2.9 SPRAY APPLICATION

Spray application involves pumping farm dairy effluent from a storage facility (i.e. farm dairy sump, holding pond or a pond system) through a delivery pipeline and out onto the land via an applicator system.

Applicators distribute the effluent across the land surface. The soil filters the effluent, and the pasture, micro-organisms and soil animals use the nutrients and organic matter for growth.

The basic components of a spray application system are a **stone trap, sump** and **storage facility** (refer to 1.7 Effluent collection and storage), **pump, delivery pipeline** and **applicator** (refer to Figure 2.9-1).

Spray application needs careful planning. It requires a knowledge of the volume and nutrient content of the effluent (refer to 2.2 Fertiliser properties of effluent), the area necessary to handle the effluent effectively (refer to 2.3 Application area) and of local soils and groundwater conditions (refer to 2.4 Application rate). Pump type and size, pipe sizes, paddock layout, applicator type and energy use are additional design parameters.

Spray application systems can be divided into three main categories, the difference being the mode of transportation of the spray application equipment. These are **travelling applicators, stationary applicators, and multiple sprinkler systems.**

Travelling applicators can be powered by a small diesel motor or, more commonly, through water pressure. Self-propelling systems with 'intermittent' or 'continuous' movement are widely accepted.

Stationary applicator systems (i.e. hand-move and end-tow) all involve application to a specific area for a certain period, then the applicator is moved to a new area. This procedure is repeated at set time intervals until the complete application area is treated. The stationary applicator system fails if the applicator is not shifted regularly. Farmers have found this unsatisfactory, especially when other farm duties require time.

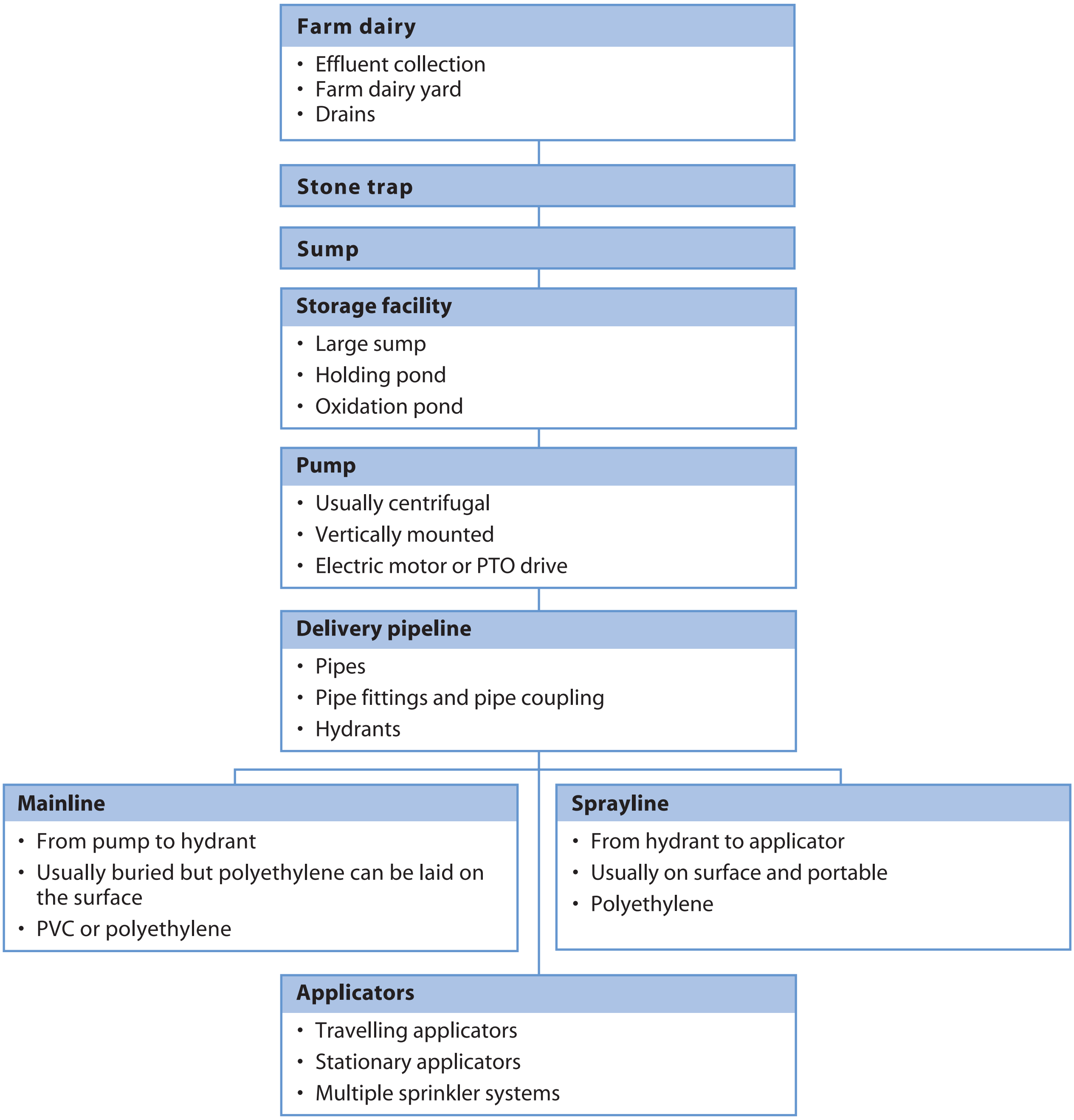
The system can be improved by employing **multiple sprinklers**. Some low-rate sprinkler systems are also available which deliver lower depth or rate of application, suitable for heavier soils or soils with mole and tile drainage.

Effluent can also be injected into an existing irrigation mainline for discharge with irrigation water (refer to 2.9.5 Using an existing clean water irrigation system). However, the solids will need to be screened and there is high potential for nozzle blockages unless suitable nozzles are fitted. Also, backflow prevention is required to avoid effluent entering an irrigation bore or surface water. Separation distances for irrigation to wells and surface water also apply. An effluent gun, nozzle or dripper can also be attached to the side of a centre pivot irrigator. Care is required to ensure effluent is not applied to soils that are already saturated from having just received irrigation.

Good spray application systems create little effluent drift, ensure even application, require minimal manual shifting and are readily expandable.

FIGURE 2.9-1

COMPONENTS OF A SPRAY APPLICATION SYSTEM



2.9.1 Pumps

Pump selection is one of the last parts of the design procedure as it requires knowledge of the pump duty (i.e. required flow rate and operating pressure). Once the quantity of effluent, the peak flow in the system and the final operating pressure are known, an individual pump's performance characteristics can be matched to the system. It is important that cutters are attached to the pump if pumping effluent from feed pads, or if the effluent contains any coarse material.

2.9.1.1 Pump duty

Care should be taken to ensure that a pump is chosen to meet the pump duty, giving the required **flow rate** and **operating pressure** at the design conditions.

There should be some reserve ability if system expansion is likely due to increases in herd numbers or feed pads or stand-off areas being connected to the effluent system (refer to 1.6 Farm dairy management). However, installing an excessively large pump just to 'make sure' will increase the running cost as well as the capital cost.

For most spray applicator systems, the pump should be **no less than 7.5 kW (i.e. 10 hp).**

Flow rate

The flow rate is the **volume of effluent delivered to the application site over time.** It is largely governed by:

- the maximum and minimum allowable velocity within the delivery pipeline. The **velocity should not exceed 2 m/s** to reduce friction losses (i.e. inefficiency) and because of water hammer (i.e. shock pounding within the pipeline when the effluent flow begins and ends), and **should not fall below 0.7 m/s** to prevent settling of solids
- the type of sprinkler used to apply the effluent (refer to 2.9.3.1 Sprinklers)
- the recommended application rates of the soil (refer to 2.4.2 Recommended applications for common soils).

For the majority of systems, pipe nominal diameter will range from 63 mm to 90mm, and the flow rates for the pump duty will range between 7 and 30 m^3/hour (refer to 2.9.2.1 Flow rate).

Operating pressure

The operating pressure is the **pressure the pump needs to generate to effectively deliver the effluent to the application site at the required flow rate.**

The selection of the pump on the basis of operating pressure requires determination of the **Total Head Requirement** of the system. This is found by adding the head losses in the delivery pipeline (refer to 2.9.2.3 Head loss) to the pressure required to drive the sprinklers and vertically lift the effluent (i.e. static head - if there is a difference in height between the pump inlet and the applicator outlet).

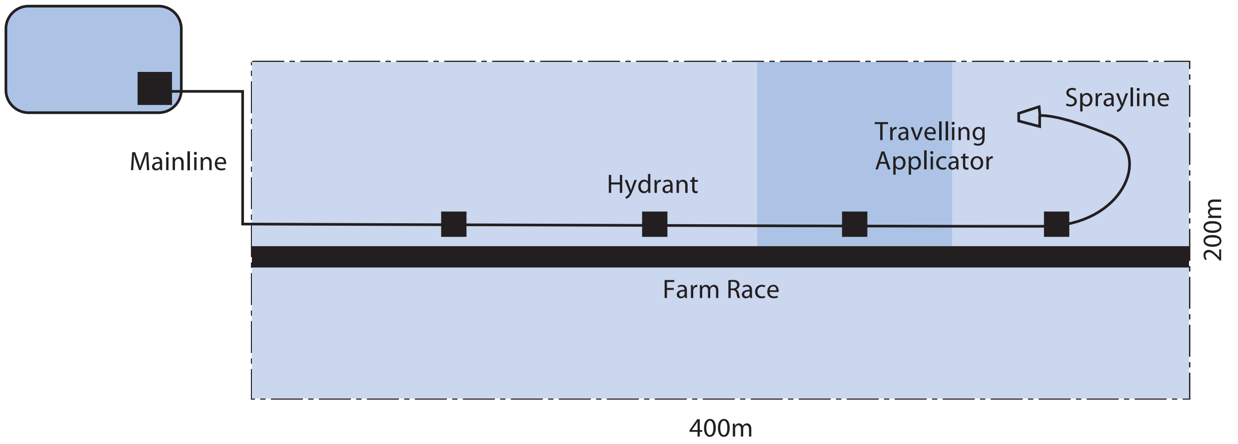
It is usual to add a **10% safety margin** in the design to allow for pump wear and inaccuracies.

The following is an example of this calculation:

Effluent is generated at the farm dairy from washdown water and 200 cows. It is to be pumped from a holding pond and applied to 8 ha of land according to a Regional Council 150 kg/ha/year N application limit. The application site is on clay soil. The holding pond and pump is 50 m from, and 0.5 m vertically below, the application site. A travelling applicator, trailing a 150 m sprayline, is to be used to apply the effluent (refer to Figure 2.9-2 and Table 2.9-1). The expected flow rate in the system is 14 m^3/h.

FIGURE 2.9-2

SPRAY APPLICATION SYSTEM EXAMPLE



From the example:

- Daily Volume of Effluent =200 cows x 50 l/cow =10 m^3 (refer to 1.6.1 Effluent characteristics and volumes).
- Maximum Application on a clay soil type is 18 mm (refer to 2.4.2 Recommended applications for common soils).
- Daily Area for 200 cows = 2 x 280 m^2 = 560 m^2 (refer to 2.4.3.1 Daily area)
- Flow Rate = 14 m^3/h = 4 l/s

TABLE 2.9-1

CALCULATION OF THE OPERATING PRESSURE IN THE EXAMPLE SPRAY APPLICATION SYSTEM PRESENTED IN FIGURE 2.9-2

Mainline head loss @ 4 l/s	400 m of 65 mm PVC Class 'B' (PN6)	60 kPa	6.0 m
Sprayline head loss @ 4 l/s	150 m of 63 mm polyethylene	83 kPa	8.3 m
Hydrant/fittings head loss	24 m equivalent length of 65 mm PVC	4 kPa	0.4 m
Sprinkler working pressure	200 kPa @ 4 l/s with 16 mm nozzles	200 kPa	20.0 m
Static head (i.e. rise/fall)	0.5 m vertical rise in the system	5 kPa	0.5 m
Safety margin of 10%		35 kPa	3.5 m
TOTAL HEAD REQUIREMENT		387 kPa	38.7 m

Note 1: For the delivery line head loss calculation, refer to 2.9.2.3 Head loss.
Note 2: For the hydrant and fitting head loss calculation, refer to 2.9.2.6 Pipe fittings and pipe coupling.
Note 3: For the sprinkler working pressure, refer to 2.9.3.1 Sprinklers.

Therefore, the pump duty requires a flow rate of 14 m^3/hr (i.e. 4 l/s) and an operating pressure of 387 kPa (i.e. total head requirement of 38.7 m).

Pump performance curves

Together, the operating pressure and required flow rate make up the pump duty. To select an appropriate pump, the pump duty can be matched to a pump's performance curves.

Manufacturers provide pump performance data in the form of pump performance curves. These are available from pump distributors.

Most distributors of spray application units recommend standard pump sizes and have a good knowledge of their system's requirements.

Pump recommendations are often based on a flat land example. **If significant rises and falls occur in the delivery pipeline then they must be taken into account.** Hence, every system requires individual attention to design.

2.9.1.2 Pump selection

Pumps used for normal water reticulation are not suitable for pumping effluent. Specially manufactured pumps for dealing with effluent are readily available.

Criteria for pump selection include:

- **closely matched to the required flow rate and operating pressure of the system**
- **seals and bearings designed to withstand the harsh conditions of pumping effluent**
- **cutters when coarse effluent is being pumped (e.g. from feed pad or stand-off areas)**
- **good clearances and appropriate volute and impeller design to minimise blockages**
- **ease of maintenance.** Pumps with an easily removed endplate are practical as they allow easy access to the pump interior for inspection, cleaning and maintenance (refer to Figure 2.9-3)
- **construction from brass,** cast iron or gun metal in preference to mild steel, as effluent can be highly corrosive
- **capital cost**
- **availability**
- **servicing support.**

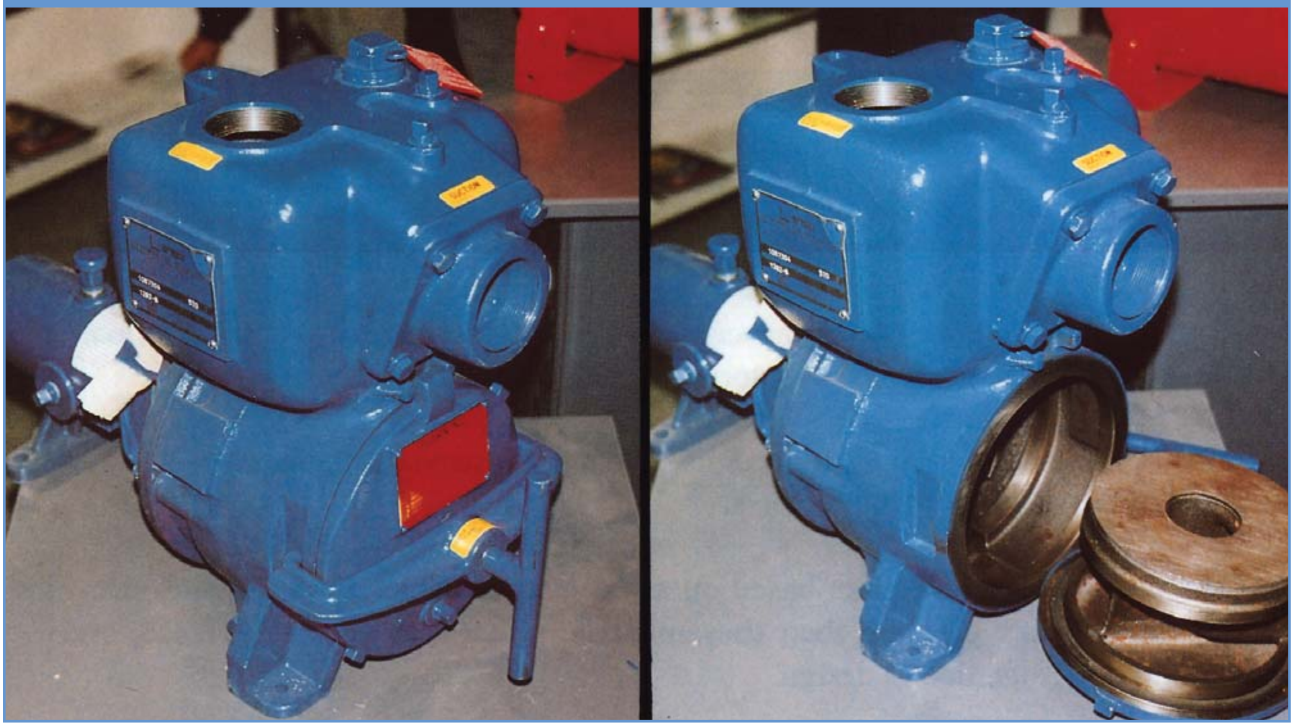
Centrifugal pumps, designed for conveying solids, are best used with spray application systems because of their low maintenance requirements, steady pressure and variable flow capabilities.

Vertical shaft centrifugal pumps with open impellers are excellent both for pumping into ponds and for spray application as they can deal with a high solids content and do not need priming. Horizontal shaft pumps with open impellers are also available. Self-priming models are available. They are more suited to high operating pressure situations (i.e. greater than 600 kPa or 60 m total head requirement) than are the vertical shaft type.

Helical screw rotor pumps are best used for very high pressure systems. These pumps **must have a pressure relief valve.**

FIGURE 2.9-3

EASY DISASSEMBLY FOR MAINTENANCE



2.9.1.3 Pump seals

Pump seals are the components most subject to wear. Failure of seals can cause:

- bearing exposure to the effluent resulting in **bearing failure**
- pump leakage resulting in **decreased pump performance** and possible **effluent overflow to waterways.**

Seals should be checked regularly. Tungsten seals are preferable to the rapidly wearing rubber and carbon seals.

FIGURE 2.9-4

VERTICALLY MOUNTED CENTRIFUGAL PUMP

FIGURE 2.9-5

A PUMP AND PONTOON SYSTEM

2.9.1.4 Pump installation

Options for pump installation include the conventional centrifugal layout with suction draw from a sump or pond. Such pumps need to be primed before starting as they are located above the source of liquid. The t**otal lift should not be greater than 6 m,** and preferably less.

A vertical shaft centrifugal installation is the most popular. Figure 2.9-4 shows such an installation. The pump and motor are supported on a sturdy frame. Probes switch the motor on and off as the effluent level in the sump rises and falls. Float switches are more commonly used to control pump operation.

Submersible pumps may also be used.

Pumps and motors need to be set on a firm base and **care should be taken to keep the pump and the motor in proper alignment.** Close-coupled pumps and motor on a common base are preferable because mounting and aligning problems are avoided at installation.

Pumps operating in a pond or large sump are best seated on a floating pontoon so the pump is positioned centrally in the storage facility. The pump will rise and fall in the pond or sump depending on the effluent level. Manufactured floats are available or it is possible to build your own (refer to Figure 2.9-5).

Care should be taken to ensure that the float is stable and accessible for pump maintenance. In some cases a walkway is attached to the pontoon for ease of access.

2.9.1.5 Strainers

FIGURE 2.9-6

STRAINER

Although special pumps and pipes are manufactured for effluent reticulation, solids need to be caught by a strainer to prevent them from moving through the pump and delivery pipeline system.

The strainer is placed on the suction pipe feeding the pump. Figure 2.9-6 shows a strainer that screws on to the suction pipe.

The strainer size is determined by the smallest apertures in the pump and sprinkler system.

For example, a 12 mm gauge strainer would be required for a spray application system using 16 mm nozzles.

The strainer should not be placed too close to the pump or be of too small a gauge, because flow to the pump through the suction end and liquid velocities may be impeded.

For most systems, **a strainer gauge of 10 or 12 mm should be used.**

Strainers may be galvanised, or made of stainless steel or plastic. Regardless of the material strainers will need occasional cleaning, the regularity depending on the solids load of the effluent.

2.9.1.6 Pump drive

Sumps and ponds can be pumped out using:

- an electric motor-driven pump. These are the most popular and practical choice. Compared with an internal combustion engine the efficiency of an electric motor is much higher. There is also the benefit of not having to constantly refuel and maintain the motor
- a **tractor-driven (i.e. PTO)** pump. The major disadvantage of using a PTO driven pump is that the tractor is regularly out of commission for other farm work. Care should be taken when backing close to ponds. If the pond bank slope is too great, the oil in the tractor engine sump may fall away from the oil pump and front pistons, and the engine may be damaged
- a **diesel motor-driven** pump. This is impractical with most systems because of servicing reasons and because the motor cannot be easily operated on a pontoon. However, larger farms or contracting operations may find a diesel motor-driven pumping system beneficial.

2.9.1.7 Pump power supply and switching

Three-phase motors should always be used where a 400 volt three-phase supply is available.

Check with the local power authority on the availability, cost and regulations surrounding bringing three-phase power to the proposed pump site. Existing power lines and transformers may need upgrading. Quotes for such work should be obtained.

If only single-phase power is available, the motor will be more expensive for the same power rating. Pump installations requiring up to 7.5 kW (i.e. 10 hp) can be served by single-phase motor drives.

In some regions, it may be worthwhile having the system operating on night power because of low tariff rates. A drawback to night operation is that there is less chance of noticing system failure.

The electric pump motor may be controlled by:

- a **direct relay,** operated by the farmer at the farm dairy
- **timers** fitted to pump systems to allow the system to operate at set times and then shut down automatically. This is most practical for pumps resting on a pontoon as float switches and probes cannot be used
- a high effluent level cut in and low level cut out system using **probes or a float switch.** This will ensure that the pump turns on and off at a predetermined effluent level. Float switches or probes should be installed so that adequate storage is left beyond the high and low range in case of pump failure

- a **switch automatically activated by the washdown system** so that when the latter is turned on the sump pump starts up also. When the sump is relatively small, it is important that the sump pump is larger than the farm dairy washdown pump or the sump will overflow.

2.9.1.8 Pump protection

The pump, together with the spray applicator, is the most expensive component of the spray application system. Therefore, adequate protection is vital to reduce the possibility of damage to the pump.

Avoid pumping directly out of the small farm dairy sump, as solid material will wear the internal pump components. Although manufacturers claim that their pumps can move coarse material, the question is: "For how long?" **Pumping out of larger sumps, holding ponds or oxidation ponds, to allow for settling of coarse solids, is recommended.**

If the pump is feeding downhill, a vacuum breaker must be installed to prevent siphoning of the sump or pond once the pump has stopped operating. It will also reduce the risk of pipeline collapse.

Other installation points to be considered are:

- **small ventilated removable enclosures should cover the pump and motor.** Plastic drums or large buckets are adequate for pump protection. Avoid metal covers
- **all electrical equipment should be housed** in a weather proof and animal proof enclosure. Dangerous equipment should be housed in a lockable enclosure
- electrical equipment is best placed as close as practical to the pumping equipment and **above flood level** and **above sump overflow level**
- keep the control board simple and accessible for basic maintenance (i.e. cleaning and repair)
- have a list of pump switching, operating and cleaning instructions conveniently displayed
- all wiring and equipment must comply with the Electrical Wiring Regulations and Codes of Practice, and supply authority requirements.

FIGURE 2.9-7

WELL HOUSED AND FENCED ELECTRICAL EQUIPMENT

Figure 2.9-7 shows a pump and electrical components sensibly installed. The electrical equipment is above flood level, enclosed and fenced off.

Electric motor overloading may occur when the pump is working with low pressures, such as when the applicator is operated at close proximity to the pump **or** is operated on land situated at a lower level than the pump. **Ensure that the pump is fitted with the correct motor for non-overload characteristics.**

To resolve an existing problem, a larger electric motor size can be used or the size of the pump impeller can be reduced.

Pump monitoring equipment and safety systems are also essential:

- **safety cut outs should include a pressure switch.** A pressure switch will turn off the pump if pressure builds up in the delivery pipeline due to blockages. A no-flow cut out (i.e. flow switch) is also practical, as such a condition can occur if the pump loses its prime
- a **lightning arrester**

- all motors should be fitted with **overload protection.** Overload switches detect any rise above normal current flow, then trip the switch shutting off power to the motor. With combustion engines, shut-down devices need to be provided to stop the motor, if engine temperatures are too high, oil pressure falls, there is a loss of delivery pressure due to mainline breaks or bursts, or there is a loss of suction pressure due to the pump losing its prime.

It is advisable to note the power meter readings. This will give a long-term assessment of the pump's performance. A notable increase in power consumption over time indicates the onset of pump bearing problems, blockages or shaft binding.

2.9.2 The delivery pipeline

The delivery pipeline is made up of a:

- **mainline** which takes effluent from the pump to hydrants at the application site
- **sprayline** which feeds the applicator from the hydrants at the end of the mainline. Sometimes it is possible to have a sprayline feeding directly off the pump.

The mainline is best placed along the fence line so that it is away from machinery when cultivating and can service spraylines in two adjacent paddocks (refer to 2.9.2.10 Sprayline).

The delivery pipeline ideally should be laid on a **steady grade** between hydrants. Avoid sharp bends and always operate as an open ended system (refer to 2.9.3.2 Travelling applicators – System set up).

To determine the pipe sizes and classes for the delivery pipeline, the following must be known:

- **system flow rate**
- **system operating pressure**
- **pump performance**
- **sprinkler nozzle characteristics (refer to 2.9.3.1 Sprinklers)**
- **available pressure to overcome head loss**
- **pipe length** and the **pipe's internal bore.**

2.9.2.1 Flow rate

With PVC pipe in particular, it is desirable to **keep velocities below 2 m/s** to reduce friction losses and water hammer. It is also important to **keep velocities above 0.7 m/s** to prevent solid settlement (refer to 2.9.1.1 Pump duty).

Since, for the majority of systems the minimum delivery pipe bore is 63 mm or 75 mm, the following range of flow rates for the delivery pipeline are recommended:

- nominal diameter 63 mm - **7 to 15m³/hour** (i.e. 2.0 to 4.2 l/s)
- nominal diameter 75 mm - **10 to 20m³/hour** (i.e. 2.8 to 5.6 l/s)
- nominal diameter 90mm - **15 to 35m³/hour** (i.e. 4.2 to 9.7 l/s).

When calculating the velocity within the various sections of the delivery pipeline, it is necessary to know the pipe's **internal bore** rather than pipe's **nominal diameter** (i.e. advertised bore). Table 2.9-2 gives the internal bores for pipe commonly used in spray application systems.

TABLE 2.9-2

INTERNAL PIPE BORES FOR PVC AND POLYETHYLENE PRESSURE PIPE

PVC (Class B or PN6)		Polyethylene (PN8)	
Nominal Diameter (mm)	**Internal Bore (mm)**	**Nominal Diameter (mm)**	**Internal Bore (mm)**
65	71	63	57
80	83	75	66
100	107	90	79

Note: Internal bores are for Class B PVC pressure pipe and medium density PN8 polyethylene pipe.

Sometimes an internal bore will be greater than the advertised nominal diameter. Pipe sold on the basis of nominal diameter should be checked to ensure that the internal bore is appropriate. Do not mistake the nominal or outside diameter for the internal bore.

Avoid elbow fittings in the pipe system. Since effluent contains a large percentage of solids, flow is seriously restricted by elbow fittings.

2.9.2.2 Operating pressure

The 'Class' of pipe refers to the ability of the pipe to withstand internal pressure. It is the pressure rating of the pipe (refer to Table 2.9-3).

TABLE 2.9-3

PIPE CLASSES FOR VARIOUS SYSTEM OPERATING PRESSURES

Pipe Classes		Pressure	Head
Old Inch	**New Metric**		
Class B	PN6	600 kPa or 85 psi	60 m
Class C	PN9	900 kPa or130 psi	90 m

Note: Classes are for PVC pressure pipe and medium density polyethylene pipe.

The 'Class' of pipe required depends on both the **operating pressure** and the **static head** of the system, as the pipe must be able to withstand this.

In the example (refer to 2.9.1.1 Pump duty), the operating pressure (i.e. including the static head) was 387 kPa. Therefore, from Table 2.9-3, Class B (PN6) pipe able to withstand 600 kPa, could be selected.

The design pipe pressure rating for systems on hilly land may need to be increased if there is a significant fall in the delivery pipeline from the pump to the application area.

Effluent is usually pumped at relatively low pressure (i.e. up to 600 kPa or 60 m head). Therefore, **Class B (PN6) pipe is generally suitable,** although a lot of people prefer to install a PN8 polyethylene pipe or a Class C (PN9) PVC pipe due to its thicker wall and lower risk of failure.

2.9.2.3 Head loss

As water flows along a pipe, friction causes a continuous drop in pressure, called the **head loss**. The head loss depends on the pipe size and type, and the water flow rate. It occurs irrespective of the slope of the pipe.

Doubling the pipe bore reduces the head loss 32 times. Therefore, when comparing the different pipes it is more important to look at the pipe head loss for the **pipe bore** rather than to select on the basis of pipe material. Pipes with an internal bore that is too small for a given pump and flow rate will cause high friction losses and inefficiency. Overly large internal bore pipes may allow settling out of the effluent solids, or the pump motor may become overloaded due to low pressures.

Manufacturers provide tables and graphs giving the head loss for various pipes and sizes, and for different flow rates using clean water. Table 2.9-4 gives typical head losses for clean water for pipe types commonly used for effluent application systems. The viscosity of the effluent being pumped will determine pipe head loss.

TABLE 2.9-4

HEAD LOSS WITHIN CLASS B PVC AND POLYETHYLENE PRESSURE PIPE									
Pipe Type		**Head Loss (m) per 100 m of Pipe at Varying Flow Rates**							
Material	**Diameter (mm)**	**1 l/s ($3.6m^3$/hr)**	**2 l/s ($7.2m^3$/hr)**	**3 l/s (10.8 m^3/hr)**	**4 l/s (14.4 m^3/hr)**	**5 l/s (18.0 m^3/hr)**	**6 l/s (21.6 m^3/hr)**	**7 l/s ($25.2m^3$/hr)**	**8 l/s ($28.8m^3$/hr)**
PVC Class B, (PN6)	65 80 100	0.2 0.1 0.1	0.5 0.2 neg.	0.9 0.4 0.1	1.5 0.7 0.2	2.3 1.1 0.3	3.2 1.5 0.5	4.2 1.9 0.6	5.3 2.5 0.7
Polyethy-lene (PN8)	63 75 90	0.5 0.2 0.1	1.4 0.7 0.3	3.3 1.3 0.6	5.5 2.2 0.9	8.0 3.3 1.4	13.0 4.6 1.9	- 6.0 2.5	- 7.6 3.2

Note: Head loss values are for Class B PVC pressure pipe and medium density PN8 polyethylene pipe.

In the example (refer to 2.9.1.1 Pump duty), the mainline head loss is 6 m for 400 m of 65 mm PVC pipe at a flow of 4 l/s (i.e. 1.5 m head loss per 100 m = 6 m head loss for 400 m), and the sprayline head loss is 8.3 m for 150 m of 63 mm polyethylene pipe at a flow of 4 l/s (i.e. 5.5 m head loss per 100 m = 8.3 m head loss for 150 m).

For recommendations of pipe sizes for spray application systems refer to 2.9.2.8 Buried mainline, 2.9.2.9 Surface mainline and 2.9.2.10 Sprayline.

2.9.2.4 Pipe length

The proposed pipe route should be drawn on an aerial photograph or surveyed plan, together with the location of all hydrants and areas to be serviced. From there, the most practical route for the delivery pipeline can be established where:

- the least amount of pipe is used
- the line is of least hindrance to other farm activities
- room for expansion is possible.

Calculate the scale from a photograph by measuring the distance between two well-defined points along a suitable fence line and compare this with the actual distance. Survey drawings will have the scale recorded.

The length of the delivery pipeline sections can be scaled from the photograph or survey drawing using a ruler.

After the design has been agreed upon, a more accurate measurement of the delivery pipeline may be made using a land wheel.

It is recommended that a level survey be carried out after the route has been established.

2.9.2.5 Pipe materials

Critical factors in deciding on the pipe material are:

- **size -** both bore and length
- **cost**
- **ease of laying and jointing**
- **pressure rating**. Class B (PN6) pressure rated pipe can be used in the majority of mainline situations although a large number of people prefer to use PN8 or Class C (PN9) due to its thicker wall and lower risk of failure.

Pipe materials for mains and the sprayline are generally PVC and polyethylene (i.e. alkathene).

PVC pipes are normally supplied in 6 m lengths with socket ends ready for solvent cement joining **or** rubber ring joining at a slightly increased cost.

PVC is usually buried so that it is not subject to heat, UV light and stock damage. PVC will tend to expand when heated and the pipeline joints may be damaged. Although it is normal to trench PVC pipe, sizes up to 80 mm can be mole ploughed.

The requirement for joining and burying PVC in trenches increases the labour needed for installation. However, the rigid nature of PVC makes it preferable where the pipeline comes above ground to form hydrant assemblies and head works.

The approximate costs of cement joined PVC and polyethylene pipe are shown in Table 2.9-5.

Rubber ring joined PVC is available only for 80 and 100 mm bore pipe, and costs approximately $0.67 per metre more than cement-joined PVC. However, rubber ring joining is preferable to cement joining (refer to 2.9.2.6 Pipe Fittings and Pipe Coupling).

It is well worth obtaining quotes. With greater lengths the prices can often be discounted.

The relative cost of fittings also needs to be considered.

TABLE 2.9-5

COSTINGS OF PVC AND POLYETHYLENE PRESSURE PIPE (Not installed)

PVC		Polyethylene	
Nominal Diameter (mm)	**Approximate Cost ($/m + GST)**	**Nominal Diameter (mm)**	**Approximate Cost ($/m + GST)**
65	5.55	63	4.20
80	7.12	75	6.82
100	10.02	290	8.60

Note 1: Prices are for Class B PVC pressure pipe and medium density PN8 polyethylene pipe.
Note 2: The price of PVC is given per metre for comparison, although it is actually sold in 6 m lengths

Polyethylene specifically manufactured for effluent reticulation comes in 50 m and 100 m lengths. Polyethylene is available at low, medium and high density. Polyethylene has greater flexibility than PVC. Contractors often have specialist equipment that can plough polyethylene into the ground, and so burying a polyethylene mainline is cheaper than trenching PVC.

Polyethylene pipes are best used in regions where there is ground movement or exceptionally cold seasonal temperatures. The flexibility of the polyethylene and the nature of the fitting system make it largely unaffected by cold temperatures. PVC has a tendency to freeze and cold temperatures can damage the pipe.

Lightweight polyethylene portable pipes, with slip joining connections, are ideal for the sprayline (refer to 2.9.2.10 Sprayline).

All pipe used must be made to approved standards, acceptable in New Zealand. New Zealand standards for both PVC and polyethylene pipe include NZS 6701: 1978, NZS 7602: 1977 and NZS 7684. Many pipes and fittings available in New Zealand are manufactured to British or Australian standards.

2.9.2.6 Pipe fittings and pipe coupling

Pipe fittings include joins, valves, end plugs or caps, tees and swept bends. Wherever possible, **avoid using 90-degree elbows** and **avoid having dead ends in the system.** These will impede flow, and may result in solids build-up and system blockage. The system must always operate as an open ended system, with all flow being directed to the sprinkler or nozzle outlet.

Pipe fittings cause a relatively high head loss. In order to allow for this, the various fittings are converted to an equivalent length of straight pipe, from manufacturer's tables, and added to the length of the delivery pipeline. The head loss for the total length of pipe is then calculated for system design purposes. **The head loss caused by the hydrants and fittings should not exceed 5% of the delivery pipeline head loss.**

Table 2.9-6 gives the head loss through various pipe fittings, in terms of equivalent length in metres of straight pipe.

TABLE 2.9-6

PIPE FITTINGS IN TERMS OF EQUIVALENT LENGTHS (m) OF STRAIGHT PIPE FOR HEAD LOSS CALCULATIONS

Pipe type		Fitting type				
Material	**Diameter (mm)**	**45º Swept bend**	**90º Swept bend**	**Tee piece**	**Gate valve**	**Reducing coupling**
PVC	65	0.7	0.8	5.0	0.8	2.0
	80	0.8	1.0	5.9	1.0	
	100	1.0	1.3	7.6	1.3	
Polyethylene	63	0.5	0.6	3.7	0.6	1.5
	75	0.6	0.7	4.4	0.7	
	90	0.7	0.9	5.3	0.9	

Note 1: Equivalent lengths are given in metres and calculated using internal bores and f = 0.017.
Note 2: 'Bend' fittings are not available for polyethylene pipe. Equivalent length values are given for situations where the flexible pipe is bent to a 45° or 90° turn.

In the example (refer to 2.9.1.1 Pump duty) five gate valves, three reducing couplings and eighteen 90° swept bends were used along the 65 mm PVC mainline. This is equivalent to 24 m of straight pipe according to Table 2.9-6 and the following calculation:

Gate valve 5 x 0.8 m

Reducing coupling 3 x 2.0 m

90° Swept bend 18 x 0.8 m

Total equivalent length 24 m

Therefore, from Table 2.9-4, the hydrant and fitting head loss is 0.4 m (i.e. 1.5 m head loss per 100 m = 0.4 m head loss for 24 m).

The best couplers for polyethylene pipe are **camlock joints** as they are readily snap joined and disconnected (refer to Figure 2.9-8 Camlock Fittings on Polyethylene Pipe). Coupling systems should be flexible to cover uneven ground. **Lie-flat hose** is popular at hydrants and at connections to the applicator because of its flexibility (refer to Figure 2.9-9).

Where two sizes of pipe are joined, it is preferable for effluent to flow from the large pipe into the small pipe.

FIGURE 2.9-8

CAMLOCK FITTINGS ON POLYETHYLENE PIPE

FIGURE 2.9-9

FLEXIBLE LIFE-FLAT HOSE AND CAMLOCK CONNECTORS

When drilling holes into PVC pipe (i.e. in order to fix connector fittings) do not create a hole more than half the bore of the pipe (refer to Figure 2.9-10). Drilling into PVC will weaken it substantially. Remember that holes drilled are actually oval due to the cross-sectional shape of the pipe so it may be difficult to obtain a good seal.

There is a trend towards using rubber-ring joints rather than using glue to join PVC pipes. Sleeving pipes is also practical. Both sleeving and rubber ring joining allow for pipe expansion and contraction.

FIGURE 2.9-10

DRILLING INTO PIPES