can result from repetitive cropping. Pasture can be an effective 'recuperation crop' in the rotation.

To gain the best recuperative effect from pasture in the crop rotation, the pasture needs to be carefully managed. Overgrazing, particularly at times when soil is vulnerable to pugging or drought, can negate many of the benefits that pasture can provide. Soils can erode or compact, which in turn can lead to increased levels of soil loss through sediment runoff.

Figure 3.6: Strip contour cultivation of a fallow block following harvest.

Practices to

3.3 Manage sediment and suspended sediment moving off the block

3.3.1 Raised accessways

Practices to manage sediment and suspended sediment moving off the block

Raised accessways should form part of your co-ordinated sediment control practices. All runoff can then be managed and treated before leaving your property, stopping the loss of valuable soil from blocks onto roads and into waterways.

A raised accessway (below) prevents water from flowing straight onto the road.

While accessways are sometimes most practically located at the lowest point of the block, when unmanaged, these become a discharge point for stormwater.

The following mitigations or practices, well planned and used together, will avoid or minimise soil losses from accessways:

1. **Position accessways away from lowest point**
   Never place accessways at the lowest point of the field where water is naturally diverted or concentrates. This may mean "off-setting" it from the bottom corner where a decanting earth bund is installed.
2. **Raise accessways**
   Raise the accessway above the surrounding area to divert water into your sediment control system. This may be as simple as using a load of metal to form a hump over the access way (see photo below).
3. **Check point**
   Use the accessway as a check point where you can spend a few minutes removing soil that has become stuck to the tractor. Soil is a valuable resource. Don't leave it on the road as you drive away. Keep it for your crops. For more information see the Vehicle and Machinery Washdown Code of Practice.

3.3.2 Diversion bund

Practices to manage sediment and suspended sediment moving off the block

Diversion bunds are normally earth banks, or haybales if temporary, that prevent water discharging straight off the block. Like raised access ways, they divert water from a block into a sediment control device, like a decanting earth bund or sediment retention pond (SRP). Diversion bunds can also be used to re-direct water from flowing into a block – this is covered earlier in this Code of Practice.

Key considerations

- The bund will create channelised flow so water should be discharged into a treatment device (e.g. a decanting earth bund or sediment retention pond).
- The bund itself should be well-compacted and stabilised with vegetation.
- It needs to be high enough to reduce the risk of it breaching in high rainfall events.
- Regular checks of the bunding are recommended, especially after heavy rain, to ensure no scouring or breaching has occurred.

Vetiver grass

The Franklin Sustainability Project trialled vetiver grass as a soil barrier (Figure 3.7). Planted at 20cm intervals it will form a dense hedge, approximately 1.5m tall of stiff erect stems in 3 years. Once established it can filter the water leaving sediment to settle in front. It suits temperate regions of New Zealand.

Figure 3.7: Example of vetiver grass being used as a soil barrier (photo credit - Master & Sons).

3.3.3 Setbacks from rivers and drains

Practices to manage sediment and suspended sediment moving off the block

Setbacks from rivers and drains can help to reduce sediment loss from cultivated blocks. A setback is 'the distance from a feature (or boundary) that creates a buffer, in which certain activities (e.g. cultivation, cropping) cannot take place'[5]. Riparian setbacks, i.e. setbacks next to waterbodies, can buffer waterbodies from the environmental impacts of horticultural production.

Uncultivated setback strips

Many Regional Plans require cultivation to have a setback distance from waterways - ensure you check with your local authority for any specific regulations. As an interim, leave a 5 m setback between the cultivated area and all rivers and other waterbodies. Over time, runoff into all rivers needs to be controlled by an appropriate sediment treatment measure, determined through the block risk assessment process.

For on-farm drains used to channel run-off, ensure a minimum 1 m setback is used. Cultivating right up to the drain edge can cause instability and increase the risk of soil and sediment loss (Figure 3.8). Leaving setbacks and implementing other sediment controls (e.g. vegetated buffers) can help to minimise this risk.

Vegetated buffer strips

A vegetated buffer strip or riparian margin is a means of managing soil that moves off a block. Buffer strips should be planned as part of the cultivation so that an adequate area is left uncultivated. Strips form a filter that can trap sediment in runoff, preventing it entering waterways. Refer to the next section on Vegetated Buffers for more details, taking note of the guidance around managing channelised flow paths, which can compromise the effectiveness of vegetated buffer strips.

Figure 3.8: Ensure blocks are not cultivated right up to the edge of block drains (left). A minimum setback of 1 m can help to prevent sediment loss (right).

5 Setback definition from Resource Management (National Environmental Standards for Commercial Forestry) Regulations 2017. https://www.legislation.govt.nz/regulation/public/2017/0174/latest/DLM7373522.html

3.3.4 Vegetated buffer strips

Practices to manage sediment and suspended sediment moving off the block

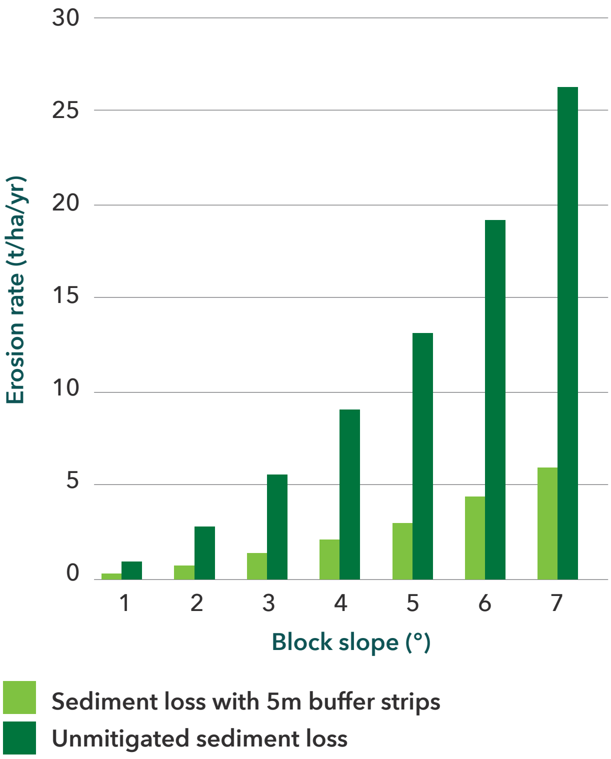
Vegetated buffer strips – also known as filter strips or riparian buffers - are a key management practice for sediment control.

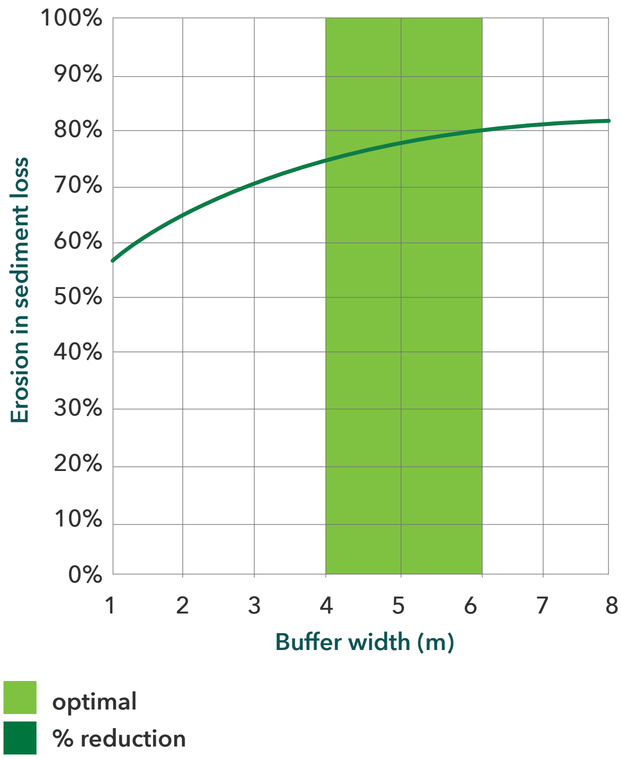
With proper installation and maintenance, strips of vegetation – typically grass - can reduce the volume of soil moving off farm and into waterways. By increasing infiltration, reducing the velocity of runoff water, and filtration by plant material, buffer strips can reduce sediment loss. Co-benefits of buffer-strips also include a reduction in nutrient and pesticide contamination to the surrounding environment.

Vegetated buffer strips are one of two commonly used sediment control practices, the other being sediment retention ponds (SRP). While buffer strips are less technical to install than SRPs, when not installed or maintained correctly they can fail to effectively reduce soil loss from the farm. Preferential flow (channelisation) can bypass buffer strips entirely, resulting in a practice that looks visually effective but has little real effect on minimising sediment loss.

Figure 3.9 below shows graphs of modelled buffer strip efficiency and quantify the reduction in sediment loss based on buffer strip width and block slope. A 5m buffer strip (the optimal width based on modelling), when installed correctly, is a powerful tool to reduce sediment loss. To note, these graphs have been produced using modelled data from Barber & Stenning – actual erosion rates will vary.

Figure 3.9: Modelled buffer strip efficiency based on block slope and buffer width (Location - Levin).





Installing vegetated buffer strips

> "Unless [buffers] can be installed so that concentrated flow is minimised, it is unlikely that they will be very effective for agricultural nonpoint source pollution control" – Dillaha et al., 1989.

Install vegetated buffer strips on blocks adjacent to rivers, streams, and farm drains connected to rivers and streams, where there is no other sediment control practice or device in place. Level the ground to minimise channelised flow prior to sowing the buffer with grass. As can be seen in the photograph above, the headland has been moved further into the block to exclude traffic from the new buffer.

Vegetated buffer strip efficiency is contingent on runoff water entering as a continuous sheet, rather than at a singular point, as this leads to channelisation and bypassing of the vegetation.

To encourage sheet flow, the area where the future buffer strip will be placed has to be levelled. This can be accomplished using a power harrow with rollers, or a levelling bar. The image above shows the ideal ground preparation prior to seeding with grass or other vegetation.

The slope of the buffer strip should be between 2-6° (3-11%), sloping away from the block and headland to encourage runoff water movement across the buffer.

Orientation of vegetable rows to encourage sheet flow is important in preventing channelisation or other means of bypass.

The vegetated buffer should be 4 m to 6 m wide. It is recommended that an additional metre is added for contingency, as the edge of the buffer strip will inevitably become compromised over time by vehicle and machinery movement. It is especially important to ensure there is adequate headland space for vehicle movement in order to prevent vehicles tracking across the buffer strips and creating ruts and therefore channelised flow. A wide headland also enables runoff water to spread out and lose velocity as it exits the rows.

The trafficked headland needs to be located between the cultivated block and the buffer strip. For many new buffer strip installations this will mean moving the headland into the block.

The choice of vegetation is also important. Most growers choose to use basic grass species, though oats, vetiver grass, and miscanthus are other species that can be used as an alternative. Generally, any plant species which has ground level vegetation and strong root systems will work to increase filtering and water infiltration. The vegetation must also evenly cover the entirety of the buffer strip to prevent preferential flow or routes of least resistance. Consideration must also be given to avoiding species that host crop and market access pests or may impact negatively on pollination.


Photo credit: Woodhaven Gardens

Maintaining vegetated buffers

> "Concentrated flow through riparian buffers [is] common and substantial" – Dosskey et al., 2002

Once established, buffer strips need to be maintained in order to keep them functioning effectively.

Buffer strips need regular inspection, particularly during winter. The first thing to keep an eye on is determining exactly where and how water is entering the buffer. It is not uncommon for small undistinctive topographical features to result in water bypassing the strip. This is often caused by soil buildup alongside the strip, which, whilst a good indication that the buffer strip is working, can often cause a bunding effect preventing water from entering the strip in a sheet flow. Therefore, it is important to watch runoff water during a rainfall event to ensure it is entering the strip without channelised flow, and to remove settled bedload from along the front edge of the buffer.

The second major issue to watch out for is channelisation within the vegetated buffer strip. This can be caused by vehicle wheel tracks or topographical variations causing channelised flow. It is important to fill in any channels, keeping a level vegetated surface to encourage sheet flow through the strip.

The last major area to be conscious of in your inspections should be the vegetation cover. Patches of no vegetation caused by errant herbicide use, channelisation or wheel tracks can further reduce the integrity of the buffer and encourage preferential flow. Re-seeding will occasionally be necessary to fill in patches in the vegetation.

The picture above shows a healthy, well maintained vegetated buffer strip with no signs of channelisation and consistent vegetation cover. The headland was recently levelled to encourage sheet flow into the buffer.

Further information on vegetated buffer strips can be found in Vegetated Buffer Strips - Background Material (Barber, Stenning, and Dobson, 2025), available from Horticulture New Zealand.

3.3.5 Silt fences

Practices to manage sediment and suspended sediment moving off the block

Silt Fences and Super Silt Fences are considered a temporary measure for trapping sediment-laden runoff from small catchments of usually less than 0.5 ha. When used on larger catchments careful consideration of the site characteristics is needed or other alternative management practices may be more appropriate. For gradients of less than 10% the slope length behind the Super Silt Fence is unlimited, however Silt Fences have a slope length restriction of just 40m. The Franklin Sustainability Project used them in trials as an effective means of demonstrating the quantity of soil that was being lost from a block. Inasmuch, they can serve as a means of justifying a more permanent, well-constructed sediment retention pond.

In cultivated growing situations Super Silt Fences are the most appropriate. These use a geotextile fastened to a wire fence (e.g. chain link fence).

Regular wind or weed matting cloth is not suitable because these materials do not have good filtering characteristics or high flow rates The geotextile fabric must meet the following minimum requirements. Grab Tensile Strength: >440N, Tensile Modulus: 0.140 pa, Apparent Opening Size 0.1 – 0.5mm. Table 3.5 provides design criteria for super silt fences.

Detailed construction guidelines can be found on the Auckland Council website's technical publication Erosion and sediment control guide for land disturbing activities in the Auckland region GD05.

Table 3.5. Super Silt Fence Design Criteria.

Slope Steepness in degrees (% in brackets)	Maximum Slope Length (m)	Spacing of Returns (m)
0 – 5.7° (0 – 10%)	unlimited	60
5.7° – 11.3° (10 – 20%)	60	50

3.3.6 Decanting earth bunds

Practices to manage sediment and suspended sediment moving off the block

A Decanting Earth Bund is often constructed along the flat contour at the bottom of a block. By moving the headland itself several metres further up the block, the full width of the block can form a ponding area that will hold runoff long enough to allow sediment to drop out of suspension prior to discharge (see Figure 3.10 below). This approach can avoid having to build deeper sediment retention ponds (SRP) in the corner of blocks in order to achieve the required volume.

Creating sufficient capacity in Decanting Earth Bunds and Sediment Retention Ponds is essential for giving sediment sufficient time to settle. The recommended capacity is 0.5% (50 m³/ha) for catchments of less than 5 ha, 0.75% (75 m³/ha) for 5 - 10ha, and 1% (100 m³/ha) for catchments over 10 ha. More details are provided in the next section on Sediment Retention Ponds.

Decanting rate

Decanting Earth Bunds and SRPs need to dewater so as to remove the relatively clean water without removing the settled sediment. The decanting rate is critical. Too fast and the sediment will not have time to settle. Too slow and the primary and emergency spillways will operate in even moderate sized rainfall events, which will also result in poor sediment capture efficiencies.

The recommended decant rate is 3 L/sec/ha. Table 3.6 shows the number of 12 mm holes required for various lengths of vertical snorkel in order to decant at a rate of 3 L/sec/ha. As the SRP becomes deeper (longer snorkel) the average flow rate through each hole increases, hence less holes are needed. For example, if the Decanting Earth Bund has a 1-hectare catchment; on a 1m snorkel drill 15 mm diameter holes. This can be done in 3 vertical rows with 5 holes each at 65 mm spaces from the top of the snorkel down to 0.3 m from the SRP floor. A deeper trap with a 1.5m snorkel requires 12 holes to achieve the same decanting rate of 3 L/sec/ha.

The number of holes will need adjusting based on the catchment area and the snorkel height. Larger catchments may require several vertical pipes.

A lookup table is provided in Appendix D showing the number of holes and their configuration for a range of catchment sizes and live storage depths.

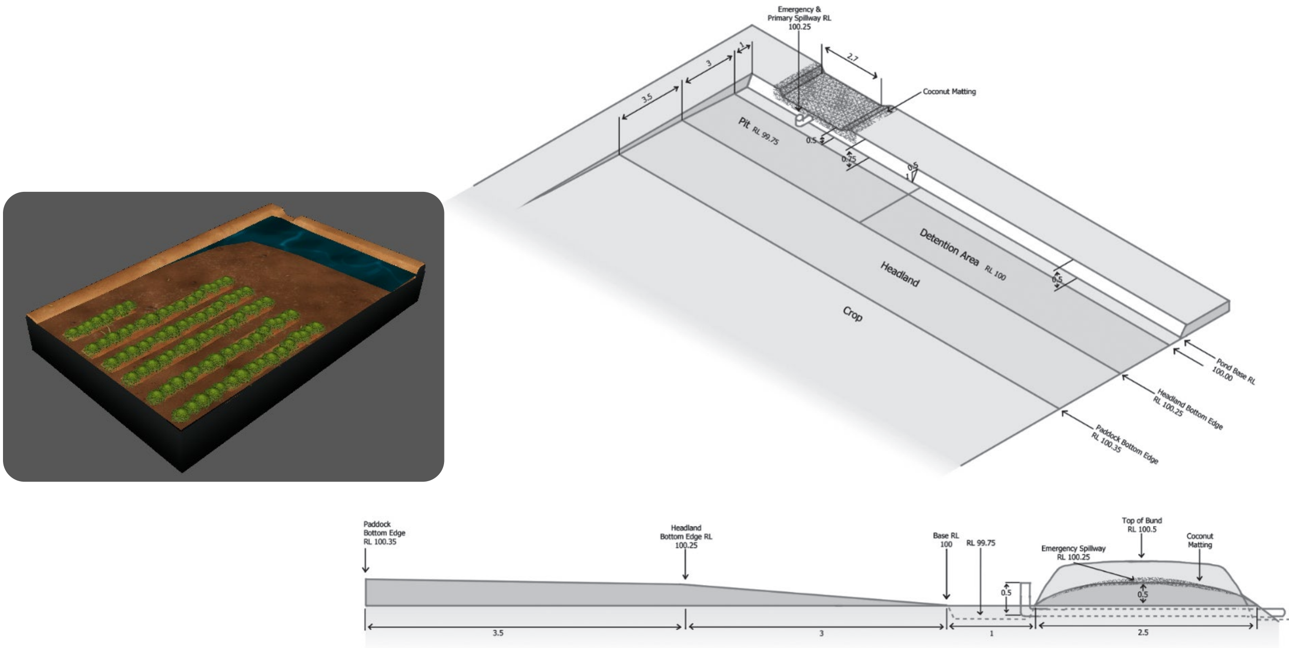


Figure 3.10: A 0.5m high decanting earth bund that uses the width of the block as its detention area. The headland was moved 4m further into the block.

Table 3.6. Snorkel hole number and configuration to achieve a discharge rate of 3 L/sec/ha (Appendix D has a more detailed table).

Snorkel length (m)	Hole length (from top) (m)[1]	Hole size (mm)	Total number of holes per snorkel	Number of hole lines per snorkel	Number of holes per line	Distance between holes (mm)	Number of snorkels
1.0 ha catchment							
1.5	1.05	12	12	4	3	350	1
1.0	0.7	12	16	4	4	175	1
5.0 ha catchment							
2.0	1.4	12	28	4	7	200	2
1.5	1.05	12	32	4	8	130	2
1.0	0.7	12	40	4	10	70	2

1. The bottom 30% of the snorkel does not have any holes. This forms the dead storage. In decanting earth bunds the holes may go all the way to the bottom if the headland needs to be kept dry.

Photo credit: Master & Sons

It is recommended that the bottom 30% of the snorkel is not perforated. This will result in a permanent pool at the bottom of the SRP, which helps sediment settle. 30% of the volume of the trap should be "dead storage" i.e. a pool of water and the other 70% is operating volume i.e. is the volume decanted off through the perforated upstand during and after rainfall events.

Key decanting snorkel requirements:

1. The open top of the snorkel acts as the primary spillway. There should be 300 mm gap between the top of the snorkel and the emergency spillway.
2. The decant rate should be 3 L/sec/ha. See Table 3.6 for examples.
3. The bottom 30% of the snorkel should not have holes in order to leave dead storage.
4. Snorkel should be securely fastened to a stake.
5. The discharge point should be stabilised by discharging onto rocks or stabilised ground.
6. The goal is to achieve 70% live storage. However insufficient outfall might prevent this. Adaptations might include reducing the gap between the top of the snorkel and the emergency spillway, or adding a forebay.

Emergency spillway

The emergency spillway discharges excess water in major storm events when the snorkel and primary spillway are unable to cope. Position the spillway as far away from the entrance as possible. The spillway needs to be stabilised with rock, geotextile or on firm vegetated undisturbed ground. The minimum width is 1.5m/ha of catchment. The spillway must be level and 300mm above the primary spillway. There should be 300mm between the top of the bund and the emergency spillway.

3.3.7 Sediment retention ponds

Practices to manage sediment and suspended sediment moving off the block


Photo credit: Balle Bros

Sediment Retention Ponds (SRPs) also known as silt traps, impound runoff water and ensure sufficient time for the suspended soil to settle. Volume is the key attribute, and essential for reducing suspended sediment. While the soil bedload drops out very quickly, the required volume is based on settling out the last 5%. It is the suspended sediment that causes the downstream environmental damage.

Whenever possible:

1. Break the block into smaller catchments with their own treatment measures and sediment retention pond.
2. Treat runoff from a catchment only once and discharge it from the block into a stabilised drain.

Sediment Retention Ponds work best in combination with other practices that reduce the amount of soil reaching the ponds. SRPs alone are not the only means of controlling soil loss but are part of an overall system.

Details on constructing a SRP are provided below, built upon knowledge gained from the Franklin Sustainability Project and the more recent project Don't Muddy the Water.

SRP capacity: How big should it be?

SRP size depends on the several factors that influence potential soil movement. Factors include the size of the area draining into the SRP (catchment area), and the slope of blocks in the catchment.


Photo credit: Master & Sons

The SRP (pictured left) has water entering as far away from the outlet as possible. The emergency spillway is stabilised with geotextile cloth, level, and wide (1.5 m/ha of catchment). There are 2 snorkels with the required number of holes and the top is approximately 300 mm below the emergency spillway.

Table 3.7 is a general guide for SRP capacity. As discussed earlier, SRPs should be used with a combination of erosion practices to reduce the quantity of soil and sediment potentially moving off your blocks.

Table 3.7. Capacity criteria for sediment retention ponds.

Catchment area	Slope *	Capacity	SRP and bund capacity examples ^
< 5 ha	< 7° (12%)	50m³ / ha catchment	1 ha catchment = 50 m³. Trap dimensions = 11 m x 4 m x 1.5 m (batter 0.5 : 1)
5-10 ha	< 7° (12%)	75m³ / ha catchment	6 ha catchment = 450 m³. Trap dimensions = 35 m x 10 m x 1.5 m. (batter 0.5 : 1) Plus a forebay
> 10 ha	Or > 7° (12%)	> 100m³ / ha catchment	12 ha catchment, trap dimensions = 56 m x 12 m x 2.0 m = 1,200m³ (Batter 0.5 : 1)

* Average block slope

^ These SRP dimensions are one example only of how to achieve the required trap capacity.

In general, aim to maintain at least 80 percent capacity. These volumes aim to detain the runoff long enough to allow for most sediment to drop out of suspension.

Constructing a SRP

Before constructing a SRP, make sure the area you have selected is clear of cables/pipes etc. Strip any topsoil and vegetation from the area to create a firm foundation (if walls are being build up from this). Keep stock away from the site to avoid any pugging or damage.

The SRP should be between 3 to 5 times longer than it is wide with inflow entering at one end and discharging through the outlet at the other. Figures 3.11 and 3.12 on the next page include an example SRP design and a graphic illustrating an SRP full to the height of the emergency spillway.

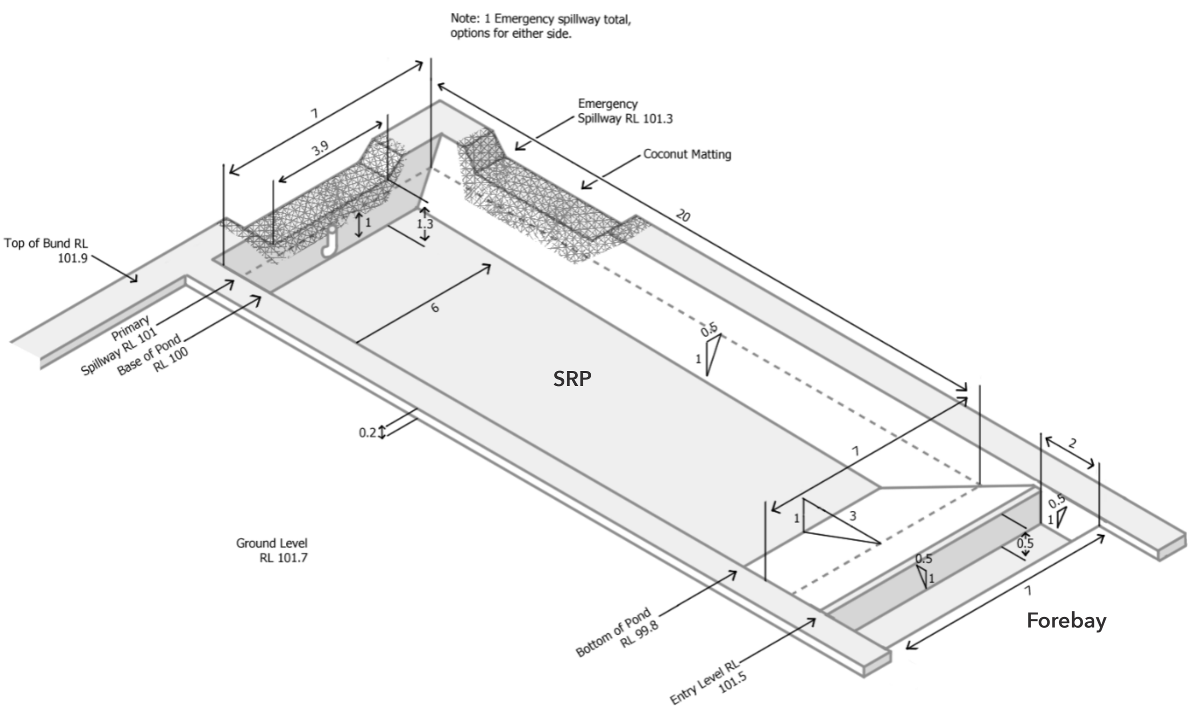


Figure 3.11: An example of an SRP for a 2.5 ha catchment. This design included a forebay, designed to make maintenance easier.

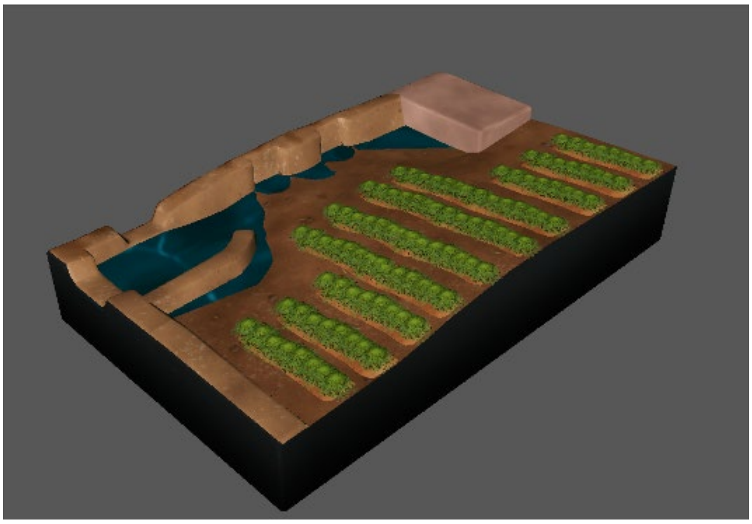


Figure 3.12: The SRP filled to the height of the emergency spillway. Along the headland cutouts can be seen dug into the bank. These further help to reduce the quantity of sediment that reaches the SRP. Consequently, reducing the accumulation of sediment in the pond which compromises the available storage and detention time, particularly in winter when the SRP cannot be cleaned out.

Silt traps have four main components:

- Bund or walls
- Detention area
- Overflow or spillway
- Discharge mechanism (snorkel)

Bund or walls

1. They must be thoroughly compacted, otherwise they can blow out in storm events. Compact each 200mm of material added to the height of walls. Usually a minimum of three passes over the entire surface per layer is required.
2. Establish vegetation cover. It may be necessary to pin down geotextile to stabilise the slope face, and plant with grasses.
3. If clay has been used it will be necessary to add a layer of topsoil over the clay to establish grass. Grass seed and fertiliser should be applied.

Detention area

This is the area where runoff from the block will collect and settle for sufficient time to allow sediment in suspension to drop out before the water drains away, through the snorkel or spillway. Benched headlands can direct water into the detention area.

Discharge mechanism

The snorkel drains the SRP between rainfall events. The target discharge rate is 3 L/s/ha.

Table 3.8. How large should the pipes be?

Pipe diameters	Catchment area
100 mm	< 2 ha
150 mm	2 – 5 ha
225 mm	> 5 ha

The number of holes in the snorkel is critical for controlling the rate of discharge. Too many holes and the detention time is shortened, and therefore the settling time for the suspended sediment is significantly compromised. Table 3.6 shows some examples for 1 ha and 5 ha catchments.

Installing the pipes:

1. The pipes are placed at the lowest point of the SRP and should discharge to an erosion-proof outfall. This may be the water table, a drain or stream.
2. Avoid crushing the pipe during installation. The soil should be thoroughly compacted around the pipe by hand.
3. Use non-perforated pipe through the bund wall, for example, solid PVC pipe.
4. For the upstand the lowest hole should be at the 30% dead storage height. Mark the 20% volume height for determining when the pond needs to be cleaned out. Protect the snorkel upstand with a waratah stake or post that the snorkel is tied to.
5. Calculate the number of holes to achieve a discharge rate of 3.0 L/s/ha (Table 3.6 has examples).
6. The top of the snorkel should be 300mm below the emergency spillway.

More information on snorkels and decanting rates can be found in the previous section on Decanting Earth Bunds.

Limited live storage

Live storage is measured between the outlet height and top of the primary spillway. There should be 70% live storage.

Underground services may prevent a snorkel being installed. Other site constraints such as outlet heights may limit the amount of live storage. In this situation firstly try to maximise live storage by raising the snorkel height (primary spillway) so that it is at the height of the emergency spillway (ideally the primary spillway is 300 mm below the emergency spillway). Perforate the pipe with the required number of holes.

The quantity of bedload entering the pond needs to be minimised due to both the lower pond suspended sediment performance and the difficulty cleaning a pond with more than 30% dead storage. This should include the use of drop out pits along drains leading to the pond and/or a forebay that is 10% of the SRP volume.

Emergency spillway

An emergency spillway discharges the excess water runoff in major storm events and stops bunds breaking.

1. Position the spillway so it is as far from the entrance points as possible.
2. If possible, situate the spillway on firm, undisturbed ground.
3. Ensure runoff discharges won't cause erosion.
4. Ensure that the minimum width is 1.5m/ha of catchment.
5. Ensure that the spillway is level across its width.
6. Make sure you protect the spillway sides against erosion, using either geotextile or coconut matting and sowing under the matting with grass. In some situations large rocks may be the best solution to stabilise the discharge point.

Sediment retention pond maintenance

SRPs need to be maintained to ensure ongoing effectiveness. Growers are recommended to prepare a maintenance plan for their traps, which includes a routine monitoring and maintenance schedule, as well as heavy rainfall response measures. The plan should outline what evidence and records are being kept of routine inspections and maintenance for auditing purposes. As part of the plan, ensure all relevant staff are aware of the health and safety risks working in and around SRPs.

Guidance for trap maintenance includes:

- Inspect traps, culverts, and drains at least every 6 months and both before and after every large storm.
- Inspection involves:
  - Measuring the depth of the trap from the top of the primary spillway to the base of the pond (see Figure 3.11)
  - Checking snorkels are not blocked, for example, with vegetation
  - Checking bunds have not been penetrated by water channels
  - Checking for seepage through the embankment or along the outlet pipe
  - Check for erosion at the outfall/spillway
  - Checking culverts remain unblocked
  - Checking all drains, including interception drains are clear
- If trap capacity reduces by more than 20% from design specifications (based on depth measurements), remove the excess sediment to restore design capacity. In general, remove excess sediment on an annual basis, or more frequently if the capacity has reduced by more than 20%.
- When digging out the trap take care not to damage the snorkel (where present), and place soil back on the paddock or stockpile for dewatering in a fully bunded area.
- Fix any damage to the trap as soon as possible after inspection.
- Always maintain access to the forebay to allow removal of accumulated sediment.

Health and safety

As with all sediment control measures, safety considerations around SRPs should be front of mind throughout the design, installation, and use phases of this mitigation:

- Identify the SRPs on your farm map, hazard registry, and H&S plan
- Make all staff, contractors, and visitors aware of the hazard
- Design a shallow, sloping entrance to the SRP with a slope 3:1 or more
- Install signage next to the SRP to visually highlight the hazard
- Ensure all SRPs are correctly bunded to prevent machinery slipping into ponds
- Consider installing an escape ladder or ring buoy
- Do not enter or be alongside an SRP unless 2 or more people are present

3.3.8 Vehicle and machinery washdown

Practices to manage sediment and suspended sediment moving off the block

Soil deposited on roads from vehicle and machinery used for horticulture production activities can contribute to sediment loss to the surrounding environment. In areas with intensive vegetable production and a significant number of vehicles and machinery moving between properties, the risk of soil moving onto roads is high. In addition to being an environmental risk, soil on roads is a health and safety risk for motorists.

The Vehicle and Machinery Code of Practice, available on HortNZ's website, includes a risk assessment and outlines a number of practices that growers can implement to reduce the risk of soil moving off site. Include an assessment and review of your vehicle and machinery washdown processes as part of your annual review for erosion and sediment control.

4 Decision support tools

4.1 Don't Muddy the Water (DMTW) web app

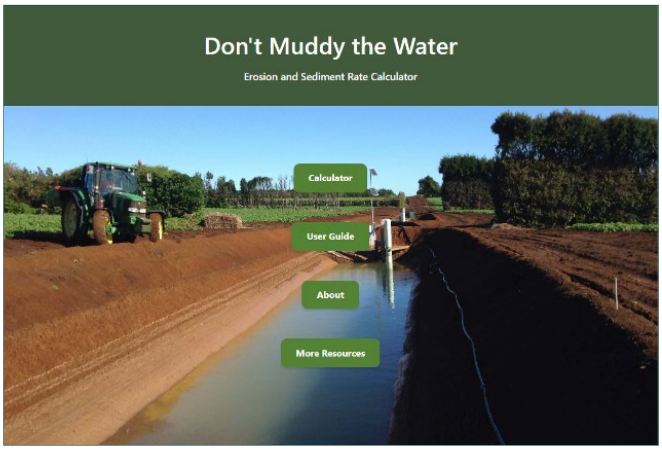
Web app overview

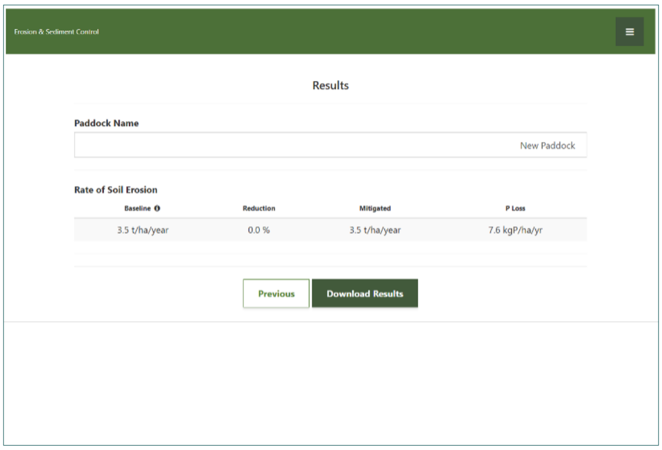
Don't Muddy the Water is a free web application for growers to calculate erosion rates from vegetable cropping land. It was an outcome from the Sustainable Farming Fund (SFF) project, Don't Muddy the Water[1]. The web app uses research results from the project, as well as factors from the Revised Universal Soil Loss Equation (RUSLE) to model erosion rates.

Growers can use the web app to calculate erosion and sediment loss rates, pre and post-mitigation for a given block based on slope, location, ground cover, row lengths and mitigation measures. Mitigations that can be modelled in the web app include:

- Cover cropping
- Wheel track ripping
- Wheel track dyking
- Cultivation: Minimum vs conventional
- Sediment retention ponds, including a range of catchment sizes
- Vegetated buffer strips

Results can also be saved and downloaded as a pdf document, which can be helpful when preparing farm plans and other evidence, or planning documentation.





Assigning erosion risk

As the web app calculates estimated erosion rate, growers can use the DMTW web app instead of the flow chart in Section 2.2 to assign erosion risk groups (very low, green, amber, or red) to production blocks. The Nutrient and Erosion Management (NEM) workbook in Appendix A provides space to enter in app results and assign an erosion risk group. The workbook then directs growers to implement a set of practices, based on Table 2.1.

The web app is currently hosted on VR&I's website: https://www.vri.org.nz/esc/.

[1] Don't Muddy the Water - Final Report (2019)

Appendix A: Nutrient and Erosion Management (NEM) workbook

These are snapshots of the Excel-based workbook available to download from the HortNZ website.

NUTRIENT AND EROSION MANAGEMENT (NEM) WORKBOOK

This Excel workbook is designed to support outdoor growers to develop and maintain two plans required for the responsible management of contaminants from horticultural production systems, including nitrogen, phosphorus, and sediment. These plans include:

- Nutrient Management Plan (NMP), in accordance with the Nutrient Management Code of Practice 2026
- Erosion and Sediment Control Plan (ESCP), in accordance with the Erosion and Sediment Control Code of Practice 2026

The Nutrient and Erosion Management (NEM) workbook steps growers through the process of undertaking risk assessments to identify practices to implement, to manage the risk of contaminant loss. This workbook should be supported with additional information required for each plan, for example nutrient budgets, records, and test results, as well as mapped locations of environmental mitigations (e.g. Sediment Retention Ponds).

The information contained in this workbook forms part of a wider farm plan. There is no requirement to use this exact workbook, but it's a helpful tool to meet the criteria set out in the Nutrient Management and Erosion and Sediment Control Codes of Practice.

Instructions:
Please use Microsoft Excel to complete this workbook to ensure all the inbuilt formulas function correctly.
This workbook should be reviewed on an annual basis to track progress towards actions.
To do this, we recommend keeping a working or current version of this workbook e.g. "J Apple Farm - NEM workbook.xlsx", and saving a separate dated copy each year before reviewing. This will allow you to demonstrate progress over time.
This workbook has a number of built-in formulas and links to help make information entry and navigation as easy as possible. Each tab contains a template you can fill in to help complete both your Nutrient Management Plan and Erosion and Sediment Control Plan. The tabs and workbook align with the relevant Codes of Practices.

Updates to this workbook may occur at any time. As part of your annual review, please check the HortNZ website to ensure you are using the latest version.

Cells coloured light yellow are fillable.

Contents

Business information	*Summary of key business details and space to write goals relating to nutrient and erosion management.*
Risk - N loss	*Space to record blocks and enter details to undertake an N loss risk assessment.*
Risk - Erosion & P loss	*Space to enter details to undertake an Erosion / P loss risk assessment.*
Risk summary	*Summary table of risk assessment results.*
Nutrient risk group (NRG) tables	
Green	*Minimum and Additional practices, with space to record actions, for all blocks in NRG Green*

BUSINESS INFORMATION

1.1 Key business details

Complete all the key information relating to your growing operation below for the next 12 months. To be updated as part of your annual review to reflect any changes.

Business name	
Physical address	
Person responsible	
Prepared by	
Date completed	
Next review date	

1.2 Goals and objectives

Goals keep your plan relevant and focused on what you are trying to achieve. Goals are useful to know if your plan is working and show how you are making decisions tied to risk and desired outcomes.

If your business goals and objectives are stored elsewhere, there is no need to fill in the cells below. Just include a link or reference to where your goals are stored.

Production *e.g. maximise crop yield, increase soil health to support long-term productivity*	
Financial *e.g. reduce fertiliser costs and improve nutrient use efficiency*	
Environmental *e.g. reduce nitrogen leaching from high-risk blocks, minimise sediment and phosphorus runoff*	
Personal *e.g. a clear plan reduces audit burden, leave a positive legacy on the land*	

NITROGEN LOSS RISK

This table will help you complete the risk of nitrogen loss assessment in Section 4.2 in the Nutrient Management Code of Practice. The risk assessment needs to completed at a block level. Blocks can be defined at the scale at which decisions are made and practices implemented, and/or delineated based on factors such as crop type, soil type, topography, or practices (e.g. fertiliser use, irrigation, or cultivation).

You will need the following information on hand for each production block, in addition to block area:

- Annual rainfall (<1000 mm, 1000-1300 mm, 1300-1600 mm, or >1600 mm)
- Soil profile available water (high, moderate, or low)
- Total annual nitrogen applied (kg N/ha)
- Quantity of nitrogen applied in a single application (kg N/ha)

The table will calculate biophysical risk and nitrogen use risk, and assign a nutrient risk group (NRG) to each block. Each NRG relates to a set of required practices to manage the level of risk. For more information on nutrient risk groups, refer to Section 5.3 in the Nutrient Management Code of Practice.

			Step 1: Biophysical risk		
No.	**Block ID**	**Productive area** (ha)	**Annual rainfall** (mm)	**Soil Profile Available Water** (mm)	**Biophysical risk**
1					
2					
3					

EROSION & PHOSPHORUS LOSS RISK

This table will help you complete the erosion risk assessment in Section 2.2 of the Erosion and Sediment Control Code of Practice (ESC COP). This risk assessment is also used to assess the risk of phosphorus loss in Section 4.3 of the Nutrient Management Code of Practice. The same risk assessment is used for both contaminants (i.e. sediment and phosphorus) because soil erosion is the most significant phosphorus loss pathway in horticultural production systems.

The erosion risk assessment needs to be completed at a block level. Blocks from tab 'Risk - N loss' will prepopulate this table. It is useful to have the following information on hand for each production block:

- Slope in degrees
- Soil texture
- Block erosivity
- Block row length

Not all information will be required for each block, depending on slope, soil texture etc. Use the risk assessment in Section 2.2 of the ESC COP for a visual guide on how the assessment uses block information to assign an Erosion Risk Group.

Refer to the blue tabs labelled 'ERG' to identify what practices are to be implemented on each block, based on the level of risk.

Instructions:
Your Block IDs and productive areas are copied across from tab 'Risk - N loss'.
As you fill out the table from left to right, cells will change colour, depending on whether further information is required to assign an Erosion Risk Group.
Continue entering in information until a risk group is assigned.
As this follows the Erosion Risk Assessment, feel free to use the flow chart in the Code of Practice instead.
A summary of the groups assigned can be found in tab 'Risk summary'.

			Erosion risk assessment *(see Section 2.2 in the ESC COP)*			
No.	**Block ID**	**Productive area** (ha)	**Is soil uncultivated or < 25% bare at any time of the year?**	**Slope** (degrees)	**Is the soil texture sand or loamy sand?** (least likely to erode)	**Block erosivity** (see map ESC CoP Page 70)
1						
2						
3						
4						
5						

NUTRIENT RISK GROUP: AMBER PRACTICES

The nitrogen loss risk assessment in tab assigns each block to a nutrient risk group, Green, Amber, or Red.
For each NRG, you are provided with a set of practices to implement to manage the risk of nitrogen loss.
While the practices are almost the same for each NRG, different practices are marked as 'Minimum' or 'Additional', depending on the risk level.
Detailed information on each practice can be found in the Nutrient Management Code of Practice.
The blocks assigned to NRG Amber are provided to the left of the practice table. This list is linked to the tab 'Risk summary'.

Instructions:
Use this table to work through each practice for the blocks assigned to Amber risk. Notes are provided for some practices.
If you mark a practice as Yes, use the Evidence column to note how this practice is implemented.
If you mark a practice as Partial or No, provide information on the action to be completed.
If you mark a practice as N/A, justify why this does not apply in your operation.
Once completed, make use of the filter buttons (e.g. practices marked as No or Partial) to focus on the actions to carry out over the next 12 months.

You should work towards achieving 100% of Minimum practice and 25% of Additional practices across all blocks in this Nutrient Risk Group.

Minimum practices achieved **0%**

Additional practices achieved **0%**

Blocks — **Practices to reduce the risk of sediment and phosphorus loss**

AMBER	ESC COP reference	Management practices	Minimum or additional	Yes/Partial/No or N/A
	1.5	Nutrient Management Plan prepared	Minimum	
	1.5	Nutrient Management Plan is updated and reviewed annually	Minimum	
	5.4.1	Manage fertiliser handling, transport, and storage	Minimum	
	5.4.2	Calibrate fertiliser spreader equipment annually	Minimum	
	5.4.3	Maintain irrigation systems	Minimum	

EROSION RISK GROUP: VERY LOW PRACTICES

The erosion risk assessment in tab 'Erosion & P loss risk' assigns each block an erosion risk group: Very low, Green, Amber, or Red.
Each erosion risk group (ERG) is linked to a set of practices to implement to manage the risk of soil and sediment loss, which is linked to phosphorus loss.
Detailed information on each practice can be found in the Erosion and Sediment Control Code of Practice.
The blocks assigned to Very low are provided to the left of the practice table. This list is linked to 'Risk summary'.

Instructions:
Use this table to work through each practice for the blocks assigned to ERG - Very low.
If you mark a practice as Yes, use the Evidence column to note how this practice is implemented.
Ensure evidence includes links to further plans or details (e.g. vegetated buffer strip maps and specifications).
If you mark a practice as Partial or No, provide information on the action to be completed.
If you mark a practice as N/A, justify why this does not apply in your operation.
Once completed, make use of the filter buttons (e.g. practices marked as No or Partial) to focus on the actions to carry out over the next 12 months.

You should work towards achieving 100% of Minimum practice.

Minimum practices achieved **0%**

Additional practices achieved **0%**

Blocks — **Practices to reduce the risk of sediment and phosphorus loss**

VERY LOW	ESC COP reference	Management practices	Minimum or additional	Yes/Partial/No or N/A
	2.4	A block evaluation is conducted on each block to note key features and plan practices to implement.	Minimum	
		Maintain good ground cover with dense vegetation or coarse mulch. Increase infiltration through higher soil organic matter and mechanical aeration.	Additional	
	3.1	Intercept overland flow: Use a combination of interception drains, diversion bunding, culverts, benched headlands, and grassed swales.	Additional	
	3.3.1	Raise all accessways.	Additional	

Appendix B: Resources

HortNZ Codes of Practice

The HortNZ Codes of Practice in this suite are listed below. These can be used by growers to build their overall farm or orchard plan.

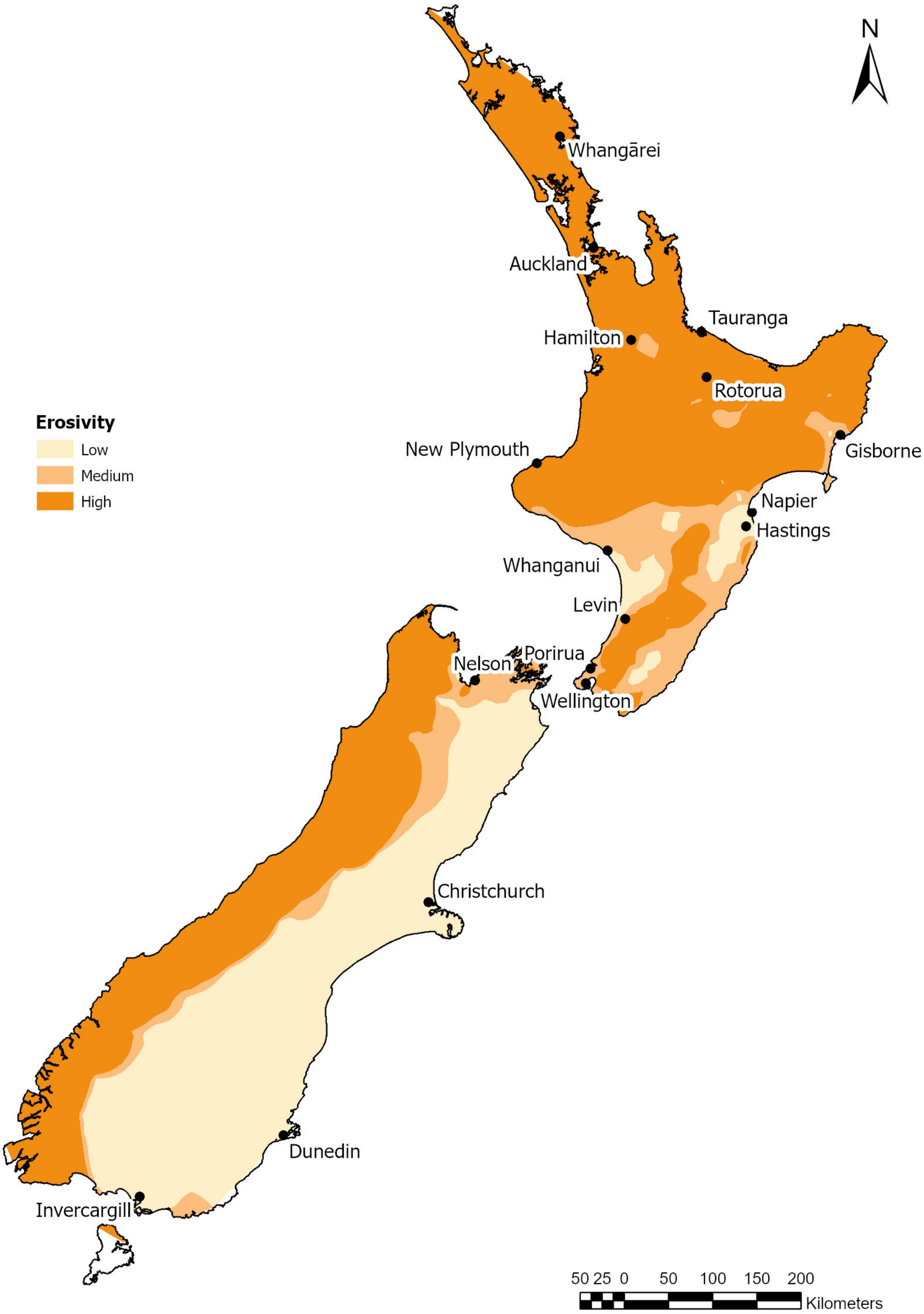
Tool	Sector	Description
Nutrient Management Code of Practice 2026	All outdoor growing systems	This Code provides direction for outdoor fruit and vegetable growers to manage nutrient use responsibly, while maintaining crop productivity. It explains how nutrients cycle through growing systems, how to assess block level nutrient loss risk, and apply appropriate practices to manage those risks. A Nutrient & Erosion Management Excel workbook supports growers to develop a Nutrient Management Plan by documenting current practices, assessing risks, and planning nutrient use in a structured and practical way.
Erosion and Sediment Control Code of Practice 2026	All outdoor growing systems	This Code provides practical direction on managing erosion and sediment loss from outdoor horticultural production activities. It includes a block erosion risk assessment process, and range of risk-based practices to minimise erosion and soil loss, maintain soil health, and protect waterways. A Nutrient & Erosion Management Excel workbook supports growers to develop an Erosion and Sediment Control Plan by documenting current practices, assessing risks, and implementing erosion and sediment control measures in a structured and practical way.
Vehicle and Machinery Washdown Code of Practice 2026	All outdoor growing systems	This Code provides direction on practices to implement to reduce the movement of soil offsite, which also prevents the spread of pests, diseases, and contaminants. It includes direction on siting washdown areas, managing washwater, and protecting soil and water from contamination.
Drain Nutrient Solution Management Code of Practice 2026	Soilless growing systems that generate drain solution requiring management	This Code outlines practices to manage drain nutrient solution from soilless growing systems. It focuses on responsible drain solution land application to protect soil and water resources and optimise resource use. The Code helps growers reduce nutrient losses and manage environmental compliance expectations by developing a Drain Solution Management Plan, which is supported by a Drain Solution Management Plan Excel workbook.
Vegetable Washwater Management Code of Practice 2026	Vegetable growing operations that generate washwater from vegetable washing	This Code provides guidance for vegetable growers, who use water for washing, to sustainably manage the resulting washwater produced. Guidance focuses on selecting the most appropriate treatment option for each grower's operation, providing high level information on a range of treatment options, with links to further resources where required.

Other guides and resources

Other guides and resources, in addition to this Code of Practice, are available online for growers.

Name	Sector	Description
Buffer Strip Background Document	All outdoor growing systems	This background document supports the Erosion and Sediment Control Code of Practice. It covers the existing literature and grower experience on the implementation, maintenance, and effectiveness of vegetated buffer strips.
Soils		
Visual Soil Assessment (VSA) Field Guide – Graham Shepherd (2000)	All sectors	Released in 2000, the VSA guide was developed to help farmers understand soil quality, and how to manage their soils sustainably. This guide is targeted towards pastoral and cropping famers: https://www.landcareresearch.co.nz/assets/Publications/VSA-Field-Guide-/VSA_Volume1.pdf FAO (UN Food & Agriculture Organisation) has several VSA volumes published in one (also co-authored by Graham Shepherd), including a guide for orchards (find on page 92): https://www.fao.org/4/i0007e/i0007e00.pdf
Foundation for Arable Research	All sectors	Nitrate Quick Tool Guide describes how and when to take soil samples, and preparing the soil for testing. Quick-test-nitrate-guide.pdf
Fertiliser Association – Sampling pastoral, arable, and horticultural soils (2024)	All sectors	This booklet sets out to recommend soil sampling methods to ensure consistency in the approach. This consistency ensures valid comparison and interpretation of repeated sampling over time. Available on the Association's resources page or here: https://www.fertiliser.org.nz/files/site/Sampling-Pastoral-Arable-and-Horticultural-Soils-Final.pdf
Hill Labs – DIY Self-sampling Guide for soil and leaf.	All sectors	A guide produced by Hill Labs, one of the major testing labs in New Zealand, on best practice soil and leaf sampling, in addition to an overview of their tests and dispatch instructions. https://www.hill-labs.co.nz/media/msehbkce/hill-diy-test-8pp-web-1.pdf
Other		
Constructed wetland practitioner guide – NIWA, DairyNZ (2022)	Written for pastoral but applicable to horticulture	This guide provides design and performance information to establish a surface-flow constructed wetland to reduce contaminant loss (nitrogen, phosphorus and sediment) from subsurface tile drains, shallow groundwater outflows from seeps and springs, and surface drains and small streams in pastoral farming landscapes. https://niwa.co.nz/sites/default/files/wetland%20practitioner%20Guide-web.pdf
Mitigating nutrient loss from pastoral and crop farms: A review of New Zealand literature. Horizons Regional Council.	All sectors	A compilation of mitigations that a pastoral and/or cropping farm operation could use to reduce its environmental impact. This document provides information on: • Wetlands (pages 1-5) • Riparian buffers (pages 6-8) https://www.horizons.govt.nz/HRC/media/Media/Consent/Mitigating-nutrient-loss.pdf

Erosivity Map



Erosivity map sourced from Klik et al. (2015). Low erosivity R factor is <1,000; moderate is 1,000 to 1,5000; high >1,500 MJ.mm.ha–1.h–1.

Appendix C: Glossary

Annual Exceedance Probability (AEP)
A statistical term defining the probability of an event occurring annually. Expressed as a percentage to define rainstorm intensity and frequency. For example, a 5% AEP event has a 5% chance of being exceeded in any one year. This has replaced the return period concept. A 5% AEP event expresses the 20 year return period in more probability terms.

Baffles
Semi-permeable or solid barriers placed in a sediment retention pond to deflect or regulate flow and effect a more uniform distribution of velocities, hence creating better settling conditions.

Batter
A constructed slope of uniform gradient.

Block
The scale at which decisions are made, and practices implemented. Blocks can be delineated based on factors such as crop type, soil type, topography, or practices (e.g. fertiliser use, irrigation, or cultivation).

Catchment
An area within which surface runoff flows to a common outlet or outlets.

Channel Stabilisation
Stabilisation of the channel profile by erosion control and/or velocity distribution through reshaping, the use of structural linings, rocks, vegetation and other measures.

Clean Water
Any water that has no visual signs of suspended sediment, e.g. overland flow (sheet or channelled) originating from stable well-vegetated or protected surfaces.

Contour
A line across a slope connecting points of the same elevation.

Contributing Drainage Area
All of that drainage area that contributes to the flow into a treatment device (e.g. earth bund). A contributing drainage area can include both clean and sediment-laden water flows. Commonly referred to as the catchment area.

Decant Rate
The rate at which water is decanted from a Decanting Earth Bund or SRP. This should be 3 L/sec/ha.

Deposition
The accumulation of material that has settled because of reduced velocity of the transporting agent (water or wind).

Drain
Any artificial waterway designed, constructed, or used for the drainage of surface or subsurface water, but excludes artificial waterways used for the conveyance of water for electricity generation, irrigation, or water supply purposes.

Source: https://environment.govt.nz/acts-and-regulations/freshwater-implementation-guidance/clarification-of-the-essential-freshwater-programme-implementation-requirements/

Emergency Spillway
An Earth Bund, SRP or Dam spillway designed and constructed to discharge flow in excess of the structure's primary spillway design discharge.

Energy Dissipator

A designed device such as an apron of rip-rap (rock) or concrete bags placed at the end of a water conduit such as a pipe, paved ditch or flume for the purpose of reducing the velocity and energy of the discharged water.

Ephemeral Waterway

A waterway that flows only part of the year; may include overland flow paths such as grassland swales and dry gullies which only flow during more intensive rainstorms.

Filter Strip

A long, narrow vegetative planting (e.g. vetiver grass) used to retard or collect sediment for the protection of adjacent properties or receiving environments.

Level Spreader

A device used to convert concentrated flow into sheet flow. Typically used at the entrance to SRPs.

Overland Flow Path

The route of concentrated flow.

Perennial Stream

A stream that maintains water in its channel throughout the year

Primary Spillway

The snorkel outlet within a Decanting Earth Bund or SRP.

Riparian margin

An area adjacent to a waterway designated as a non-disturbance zone to provide a buffer between the waterway and cultivated block.

Rip-rap

Rock or other material used to armour channels, culvert abutments, and spillways against erosion.

River

A continually or intermittently flowing body of fresh water; and includes a stream and modified waterway; but does not include any artificial waterway (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal)

Source: RMA 1991 (https://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230272.html?search=sw_096be8ed81f72914_river_25_se&p=1&sr=1)

Sediment

Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from the original block by water or air and has come to rest.

Sediment Yield

The quantity of sediment discharged from a block in a given time, measured in dry weight or by volume. When erosion and sediment control measures are in place, sediment yield is the sediment discharged from the site after passing through those measures.

Settling

The downward movement of suspended sediment through the water column.

Snorkel

In a Decanting Earth Bund or SRP, a vertically placed pipe which decants water and forms the inlet to the primary spillway.

Spreader (Hydraulics)
A device for distributing water uniformly in or from a channel.

Stabilisation
Providing adequate measures, vegetative and/or structural that will protect exposed soil to prevent erosion.

Surface Runoff
Rain that runs off rather than being infiltrated or retained by the surface on which it falls.

Suspended sediment
The fine soil particles that remain suspended in the water column rather than settling to the bottom.

Swale
A constructed depression or shallow channel across a block, that can be used to transport clean stormwater. It is usually heavily vegetated, and normally only flows during heavy storm events.

Waterway[6]
A waterway refers to all freshwater environments that have continually or intermittently flowing freshwater or surface water present. Waterways include natural, modified, and human-made or artificial waterways (also referred to as drains).

[6] https://environment.govt.nz/assets/publications/works-in-waterways-guideline.pdf#:~:text=For%20the%20purposes%20of%20this%20guideline%2C%20a%20waterway,or%20artificial%20waterways%20%28also%20referred%20to%20as%20drains%29.

Appendix D: Snorkel hole number and configuration

Snorkel hole requirements to achieve a discharge rate of 3 L/sec/ha

Hole diameter	12 mm	15 mm

Live depth (mm)	Catchment area (ha)												
	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.5
400	4 (2/2 - 200 mm)	8 (4/2 - 200 mm)	12 (4/3 - 133 mm)	12 (3/4 - 100 mm)	12 (4/3 - 133 mm)								
500	4 (1/4 - 125 mm)	8 (4/2 - 250 mm)	12 (3/4 - 125 mm)	15 (3/5 - 100 mm)	20 (4/5 - 100 mm)	16 (4/4 - 125 mm)	16 (4/4 - 125 mm)	20 (4/5 - 100 mm)	20 (4/5 - 100 mm)	24 (6/4 - 125 mm)	25 (5/5 - 100 mm)		
600	3 (1/3 - 200 mm)	6 (3/2 - 300 mm)	9 (3/3 - 200 mm)	15 (3/5 - 120 mm)	16 (4/4 - 150 mm)	12 (4/3 - 200 mm)	16 (4/4 - 150 mm)	16 (4/4 - 150 mm)	20 (4/5 - 120 mm)	24 (6/4 - 150 mm)	25 (5/5 - 120 mm)		
700	3 (1/3 - 233 mm)	6 (3/2 - 350 mm)	9 (3/3 - 233 mm)	12 (3/4 - 175 mm)	16 (4/4 - 175 mm)	20 (4/5 - 140 mm)	24 (4/6 - 117 mm)	15 (3/5 - 140 mm)	18 (3/6 - 117 mm)	20 (4/5 - 140 mm)	25 (5/5 - 140 mm)	24 (4/6 - 117 mm)	24 (4/6 - 117 mm)
800	3 (1/3 - 267 mm)	6 (3/2 - 400 mm)	9 (3/3 - 267 mm)	12 (3/4 - 200 mm)	15 (3/5 - 160 mm)	20 (4/5 - 160 mm)	20 (4/5 - 160 mm)	24 (4/6 - 133 mm)	28 (4/7 - 114 mm)	20 (4/5 - 160 mm)	20 (4/5 - 160 mm)	24 (4/6 - 133 mm)	24 (4/6 - 133 mm)
900	3 (1/3 - 300 mm)	6 (3/2 - 450 mm)	8 (2/4 - 225 mm)	12 (3/4 - 225 mm)	15 (3/5 - 180 mm)	16 (4/4 - 225 mm)	20 (4/5 - 180 mm)	24 (4/6 - 150 mm)	24 (4/6 - 150 mm)	28 (4/7 - 129 mm)	32 (4/8 - 113 mm)	24 (4/6 - 150 mm)	24 (4/6 - 150 mm)
1,000	3 (1/3 - 333 mm)	6 (3/2 - 500 mm)	8 (2/4 - 250 mm)	12 (3/4 - 250 mm)	12 (4/3 - 333 mm)	16 (4/4 - 250 mm)	18 (3/6 - 167 mm)	24 (4/6 - 167 mm)	24 (4/6 - 167 mm)	28 (4/7 - 143 mm)	32 (4/8 - 125 mm)	32 (4/8 - 125 mm)	32 (4/8 - 125 mm)
1,100	2 (1/2 - 550 mm)	6 (3/2 - 550 mm)	8 (2/4 - 275 mm)	9 (3/3 - 367 mm)	12 (3/4 - 275 mm)	15 (3/5 - 220 mm)	18 (3/6 - 183 mm)	20 (4/5 - 220 mm)	24 (3/8 - 138 mm)	24 (4/6 - 183 mm)	28 (4/7 - 157 mm)	32 (4/8 - 138 mm)	32 (4/8 - 138 mm)
1,200	2 (1/2 - 600 mm)	4 (2/2 - 600 mm)	8 (2/4 - 300 mm)	9 (3/3 - 400 mm)	12 (3/4 - 300 mm)	15 (3/5 - 240 mm)	18 (3/6 - 200 mm)	20 (4/5 - 240 mm)	24 (3/8 - 150 mm)	24 (4/6 - 200 mm)	28 (4/7 - 171 mm)	32 (4/8 - 150 mm)	32 (4/8 - 150 mm)

Notation: number of holes (number of columns / number of holes per column - distance between holes), i.e., for a 1.0 ha catchment with 500 mm of live storage the hole configuration is 20 (4/5 - 100 mm). There are 20 12mm diameter holes with 4 columns and 5 holes per column spaced 100 mm apart.

If there is more than 2.5 ha, then use a combination of 2 snorkels. For example, 3.2 ha use 2 x 1.6 ha specified snorkels, or for 3.0 ha use 2 snorkels based on the 1 ha and 2 ha specified holes.

Literature & further reading

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Zespri. Good practice guidance for kiwifruit growers is available from the Manage soil page of the Zespri Canopy website

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