# FARM DAIRY EFFLUENT

*Best Practice Guidelines*

environment SOUTHLAND
Te Taiao Tonga

# FOREWORD

The impetus for these guidelines has come from a collective determination to halt and reverse the trend of deteriorating water quality in the intensively farmed areas of Southland.

There are many factors influencing water quality and Environment Southland is committed to working with all sectors of the community – rural and urban – to influence change. We have set ourselves a demanding goal – to significantly improve water quality by reducing non-point source pollution by 2015. Minimising the impact that farm dairy effluent has on our environment will be an important part of achieving the community's expectations of clean water, but can only be done with the active cooperation of dairy farmers.

We recognise that there is no one-size-fits all solution, and that individual farmers have to have the flexibility to choose dairy effluent disposal systems which suit their own properties. But research and innovative practice is leading the development of new systems which are better for the environment and make it easier for farmers to meet their resource consent conditions. As recent Environment Court decisions have shown, public patience with poor on-farm management is running out.

Environment Southland prefers to work with farmers to educate and promote best practice. These guidelines are an important tool that I am certain will encourage environmentally responsible and sustainable farm management in our region.

*Stuart Collie*
*Chairman*
*Environment Southland*

May 2007

# KEY MESSAGES

- In Southland the discharge of effluent to land from dairy sheds servicing more than 50 cows requires resource consent. A change to the resource consent is needed to increase cow numbers or expand or change an effluent disposal area.
- Reduce the amount of water going into your effluent system so you have less effluent to dispose of. Environment Southland recommends a maximum use of 50 l/cow/day in the dairy shed.
- Design an effluent disposal system that is efficient, effective and environmentally sustainable. For a new system, consult an expert.
- Low application rate systems using small diameter sprinkler nozzles (e.g. K-line or Larall) are more efficient at applying effluent to land in Southland conditions. **Low application rate systems are therefore Environment Southland's preferred disposal method.**
- Only irrigate when soil conditions are suitable. **Effluent should not be applied when soils are wet.**
- Environment Southland recommends that **effluent is applied to an area of 8 ha/100 cows or greater** and at a rate which does not result in runoff or leaching.
- Use a deferred irrigation system i.e. store your effluent and apply it when soil conditions are suitable. Deferred irrigation in Southland is better because of our wet climate, extensive mole and tile drainage network, high water table and soil types (including both well and poorly drained soils). For these reasons, **deferred irrigation is Environment Southland's preferred disposal method.** However, we recognise that there is no "one size fits all" solution.
- Maintain enough storage so the effluent can be applied at appropriate times of the year. Environment Southland recommends that Southland dairy farmers have approximately **2 months storage** if using a low application rate system (e.g. K-line or Larall), or **3 months storage** if using a high application rate system (e.g. travelling irrigator).
- **Use a qualified and experienced person when designing and constructing a storage system.**
- **Maintain an effluent management plan** (EMP) to help you manage your effluent system. An EMP describes your approach to effluent management, staff training, machinery and equipment maintenance, contingency planning and nutrient management. It will include an application plan showing the paddocks that receive effluent, the number of runs per paddock and exclusion zones (streams, bores, mole and tile drains etc).
- **Make the most of the fertiliser value of your effluent by completing a nutrient budget.** Farm dairy effluent provides nitrogen (N), phosphorus (P), potassium (K), sulphur (S), Magnesium (Mg) and trace elements to increase

pasture or crop production. Organic matter in effluent will also improve soil water holding capacity, soil aeration and drainage, and soil tillage characteristics. Applying effluent to pastoral soils may also increase earthworm numbers. Managing application depths will help you get maximum benefit from these nutrients while avoiding potential negative environmental impacts. **Analysing the potassium and total nitrogen content of your effluent is recommended so the appropriate depth is applied.**

- An effluent management system is only as good as the staff operating it. Keep your system efficient and trouble free by ensuring your staff are well-trained and aware of their responsibilities.
- Ensure machinery and equipment are well maintained.

# 1. RULES & REGULATIONS

The discharge of effluent to land from dairy sheds servicing more than 50 cows requires resource consent under Environment Southland's Regional Effluent Land Application Plan for Southland.

Other resource consents may also be required such as a water permit to take water for milk cooling and wash down purposes. The discharge of effluent from feed pads requires resource consent as well.

To expand or change an effluent disposal area requires a change to the resource consent. While a larger effluent disposal area will generally reduce adverse environmental effects, the suitability of the new area needs to be assessed and any resource management issues addressed. A change to the resource consent is also required to increase cow numbers.

The construction of an effluent storage pond does not require resource consent from Environment Southland provided the pond doesn't leak.

A variety of rules apply to general farming activities such as stock access to surface water, construction of bridges and culverts, silage pits, offal pits and farm waste pits. Further information about these rules can be obtained by phoning Environment Southland on 0800 76 88 45 or accessing Environment Southland's website **www.es.govt.nz**

# 2. MINIMISING EFFLUENT AND WATER USE

*Recommended Goal: Maximum use of 50 l/cow/day in dairy shed*

Water costs money. The more water you use the greater the pump running costs and the more effluent and water you need to dispose of. Reducing the amount of water used not only saves you money, it increases the efficiency of your storage so you will be less likely to need to apply effluent onto saturated soils. Here are some ways you can reduce the amount of water going into your effluent system:

- ensure holding tanks, drinking troughs on concrete yards and other clean water systems do not overflow;
- do not leave hoses running unnecessarily;
- repair leaks;
- install effective guttering on dairy shed roofs and pipe clean rainwater to storage tanks for use for washdown or stock drinking water or discharge to a farm drain;
- install an effective stormwater diversion – and use it especially in the off-season;
- pre-wet the yard before milking. This speeds up the hosing down;
- use a scraper to remove most of the solids before hosing. A chain can also be used on the backing gate to break up pats;

- use a high flow (3.5-4.5 l/s) low pressure (100-150 kpa) washdown system. This is the most water-efficient method of washing down;
- the hose diameter should be at least 40mm with a nozzle diameter of 20-25 mm;
- reuse the cooling water by storing for washdown;
- whenever possible, avoid/reduce situations which upset the cows and their routine, such as
  - slippery surfaces
  - dogs
  - unusual activity
  - stray electricity
  - forcing cows to move quickly
- avoid feeding the herd during milking time.

## 3. SYSTEM DESIGN AND SET-UP

*Recommended Goal: A system that is efficient, effective and environmentally sustainable*

Most dairy farms in Southland dispose of dairy effluent by applying it to land. When effluent is applied at the right time and rate, you can achieve maximum assimilation of nutrients and no runoff to surface waters or leaching to groundwater. Achieving this goal requires careful design and planning. Pump type and size, pipe sizes, paddock layout, topography, applicator type, soil type and condition, presence of drains, storage requirements and energy losses must all be considered. Here are some questions you should ask to make sure your system is efficient, effective and environmentally sustainable:

- for a new system, consult an expert. This will save you money in the long run by avoiding design mistakes;
- identify what limits the present environmental performance?
  - is pump capacity large enough?
  - are stone traps effective and cleaned regularly?
  - is the combination of reticulation pipes right?
  - have you set the correct application rate and depth?
  - is there enough storage to get through wet periods?
  - is there a vacuum release valve to stop siphoning when the pump is not running?
  - do you have a high and low pressure warning system and systems shutdown so they go off if the hose comes off?
  - is there a warning system to indicate overflow of sump or storage?
  - are your staff fully aware of consent conditions and how to operate and maintain the equipment?
  - do you have a pump wear contingency plan?

- is the system laid out correctly?
  - for pumps on pontoons, are the guide wires that secure the pump in the storage pond correctly aligned? They should be secured behind the pump (not in front) to ensure it stays level;
  - are you using the best irrigator nozzles? There is a range of nozzles on the market so experiment to find the best for your system. Cone nozzles are successful in many situations;
  - are you laying the supply pipe out correctly in front of the irrigator? A poorly laid pipe increases drag, slowing the irrigator down and increasing the risk of applying excess effluent;
  - are you irrigating land where the risk of contaminating waterways is minimal? Avoid irrigating soils at times when they are wet, or extremely dry or cracked;
  - where possible, run your irrigator at right angles to drains to minimise the possibility of effluent discharges;
  - is the angle of the spray nozzle at 30-45 degrees above the horizontal? This allows the irrigator to run most efficiently;
  - are anti-siphon valves used to prevent continued discharges after the pump has stopped? This will prevent siphoning when the irrigator is downhill from the effluent pond;
  - avoid irrigating over or near tile drain system breather pipes as dairy effluent may flow directly into tile drains.

*Pipe layout behind irrigator - Photo courtesy Otago Regional Council*

# 4. EFFLUENT APPLICATION METHODS

When deciding on your effluent application system, the irrigator's application rate is the key environmental consideration. Consider the following:

- the ability to apply a low application depth of effluent (mm) and low application rate (mm/hr);
- the wetted width and the uniformity of application;
- the height of effluent application (should be applied low to the ground);
- presence of automatic shutdowns, low pressure alarms and anti-siphon valves;
- the requirement for maintenance;
- the requirement for ongoing labour i.e. shifting irrigator;
- the suitability of the topography and soil type;
- ease of conversion in order to treat a larger area should the herd size increase;
- capital outlay.

**Low application rate sprinkler system** - these are low application rate systems using small diameter sprinkler nozzles. Liquids are separated through a mechanical separator or a weeping wall leaving solids behind. Systems such as K-line and Larall are now coming into use across Southland.

Under Southland conditions, low application systems are more efficient at applying dairy effluent to land reducing potential losses. Recent research done by the Dairy Green project and AgResearch supports this, making it Environment Southland's preferred option.

Benefits of these systems are:

- allows control of the depth and rate of application;
- reduced ponding of effluent and reduced runoff;
- greater retention of nutrients in the root zone reducing nutrient and bacteria loss to waterways and groundwater;
- easy to move.
- flexibility to apply effluent to land when soil conditions are suitable (ie not saturated or severely cracked)

**Travelling irrigators** are widely used to apply effluent to land. They require regular maintenance and a high level of supervision when being used. Rotary travelling irrigators tend to have non-uniform application patterns. Oscillating travelling irrigators have a more even application pattern. Travelling irrigators tend to have high application rates. For this reason it is important to:

- check low-lying areas for ponding;
- set the irrigator to the fastest speed, particularly when ground conditions are wet;
- check the end of the irrigator run to make sure the pump switches off;
- check irrigator nozzles frequently for blockages and split nozzles;
- check tile drain outlets to ensure that effluent is not running out of the drains;
- attach anti siphon valves to the irrigator system;
- attach pressure sensing switches.

**Slurry Tankers** – This allows for better utilisation of nutrients and flexibility of spreading on parts of the farm where environmental risks are lower, particularly at times when there may be a high risk of loss to the environment.

**APS pond systems** – Large pond systems such as the Advanced Pond System (APS) treat effluent via a series of ponds designed to remove nutrients and bacteria via natural processes. Contact Environment Southland for more information on APS systems.

*Low application rate system: K-line.*

*Travelling irrigator*

# 5. APPLICATION OF FARM DAIRY EFFLUENT

Several factors will influence your decision on when and how to irrigate. From an environmental perspective, the weather, pasture growth and application rate are critical factors in mitigating environmental effects.

## 5.1 WHEN TO APPLY?

*Recommended Goal: Only apply FDE when conditions are suitable*

- **Only irrigate when soil conditions are suitable.** Effluent should not be applied when soils are wet (near field capacity1) because there is a high risk that effluent will run off via overland flow, through subsurface drainage (mole and tiles), or move through free draining soil into groundwater. Adding effluent to already wet soils also compounds grazing management problems. Equally, for some soil types, particularly those with high clay content, effluent should not be applied when soils are too dry. Under dry conditions these soils are prone to cracking and effluent can flow down through the cracks into tile drains or groundwater. Good storage capacity provides flexibility and reduces the risks outlined above.
- **Irrigation should be avoided when soil temperatures are less than 5ºC during spring or less than 7ºC in autumn.** When the soil temperatures are below these values pasture growth is negligible so nutrient uptake by plants stops. Any effluent applied at this time will sit in the soil and leach into ground and surface water with the next rainfall.
- **Apply effluent to short pasture but not pasture which has just been grazed.** If you apply effluent to pasture straight after grazing you may find that it ponds on the surface, particularly if the surface has been "scuffed" and "sealed" by cows hooves.
- **Adjust the irrigator to its fastest ground speed** especially if applying effluent to mole and tile drained land and wet soils. This will minimise application depths, reducing the risk of overloading the soil's ability to retain the effluent.
- When irrigating near tile or mole drains, check them for effluent discharges during and after irrigation.

**Environment Southland monitors soil moisture and soil temperature at 10 sites around the region and this data is available on our website. Visit www.es.govt.nz to find out if soil conditions are suitable for irrigation in your area.**

[1] Field capacity is commonly defined as "The amount of water held in soil after excess water has drained away and the rate of downward movement has materially decreased". This usually takes place within 2 or 3 days after rain or irrigation in free draining soils.

## 5.2 HOW MUCH TO APPLY?

*Recommended Goal: Effluent is applied to a farm area of 8 ha/100 cows or greater and at a rate which does not result in runoff or leaching*

- Application depth (mm) is the amount of effluent applied at one time. If this amount is too high, soil may become saturated in the root zone and affect pasture growth. Suitable depth will depend on the soil's water-holding capacity and the depth of the root zone. **Application depths should not exceed 15mm per individual application.** Measure the application depth by placing ice cream containers at 2 metre intervals across the path of the irrigator and checking the amount collected in one hour. Do this at least once a year to check that you get maximum performance from your system.
- Application rate (mm per hour) is the maximum rate possible without causing ponding in low lying areas, runoff to surface waterways, or leaching into groundwater, and depends on the infiltration rate. Soil type, slope, vegetation cover and the proportion of solids in the effluent all influence infiltration rates. **Ideally, application rates should not exceed 10mm/hr, and often may need to be less than this.**
- A travelling irrigator should generally be set at the highest speed and must be in motion when applying effluent so that application rates and depths are not excessive. An alarm system can be attached to the irrigator, which switches the pump off when there is low pressure.
- The forward speed of a travelling irrigator is critical to achieving consented application depths. It is recommended that forward speed be regularly monitored throughout the season. To achieve a 15mm application depth, a typical system with a flow of 18000l/hr through the irrigator (YardmasterRH7 pump) and a wetted width of 25m requires a forward speed of 48m/hr. Regular measurement of forward speed will highlight issues such as pump wear and hose drag that slow the irrigator and increase application depth.
- Application area is the area of pastoral land set aside for receiving effluent. You must have a large enough application area to cope with the nutrients and water volumes applied. Adequate land application area reduces nitrate leaching, avoids physical deterioration of soil, prevents ponding and surface runoff, reduces weed invasion and improves the use of the extra pasture grown. **In Southland, an area of at least 8ha/100 cows is recommended.** *An area of 4 hectares per 100 cows is recognised nationally as the minimum area of land application. This will apply effluent N at about 150 kg/ha/yr* ***but***

***will oversupply potassium resulting in increased potassium soil fertility levels (see Section 8.2 Metabolic Problems)***

- Minimum application interval (days) is the time between effluent applications. Effluent can be applied repeatedly but there should be a minimum interval between applications to allow for infiltration and soil uptake of solids. Other factors which may influence your decision on when to reapply include stock rotation, pasture length, the prevailing weather, fertiliser value of the effluent and animal health risks. **28 days is normally taken as the minimum return period, but can be less if a low application rate system is used.**

## 5.3 DEFERRED VS DIRECT IRRIGATION

*Recommended Goal: Use a deferred irrigation system*

Deferred irrigation is when effluent is stored and irrigated when soil conditions are suitable (when soil moisture is below field capacity). There are several advantages to deferred irrigation including:

- greater flexibility – the effluent can be applied when it is more likely to meet plant nutrient and water requirements;
- the provision of storage allows the application to be deferred until time or labour are available;
- solids separation means fewer problems with pumps, pipe blockages and spraying equipment;
- there are more options for effluent application, including the use of low application rate systems such as Larall and K-line.

In Southland two day storage ponds are commonly used, but these are not considered to be deferred irrigation because effluent must be disposed of daily.

Direct land application is when effluent is irrigated on **a daily basis.** It is difficult to manage direct land application without large storage, unless using a low application rate system. Disadvantages of irrigating effluent directly from the dairy shed include:

- careful management is required to avoid environmental contamination from surface runoff, leaching or flow into tile drains;
- sufficient area must be available to ensure that the effluent does not cause deterioration of the soil structure (ie, by clogging the soil pores and reducing infiltration);
- direct application provides the least opportunity for the control of any harmful pathogens;
- without storage facilities there is very limited opportunity to manage the application to complement other farm management requirements. Applying effluent to pastures at times that don't

suit the grazing rotation will also be inappropriate;

- the high solids content of the effluent is especially hard on pumps, pipes and spray equipment. Continuous maintenance is vital to ensure that environmental pollution does not occur through pump failure;
- strong winds can cause aerosols.

In Southland deferred irrigation is better because of our wet climate, extensive mole and tile drainage network, high water table and soil types (including both well and poorly drained soils). For these reasons, deferred irrigation is the disposal method preferred by Environment Southland, but we recognize that there is no "one size fits all" solution.

The same principles apply to effluent from feed pads, wintering pads and winter milking. If this effluent can be stored until conditions are appropriate (i.e. deferred irrigation), there is a much lower risk of contaminating the environment.

# 6. STORAGE

*Recommended Goal: Maintain enough storage so the effluent can be applied at appropriate times of the year*

Storage (or holding) ponds collect effluent before it is applied to land. This is particularly important in wet periods when land application is impractical or undesirable. Southland experiences longer wet periods than most other regions in New Zealand. As a result, Southland farmers require more storage than farmers in other areas of New Zealand.

**REGIONAL STORAGE SUGGESTIONS AND APPLICATION PERIODS**

| Region | Best Months for Application | Storage Recommendation | Storage Volume per 100 cows |
|---|---|---|---|
| Canterbury and Otago | September - April | 1 month | 160 $m^3$ |
| Northland, Auckland, Nelson and Marlborough | October - April | 2 months | 340 $m^3$ |
| Waikato, Taranaki, Gisborne, Hawkes Bay, Wellington, Tasman, South Otago and **Southland** | **November - April** | **3 months** | **500 $m^3$** |
| Bay of Plenty, Manawatu and Wanganui | December - April | 4 months | 690 $m^3$ |
| West Coast | Whenever possible | 4 months | 690 $m^3$ |

*Note: **assumes 50 l/cow/day and stormwater is diverted.***
*If you milk over winter or have feed pads, you may require larger storage facilities.*
*Contact Environment Southland for further advice*

(Dairying and the Environment Committee, 2006. *Dairy and the Environment – Managing Farm Dairy Effluent.)*

**It is recommended Southland dairy farmers have approximately 2 months storage if using a low application rate system, or 3 months storage if using a high application rate system such as a travelling irrigator.** This enables effluent to only be applied when soils are below saturation or field capacity, reducing the risk of overland flow, runoff through mole and tile drains and leaching into groundwater. Three months is based on the average length of time soils are close to field capacity. If you have feed pads, wintering pads or milk over winter, you will require more storage than this.

Although 2 months storage is recommended under low application rate systems, current Environment Southland policy requires a minimum of two days of storage and contingency planning for any adverse events. A review of the Regional Effluent Land Application Plan is scheduled to commence in 2007/2008 and will include a review this policy. If you have any concerns regarding storage requirements, please contact Environment Southland.

Below is a guide to capacity needed for 30, 60, and 90 days storage for 50 l/cow/day water use. It may be necessary to have two smaller storage ponds rather than a single large pond if:

- the pond is likely to be too large for effective pumping, desludging and stirring;
- the pond is too long for the site and interferes with existing structures such as fences. In the case of site restrictions to pond length, two smaller storage ponds could be placed side by side;
- herd numbers are high or herd size increases.

**Approx volume of storage required** (cubic metres)
based on 50 L/cow/day with stormwater diverted

| Number of Cows | Number of days storage | | |
|---|---|---|---|
| | 30 days | 60 days | 90 days |
| Per cow | 1.5 m3 | 3 m3 | 4.5 m3 |
| 200 | 300 | 600 | 900 |
| 300 | 450 | 900 | 1350 |
| 400 | 600 | 1200 | 1800 |
| 500 | 750 | 1500 | 2250 |
| 600 | 900 | 1800 | 2700 |
| 800 | 1200 | 2400 | 3600 |
| 1000 | 1500 | 3000 | 4500 |
| 1200 | 1800 | 3600 | 5400 |

An example of the dimensions for a two month storage system for an average herd size (700 cows) dairy farm would be:

- Sludge pond: 30m x 8m x 1m
- Storage pond: 36m x 25m x 3m

Remember:

- **for maximum flexibility and effectiveness, maintain as much storage as possible within your ponds at all times without compromising the "too wet – no spread" rule.** Even in wet periods there are often spells when it is suitable to irrigate if using a low application rate system. If your pond is full most of the time then you probably need more storage;
- extra storage provides you with the flexibility needed to effectively manage your system in these situations;
- empty the pond in summer (assuming soil conditions are suitable) and keep low in autumn so you can go into the new season with maximum storage.

*Sludge pond and weeping wall - Photo Courtesy Scandrett Rural*

*Storage pond*

# 6.1 DESIGN AND CONSTRUCTION

**It is very important to use an experienced person when designing and constructing a storage system.**

Deferred storage used in conjunction with a low application rate system (small nozzles) requires a primary sludge pond, solids separation and a large storage pond. Solids are trapped allowing liquid effluent to filter into the storage pond which is then irrigated when soil conditions are suitable. Alternatively, deferred storage used in conjunction with a high rate application system (large nozzle) can consist of a single storage pond. Machinery is used to mix the ponds contents when effluent is being irrigated.

Here are some things to consider when designing and constructing a storage pond:

- **Use a qualified and experienced person to design and construct the system**
- Assess site suitability.
- Install a stormwater control and stone trap to minimise the entry of clean water and sediments into the pond system.
- Ensure the embankment is built properly so that the pond structure is stable
- The pond must be constructed so no effluent can escape and groundwater cannot enter. Leakage is likely when the clay content of the soil is less than 20% by weight and/or there has been insufficient compaction during construction.
- The pond must have a space of 500 mm freeboard between the highest level of the effluent and the top of the embankments.
- The storage pond floor and sides should be scarified to a depth of 20

*Recently constructed storage pond Photo Courtesy Scandrett Rural*

cm and rolled under optimum moisture conditions to a dense tight layer with 4-6 passes of a compacting machine.

- For pond depths greater than 3 m the impervious layer will need to be proportionally thicker. This will require compacting of the soil in layers not exceeding 20 cm a time. The impervious layer should be a minimum of 40 cm thick.
- Inlet and outlet structures should be correctly installed and positioned.
- Should an artificial liner be required, specific engineering advice should be sought regarding the installation.
- Make sure you will be able to clean the sludge pond with a digger – do not make the sludge pond too wide or too deep.

*Compaction of embankment during construction of storage pond Photo Courtesy Scandrett Rural*

The Dairying and the Environment Committee's 2006 publication *Dairy and the Environment – Managing Farm Dairy Effluent* contains further guidance on the steps in constructing a storage pond. Visit the Environment Southland website **www.es.govt.nz** for a link to this document. Remember - it is advisable to seek professional assistance before starting construction.

# 7. EFFLUENT MANAGEMENT PLANS

*Recommended Goal: Demonstrate that you are managing your effluent effectively.*

There are a lot of things to consider when deciding where, how and when to apply effluent on a farm. An effluent management plan (EMP) documents the way you manage your effluent. It shows that you have thought about the issues and have done everything possible to avoid problems.

A plan will save you money in the long term by:

- reducing opportunities for system failure and costly repairs;
- reducing the time that you need to spend supervising staff;
- reducing the likelihood of mistakes that result in enforcement action;
- ensuring that maximum fertiliser benefit is gained from the effluent application.

Components of an effluent management plan include:

- an application plan – see below;
- staff training schedule – see example in Section 10. Staff need to be trained to operate and maintain the effluent irrigation system and training should cover all aspects of staff responsibility;
- equipment and machinery maintenance schedule – see example in Section 11;
- risk analysis and contingency planning – think about the risks, systems failures and the consequences of these risks. See below for some simple things you can do to reduce breakdowns;
- nutrient budget – see Section 8.1.

## APPLICATION PLAN

Might include:

- paddocks which receive effluent and the number of runs per paddock;
- exclusion zones over and beside bores and wells, streams, wetlands and mole and tile drains;
- The fact that farm dairy effluent must not be applied when soils are wet or extremely dry and cracked.

## RISK REDUCTION

There are some simple things you can do to reduce breakdowns:

- water blast your irrigator regularly. This ensures that the irrigator works efficiently and does not get blocked up;
- regular maintenance on the irrigator is essential – check all hose fittings, gear mechanisms, nozzles and anti-siphons;
- grease your irrigator weekly and check all bushes, bearings and nozzles;
- clean the stone trap at your effluent pond regularly;

- ensure that you keep up to date with your pump maintenance and monitor pump performance regularly (e.g. use a pressure gauge on the pump discharge, or monitor the irrigator speed).
- staff training is essential – your equipment and plant are only as good as the people operating them.

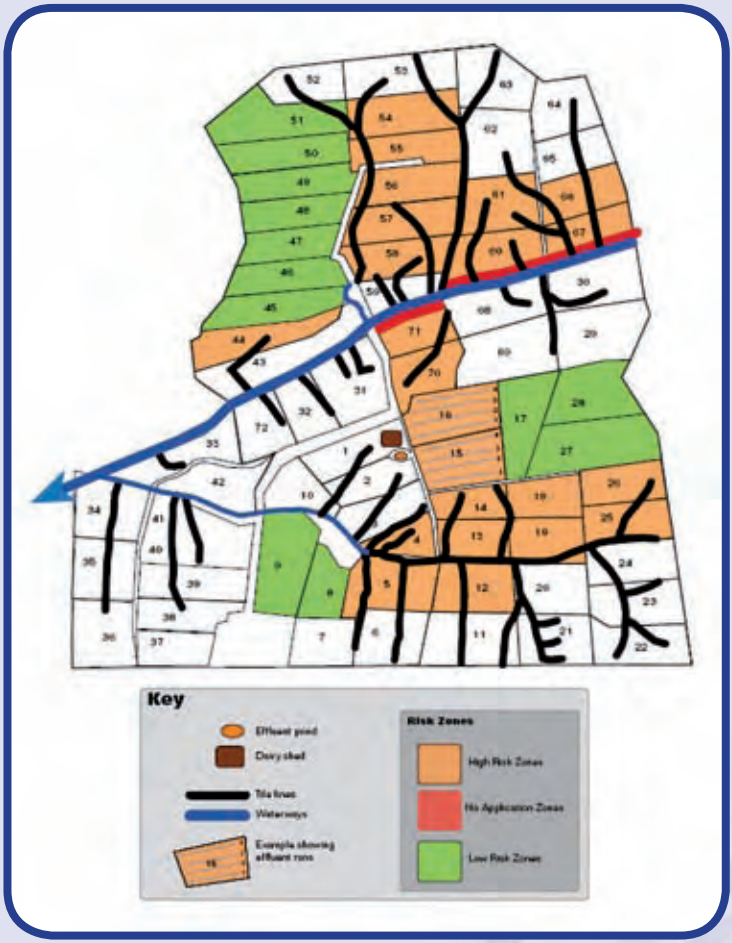


*Diagram courtesy of Otago Regional Council*

# 8. NUTRIENT MANAGEMENT

*Recommended Goal: Use your effluent as fertiliser*

Farm dairy effluent provides nitrogen (N), phosphorus (P), potassium (K), sulphur (S), Magnesium (Mg) and trace elements to increase pasture or crop production. Organic matter in effluent will also improve soil water holding capacity, soil aeration and drainage, and soil tillage characteristics. Applying effluent to pastoral soils may also increase earthworm numbers.

**Managing application rates will help you get maximum benefit from these nutrients while avoiding potential negative environmental impacts.**

The composition of effluent from the farm dairy is extremely variable, due to differences in the nutrient content of dung and urine (which varies with diet, age and season) plus differences in the amount of wash-down water used at the farm dairy. The nutrient content of the effluent also changes during storage.

The only way to know the content of your dairy effluent is to have a sample analysed. During spring, collect a sample from your irrigator and send this to a laboratory that does soil, herbage and fertility analysis. The values in the below table are a rough guide.

**EQUIVALENT FERTILISER VALUE OF EFFLUENT FROM 100 COWS**

| Nutrient (Kg/year) | | | | | | Solid Fertiliser Equivalent (tonnes/year) | Value ($/year) |
|---|---|---|---|---|---|---|---|
| N | P | K | S | Mg | Na | | |
| 590 | | | | | | 1.3 of urea | $700 |
| | 70 | 540 | 80 | | | 1.3-2.2 of 50% Potash super | $400-700 |
| | | | | 100 | | 0.2 of Mg Oxide | $100 |
| | | | | | 70 | 0.2 of Salt | $30 |
| **Total value per annum** | | | | | | | $1200-$1500 |

These figures are based on a typical all-grass system. Information source: Dexcel Farm Fact 6-5 fertiliser value of effluent September 2006.

Research shows that 1kg of nitrogen from effluent is equivalent to 1kg of nitrogen from urea in terms of pasture production, composition and nitrate leaching.

This means farm dairy effluent can produce a good pasture response, e.g. 10-15 kg DM per kg /N applied in effluent. Most potassium in effluent is readily available for pasture (up to 90%) but phosphorus will take time to break down into a plant-available form.

# 8.1 NUTRIENT BUDGETING

Nutrient cycling is an important feature of sustainable farming and a nutrient budget is a way of managing the nutrient balance in a farming operation if budget recommendations are implemented. Overseer® nutrient budgets 2, developed by AgResearch, is the software used most widely in New Zealand to do nutrient budgeting. It can be downloaded free from the AgResearch website: **www.agresearch.co.nz\overseerweb**, although it is a good idea to run the programme for the first time with someone who is familiar with it and can interpret the results. A trained fertiliser representative, consultant or Environment Southland land sustainability officer are good people to ask for help.

Nutrient budgeting looks at nutrient inputs and outputs from all sources of the farming system. The aim is to match inputs with outputs with the objective of minimising losses to the environment and running a cost effective fertiliser regime.

Nutrient budgeting will indicate if soil fertility is increasing or decreasing and whether you are using too much fertiliser or not enough.

If sufficient nutrients are not provided then soil fertility and production will decrease, which affects profits. Conversely, if excessive nutrients are provided there can be negative effects on the environment and or on animal health.

A nutrient budget can:

- Determine the optimum area effluent should be applied to so as to achieve the desired rate of nutrient application, ie kgN/ha/yr
- provide a method for comparing nutrient flows associated with different farm management practices;
- give average estimates of the fate of the nutrients N, P, K and S in kg/ha/yr for different nutrient inputs and management practices. (e.g. stocking rate, supplementary feed inputs);
- estimate leaching of nutrients below the root zone, which includes potential nitrate leaching to groundwater. This aspect of the model makes it a valuable tool for assessing the effects of different farm practices;
- optimise fertiliser requirements on effluent blocks by accounting for nutrients already provided in the farm dairy effluent;
- maximise the productivity of fertiliser and minimise fertiliser costs;
- improve soil health and balanced fertility;
- avoid potential metabolic problems;
- potentially reduce nitrate leaching;
- potentially lower the risk of phosphorus from effluent and fertiliser entering waterways.

It is a good idea to do a separate nutrient budget for the effluent area. Effluent adds significant amounts of nutrients, particularly N and K, and you should adjust fertiliser inputs to compensate for this. You should also soil test your effluent block separately and make sure your fertiliser representative uses nutrient budgeting when planning your fertiliser requirements.

# 8.2 METABOLIC PROBLEMS

**Caution is required when managing the potassium content of effluent.**

Over time, the application of farm dairy effluent to land can increase potassium levels in soil and pasture, particularly during winter and spring. This can increase the risk of metabolic problems at calving and in early lactation. A nutrient budget will identify this risk and with careful management you can overcome it:

- where milk fever and grass staggers are a likely problem, plan to avoid grazing effluent disposal areas with springing cows and recently calved cows. Where this is not possible, take additional measures to prevent these metabolic disorders, such as increasing magnesium supplementation;
- analyse pasture from effluent and non-effluent areas separately for chemical composition. Adjust magnesium supplementation levels and supplements fed in consultation with a farm consultant or veterinarian, if necessary;
- On farms with high pasture potassium levels, the potassium content of the effluent needs to be considered when deciding effluent application rates and maintenance fertiliser applications. Soil test effluent areas separately from the rest of the farm as they are unlikely to require any additional potassium fertilizer;
- increase the area irrigated – this will reduce the content of both nitrogen and potassium applied per hectare. The area irrigated may need to double to bring potassium application rates down to maintenance levels;
- harvest a crop of silage, baleage or hay off the effluent block to reduce potassium levels.

Consider expanding your effluent disposal area. Spreading effluent to a larger part of the farm will help reduce soil potassium levels.

# 9. WHAT IF THINGS GO WRONG

Your Effluent Management Plan (see Section 7) should identify what can go wrong and what will be done if it does.

If something goes wrong, the first priority is to stop the discharge:

- if the discharge is coming from a tile – block the tile;
- if the discharge is going into the drain – block the drain if practical to stop the discharge exiting the property.

Once the discharge has been stopped, the next step is to investigate the source of the problem and fix it immediately, in such a way the problem does not reoccur.

If you have a discharge into a waterway or are unsure of how to reduce the environmental impact of the discharge, then contact Environment Southland. We are here to help you to protect the environment and can provide you with information and advice.

# 10. TRAINING

*An effluent management system is only as good as the staff operating it. Keep your system efficient and trouble free by ensuring your staff are well-trained and aware of their responsibilities.*

*Staff training*

## EFFLUENT MANAGEMENT TRAINING RECORD

| Name: | | | | |
|---|---|---|---|---|
| Skills | **Date** | **Trained by** Print name | **Signed By** Trainer | Employee |
| **Minimising water use** | | | | |
| ☐ Yard wash-down<br>☐ Checking for leaks<br>☐ Effluent Pump Maintenance<br>☐ Cleaning stone trap<br>☐ Greasing pump nipples | | | | |
| **Irrigator Setup and Maintenance** | | | | |
| ☐ Position of pipes<br>☐ Checking nozzles for blockages<br>☐ Checking irrigator for worn components<br>☐ Greasing irrigator nipples<br>☐ Changing speed of irrigator<br>☐ Measuring application rate | | | | |
| **Monitoring** | | | | |
| ☐ Checking for ponding or runoff<br>☐ Checking irrigator for problems<br>☐ Checking for tile and mole drain discharges<br>☐ Checking storage freeboard | | | | |
| **Other** | | | | |
| ☐ Mark on map and on farm all tile and drain outlets into waterways<br>☐ Familiarity with Effluent Disposal Area – ensure there is a map available to all staff showing this area<br>☐ Provide an ongoing record of the location of the irrigator and the dates it was there – get staff to continue this each day.<br>☐ Ensure when irrigator is moved that all camlocks go with the pull of the irrigator | | | | |

# 11. MAINTENANCE

## EQUIPMENT AND MACHINERY MAINTENANCE SCHEDULE

**Person responsible:**

| Daily | Regularly | Six monthly to Annually |
|---|---|---|
| | ☐ If over ground piping is used, ensure that the connection joints are kept clean. Dirt caught in the joints will move through the lines and block nozzles. | ☐ Strip down the pump for oiling and cleaning as per manufacturer's instructions |
| ☐ Assess whether the soil is dry enough to allow effluent application to the pasture without excessive ponding, runoff or leaching | ☐ Tyres are inflated to the right pressure as under inflated tyres put pressure on the winch | ☐ Check the pump seals as these are the components most susceptible to wear |
| ☐ Check low-lying areas in the irrigator run. If effluent is ponding here then you are applying too much effluent or applying it too quickly. | ☐ Flush clean water through the delivery line and sprinklers to keep them from blocking. | ☐ Check the pump impeller and casing for wear |
| ☐ Waterways and tile drains should be checked during and after irrigation to make sure effluent is not discharging into water. | ☐ Check the hole on the rubber nozzle on the end of the irrigator arm is not split. This affects the efficiency of the irrigator and increases the amount of effluent being applied. | ☐ Check the reticulation lines for leaks |
| ☐ Check at the end of the irrigator run to make sure the irrigator switches off and effluent has not ponded | ☐ Grease the applicator, ratchet drives and cable winch drums regularly. Grease nipples should be evident. | ☐ General storage facility maintenance. Remove sludge from the storage facility and spray any weeds growing on storage ponds. |
| ☐ Make sure the winch is in gear at the start of a new run and that the irrigator is anchored securely, with hose attached | ☐ Check that the float switches are clear and working | ☐ Check pump capacity |
| ☐ Manage the irrigator drag hose to reduce the strain on the irrigator winch. | ☐ Check that the nozzles are not blocked or damaged | ☐ Have a nutrient analysis done on the stored effluent, soil and pasture. |
| ☐ Irrigator is operated during daylight hours so the operation can be monitored | ☐ Make sure the spray application system is not sending effluent into the water troughs | ☐ Stormwater diversion is useful particularly in the off-season. |
| ☐ Make sure the irrigator is clean and does not have a heavy coat of effluent on it | ☐ Clean and clear the effluent stone trap and gratings | ☐ Check anti-siphon valves for blockages |
| | ☐ Shift the spray applicator system to a new area that has been recently grazed | |

# 12. HOW DOES MY SYSTEM STACK UP?

| | Optimum | Okay | Take Action |
|---|---|---|---|
| **Effluent Irrigation** | ☐ Irrigate from a deferred storage pond system | ☐ Irrigate daily from a storage pond | ☐ Irrigate direct from sump |
| **Minimizing Effluent and Water Use** | ☐ Use <50L/cow/day; stormwater is diverted from storage ponds | ☐ Use 70L/cow/day and stormwater is diverted from storage ponds | ☐ Use more than 80L/cow/day and stormwater is diverted from storage ponds |
| **System Design and Set-up** | ☐ Set up that has been designed in consultation with an expert specifically for the property | ☐ A standard system ("off the shelf") that has been designed by an expert. | ☐ Mix and match – a system that has been put together with no expert consultation or consideration for the specific property |
| **Application Timing** | ☐ Irrigate only when soil moisture is low | ☐ Irrigate only after one week since a significant rainfall event | ☐ Irrigate daily or when storage facilities are full, despite weather conditions and soil moisture |
| **Application Rates** | ☐ Application depth and rate are based on the soil properties (i.e. water holding capacity and root zone depth) | ☐ Application depths are less than 15mm per application, applied at a rate slower than 10mm/hr | ☐ Application depths are 15mm per application, applied at a rate of 10mm/hr |
| **Application Area** | ☐ Effluent is applied to a farm area greater than 8ha/100 cows or is applied based on its N or K content | ☐ Effluent is applied to a farm area of between 4-8ha/100 cows | ☐ Effluent is applied to a farm area of 4ha/100 cows, or less |
| **Storage** | ☐ Have 90 days storage with pond desludged annually | ☐ Have 30 days storage with pond desludged regularly | ☐ Have less than 30 days storage with pond desludged infrequently |
| **Application Method** | ☐ Low rate application system | ☐ Adjustable application rate system | ☐ High application rate system |
| **Training and Maintenance** | ☐ Skilled staff doing daily maintenance and checks | ☐ Skilled staff doing regular maintenance and checks | ☐ Untrained staff doing ad-hoc maintenance |
| **Effluent Management Plan (EMP)** | ☐ EMP has been prepared, is on display and is used by staff on a regular basis | ☐ EMP has been prepared but is not used on a regular basis | ☐ EMP has not been prepared for the property |
| **Nutrient Management** | ☐ You soil test regularly and prepare a nutrient budget, then strategically use supplemental fertiliser based on these results | ☐ You manage nutrients by regular soil testing and applying supplemental fertiliser based on these results | ☐ Effluent paddocks receives the same amount of fertiliser as the rest of the farm |

***Remember – if things go wrong the first priority is to stop the discharge then address the cause or contact Environment Southland as soon as possible.***

## WHAT TO DO IF YOU ARE:

### Take Action:

If you have ticked any activities with this classification then you are at high risk of short-term problems such as the potential pollution of waterways or groundwater. To lower the risk you can:

- install a storage pond and irrigate only when soil moisture is low;
- increase the effluent irrigation area to greater than 4 ha/100 cows (even double this to 8 ha/100 cows to decrease potassium loading);
- decrease your effluent application depth to 10 mm or less. This will require you to shift your irrigators more frequently.
- increase the area that you apply effluent to (you probably need a consent variation to do this in Southland). Although you are at the recommended minimum area where you will be applying 150 kg/N/ha, why not increase this so that you are spreading your "risk" over a greater area? The benefits are more flexibility in your rotation – both in irrigating and grazing, and decreasing the risk of metabolic disorders in your cows by applying less potassium per hectare;
- if possible, when soil moisture is higher, decrease the rate at which you apply effluent (i.e. speed up your irrigator);
- irrigate only when soil moisture is low. This may require you to increase your storage capacity.

### Okay:

If you have ticked any activities with this classification then your effluent management system is satisfactory in the short-term; however, improvements can be made to further minimise any risks:

### Optimum:

If you have ticked all the activities with this classification then you have an excellent effluent management system and you are approaching sustainability.

# 13. SOIL QUALITY

Maintaining healthy soil is an important part of overall effluent management. Soil structure and pore space are important attributes allowing the soil to absorb nutrients and water applied in effluent.

When soil is compacted, infiltration rates are lowered, reducing the soils ability to absorb and store the applied effluent. This may in turn lead to ponding and / or surface runoff.

The physical condition of a soil influences farm economics and the environment and because some Southland soils are highly susceptible to compaction and erosion, it pays to know your soil.

***Soil maps are available on the Environment Southland website – www.es.govt.nz. Contact Environment Southland for further information on your soil type and its properties.***

Soil structure is a key component of soil quality as it refers to the arrangement of the aggregates and pores within the soil. The structure of the soil determines the porosity, strength and stability of a soil which influence:

- a soil's ability to absorb nutrients and water applied in dairy effluent;
- water movement, storage and drainage of excess water;
- the ability of roots to penetrate, grow and withdraw water and nutrients;
- plant production potential;
- the ability of the soil to resist erosion.

A well structured soil has many stable aggregates with a wide range of sizes and a large number of pores within and between those aggregates. Poorly structured soil either does not have aggregates of many different sizes or the aggregates are packed tightly together with few pores.

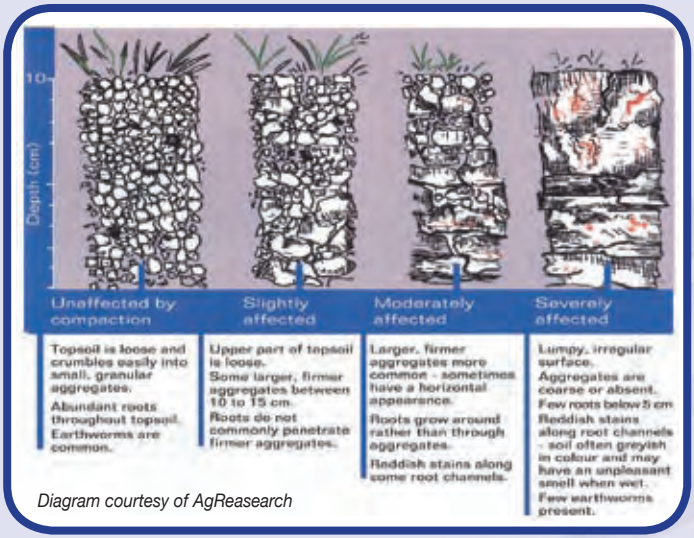

*Diagram courtesy of AgReasearch*

Compaction can significantly reduce soil quality. Soil compaction occurs when the soil is compressed or 'squeezed', thereby reducing the number and volume of large soil pores and increasing soil density. It is caused when forces acting upon the soil are greater than the soil's strength. This packs the aggregates and particles closer together. Heavy machinery and stock treading are both causes of soil compaction. Cattle (both dairy and beef) can cause 3-4 times more damage to soils than sheep so careful management of cattle is important, particularly in winter and spring. The wetter the soil, the greater its susceptibility to compaction.

When soil is compacted it can pond more frequently and persistently, causing inadequate soil aeration, nutrient losses, a reduced efficiency of nutrient uptake, reduced root penetration and reduced nutrient accessibility to plants. Such changes make soils difficult to manage, affect the root environment, decrease pasture growth and increase surface runoff of water and pollutants to streams and rivers.

# 13.1 ASSESSING YOUR SOIL

You can assess the structure of your soil by carefully examining a spadeful of topsoil. If the structure is crumbly, loose, fine and open, and the soil appears brown or yellow-brown in colour, then the soil's aeration, root penetration and drainage should be OK.

Compare any suspected compaction with another paddock or part of the paddock which is not compacted. Look for damage signs such as:

- large soil aggregates;
- few earthworms;
- hard aggregates with few large pores;
- roots going around but not through aggregates;
- signs of blue/grey colours and orange, red or rusty mottles.

The visual soil assessment (VSA) technique has been developed by Landcare Research as one way of assessing your soil health. It is simple to use and does not require technical skills, allowing the land manager to link soil quality to management practices. VSA is available free from Regional Councils - contact Environment Southland for a demonstration.

The 'macroporosity' test developed by AgResearch is also a good way of assessing the level of compaction. This test involves taking soil cores similar to those used for soil fertility tests. See the booklet 'Managing Treading Damage on Dairy and Beef Farms in New Zealand' for more information about this test (contact AgResearch for a copy).

*Compacted soil (poor structure)*
*Photo's courtesy of AgResearch*

*Non compacted soil*
*(Well structured)*

# 13.2 IMPROVING SOIL STRUCTURE

Given time, some soils may recover to some extent on their own if you encourage strong pasture growth, particularly in summer. Taking the paddock out of the rotation or using it for silage may also help. Graze the affected paddock with young, light-weight stock.

Aeration can mechanically loosen compacted soil thereby improving soil health. It uses rigid tines to loosen compacted soil without cultivation and without mixing the different soil depths. A wide range of aeration equipment is available, usually operated at depths of up to 30cm below the soil surface to loosen the compacted layer.

You will need to assess the soil structure to decide if there is a need for aeration. Professional advice is recommended because unwarranted aeration is a needless expense that won't show a positive return in pasture production.

**Best Practice when aerating**

- If the soil is too wet, the aerator will not lift and crack the soil but will instead create additional compaction and soil smearing.
- Poor shattering will occur if the soil is too dry because large blocks of soil will lift without breaking up.
- The best time for aeration is in autumn or spring when soil is more likely to be moist and friable. A small block of soil should crack or crumble when pressed between your fingers.
- For each combination of implement type and soil condition, there will be a particular depth at which the aerator is most effective.

*Photo courtesy of James Engineering*

- If an implement is operated too deeply, i.e. below its critical depth, much less soil will be loosened. Soil around the passage of the tines will actually be compacted instead.
- For uniform loosening, horizontal tine spacings on conventional aerators should be greater than 1.0–1.5 times the operating depth. Spacings of up to 2.0 times the working depth may be satisfactory for winged implements.
- Always aerate along the contour. Aeration up and down slope will increase the risk of effluent runoff if applied shortly after soil loosening.

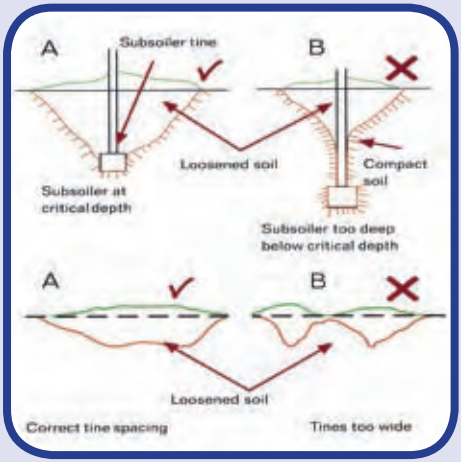


*Diagram courtesy of Otago Regional Council*

# 14. RIPARIAN MANAGEMENT

Appropriate management of rivers, streams, creeks or drains can:

- reduce erosion and stock losses;
- protect water quality by filtering surface runoff and preventing sediment, nutrients and faecal bacteria from entering waterways;
- and provide food and habitats that improve the amenity and quality of stream life.

Where effluent application areas are in paddocks near streams or drains, riparian margins play an important role in intercepting any runoff. For a riparian margin to be effective it needs to be an appropriate width and contain suitable vegetation, which will depend on factors like slope and land use.

The pictures below highlight the benefits of different waterway management approaches. Depending on your situation it might be appropriate to use a mix of all four approaches or just focus on one.

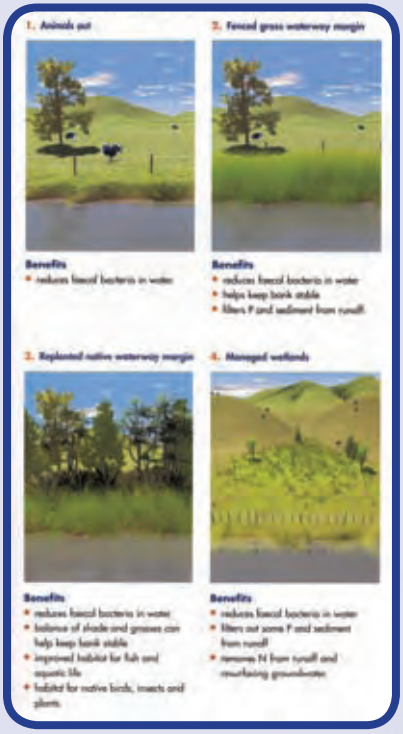


Diagram from Dexcel and Environment Southland, 2004, Clean Streams – *A Guide to Managing Waterways on Southland Farms.*

For more information on riparian management see the booklet Clean Streams – A Guide to Managing Waterways on Southland Farms or contact Environment Southland for assistance or a copy of the booklet.

# 15. REFERENCES, ACKNOWLEDGEMENTS & RESOURCES

If you are seeking more information about dairying in Southland, log onto **www.es.govt.nz.** There is a specific dairy link on the home page. Information on the website includes:

- case studies;
- additional information to this booklet such as pond construction steps;
- soil moisture and temperature monitoring;
- soil maps.

## REFERENCES


- Dairy and the Environment: Managing Farm Dairy Effluent (2006). Dairying and the Environment Committee.
- Environmental considerations for managing dairy effluent application to land in Otago (2004). Otago Regional Council
- Clean Streams – A Guide to Managing Waterways on Southland Farms (2004). Dexcel and Environment Southland.
- Managing Treading Damage on Dairy and Beef Farms in New Zealand (2003). AgResearch


## ACKNOWLEDGEMENTS


This booklet contains information from several sources. Environment Southland acknowledges the contributions of the Fonterra suppliers, Dexcel, Fonterra, AgResearch and the Otago Regional Council.


environment
SOUTHLAND
Te Taiao Tonga