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THE 2006 EDITION

This is the Revised and Updated Edition of this manual.

The original manual was written by Philip Heatley in 1996 with extensive input from dairy farmers, dairy company personnel, councils and rural professionals under the umbrella of the Dairying and the Environment Committee.

Revisions were undertaken by Helen Ritchie and coordinated by Fonterra under a project funded by New Zealand dairy farmers through Dairy InSight.

A new chapter has been added on effluent from feed pads and stand-off areas, and new sections added to existing chapters to discuss low-rate irrigation systems, advanced pond systems and solids separation.

PURPOSE

The purpose of this manual is to assist dairy farmers and farm management specialists with the practical, effective, safe and legal management of farm dairy effluent.

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- Northland Regional Council
- Auckland Regional Council
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- West Coast Regional Council
- Otago Regional Council
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- NIWA
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Apart from above organisations, important contributors to the original manual included:

- Livestock Improvement Advisory
- Mike O'Connor – AgResearch
- Andrew Dakers and Keith Cameron – Lincoln University
- Jim Barnett and John Russell – NZ Dairy Research Institute
- Chris Tanner – NIWA
- Frank Muldowny

Contributors to the revised and updated version included Chris Tanner and Rupert Craggs of NIWA, John Scandrett (consultant) and Ian Howatson (engineer).

HOW TO USE THIS MANUAL

A '**Glossary of Terms**' follows this introduction to the manual, as does the '**Table of Contents - An Overview**'. A separate, comprehensive '**Table of Contents**' can be found at the front of each chapter.

Chapter One '**Managing Farm Dairy Effluent**' gives an overview of the issues relating to effluent management. Practical guidelines on effluent management in the farm dairy are given, including practices that minimise the amount of effluent produced, ideas on how effluent is best collected and stored, an overview of various effluent treatment systems, and suggestions on how to successfully select and plan such systems.

Effluent treatment system processes and components are grouped under the relevant chapter, with cross-referencing to topics discussed elsewhere. Effluent treatment systems are broadly defined by the following chapters:

- Chapter Two '**Land Application**' (which includes information on solids separation and methane digestion).
- Chapter Three '**Pond Systems**' (which includes information on barrier ditches and constructed wetlands).

Effluent collected from sites other than the farm dairy is discussed in Chapter Four '**Effluent from Feed Pads, Stand-off Areas and Other Sources**'. This includes managing effluent from silage pits, races, crossings and underpasses.

Regional Council issues are addressed in Chapter Five '**Regional Council Perspectives**'. This chapter outlines the function of Regional Councils under the Resource Management Act (1991) and the process of applying for resource consents for effluent management.

All information has been compiled using current research data and following lengthy consultation with farmers, contractors, consultants, researchers, Regional Councils and Dairy Industry groups. Data presented in these sections are typical values for typical situations.

All effluent treatment systems and recommendations are addressed in regional or general terms, so there is a need for local interpretation. That is, the application of these guidelines may be varied depending on '**on-site conditions, practicability, economy, and regional regulatory controls**'.

The recommendations within this manual should be used in conjunction with local knowledge sourced from the Dairy Industry, Regional and District Councils and consultants.

GLOSSARY OF TERMS

Activated sludge treatment

Aerobic biological treatment system where a high concentration of active aerobic bacteria are maintained.

Advanced pond system

Systems where the second pond of a two-pond system is replaced with a further three ponds, each performing a different function, developed to enhance the removal of BOD, nutrients and micro-organisms, even in cooler climates.

Aeration

Mixing air and effluent together in order to raise the concentration of dissolved oxygen within the effluent.

Aerobic bacteria

Bacteria that require free oxygen for growth. They are involved in effluent treatment within the aerobic pond.

Aerobic conditions

Conditions where oxygen is freely available either in air or as dissolved oxygen within the effluent.

Aerobic pond

The second pond in an effluent pond treatment system. Effluent entering the aerobic pond from the anaerobic pond is converted into carbon dioxide, water, and new bacterial and algae cells in the presence of oxygen - 'aerobically'.

Algae

Primitive plants, usually aquatic, and capable of photosynthesis.

Ammonia-N

Nitrogen occurring in the form of ammonia (i.e. NH_3).

Ammonium-N

Nitrogen occurring in the form of ammonium (i.e. NH_4^+).

Anaerobic bacteria

Bacteria that do not require free oxygen for growth. They are involved in effluent treatment within the anaerobic pond.

Anaerobic conditions

Conditions where oxygen is not freely available either in air or as dissolved oxygen within the effluent.

Anaerobic pond

The first pond in an effluent pond treatment system. Effluent is initially piped to the anaerobic pond from the farm dairy sump. In the anaerobic pond, the effluent begins breaking down in the absence of oxygen - 'anaerobically'. Anaerobic bacteria are involved in these processes.

Applicator

Irrigator specifically used to spray effluent onto pasture or crops.

Approved

Approved by a competent body to a recognised Dairy Industry standard.

Aquifer

A layer of rock or soil that is able to hold or transmit water.

Batter

A slope immediately above or below a track, road, pond, ditch or other excavation.

Best practicable option

The best effluent treatment method identified after due consideration of its adverse effects on the environment, the sensitivity of the environment to such effects, the financial implications as compared with other options, and the state of technical knowledge at the time.

Bioremediation

Process using bacteria to degrade effluent solids to liquids.

BOD

Biochemical Oxygen Demand gives an estimate of the amount of oxygen required by bacteria to break down the organic matter in effluent. This oxygen could otherwise sustain aquatic life in a waterway.

BOD₅

Biochemical Oxygen Demand measured in a five-day bottle test at 20°C. It may express biochemical oxygen uptake in terms of quantity (i.e. BOD₅ g), concentration (i.e. BOD₅ g/m³) or loading rate (i.e. BOD₅ g/m³/day).

Catchment

Watershed area defined by the ridges of the terrain, where surface water runs towards a storage area or waterway.

Cavitation

Rapid formation and collapse of vapour pockets in a flowing liquid where there is very low or negative pressures. Frequently causes structural and mechanical damage to pumps.

Clean

Visibly free from dirt, manure, milk residues and other objectionable matter.

Coliforms

A group of bacteria used as an indicator of the total concentration of bacteria in an effluent sample.

Conditions

In terms of regional plans and resource consents includes terms, standards, restrictions and prohibitions.

Constructed wetland

An artificial wetland designed to further treat effluent.

Consultation

Involves putting forward a proposal that is not yet finally decided upon, listening to the reactions of other parties, considering their responses and then deciding what action should be taken.

Controlled activity

An activity that complies with conditions specified in the regional plan, is assessed according to matters the Regional Council has reserved control over, and is allowed only if a resource consent is obtained.

Crusting

The accumulated effluent solids that typically gather on, and completely cover, the surface of effluent ponds.

Deferred irrigation

Involves storing effluent in a pond and then applying it strategically when there is a suitable soil water deficit to reduce the risk of surface runoff or drainage.

Delivery line

The complete pipeline carrying the effluent from the storage facility to the applicator.

Denitrification

A biological process, carried out by specialist bacteria, where nitrate (i.e. NO₃-) is converted to nitric oxide (i.e. NO) or nitrous oxide (i.e. N₂O) or nitrogen gas (i.e. N₂). Anaerobic conditions, with a supply of free carbon, are required for denitrification.

Deoxygenation

Removal of dissolved oxygen from water.

Digestion

Anaerobic breakdown of organic matter within the effluent.

Discharging

Includes 'emitting', 'depositing', or 'allowing to escape' any contaminant into the environment.

Discretionary activity

An activity that complies with conditions that may be specified in the regional plan, is permitted at the discretion of the Regional Council, and is allowed only if a resource consent is obtained.

Dissolved oxygen

The concentration of free oxygen dissolved in water, and usually expressed as g/m³ or mg/l.

E. coli

Escherichia coli is the main coliform found in the gut of warm blooded animals.

Ecosystem

The interaction of collective plant, animal and micro-organism communities and their non-living environment.

Effluent

Effluent may contain stormwater, spilled milk, soil and feed residue, detergents and other chemicals, in addition to the faeces, urine and washdown water. Effluent referred to in this manual is material containing between 5% and 20% solids. Effluent less than 10% solids can be conveyed through piping systems by gravity or pumps, or by using vehicle spreaders. Effluent between 10 and 20% total solids is referred to as slurry. Effluent exceeding 20% total solids is referred to as sludge.

Euphotic depth

The depth immediately below the water surface at which photosynthetically active radiation (i.e. PAR) is reduced to 1% of its value.

Evaporation

The loss of water, from a surface (e.g. soil) to the air, in the form of vapour. Usually expressed in mm in a given time period (e.g. mm/day).

Evapotranspiration

The combination of evaporation and transpiration (i.e. the combined loss of water from the soil and from plant surfaces to the air, in the form of vapour). Usually expressed in mm in a given time period (e.g. mm/day).

Facultative bacteria

Bacteria that can grow both in the presence and in the absence of free oxygen.

Facultative pond

The correct term for what are commonly referred to as aerobic ponds. A facultative pond has both an aerobic upper layer and an anaerobic lower layer. Therefore, both aerobic and anaerobic processes are carried out in a facultative pond.

Faecal coliforms

A group of bacteria associated with the faecal wastes of warm-blooded animals. They are used as an indicator of the extent of faecal contamination in a liquid sample (e.g. water or effluent).

Farm dairy

Includes any milking area, milk receiving area, milk storage area, and yards used in connection with milking.

Freeboard

The vertical distance between the top of the embankment and the maximum effluent level of the storage facility.

Groundwater

Subsurface water contributing to the water table, an aquifer or a confined aquifer.

Hapu

Subtribe, usually associated with one or more marae of a local area.

Herbicide

Any substance used to destroy or control any form of plant life.

Holding pond

A pond storage facility usually used for the storage of effluent prior to land application.

Hydraulic loading

Volume of water applied to an area of land (mm).

Hydrological design

Irrigation design process which determines the volume of water to be applied and the interval between successive applications.

Hydrometer

Instrument for determining the density of liquids.

Infiltration

The process of effluent entering the soil surface.

Instantaneous application rate

The actual rate at which water or effluent is applied to a site (amount of liquid applied over a defined time period). Unlike average application rates that mask uneven distribution patterns, instantaneous application rates give the quantity of water or effluent being applied to any one spot at that time, a more accurate description of loading to the soil.

Iwi

Tribal grouping with an association to a particular district.

K

Potassium.

Lactation days

The average number of milking days in an average year.

Leaching

The removal of soluble constituents (e.g. salts, fertiliser nutrients) from the soil by water moving downward through the soil profile.

Local Authority

A Regional Council or Territorial Authority (i.e. District Council or City Council or Unitary Authority).

Mainline

The initial section of the delivery pipeline carrying the effluent from the storage facility to the sprayline.

Marae

Traditional meeting centre of the hapu or iwi.

Maximum application

The maximum amount of effluent that should be applied to pasture at one time (mm).

Maximum application rate

The maximum speed at which effluent should be applied to pasture (mm/h).

Mechanical aeration

Mechanically mixing air and effluent together, using air pumps, agitators or liquid sprayers, in order to raise the concentration of dissolved oxygen within the effluent.

Micro-organisms

Microscopic organisms, such as bacteria, viruses, algae and fungi, that can live in water, soil, air, animals and plants.

Mineralisation

Conversion of organic matter into a mineral substance.

Minimum application interval

The minimum interval between successive effluent applications to pasture (days).

Multiple sprinkler system

Involves either a portable sprayline carrying several sprinklers or a series of fixed spraylines carrying a single or several sprinklers. Where the sprayline is portable, sprinklers require individual stands, a base, or a pod for support.

N

Nitrogen.

Nitrification

A biological process carried out by specialist bacteria where ammonium-N (i.e. NH_4^+) is converted to nitrate (i.e. NO_3^-). Aerobic conditions are required for nitrification, although the process can continue at low oxygen concentrations.

Non-complying activity

An activity that contravenes a rule in the regional plan or is not included in any other category. Applications for a resource consent can be made and will be assessed on their individual merit.

Notification

Public notification of a resource consent, or any policy statement or plan, or changes to them.

Nutrient budget

A system of calculating and comparing nutrient inputs and outputs from all or part of the farm system to help select fertiliser rates and management techniques for efficient nutrient use and reduced environmental impact.

Organic matter

Substances of animal or plant origin.

P

Phosphorus.

PAR

Photosynthetically active radiation which is radiation (light) useful to plants and algae for growth.

Pathogenic micro-organisms

Micro-organisms (e.g. bacteria, viruses, cysts, eggs and larvae of parasites) considered harmful to animals, plants and humans.

Permeability

The property of a soil describing the ability to allow significant movement of water through it.

Permitted activity

An activity that is allowed by a regional plan without a resource consent if it complies in all respects with any conditions.

Pesticide

Chemical substance used to destroy, control or repel animal or plant pests.

pH

The pH is usually measured using a water extract and is a way of expressing how acidic or alkaline a solution is. A pH of 7.0 is neutral whereas lower values are said to be acidic and higher values are alkaline.

Plate cooler

A milk cooler consisting of a series of plates separated by gaskets. The cooling is effected by alternating milk and water flows through the plates.

'Pod'-type sprinkler system

A sprinkler system consisting of a series of sprinklers set on 'pods' along a water pipe, capable of delivering low depths or rates of application and suitable for mole or tile drained soil or soils with low infiltration rates.

Polishing

Where primary and secondary treated effluent undergoes a final treatment.

Pond system

A constructed ponding system designed for the holding and/or treatment of farm dairy effluent before discharge to a waterway or constructed wetland, or application to pastoral land. A treatment pond system is composed of an anaerobic pond and one or more aerobic ponds. A holding or storage pond does not treat effluent, but retains it prior to land application.

Prohibited activity

An activity that is not allowed under any circumstances.

PTO

Power take off. The tractor-driven rotating shaft.

Region

An area in relation to, and under the management of, the Regional Council.

Regional plan

A plan prepared by the Regional Council for managing the use and protection of natural and physical resources (i.e. geothermal, coastal, water, air and soil resources).

Regional policy statement

A statement that guides or directs the decision making in a region, so that the eventual course of action achieves the desired results.

Retention time

This is the average time, in days, that the effluent will remain in the storage facility. It is calculated by dividing the volume of the facility by the volume of effluent entering daily.

Sediment

Solid material (e.g. silt and sand) that is carried in water or effluent that will ultimately settle to the bottom of sumps, ponds, barrier ditches, constructed wetlands or waterways.

Seepage

Loss of effluent through the permeable floor and walls of a storage facility.

Sludge

Sludge referred to in this manual is effluent exceeding 20% total solids. Sludge accumulates at the bottom of sumps, barrier ditches or ponds. Sludge will not flow and requires mechanical spreading equipment such as scrapers and front-end loaders.

Slurry

Slurry referred to in this manual is effluent with between 10 and 20% total solids. Such material can be conveyed by using vehicle spreaders but cannot be conveyed by gravity or pumps through piping systems (refer Effluent).

Sprayline

The latter section of the delivery pipeline carrying the effluent from the mainline to the applicator.

Stationary applicator

Irrigates a specific area for a certain period, before being towed or hand-moved to a new area. This procedure is repeated at set time intervals until the complete application area is treated.

Stone trap

A screen or barrier facility placed before the farm dairy sump. Used to prevent solid materials within the flushed effluent (e.g. gloves, gravel, plastic containers, grass etc) from entering the sump and effluent treatment system.

Stormwater

Rainwater that has drained from the farm dairy and collected in guttering/pipes, or has run off from the surrounding land.

Submission

A written statement in support of, or in opposition to, a resource consent, policy statement or regional plan, or changes to them.

Sump

A small effluent storage facility located close to the farm dairy. Used to collect flushed effluent from the farm dairy and store it for short periods, prior to land application or pond treatment.

Suspended solids

Effluent solids that are in suspension within the liquid effluent but are removable through filtering.

Sustainable dairying

Farm practices that are economically viable, environmentally sound and socially acceptable.

Taonga

Treasured possession.

Top bank

The top of the pond embankment.

Total solids

The sum of dissolved solids and undissolved solids in effluent or water.

Transpiration

The loss of water from plant surfaces (e.g. leaves) to the air, in the form of vapour. Usually expressed in mm in a given time period (e.g. mm/day).

Travelling applicator

A mobile irrigator, powered by a small diesel motor or, more commonly, through water pressure, with a rotating boom and a nozzle at each end. Drags along by a winch and cable mechanism at a rate set by the operator.

Unitary Authority

These combine the functions of Regional and District / City Councils. The Unitary Authorities are Gisborne, Nelson, Marlborough and Tasman.

Volatilisation

Loss of ammonia gas (i.e. NH_3) to the atmosphere following its conversion from ammonium-N (i.e. NH_4^+). Volatilisation is pH and temperature dependent, increasing with increasing alkalinity and/or increasing temperature.

Waahi tapu

Sacred site or place.

Waterway

Fresh or geothermal surface water in a river, lake, stream, pond or natural wetland.

Wetland

Permanently or intermittently wet areas, shallow water and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

Yards

Those parts of the farm dairy used for holding livestock for milking, breeding or veterinary treatment.

TABLE OF CONTENTS - AN OVERVIEW

This manual is divided into the following five chapters and sections.

1. Managing farm dairy effluent

- 1.1 Overview
- 1.2 Local government
- 1.3 Questions and answers for farmers
- 1.4 Why control the discharge of effluent?
- 1.5 Keeping property records
- 1.6 Farm dairy management
- 1.7 Effluent collection and storage
- 1.8 Effluent treatment systems

2. Land application

- 2.1 Overview
- 2.2 Fertiliser properties of effluent
- 2.3 Application area
- 2.4 Application rate
- 2.5 Application site selection
- 2.6 Pasture and grazing management
- 2.7 Cropping land management
- 2.8 Land application of sludge
- 2.9 Spray application
- 2.10 Vehicle spreading
- 2.11 Border dykes
- 2.12 Processing options prior to land application
- 2.13 Land application regulations

3. Pond systems

- 3.1 Overview
- 3.2 How pond treatment systems work
- 3.3 Holding ponds
- 3.4 Siting of ponds
- 3.5 Pond design criteria
- 3.6 Construction of ponds
- 3.7 System additions to improve effluent quality
- 3.8 Pond system maintenance
- 3.9 Pond system regulations
- 3.10 Constructed wetlands

4. Effluent from feed pads, stand-off areas and other sources

- 4.1 Overview
- 4.2 Volume and characteristics of effluent
- 4.3 Options for effluent management
- 4.4 Siting, design and construction
- 4.5 Feed pad and stand-off area regulations
- 4.6 Other areas of concentrated effluent build-up

5. Regional Council perspectives

- 5.1 Overview
- 5.2 Resource Management Act (1991)
- 5.3 Regional plans and resource consents