## 1.7 EFFLUENT COLLECTION AND STORAGE

The design and construction of the farm dairy will largely influence the success of the effluent collection and storage system.

Effluent accumulates on the farm dairy floor. From there it is systematically conveyed to a single collection point, the sump. From the sump, the effluent can be sprayed directly on to pasture, or pumped to a holding pond, or to oxidation ponds.

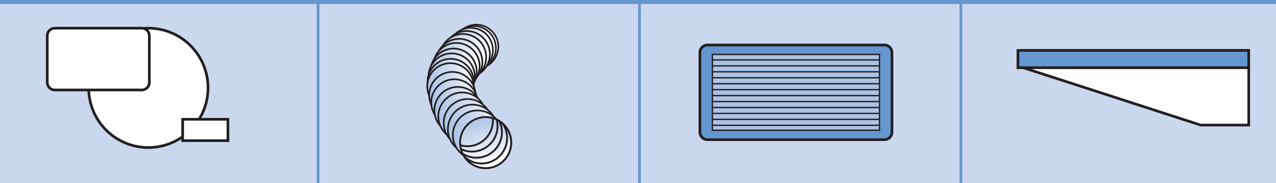
As previously discussed, an extremely important principle for an efficient collection and storage system is **to minimise the volume of farm dairy effluent washdown** (refer to 1.6.8 Reducing effluent volume and conserving water).

For land-based effluent management systems, a decision is required as to whether to irrigate on a daily basis (or every two days) or to practise **deferred irrigation.**

Figure 1.7-1 summarises the effluent collection and storage process and gives the major design specifications.

FIGURE 1.7-1

**EFFLUENT COLLECTION**



| **Farm Dairy** | **Drains** | **Stone Trap** | **Farm Dairy Sump** |
|---|---|---|---|
| • Uses gravity to collect effluent<br>• Roof run-off and stormwater diversion<br>• Milking pit drained<br>• Enclosing kerb to stop water run-off and entry | • Convey all effluent to a single collection point<br>• Minimum pipe diameter 100 mm with fall 1 m in 35 m | • Prevents blockages in the distribution line<br>• Self-draining<br>• Regularly cleaned | • Preferably constructed of concrete<br>• Large<br>• Designed for easy cleaning<br>• Sloping floor towards outlet |

### 1.7.1 Farm dairy design and construction

A well sited, designed and constructed farm dairy not only looks attractive, but also will operate efficiently, reduce the likelihood of milk contamination, and be easy to clean and maintain.

Every effort should be made to make use of the fall of the land so that the effluent can flow via gravity. The alternative is pumping, which is expensive and susceptible to mechanical failure. **Utilising gravity should be a major consideration when siting farm dairies** (refer to 1.7.3 Drains).

In regard to design and construction, Food Safety regulations for the dairy industry (i.e. the Farm Dairy Code of Practice NZCP1) require all floors of the farm dairy to:

- be **made of concrete** or similar impervious material for a distance of 10 m from the milk storage room, receiving room and edges of the pit or milking platform
- be **uniformly graded** and have a fall to allow drainage to approved outlet points. The minimum recommended **fall for yards is 1 m in 50 m** with all **other areas 1 m in 80 m**
- be **capable of being readily cleaned**
- in the case of yards and yard races, **have a kerb which is a minimum of 150 mm above the level of the yard surface** and made of concrete or another approved material (refer to Figure 1.7-2). At yard entrances, the kerbs can be as low as 50 mm.

A kerb prevents soil and dung being washed over the sides of yards and yard races. At these places, there is often poor drainage due to the persistent stock and vehicle loads. Lack of drainage will cause pugged and foul conditions, create odours and attract flies. In addition, regulations require that there must be no ponding on farm races within 45 m of the farm dairy.

FIGURE 1.7-2

**KERB GUIDE TO SUMP DRAIN**

In the milk storage and collection area, Food Safety regulations for the dairy industry (i.e. the Farm Dairy Code of Practice NZCP1):

- require the **floor to slope inwards from the outer edge of the room** where the milk tanker loads the milk. This is to prevent milk and cleaning residues from flowing on to the tanker, road or steps
- recommend there be a nib wall constructed, 25 mm high and extending across the main load-out doorway
- require that all new milk storage areas and colostrum for supply storage areas have **an adequately sized drainage basin beneath the outlet pipe of the vat,** draining to the effluent treatment system (refer to Figure 1.7-3)
- require that all farm dairies have **a concrete apron constructed at the road level, under the milk collection point** and good drainage provided in the standing area for the milk tanker. The concrete apron must be at least 700 mm wide, at least as long as the length of the vat stand, at road level under the collection point. This should slope towards a drainage point leading to the effluent treatment system (refer to Figure 1.7-4)
- require all new milk storage areas and colostrum for supply storage areas to have a tanker pad the width of the tanker road (at least 6 X 5 m wide X 150 mm deep), sloping toward the effluent treatment system.

FIGURE 1.7-3

**DRAINAGE BASIN**

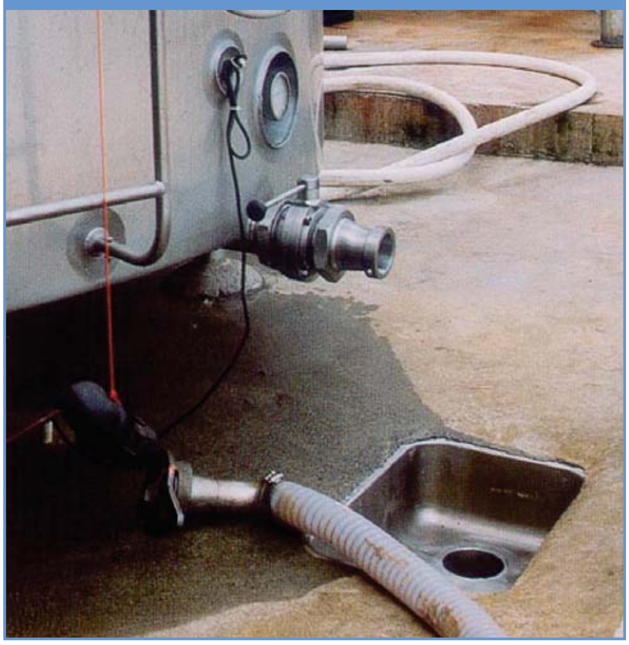
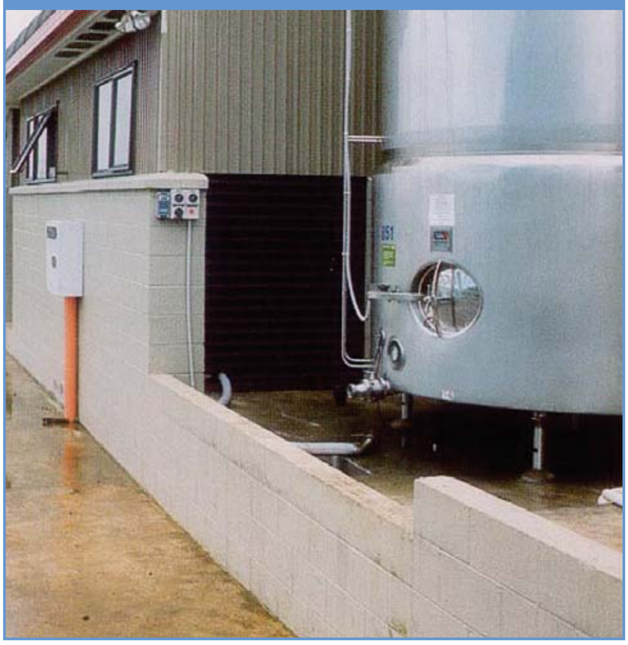


FIGURE 1.7-4

**CONCRETE APRON**



### 1.7.2 Effluent collection

Washdown hoses, flood washing and scrapers can all be used to move effluent to collection areas (refer to 1.6.8 Reducing effluent volume and conserving water).

Ultimately all effluent from the yard races, yards, milking pit and milk storage area should drain to a single, temporary storage point. This point is the effluent sump (refer to 1.7.5 The farm dairy sump). There are four areas within the farm dairy where effluent is collected:

- the **step barrier** at the yard entrance
- **grate traps** throughout the farm dairy
- the **milking pit**
- effluent and wash water **drains.**

**Effluent from all these areas must be directed to the effluent collection facility.**

FIGURE 1.7-5

**AN EFFECTIVE TIMBER POLE STEP BARRIER**

**Place a step barrier at the end of the race where it meets the yard.** The step will catch loose material and flick it off cows' hooves, reducing stone and soil entry into the yard. A small nib wall (50 mm high) across the end of the race will help prevent soil and dung from being brought into the yards by the herd. It will also help guide wash water to drains and prevent effluent flow into the farm races and stop stormwater from entering the farm dairy area.

Concrete nib walls may be hard on cows' feet, especially while they are getting used to it. Timber is also an option, e.g. half-buried posts or telephone poles can be laid across the yard entry (refer to Figure 1.7- 5).

**Grate traps** should be placed around the yard so that stones can be caught when effluent falls through the grating into the drains below. It is important that the grating has gaps of no less than 25 mm and that it is easily removable for maintenance (refer to Figure 1.7-6).

The grating should be flush with the yard concrete so cows do not clip their hooves.

There can be difficulty in flushing effluent down traps placed in the centre of the yard, as there is no backing wall to prevent the effluent running past the trap.

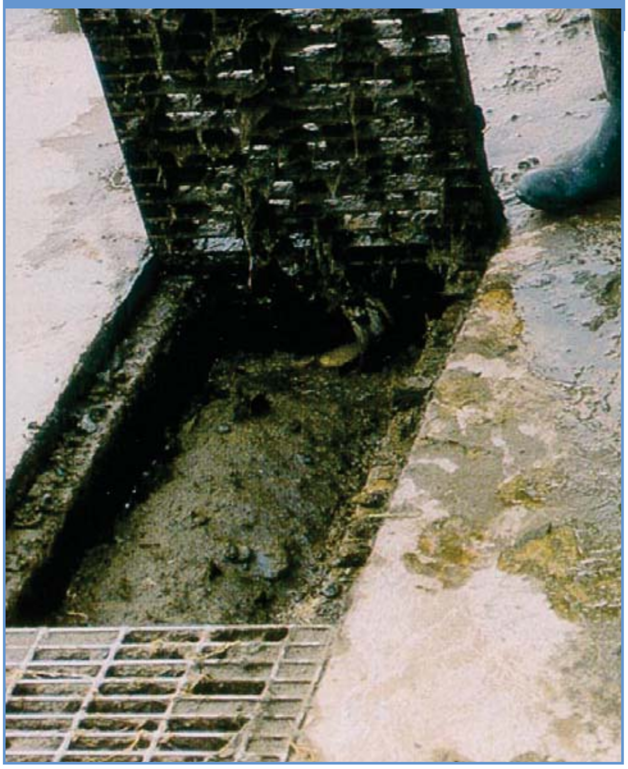
Gratings placed across the line of stock traffic can halt cow flow, because of the noise of water passing under the grill, and because cows may consider the grill a physical barrier.

Orientate the grate trap so that the grating runs perpendicular to the line of traffic. This will aid cow flow as cows will be less able to perceive the gaps in the grating.

Otherwise, the traps should be placed along the sides of the yard against the nib wall backing.

FIGURE 1.7-6

**REMOVABLE GRATING**



The milking pit collects high volumes of cow dung and water. Where **milking pits** are built into the ground, and there is a drain provided to carry water and effluent from the pit to the sump, care should be taken to ensure that the fall is not too slight. Otherwise the effluent will back flow if the sump is flooded during a storm, or if the sump outlet is blocked. The pit will fill in due course, making milking uncomfortable or impossible until flushing is undertaken.

### 1.7.3 Drains

To maintain hygiene standards, it is better to pipe or channel effluent rather than to let it flow across open concrete. Drains convey effluent from the farm dairy to the sump, and from the sump to the holding pond or oxidation ponds in the following ways:

- **gravity flow in pipeline**, flowing full or partly full
- **pressure flow in a pipeline** connected to a pump.

Generally, **channel systems** are more cost effective than pipelines. However, problems with maintenance and weed control, channel crossings, and health and safety risks limit the value of channels. Unlined open channels should only be used once solids have been removed from the effluent.

Channels should be concrete and constructed with sloping walls. The added expense of concrete is justified due to a more successfully operating channel with a much lower maintenance requirement. Channel drains are available as pre-cast sections and can be installed by the farmer (refer to Figure 1.7-7).

FIGURE 1.7-7

**PRECAST DRAIN SECTION**

**Gravity flow pipelines** can be a major cost, especially where large-diameter gravity pipelines are used. Cost savings can be achieved through minimising the length of the line, and by removing solids from the effluent. This will allow smaller pipes to be used. To obtain cost savings, shop around when purchasing pipe material.

The recommended **minimum diameter for gravity flow pipes is 100 mm**. Use sewer class pipes rather than stormwater class pipes. The fall can be reduced with larger diameter pipes and more liquid effluent. Table 1.7-1 gives recommended fall requirements for effluent pipe.

TABLE 1.7-1

**MINIMUM FALL FOR GRAVITY PIPE DRAINS CONVEYING EFFLUENT**

| Diameter of Pipe (mm) | Minimum Fall | |
|---|---|---|
| | Effluent High in Solids | Effluent Low in Solids |
| 100 | 3% **or** 1 in 35 | 1% **or** 1 in 100 |
| 150 | 2% **or** 1 in 50 | 0.5% **or** 1 in 200 |

Using pipes that are too small in diameter for free flow of solids, and installing them at low gradients, are common mistakes. A relatively even fall for the pipeline is necessary to avoid airlocks.

PVC pipe is often used for buried drain lines. Other products include Corflow and large-diameter polyethylene pipe. Burying is essential for PVC and Corflow pipelines for protection from stock damage, vehicle damage and sunlight. **Pipes should be buried to at least 600 mm depth.**

**Do not use perforated, ribbed drain coil** for conveying effluent as it restricts effluent flow, is readily damaged by stock and plant roots will move into it if it is buried. It is important that all pipe used for effluent has a smooth barrel.

For **pressure pipelines,** having a pipe class too low for the pressure in the system will result in leaks and bursts. Pipe class is an important consideration when effluent is pumped or when there is a vertical fall in a gravity flow pipeline of more than 5 m (refer to 2.9.2 The delivery pipeline).

Food Safety regulations for the dairy industry (i.e. the Farm Dairy Code of Practice NZCP1) relevant to farm dairy drain construction:

- require **all drains, sumps and traps to be of sufficient size to cope with total effluent flow**
- require **adequate fall in drains to the drainage point**

- require **open drains within the farm dairy to be constructed of concrete** or another approved material so that they are easily cleaned and free-draining
- recommend **open drains within the farm dairy be rounded off at the bottom** to assist in self cleaning and prevent the build-up of silt, gravel and weeds in corners
- recommend that a recess be built into the yard floor for receiving and conveying wash water drained from the milking pit with a pump or venturi. The sides and bottom of this recess should be finished to a smooth surface and sealed to prevent any seepage
- require that **all drains that run from the farm dairy sump to a holding pond, or to oxidation ponds, be fully enclosed and impervious to moisture**
- recommend a **minimum diameter of 100 mm** for enclosed drains, with a fall towards the draining area of 300mm in every 25 m (1 in 80).

The size of the channels and pipeline is also dependent on the solids content of the effluent (refer to Table 1.7-1). The velocity of flow should **not exceed 2 m/s in pipelines or be less than 1 m/s.**

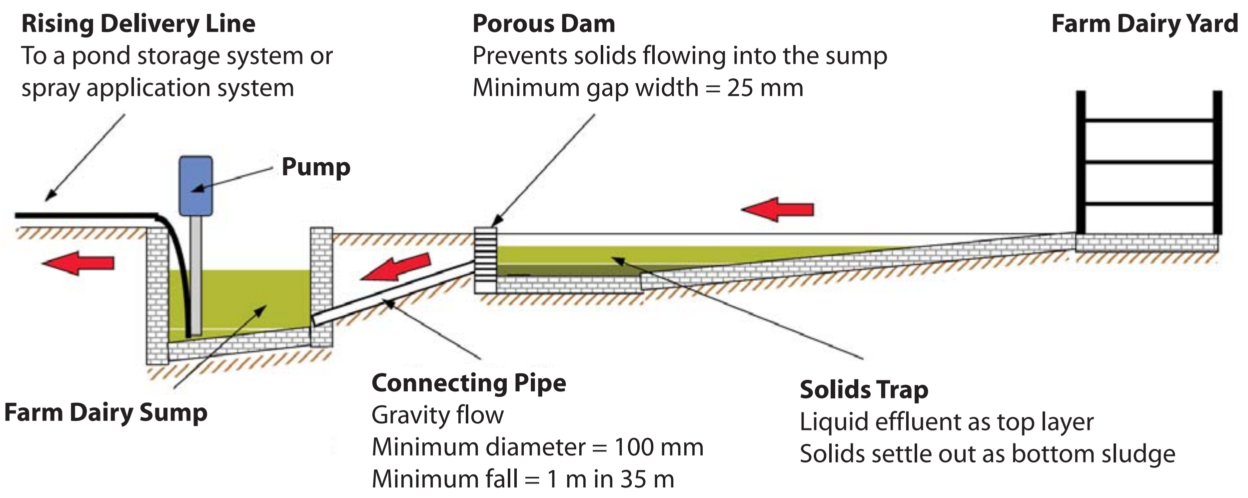
It is useful to have grating to cover any inflow points to underground piping (refer to 1.7.2 Effluent collection). The grating is designed to intercept twine, plastic waste products, grass and stones which can interfere with effluent flow and the successful operation of the effluent treatment system. If suitable grating is not available, a ball of wire in the pipe entrance may be satisfactory.

## 1.7.4 Stone trap

Stone traps (i.e. stone, sand and solids traps) are drainage line devices designed to intercept and hold sand, gravel and foreign objects such as baling twine and clumps of grass that are washed off the yard area. The aim of the trap is to prevent blockage in drain lines, in the pump and in the spray systems (refer to Figure 1.7-8).

FIGURE 1.7-8

**STONE TRAP AS PART OF THE SUMP AND PUMP SYSTEM**




**A stone trap reduces the size of sumps and ponds required to store and treat effluent.** An effective stone trap can capture around 50% of the solids from effluent. This can be stored and spread on the land (refer to 2.8 Land application of sludge).

Solids from the stone trap should be removed onto a sealed area rather than piled on unsealed surfaces to avoid the risk of nitrate leaching to groundwater.

A stone trap, as part of the sump, may be employed in the form of a low dividing barrier. In Figure 1.7-9 the barrier between the two stages has a narrow gap running horizontally and 100 mm above the stone trap floor. Liquid effluent drains through the gap into the second section. Although an effective system, this particular trap is relatively small, so will fill quickly and require regular emptying and cleaning.

**The stone trap must have sufficient capacity to not require continual cleaning,** and have the ability to be cleaned easily using either a wide mouthed shovel or a front end loader bucket.

Therefore, it is important that the stone trap is made large enough to allow the use of such cleaning equipment. Figure 1.7-10 shows a large capacity stone trap that needs emptying only every few months. It is designed for tractor entry and so can be easily cleaned.

**A 'no stone trap' option will result in rapid sediment build-up within the sump or pond. Desludging will need to be carried out regularly.**

FIGURE 1.7-9

**SMALL STONE TRAP WITH SUCCESSIVE DIVIDING BARRIERS**

FIGURE 1.7-10

**LARGE CAPACITY STONE TRAP DESIGN**

## 1.7.5 The farm dairy sump

Food Safety regulations for the dairy industry (i.e. the Farm Dairy Code of Practice NZCP1) require that sumps be:

- **designed to be easily cleaned**
- **constructed of concrete** or impervious material.

Sumps with **a floor sloping towards the pumping or draining** end are most practical. The slope will help with the emptying of the sump by providing sufficient depth for pumping. It will also aid cleaning, with either a wide mouthed shovel or a front-end loader bucket, as the effluent sludge will be gathered in a distinct area (refer to Figure 1.7-11).

Otherwise, a septic tank can make a good sump.

The **inlet to the sump should be well above the outlet.** This will ensure that there is no back flow up the feeder drains.

It is also important to have the sump **inlet on the opposite end to the outlet.** This will ensure that there is time for solids to settle. Such material may otherwise be damaging to the pump or may block flow down the pipeline.

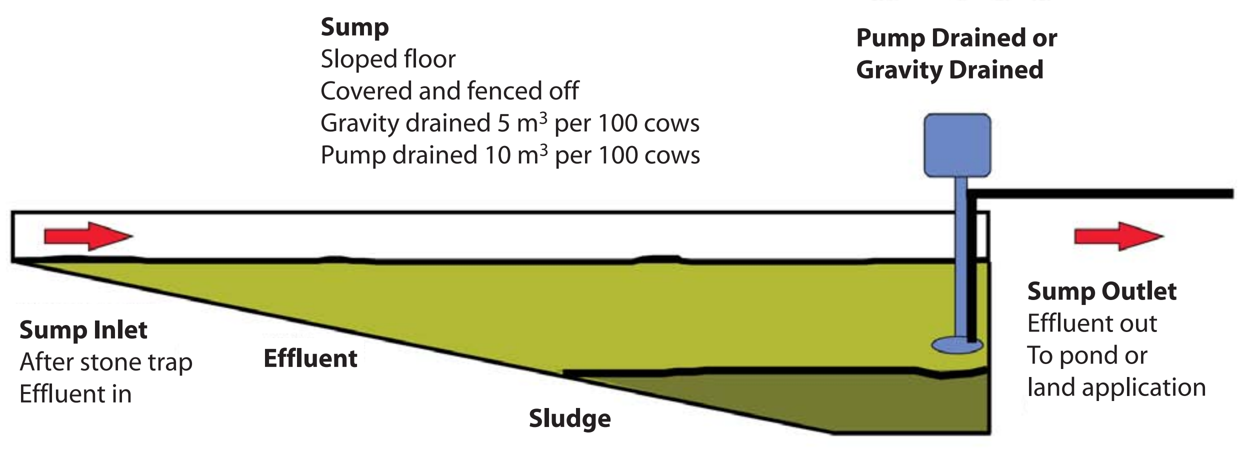
Designs for sumps should also include:

- **provision for overflow and further storage,** especially if the sump is small. The overflow should lead to a temporary holding facility. (Refer to 1.7.5.3 Sump capacity). Sumps can be fitted with an overflow warning device
- **no sharp corners or dead spots** that cannot be easily cleaned or flushed

- **a stone trap** prior to effluent entry (refer to 1.7.4 Stone trap) and a removable mesh grill (i.e. aperture up to 30 mm) guarding the outlet to the pipe system
- **a cover** (e.g. heavy timber or metal plate) for human and animal safety. The Health and Safety in Employment Act (1992) requires that **a safety fence** be erected, where practical, around any liquid container at ground level such as sumps, to the height of 1m (refer to Figure 1.7-12). The fence should be sited to allow machinery access.

FIGURE 1.7-11

**SUMP DESIGN**




### 1.7.5.1 Sumps for pumping

When the sump is pump drained, a float switch or probe system often works to maintain the volume of effluent in the sump at the correct level (refer to 2.9.1.7 Pump power supply and switching).

**When selecting or designing a sump for pumping, consider the inlet position.** Turbulent flows from the inlet pipeline can cause air entry into the pump and delivery line. This will restrict the performance of the pump and may result in pump damage through cavitation. Therefore, inlets that encourage rotational movement of effluent, and inlets with long falls, should be avoided.

There should be sufficient depth to the pump's suction inlet. The inlet should be **submerged at least 1.5 times the diameter of the inlet,** at the lowest occurring effluent level.

**Avoid cylindrical sumps of small diameter with snug fitting pumps.** Sumps should be large enough to enable the farmer to bend down and shovel out the effluent sludge. The sump depth should be matched to the column length of the pump.

For reasons of stability, the sump design should allow for mounting of the pump on beams above the sump. Alternatively, pumps can be placed on a float (refer to 2.9.1.4 Pump installation).

### 1.7.5.2 Sump agitation

It is necessary to agitate the effluent in sumps to combat surface crusting and evenly mix the solids and liquids prior to land application.

The best means of sump or effluent pond agitation or mixing is to use a mechanical stirrer. The mechanical stirrer can either be electrically driven and permanently mounted or PTO-driven and portable, used periodically to break up solids or crust formations. Some effluent pumping systems, especially those mounted on a pontoon have both an effluent pump and a stirrer mounted on the pontoon. The cost of an electrical stirrer ranges from $2,400 -$4,600 + GST depending on the size required which is generally determined by the size of the holding facility. Where the effluent is quite concentrated e.g. where a feed pad is in use or the yards are scraped rather than being washed there may be a greater need for a stirrer.

The other important pumping consideration is the use of cutters on the effluent pump. This will enable solids such as those washed from a feed pad to be pumped. However, it is important to note that if excessive solids are washed or pushed into the sump/pump, blockage of the pump or pipeline will occur.

### 1.7.5.3 Sump capacity

If the effluent is to be **gravity fed into a holding pond or pond system** then the capacity should be for 1 day's storage (refer to Table 1.7-2).

If the effluent is to be **pumped into a holding pond or pond system** then the sump design specifications should take into account the possibility of system breakdown (e.g. pump failure, system blockages, pond maintenance). Capacity specifications per 100 cows are given in Table 1.7-2.

TABLE 1.7-2

**SUMP DESIGN SPECIFICATIONS PER 100 COWS**

| Storage Capacity | Storage Volume | Sump Volume per 100 Cows |
|---|---|---|
| 1 day's storage | 50 litres per cow per day | 5 $m^3$ |
| 2 days' system breakdown | 50 litres per cow per day | 10 $m^3$ |

For land application, the use of a small sump feeding to a pond storage facility is the most practical choice. Where effluent is **pumped directly on to the pasture from a sump,** a very large sump is needed (refer to 3.5.8 Holding pond design).

Pumping onto the land directly from the sump requires enough storage for those months where land application is not possible, and should allow for the possibility of system breakdown. The capacity required makes a large storage sump, for direct land application, costly. It is better to construct a correctly sized pond.

Capacity should also take into account rainfall. Stormwater diversion is very important especially in wetter climates.

Some Regional Councils have storage requirements specified in their Regional Plans and rules, or these may be included as conditions for a consent or permitted activity (check with your Regional Council for requirements).

Food Safety regulations for the dairy industry (i.e. the Farm Dairy Code of Practice NZCP1):

- **require that sumps not be located within 10 m of the milking area, milk receiving area and milk storage area unless the effluent is pumped away on a daily basis or piped to effluent ponds**
- **sumps greater than 22,500L must not be within 45 metres of the above areas.**

### 1.7.5.4 Construction materials

Sumps should preferably be made of concrete or a similar impervious material. Some Regional Councils have requirements regarding sealing of all sumps and ponds (check with your Regional Council for requirements).

#### Concrete

**Below-ground concrete sumps** are often used to store small amounts of effluent for a short time. They are usually too expensive to store effluent for an extended time, but can be used as reception pits to collect effluent before it is pumped onto pasture or into ponds. Concrete blocks can form a retaining wall around the sump (refer to Figure 1.7-9), when it needs to be subsurface to gain sufficient fall for gravity flow.

Concrete sumps are built from rendered reinforced blocks, reinforced concrete made on-site or from ready made concrete panels. Sumps made from concrete poured on-site can be made more impermeable than those built from rendered reinforced blocks. **In localities where there is a high water table, or other site difficulties, it is recommended that reinforced concrete made on-site be used in preference to block work.**

When building and utilising below-ground concrete sumps, consider the following:

- **care should be taken to seal the walls and sump floor.** Surface treatments are generally more durable than plastic liners. Such treatments include surface hardeners and penetration sealants
- **site conditions, especially groundwater levels**, are extremely important when constructing stores below ground (refer to 3.4 Siting of ponds)
- **below-ground tanks should be large enough to suit the circumstances and the emptying method.** Sumps that are emptied or desludged by a tractor-drawn vehicle spreader should be placed where the tractor can easily get to them

- **cover or fence off below-ground sumps for occupational safety reasons**
- **if the sump is fully enclosed, do not go into it as it will contain lethal gases.**

Precast concrete panels can be used for above-ground circular tanks. Such tanks are invariably supplied and erected as a complete package, including the foundation works. The concrete panels are usually held together by post-tensioned, steel hoops. Good joint design is essential, and often cement grouting or synthetic rubber strips are used prior to tensioning to ensure tank sealing.

Alternatively, above-ground circular tanks can be made from curved steel panels.

### Steel

**Above-ground circular tanks** minimise the effects of rainwater collection which tends to be a problem with the low, large diameter tanks. Above-ground tanks are useful in regions where only one month's storage is required. Since the storage depth can be up to 6 m, they take up less space than large sumps or ponds.

Steel tanks are constructed from vitreous enamelled steel or galvanised steel. **Vitreous enamelled steel** provides excellent corrosion protection, provided the protective coating remains intact. Flaking of the coating often occurs around bolt holes and where there has been physical damage or abrasion. Maintenance is normally confined to applying a protective coating or renewing panel sealants. Damaged steel sheets can be repaired by plating on either side. **Galvanised steel** will be protected from corrosion only if a suitable factory applied protective coating is used.

When utilising above-ground circular tanks, consider the following:

- **no part of the system should be placed within 10 m of a surface waterway or the farm dairy.** Some Regional Councils have specific guidelines regarding the placement of large effluent storage facilities
- **make sure the storage site gives a stable foundation for the tank.** The tank base should be designed to suit the size of the tank and the site conditions
- **no tank should be extended in height following initial construction,** unless the whole of the tank has been inspected by an engineer and the manufacturers are involved
- **a space of 300 mm freeboard must be left** between the level of the effluent and the top of the tank when working out the size of the tank. This will allow for shock loading and rainfall. Tanks should not be allowed to overflow at any time
- where the tank is linked to a sump, or where the vehicle spreader is connected to the tank, **there should be a double valve in the connecting pipe.** This valve can be locked in the closed position when not in use to reduce the risk of effluent leakage
- **all tanks should be impermeable,** with no reliance on any self-sealing properties of the effluent
- **the tank should be checked regularly for any signs of leaking**
- if the tank is made of steel, the **panels should be coated to protect against corrosion**
- **completely empty the tank annually.** Clean it down and check for any signs of corrosion or damage
- **the tank contents should be checked regularly, and mixed if there are signs of crusting.** However, mixing causes the contents to give off odours. A system that keeps the amount of necessary mixing to a minimum will reduce the odour problem
- **equipment is required to break up crusts on the surface** and move any sediment, before it is emptied
- **safety and warning signs** informing of dangerous gases, and the risk of naked flames and smoking, should be placed near any enclosed tank.

### Earth-banked sumps

**Some Regional Councils will not allow earth-banked sumps** (check with your Regional Council). **Some Regional Councils will accept earth-banked sumps as long as there is no seepage to groundwater,** i.e. they are sealed or lined (refer to 3.6.4 Sealing and lining).

**It is essential to select a suitable site for any sump that is to be built into the ground** (refer to 3.4 Siting of ponds). Site conditions, particularly water table levels, are extremely important when constructing earth walled storage facilities below ground. Earth-banked sumps cannot be built properly in many regions because of unsuitable soil and high water tables.

**Have sufficient batter slope on the sump banks to prevent wall collapse.**

Where sumps are lined with a plastic liner, care should be taken to ensure that the pump is installed a distance from the sump bottom or it may interfere with the liner.

Contractors, employed to desludge earthen sumps, should be made aware that a liner is present so that they can keep equipment away from its surface.

Figure 1.7-12 shows an earthen sump sealed with a polyethylene liner. This particular sump, although well lined, is not desirable as the banks are vertical. **Banks should have sufficient slope to prevent embankment collapse (i.e. batter of 2 : 1).**

FIGURE 1.7-12

SEALED EARTHEN SUMP AND SAFETY FENCE

## 1.7.6 Pond storage facilities

From the sump the effluent may be:

- pumped directly onto the pasture from a large sump (refer to 1.7.5.3 Sump capacity)
- pumped **or** gravity fed into a holding pond prior to land application
- pumped or gravity fed into a solids-settling pond or bed or mechnical separation system. (Refer to 2.12 Processing options prior to land application)
- pumped **or** gravity fed into a pond system for treatment, then discharged into a waterway or applied to land.

Diaphragm pumps are useful for simple lift situations conveying effluent from sumps to ponds. Otherwise centrifugal or helical screw rotor pumps can be utilised where there is a large vertical distance (i.e. lift) between pond and sump (refer to 2.9.1.2 Pump selection).

For the design and construction of pond type storage facilities, refer to Chapter 3. Pond systems. For the sizing of storage facilities used to hold effluent prior to land application, refer to 3.5.8 Holding pond design.

Having sufficient storage facilities allows for **deferred irrigation** of effluent onto land. The advantages of this are greater flexibility with:

- soil and plant conditions – the effluent can be applied when it is more likely to meet plant requirements and application of effluent to wet soils can be avoided
- labour demands in the farm system – storage allows the application to fit in when time or labour are available
- application options – effluent can be applied from the pond by travelling irrigators, sprinklers or vehicle spreading. If two ponds are used, the low solids content means fewer problems with pumps, pipe blockages and spraying equipment.

## 1.7.7 Top tips to avoid trouble

- **Avoid having loose material on races running up to the farm dairy. Where wood chips are placed on races near the yard area they are commonly brought into the farm dairy by the cows and block the drains, sump inlets and pump.**
- **Maintain drains and repair broken or badly laid concrete to prevent effluent from ponding.**
- **Rubberware and ear tags commonly block sumps. A rubbish collection facility should be placed outside the farm dairy for bags, tubes and other disposable items.**
- **Clean out screens, filters and solid traps regularly. Coarse materials moving through pumps and piping will cause damage and wear.**
- **Over the calving period, watch out for afterbirth entering and blocking the stone trap.**

### 1.7.8 Further reading

Ministry of Agriculture, Fisheries and Food, 1991. "Code of Good Agricultural Practice for the Protection of Water". MAFF, Cardiff, Great Britain.

New Zealand Food Safety Authority, 2005. "Farm Dairy Code of Practice (NZCP 1)". New Zealand Food Safety Authority, Wellington.

Scottish Agricultural College, 1995. "Design and Construction Guidelines for Farm Waste Storage". Scottish Agricultural College, Edinburgh, Great Britain.

Vanderholm, D.H., 1984. "Agricultural Waste Manual". New Zealand Agricultural Engineering Institute Project Report No. 32. NZAEI, Lincoln College.

Wrigley, R., 1993. "Managing Dairy Shed Wastes: Volume Two". Dairy Research and Development Corporation, Victoria, Australia.

# 1.8 EFFLUENT TREATMENT SYSTEMS

## 1.8.1 System selection

In selecting the best system to treat farm dairy effluent, it is important to consider the following:

- **Regional Council regulations**
- **local environmental conditions**
- **cost**
- **labour**
- **maintenance**
- **the views of interested parties.**

**No single system is best for every situation.** Systems need to be adapted to suit individual properties. 'Recipe book' solutions are inappropriate.

All systems can fail, even if that failure is only temporary. **Successful systems are those that are accurately designed, correctly operated and regularly maintained.**

**It is important to obtain reliable information on property requirements and equipment on which to base the system design. For this reason, Regional Council staff, agricultural consultants and effluent specialists or agricultural engineers should be involved from the beginning.**

### 1.8.1.1 Regional Council and District Council regulations

**The effluent treatment system must prevent the pollution of waterways.**

The final destination of treated effluent is either soil or waterways. For this reason, rules are put in place by Regional Councils to protect the environment. **Regional Council regulations need to be adhered to, so that environmental pollution is avoided, and farmers are not faced with fines and legal action.**

When selecting an effluent treatment system, consider its ability to treat effluent to the satisfaction of the Regional Council. Some Regional Councils promote certain systems and discourage others. Furthermore, some systems need to be operated in a specific manner (e.g. buffer distances from public places when applying effluent to land) to be acceptable to Regional Councils.

District Councils often have rules in place for effluent application to land that require set-back distances from property boundaries and/or dwellings. These need to be taken into account when designing a system.

### 1.8.1.2 Local environmental conditions

Local environmental conditions that can limit or promote the success of an effluent treatment system include:

- **soil type**. For example, soils need to be suitable to receive effluent applied to land, and for the successful construction of sealed ponds
- **water tables**. Seasonally high water tables can affect the soil's ability to receive land applied effluent, or the ability of a pond or barrier ditch to retain effluent within its walls
- **topography**. Machinery access is often affected by topography, as is the potential for run-off of effluent applied to land
- **climate**. High rainfall areas may limit the use of land application as a method of effluent treatment for several months over the season. Wind patterns govern the effects of odour on neighbours
- **location of waterways**. The proximity of waterways to a discharging pond or a land application system will affect the siting of the various system components
- **location of neighbours and public amenities.**

### 1.8.1.3 Cost

Farmers require a practical and cost effective method of handling the farm dairy effluent generated by their herds. If too expensive, the incentive to manage effluent properly drops significantly.

**Capital costs** and **ongoing costs** generated by the need for labour, maintenance and borrowed money are important. Costs also arise through Regional Council charges for consent applications, administration, monitoring and penalties if systems fail.

Ongoing costs may be high when capital expenditure is low. For example, the cost of paying vehicle spreading contractors to empty effluent from holding ponds on to land may be comparable to the capital outlay involved when installing a fixed spray application system. Financial returns may be gained with some systems. Dairy farmers are becoming increasingly aware of nutrient management. This has created much interest in systems that return valuable nutrients, contained within effluent, to the land (refer to 2.2.8 Costs and benefits of returning nutrients to land).

### 1.8.1.4 Labour

**To function as it ought, an effluent treatment system must be managed correctly.** The labour involved in the daily running of the system has greatest influence on the management, so it is important that the effluent is easily handled and that the effluent treatment system is simple to operate. The following matters should be addressed:

- who will run the effluent treatment system on a daily basis?
- who will take care of regular machinery and equipment maintenance?
- who will ensure good records are kept?
- are these responsibilities clearly spelled out in job descriptions and fully understood by staff?
- are the conditions of the consent or permitted activity fully understood by staff? (Consider laminating the conditions of the permitted activity or consent and displaying in a prominent place in the farm dairy)
- what staff training is required?
- will the system require so much labour that it is neglected or resented?
- how can the amount of time spent handling effluent be minimised?
- does labour availability in weekends or holidays present a problem?
- what will happen when a breakdown or blockage occurs?
- are there any safety precautions farm staff need to be aware of?

The cost of labour is an important factor. The relative differences in costs for labour, from region to region, can be significant.

### 1.8.1.5 Maintenance

Farmers prefer an option that requires minimum attention and maintenance. This is especially desirable during busy times in the season. The time, labour and finances required for system maintenance can be broken down into daily, regular, and annual commitments.

**Daily maintenance** involves successfully operating and monitoring the performance of the system. Checking the system's operation in view of prevailing weather is an important daily consideration. Applicators may require daily shifting. Information needs to be recorded.

**Regular maintenance** involves cleaning the system, oiling pumps and other machinery, and replacing components. It is sensible to avoid equipment for which spare parts are difficult to obtain.

**Annual maintenance** commitments include cleaning out storage facilities and the administration side of meeting consent requirements from the Regional Council.

### 1.8.1.6 Other interested parties

It is important to take into account information contributed by other interested parties, especially those who may be affected by the proposed effluent treatment system. Any system that can eliminate nuisances such as flies and odours, and the risk of human and animal disease deserves consideration. **When considering any system, it is wise to liaise with neighbours and local iwi.** Neighbours and iwi can have a significant input into the Regional Council planning and acceptance of individual consent applications.

### 1.8.2 System planning and design

When selecting, planning and designing an effluent treatment system, many factors need to be considered so that a practical and cost effective compromise is reached. Figure 1.8-1 outlines the selection, planning and design process.

Systems and practices need to be sustainable. Farmers proposing to install facilities should look beyond the immediate problem and consider the likely long-term consequences before selecting an effluent treatment system. Stop-gap measures are rarely successful.

FIGURE 1.8-1

**EFFLUENT TREATMENT SYSTEM SELECTION, PLANNING AND DESIGN**

**Peak Effluent Volume**
- Calculate the effluent loading at the farm dairy
- Volume of solids and liquids
- Consider future expansion or intensification

**Environmental Conditions**
- Consider climate, soils, topography, water tables and location of waterways

**Regulations**
- Consider Regional Council requirements
- Consider Food Safety requirements
- Consider District Council set-back requirements

**System Options**
- Calculate the effluent loading at the farm dairy
- Land application, ponds, wetlands or a combination of these

**Cost**
- Estimate capital and ongoing costs
- Consider capital investment vs use of contractors

**Labour**
- Estimate labour requirements
- Who will do it? When will it be done?

**Maintenance**
- Estimate maintenance requirements
- Consider cost, time and labour for maintenance

**System Selection**
- Select the most suitable system
- Consider upgrading or adding to existing systems

**Site Selection**
- Select a suitable site for the system
- Consider future system expansion

**System Design**
- Liaise with consultants and Regional Councils
- Liaise with other interested parties

**System Installation**
- Install according to design specifications
- Consider Regional Council requirements

**System Management**
- Operate correctly
- Monitor regularly

**System Maintenance**
- Carry out daily, regular and annual maintenance
- Address system failure promptly

As part of the planning procedure:

- **talk to other farmers** about the advantages and disadvantages of their systems, and about their experiences with designers and contractors
- **consult** Regional Council staff, agricultural consultants and effluent specialists or agricultural engineers
- **consider current farm operations and land uses, and the influence that new works and activities may have on these**
- **determine likely property expansion,** increases in herd size, changes in land use, relocation of the farm dairy
- **consider future residential developments**
- **obtain a plan of the property** (i.e. aerial photograph or plan drawing). Identify waterways, natural drainage patterns and installed drains, prevailing wind direction and soil types
- **assess pollution risks associated with the failure of the system** (i.e. pump breakdown, broken pipelines, surface runoff or subsurface drainage direct to waterways and breached pond embankments).

**Once installed, modifications to the effluent treatment system are invariably costly.** It is vital to obtain reliable data from the beginning on property requirements and equipment on which to base the design (refer to 1.5 Keeping property records).

### 1.8.2.1 Design approaches

Options for collecting reliable information and designing the system include:

- **a 'do-it-yourself' approach where responsibility of accuracy lies with the farmer.** Shop around as prices for labour and materials can vary. Fair costs and a good design will result if there is consultation with equipment suppliers and other farmers who have installed a similar system. Beware of unskilled labour
- **employing an independent designer to obtain design and equipment specifications.** Then farmers can select components for the minimum cost, similar to competitive tendering. The quality and cost will be dependent on the individual designer, but design fees could be 5-10% of the total capital outlay. Farmers should be wary if a very low basic design fee is quoted, as extras for all direct or indirect costs can raise the total bill back to standard levels very quickly (e.g. photocopying, telephone). The consultant will carry the responsibility of the system operating correctly. As with all contracts, these points should be made clear in writing before the work is started
- **machinery and equipment company representatives may act as designers.** In this case the responsibility of ensuring that accurate information is gathered and passed on rests with them. In most cases the design is sound but the equipment specified is tied to the company products, and so choice may be limited.

### 1.8.2.2 Choosing consultants

Guidelines to selecting the right people to do the planning and design work, and supply equipment, include:

- **experience and sound theoretical knowledge** of local soils, pasture growth and engineering
- **suppliers should have a good understanding of their product** including any limitations as well as the strong points
- **the availability of parts** and after-sales service, with prompt service if system breakdown occurs.

**Use www.envirodirect.co.nz** to find machinery and equipment company representatives in your area, as well as system designers (agricultural consultants, effluent specialists or agricultural engineers).

### 1.8.3 Effluent treatment options - a summary

### 1.8.3.1 Land application

A spray application system, made up of a pump, delivery line and applicator, is used to apply the effluent to the land. Effluent can be collected in a sump from the farm dairy and applied directly to pasture. **Alternatively, the effluent can be stored in a holding pond, or an active or disused oxidation pond (if sealed), and applied to land when the soil and climatic conditions are suitable.** This may involve the use of a spray application system, or a vehicle spreader may be employed to apply the effluent several times annually. In most cases, the storage of effluent in holding ponds or oxidation ponds is preferable, as the farmer is able to choose the best time for effluent application. The farmer can then avoid applying effluent to already saturated soils, increasing the risk of runoff to surface water or leaching to groundwater and loss of valuable nutrients.

Once the effluent is applied to land, soil filters the farm dairy effluent and absorbs nutrients. Pasture, micro-organisms and soil animals use the nutrients and organic matter for growth. In certain conditions, volatilisation and denitrification processes can disperse N into the air.

By selecting the appropriate combination of effluent application rates for soil type and subsequent land uses (i.e. pasture or cropping) farmers can benefit from the nutrients and water replaced to the soil.

**Advantages:**

- **minimal effect on waterways if the system is well designed, maintained and managed**
- **it is a preferred method of most Regional Councils as it creates fewer adverse environmental effects**
- **farm dairy effluent has value as a soil conditioner and fertiliser. The nutrient value can offset fertiliser costs**
- **since operation involves passing effluent through soil, it meets Maori cultural requirements for effluent purification.**

**Disadvantages:**

- **land application has a higher capital cost and a higher running cost than pond treatment systems**
- **spray application systems require accurate design, close monitoring, skilled management and regular maintenance.**

### 1.8.3.2 Treatment ponds

**Pond treatment systems comprise two or more sealed ponds in a series.** Effluent is firstly piped to the anaerobic pond from the farm dairy sump. **The anaerobic pond acts like an uncovered septic tank, by separating out solid from dissolved material and depositing a sludge on the bottom of the pond.** Organic material is dissolved and digested, and partially treated effluent is allowed to pass out of the anaerobic pond to the aerobic pond. This effluent can contain up to 70% less BOD than the initial effluent.

Effluent is transported to the aerobic pond via a pipe and baffle. The baffle, commonly a t-piece, prevents the movement of solids between the ponds. **The aerobic pond functions by further anaerobic treatment in the lower pond layer and aerobic breakdown of most remaining organic solids near the pond surface.** In the aerobic pond the amount of disease-causing micro-organisms is significantly reduced and ammonia-N evaporates into the air. Further solid residues settle out as bottom sludge.

From the aerobic pond, effluent may pass through further ponds, be applied to land, pass through a wetland system, or be discharged directly into a waterway. The success of the effluent treatment system is dependent on:

- an adequate oxygen supply
- an adequately sized system and sufficient retention time
- warm temperatures
- an absence of chemical pollutants.

**Advantages:**

- **a simple system to operate**
- **comparatively low construction costs and low maintenance and labour requirement to operate**
- **can readily fit into a larger effluent treatment system (e.g. land application or wetlands) as an initial treatment**
- **storage provision allows flexibility in land application and provides a buffer against flash loadings. Settling of solids occurs so the effluent can be sprayed on using a pump and pipeline or a vehicle spreader.**

**Disadvantages:**

- **inadequate maintenance and poor design have traditionally resulted in poor pond performance**
- **no use made of fertiliser value of effluent unless subsequently applied to land**
- **removal of land from potential pastoral use**
- **major adverse environmental impacts can result from discharging inadequately treated effluent into waterways. Pond systems have the potential to leak effluent to groundwater**
- **many Regional Councils no longer favour pond systems as a sole effluent treatment option and in some regions they are not allowed. Resource Consents are required to discharge to waterways**
- **since pond system operation does not generally involve passing effluent through soil, it may not meet Maori cultural preference for ground purification.**

### 1.8.3.3 Constructed wetlands

**The constructed wetland is designed to further 'polish' effluent flowing from a pond system, before it discharges into a waterway.** The wetland utilises water plants like sedges and reeds, plus air, sunlight, and insect life, to reduce solid waste and take up some plant nutrients.

Since constructed wetlands can handle only partially treated effluent that flows from ponds or barrier ditches, they are not suitable as a stand-alone system in themselves.

The wetland system does not have to be complex. From a pond system or barrier ditches, the effluent can simply flow through a series of channels filled with sedges and rushes.

**Advantages:**

- **well-designed constructed wetlands can remove up to 80% of the BOD and suspended solids of inflowing effluent, 45 to 70% of the nitrogen and, initially, some phosphorus**
- **constructed wetlands may result in zero discharge to waterways due to effluent evaporation**
- **constructed wetlands can be easily added on as an additional treatment to existing systems to substantially improve the quality of pre-treated effluent**
- **constructed wetlands are a lower-cost alternative land application system that are likely to meet Maori cultural preferences for ground purification**
- **they require less ongoing maintenance and continual energy inputs than spray application.**

**Disadvantages:**

- **effluent flowing into a constructed wetland system requires pre-treatment**
- **knowledge of design and function is still evolving**
- **land area is taken up and the wetland may have to cut across existing pasture and fence lines and require new fences to be built around the wetland**
- **time and expertise are required to see wetland plants established successfully**
- **no use made of fertiliser value of effluent.**

#### 1.8.3.4 Barrier ditches

**Barrier ditches consist of three or more ditch sections through which effluent passes before entering a wetland system, or being discharged directly into a waterway.** The widened ditches are usually 3 to 4 m wide and up to 2 m deep and can run a considerable length, this being largely dependent on the size of the herd.

The system works like an extended pond system. **In the first ditch, solids settle out and some bacterial action occurs, breaking down the organic material in the effluent.** Solids are separated from dissolved material, digested and stored as bottom sludge. Partially treated effluent is then allowed passage to remaining ditch sections via a baffle, preventing the movement of solids between the sections.

**In the remaining ditch sections, the effluent is subject to aerobic treatment and further anaerobic treatment.** Solids are separated, dissolved and digested and further residues settle out as bottom sludge. There should be a minimum of three sections, before a discharge into a wetland system or a drain that carries the effluent into a receiving waterway.

**These systems have rarely been found to work effectively and therefore are not encouraged by Regional Councils. They can cause major adverse environmental impacts from discharging inadequately treated effluent into waterways. Any new application to use a barrier ditch method would have to meet conditions for a surface water discharge. These systems are not recommended unless as an initial storage area prior to land treatment.**

### 1.8.4 Further reading


Andrews, J.E., 1991. "Livestock Waste Management System Planning Flowchart". ASAE Paper No. 912538. The American Society of Agricultural Engineers, Michigan, USA.

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