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# Planning Animal Waste Disposal Systems

Extension Circular 763 May 1971

COOPERATIVE EXTENSION SERVICE
OREGON STATE UNIVERSITY, CORVALLIS

# Foreword

Pollution is associated with agriculture as well as industry. Animal waste disposal will become more costly in the future because there will be more animals per farm and fewer acres on which to put waste material. To safeguard the public interest, livestock producers need financial assistance to control water pollution.

Livestock operators and dairymen should plan for the future when designing facilities to handle animal wastes. Before undertaking any construction dealing with the handling, storing, and disposing of animal wastes, livestock operators should consult the County Extension Agent about legal restrictions.

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# Planning Animal Waste Disposal Systems

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Water is water, waste is waste, and the two should never meet. This seems to be the basic interpretation of various state pollution laws as related to animal wastes. Keeping wastes and water resources separated is of utmost importance. Prevention of contamination of surface and underground water supplies is paramount. Such supplies include water in wells, ponds, lakes, streams, and springs.

Pollution from animal wastes is a relatively new but rapidly expanding threat to water resources and requires the close attention and cooperation of many people. Waste management technology has been lagging behind the rapid growth of the livestock industry. The recent increase in concentrated feeding operations and the proximity of them to residential areas has brought about the immediate need for solutions to both water pollution and odor problems. The cost of collection, storage, treatment, and disposal of animal wastes becomes an important cost of animal production.

Animal wastes have been shown to be a major source of surface water pollution in some areas and have been implicated in some cases of ground water pollution. Untreated animal wastes can transmit animal and human diseases.

The trend toward increasing animal feeding in close confinement will create greater concentrations of wastes of greater pollutional nature as the feed rations slowly change to feeds that contain less roughage and more biodegradable material. At the present time approximately 50 to 75 percent of the nitrogen ingested by livestock is excreted. Methods of handling the wastes may affect air, water, and soil quality, as well as offend the sensitivities of area residents. This publication is intended to assist stockmen in recognizing potential pollution problems. It suggests measures to aid in meeting regulations with a minimum cash outlay. Several groups and agencies have interests and responsibilities in meeting the objectives of proper animal waste disposal. Unfortunately, no simple or separate solution to animal waste disposal is at hand.

## Problem Situations

Animal wastes are essentially solid material, with some water. Although runoff may dilute animal wastes, the concentration of pollutants in the runoff is of much greater potency than domestic sewage.

It has been estimated that if conventional processes used for municipal wastes were applied to animal wastes, a dairyman would pay about $200 per cow per year for waste treatment. This figure is unrealistic when applied to animal production facilities.

Until animal wastes enter ground or surface waters, they seldom create a serious water pollution problem. Runoff from confinement areas and from land used for disposal of the wastes can occur during and following rainfall or excess application of waste by the sprinkler method.

In some areas winter flooding of farm land makes it difficult for farmers to dispose of animal waste. A combination of extra storage capacity in holding tanks and distribution of manure on higher ground can usually assist in solving the problem.

Flies can be a nuisance in and around animal production and waste handling facilities (Figures

Figure 1. Rain-saturated field, plus liquid manure application, caused accumulation at lower end of field.

2 and 3). According to California research by Smith, Black and Hart in 1960, fly production can be partly controlled by covering the piles with at least three inches of dried manure or with a plastic tarpaulin. Screening of manure area will also help. Pollution of ground waters from manure holding pits, lagoons, or storage pits for stock feed must be avoided (Figure 4).

Livestock confinement operations must be separated from public water courses to prevent water pollution. Where there is open range grazing, the animals are allowed free access to public waters only if the water source is not used by a community for its domestic water supply (Figure 5).

Figure 2. Handling manure by hand is tedious. In addition, the concentrated mounds can cause fly problems and may contribute to a high nitrate concentration of ground water which may be used for domestic purposes.

Figure 3. Piling of animal wastes in fields is a potential fly hazard, can create objectionable odors, and is unsightly. Spreading on fields provides better benefits from fertilizer elements.

Figure 4. High-pressure liquid manure pump operated by tractor, PTO. Liquid is pumped to a large-capacity revolving sprinkler for final distribution on fields. This open pit received material from the feeding and milking areas. The crusted layer complicates proper agitation prior to pumping into pipe line. Also, the crusted top is a potential area for fly breeding if not handled properly.

Figure 5. Scattered livestock, not large confined herds, have free access to streams unless the stream is the source of a community water supply. However, diseased animals can infect other livestock and humans who swim in the stream. Water for livestock drinking purposes can be pumped to watering troughs or tanks.

## Methods of Handling Animal Wastes

The most practical method of animal waste disposal is application on the land. This can be done by irrigation, tank wagon, manure spreader, or by direct incorporation into the soil. Two of these methods are illustrated in Figures 6 and 7.

Land application has been used primarily to recover the nutrient content of wastes and to increase crop production. However, on many farms, the value of nutrients contained in manure does not offset the investment and labor required to give it the special handling necessary. According to the Agricultural Research Service and others, the average value of manure ranges from 2-4 dollars per ton, while the cost in time, labor, and equipment needed to move it from origin to final disposal could run as high as $6 to $8 per ton. Even so, it is suggested that land disposal of animal wastes is one of the least expensive methods of disposal.

Figure 6. An electric-powered chopper-type pump installed on liquid holding tank for distribution by the sprinkler method. Pump has a built-in agitation system. An electric fence is used around the tank area to keep animals away from the pump and tank opening.

Figure 7. Distributing liquid manure under pressure on field.

The wastes maintain and improve the soil and increase its water-holding capacity. Table 1 shows the fertilizer value of liquid manure.

Tests at Wisconsin have shown that up to 60 percent of the nitrogen in fresh manure spread daily is lost within four days if the manure is not worked into the soil at once.

The question can then be asked: How much manure can be applied on land? The manure management project in Washington State, which is financed by the Health, Education, and Welfare Department (HEW), has been making such studies in consideration of nitrate accumulation in soil and plants. The work is conducted on typical bottom land adjacent to a major river[1].

A progress report on the Monroe project reveals that soil structure is the key to the amount of manure that can be applied. Research work shows that approximately 100-150 pounds of nitrogen per acre is adequate to reinforce soil N to get good crop production and that perhaps 200-300 pounds of N can be utilized by high-yielding crops like corn silage. In one test 1,550 pounds of N, as manure, was applied per acre and caused faster corn growth than 400 pounds of commercial N. The manure was applied through sprinklers until the soil was completely saturated and puddling. This level killed clovers, but rye grass recovered excellently and corn sprouted and grew well a month later.

From this is was concluded that manure can be applied at one time to the point of direct run-off. Repeated applications of this amount (1,550 pounds of N as manure) eventually would result in build-

[1] The manure management project is located near Monroe, Washington, and the land borders the Snoqualmie River.

**Table 1. Average Amounts Fertilizer in Manures from Different Farm Animals***

| Kind of manure | Percent water | Pounds per ton of manure | | |
|---|---|---|---|---|
| | | Nitrogen | Phosphorus | Potassium |
| Chicken— | | | | |
| a. From dropping boards without litter | 54 | 31.2 | 8.0 | 7.0 |
| b. With old floor litter | 61 | 33.8 | 12.4 | 12.8 |
| Dairy cattle | 79 | 11.2 | 2.0 | 10.0 |
| Fattening cattle | 80 | 14.0 | 4.0 | 9.0 |
| Hog | 75 | 10.0 | 2.8 | 7.6 |
| Horse | 60 | 13.8 | 2.0 | 12.0 |
| Sheep | 65 | 28.0 | 4.2 | 20.0 |

* From Michigan State University Circular Bulletin 231, 1961

up of total dissolved salts in underground water.

Before the final application of wastes is made on the land, however, careful planning for collecting, handling, and storing is important. To determine the storage requirements, the amount of manure produced per animal needs to be known. Table 2 shows the approximately daily manure production of farm animals.

The volume of manure produced per animal per day varies with the size of the animal and the quantity and quality of feed consumed. In regard to dairy cows, when using the figures in Table 2, add 3 gallons per day per cow for washing of holding and milking areas. If a flush system is used to clean the alleys, add 25 gallons per cow per day to the figures given in Table 2.

Some specific waste handling methods being used are:

**1. Dry or semi-solid**

This contains about 20-30 percent dry matter and is common in feedlots, drylot dairy and many poultry operations. In dry climates this is successful. The manure is loaded on spreader trucks and hauled to the fields. Dry corral waste accumulation sometimes is sacked and sold as fertilizer to gardeners and landscape contractors.

**2. Semi-liquid**

This slurry contains about 10-20 percent dry matter and is common in dairies. Normally under these conditions the waste is scraped into a holding tank. When the tank is full, it is agitated and then hauled in manure wagon onto the field. Vacuum-type pumps are commonly used to fill the wagon tank.

**3. Liquid manure**

It contains less than 10 percent dry matter. This is manure with water added to create a thin slurry. The flush systems of clearing alleyways and holding pens are in this category (Figure 8). Generally this manure can be handled by irrigation sprinklers designed for liquid manure handling.

Figure 8. A flush-down manure removal system.

**Table 2. Average Manure Produced Per Animal Per Day**

| Animal | Weight in pounds | Gals. per day (solids & liquid) | Cubic ft. per day | No. animals to produce 1 ton |
|---|---|---|---|---|
| Horse | 1000 | 5.25 | 0.70 | 46 |
| Beef | 500 | 5 | 0.67 | 48 |
| | 800 | 7 | 0.93 | 34 |
| | 1000 | 8.5 | 1.13 | 28 |
| | 1200 | 10 | 1.33 | 24 |
| Dairy | 800 | 10 | 1.33 | 24 |
| | 1000 | 12 | 1.60 | 20 |
| | 1200 | 14 | 1.87 | 17 |
| | 1400 | 16 | 2.13 | 15 |
| Hogs | 50 | 0.5 | .067 | 500 |
| | 100 | 1.0 | .133 | 250 |
| | 150 | 1.60 | .213 | 160 |
| | 200 | 2.10 | .28 | 120 |
| | 250 | 2.60 | .35 | 97 |
| Poultry | | | | |
| Fresh Manure (75-80% moisture content) | 5 | .046 | .0062 | 5,300 |
| Sheep | | 0.40 | | 600 |

To operate a liquid manure sprinkling system properly, the manure slurry should have a dry matter content below 6 percent. The reasons for the use of a thin slurry are primarily to reduce intake and discharge nozzle clogging and to reduce pipe and pump friction losses. Table 3 shows the amounts of water that must be added to manure to thin it to a dry matter content of 5 percent, which is desirable for irrigation application of liquid manure.

**Table 3. Reducing Manure Dry Matter Content Below 5% Addition of Water**

| Dry matter content of manure | Gallons of additional water needed per gallon of manure |
|---|---|
| 30% | 5 |
| 20% | 3 |
| 15% | 2 |
| 10% | 1 |

### 4. Lagoons

Lagoons have had varying degrees of success. One reason is that climate influences the effectiveness of lagoon operations.

In the case of aerobic lagoons, however, land requirements are usually the limiting factor. The high oxygen demand associated with animal wastes requires extremely large surface areas and volumes. A confinement unit holding 1,000 head of beef cattle would require an oxidation pond of at least 40 acres; a unit of 1,000 hogs would need a pond of at least 10-20 acres. The size of the lagoon could be reduced by addition of aeration equipment.

Adequate land areas may be available when confinement feeding is far from urban areas. There has been a strong trend, however, to develop confinement feeding operations near communities, and operators are cautioned to carefully investigate current regulations before starting construction. Land values are higher nearer communities, and operators must realize that odors and other nuisances will not be tolerated.

Anaerobic lagoons offer considerable potential for handling and treating concentrated animal waste with its high solid and low water content. Anaerobic lagoons can be used as a controlled biological unit, as a holding unit prior to land disposal, to control runoff from confinement areas, or any combination thereof.

In general, the purpose of anaerobic lagoons is the removal, destruction, and stabilization of organic matter and not water purification. They can and are used as primary settling units to reduce the load on subsequent treatment units; however, they differ from conventional sewage treatment units in that the settled solids are not routinely removed but are left in the unit to degrade. Solids will gradually build up, the rate depending on the solids loading rate and type of manure as well as the rate of solids stabilization. Periodic solids removal will be necessary.

The high solids content and high oxygen demand of animal wastes indicate that anaerobic biological systems can be successful. The recommended design loading rate over the United States for anaerobic lagoons for hog manure varies from .001 to .01 pounds of volatile solids per cubic foot of lagoon per day. A good loading rate for hogs for the Northwest might range from .006 to .01 pounds of volatile solids per cubic foot of lagoon per day and for dairy a figure of .06 to .1 pounds of volatile solids may be feasible. Additional capacity is desirable in colder climates and where intermittant loading is anticipated.

Anaerobic lagoons may also function as liquid or solids holding units where surge capacity is needed. They have been particularly useful for holding animal wastes prior to field spreading. Allow a minimum of two cubic feet of lagoon volume per pound of total animal weight and provide three cubic feet of lagoon volume per pound of poultry weight.

There is no need for a large surface area to promote surface reaeration and to obtain adequate light energy for photosynthesis, as is the case with aerobic lagoons. Anaerobic lagoons require less land area than do aerobic lagoons since they are more heavily loaded. The depth of the lagoon is not restricted by light penetration. Anaerobic lagoons should be built with a small surface area and as deep as possible consistent with construction factors and ground water conditions.

In anaerobic lagoons there is a relatively solids-free liquid layer above a layer of settled solids. A floating scum layer usually will occur, depending upon the type of waste. With a small surface area, the scum can form an effective floating cover to provide some insulation for lagoon contents during cold weather.

The actual depth of the lagoon will be restricted by existing temperatures. The lagoon temperature may decrease with depth and may reach a point where biological reactions in the settled solids are inhabited. Temperature is one of the most important factors affecting the performance of anaerobic lagoons. As expected, anaerobic lagoons function better in warmer climates and are less effective in colder climates. Depths up to 10 to 12 feet have proved popular and appear to be satisfactory.

The effluent from lagoons handling animal manures contain considerable organic material. Quality of streams can be impaired if the effluent is discharged without treatment. In practice, the quantity of excess liquid from a lagoon could be small, but it should be applied on the land for final disposal. Seepage and evaporation losses may require the addition of water during the summer months to maintain desired lagoon level. In the winter heavy rains may increase the lagoon water level above desired level and require removal of excess liquid.

### 5. Manure treatment

Treatment is probably the least polluting of all methods, but the cost is essentially prohibitive. It has been estimated that it would cost about $200 daily to treat the waste from a 10,000-head feedlot, and it would cost about $1,000,000 to construct a treatment plant. Cattle manure is reported to be about 100 times as costly to treat as a like volume of human wastes.

### 6. Liquid-solids separation

This is a new method being developed in California and could have application in many areas of the Northwest (schematic diagram, Figure 9). The following is a brief description of the process.[3] Liquid manure can be de-watered with special separators such as these shown in Figures 10 and 11. Some designs have not been successful because of clogging due to fat, colloids, or cow hair. Stainless steel screens of 10 to 16 mesh have been most successful. Separator systems are usually designed for flows ranging from 200 to 400 gpm.

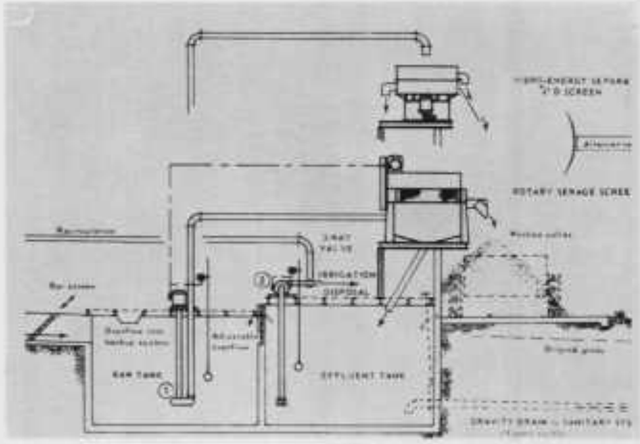

Figure 9

The screened effluent will contain up to 95 percent of the original BOD[4], depending upon the amount of added water and effectiveness of washing ahead of separation. The removed fiber solids are about 80 percent moisture, have the appearance of wet sawdust, and are quite innocuous. There is insufficient food in the debris for fly larva development. The fiber will compost ideally if aerated and protected from rain and chilling air currents.

The effluent is easily sprinkled onto the land with conventional irrigation equipment. Removal

[3] Submitted by Mr. W. C. Fairbank, Extension Agricultural Engineer, University of California Cooperative Extension Service.

[4] Biochemical Oxygen Demand. A measure of the concentration of biologically degradable material present in organic wastes. It is the amount of free oxygen utilized by aerobic organisms when allowed to attack the organic matter in animal wastes.

Figure 10. Removing water from manure with a mechanical screen.

Figure 11. Removing water from manure with another special type of separator.

of fiber and coarse sediment prevents pipeline and sprinkler fouling. Flood irrigation and "big gun" dispersal are also common, but have created problems of uneven application which resulted in soil saturation. Manure water applied excessively can seal fine-textured soils, turning the upper layer anaerobic and drowning the beneficial organisms. It is important, then, to apply the organic-laden waste water to a different area each day or on a schedule to be determined by the quantity of suspended solids, the total volume of effluent, and crop and soil characteristics. Careful pasture or crop management is important. Where manure odors are a problem during sprinkling, a holding lagoon having a 30 day liquid holding capacity could be used. The lagoon must be primarily aerobic. This can be accomplished by using a surface aerator on the lagoon to provide the necessary oxygen to maintain aerobic conditions. Successful odor control has been reported on lagoons as deep as four feet. Research results on odor control on a deeper lagoon is pending further trials at various research stations.

Washed dairy manure solids make excellent free-stall bedding. In California they are placed wet into the stalls in two 2-inch layers to get compaction. (Dried solids are too fluffy). In a wetter climate some air drying may be desirable. It might be practical to store some summer-dried solids to blend with wet solids in the winter months.

Washed manure solids also make excellent plant mulch. Limited observations suggest they can be used around the home garden in a manner similar to peat moss.

In support of the liquids-solids separation method, research work at Cornell University on livestock manure indicates the method can be used to control obnoxious odors by: (1) removing water from the manure, (2) aerating the manure, and (3) disposing of the manure before odors can be produced.

### 7. Incineration and drying

Incineration and drying have been suggested to reduce the total volume of the wastes and to minimize water pollution problems.

Investigative work regarding incineration of animal wastes has been limited to poultry manure. The cost of fuel needed when the manure contained 80 percent moisture was triple that needed when the manure contained 70 percent moisture. The ash would require further handling. The ash in poultry manure will run between 20 and 25 percent of the initial dry matter. Air pollution is an inherent liability of the process, which calls for adequate control of gases generated.

There are indications that manure with a moisture content higher than 30 percent cannot be fed directly into the combustion chamber of an incinerator. Pre-drying, possibly using waste heat from the incinerator, would be necessary. The need for pre-drying is less acute for animal manures that are not diluted such as those collected without additional water from cattle feedlots and certain hog operations. Dry waste collection systems are necessary if incineration is to be used.

It has been estimated that dehydration would not be economical unless the product can be sold at least $30 per ton since, depending upon the moisture content, the cost of dehydrating poultry manure is of that magnitude. The marketing potential of dehydrated manure is unknown. It should be noted that composting, which produces a similar product, has not been economically successful in the United States due to lack of a ready market.

### 8. Composting

Investigation of on-site composting of poultry manure, i.e., within the poultry house, has been carried on. The poultry litter was inoculated with selected microorganisms to aerobically decompose the resulting manure. It is reported that the process was relatively inexpensive, provided an odorless and fly-free environment, and kept dust to a minimum.

A suitable market should be available before composting can be attractive as a method of waste treatment and disposal. While composting may be feasible for isolated animal production units, it is doubtful that it is suitable for the volume of animal wastes generated throughout the country. Without a market, virtually all of the original dry matter remains for further disposal.

### 9. Subsoil injection

One way to avoid pollution caused by runoff is to incorporate the wastes into the soil soon after spreading. Sub-soil injection as a method of manure disposal shows definite promise, particularly with poultry wastes. Two inches of poultry manure can be deposited in the bottom of a furrow and covered immediately with an attachment on a field distribution unit. The rate of disposal is estimated at about 20 tons per acre. For over three years, in one research study, the wastes from 1,000 chickens were plowed into one-half acre of land with no offensive odors to neighbors. The maximum land application that can be handled in this manner will depend upon the type of soil, possible build-up of toxic materials in the soil, and potential ground water pollution.

### 10. Oxidation ditches

The oxidation, or Pasveer, ditch (shaped like a race track) has attracted considerable attention in some parts of the United States as a feasible method for maintaining adequate aerobic conditions with relatively small land areas. The attraction has resulted due to the possible low cost of the process and the minimum attention that is needed. It has been estimated that oxidation ditch costs may be about one-tenth those of conventional aerobic treatment facilities.

The minimum ditch volume needed per animal might be 7 cubic feet per hog, 50 cubic feet per head of dairy or beef cattle, and 1 cubic foot per chicken. It is estimated that for a ditch operating as a continuous unit, the daily addition of manure should not be more than 1.5 percent of the ditch volume. Approximately 3½ pounds of oxygen can be added to the ditch per net horsepower-hour applied to the rotor when immersed at a depth of six inches. One foot of rotor per 400 cubic feet of ditch has been established as a guide. A velocity of at least one foot per second is necessary to keep solids from settling. The cost of the aeration devices will vary from approximately 2 to 4 dollars per hundred-weight of animal. The energy cost for rotor operation would vary in the northwest from 30 to 60 cents per hog per finishing period. Additional research work needs to be conducted to establish the practicability of the oxidation ditch in Oregon, particularly in the heavy rainfall areas.

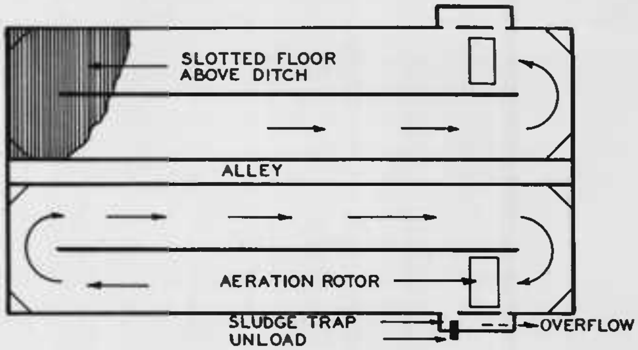


Figure 12. Schematic diagram of a typical oxidation ditch for a swine installation below a slotted floor.

## Guidelines for Handling Animal Wastes

These suggestions are based on research data and experiences of many people in the livestock business and regulatory work. If legal requirements are to be met in accomplishing the objectives of animal waste handling, careful planning and good design and construction are necessary. But as water pollution or other unsanitary conditions occur, the legal requirements are not satisfied. So, good management, proper maintenance, and repair are also essential.

Every livestock operator should have an overall plot plan of his operation which should show the following:

1. Location of buildings and yards.
2. Exact location of wells and other water sources.
3. Size and location of the liquid manure storage tank, lagoon, and/or holding pit. (Give depth, length, and width, or diameter of tank). Show location by giving distances in feet from water supply, buildings, and other prominent landmarks.
4. Show cross-section of the tank in relation to ground level and floor level if in the building. Also show opening where the tank will be emptied and how it will be ventilated if it is located in a building.
5. Show general direction of drainage and amount of slope in the area where the tank, lagoon, or holding pit is constructed. Show how flooding caused by surface run-off, will be prevented. Also show location and size of area where manure will be stored when it is not hauled directly to the field or put in the tank.
6. Give number of animals (cows, heifers, and others) that will be handled by this facility.

The preceding data will also be handy and valuable if an application for tax relief for a pollution control facility is filed with the Department of

Environmental Quality. Likewise, the same information will facilitate the application to the Agricultural Stabilization and Conservation Service for a pollution abatement practice, where available, which provides cost-sharing for facilities to handle animal wastes.

Provision for agitating manure in the tank is necessary. Agitate material in holding tank not less than 30 minutes each day. Agitation adds oxygen to material which slows down the action of anaerobic bacteria. Without agitation, anaerobic bacteria prevail, and they are the type largely responsible for offensive odors and gas. If the tank is under a building, ventilation should be provided for the removal of gases, especially during agitation and emptying. This precaution is essential for the protection of humans and animals from the dangerous gases produced by anaerobic action. Sometimes it is essential to agitate and *empty* the holding tank daily for best control of odors. This is particularly true of the smaller-sized holding tanks. Obtain USDA Plan No. 5984 for a circular tank and Plans No. 5981 and 5987 for rectangular tanks. These are available through your County Agent at a nominal fee. Concrete block construction is not recommended for manure tanks. The underground hydrostatic pressure during the winter could damage the tank severely.

Apply animal wastes on the land in a manner so that surface run-off will be avoided. The wastes contain nitrogen and other nutrients which contribute to degradation of water quality by promoting the growth of slime and algae. Special attention must be given to the operation of manure sprinkler systems. A manure sprinkler system should be operated in a manner which will not contaminate surface waters. The application of manure must not be closer than 50 feet from surface waters and no closer than 100 feet from a domestic water supply.

Applications of liquid manure to the land should be governed by existing wind conditions. To prevent drift of particles, do not operate in high wind. Consider neighboring property when windy conditions exist. Many farmers operate their sprinkler system early in the morning, or at night, with highly successful results.

Always consider the proximity of neighbors. Maintain good relationships with neighbors to prevent the possibility of being a nuisance.

Provide safety precautions for openings into liquid tanks to safeguard equipment, animals, and especially children and pets.

Liquid tanks are for animal waste only. No human waste is allowed in liquid tanks. Effluent from septic tanks serving the house or toilets in other buildings cannot be drained into the manure tank.

Where high-water tables exist (Figure 13), liquid tanks must be securely anchored to avoid rising out of the ground when almost empty.

Gutters and downspouts on eaves (Figure 14) can prevent hundreds of gallons of excess rainwater from entering manure tanks, thus reducing the size of tanks and eliminating the pumping and distribution of unnecessary water mixed with the manure. A flap valve on downspouts can divert roof water into the manure tank when needed or direct it through an underground field drain.

Figure 13. High water table during rainy season can cause concrete liquid tanks to rise out of the ground when empty unless tank is anchored properly.

Figure 14. Gutters and downspouts on eaves can prevent hundreds of gallons of excess rainwater from entering manure tanks.

The following table can be used to determine the amount of rainfall (in gallons) to allow in liquid tanks when rainfall is directly on uncovered concrete areas of the livestock operation. *Example:* There was 10 inches of rain in January in the Eugene area and a dairyman had 2 areas of uncovered concrete, each 10′ x 50′. Total area equals 1,000 square feet. The table shows that a 10-inch rainfall on 1,000 square feet amounts to 6,230 gallons of water. This must be added to the amount of liquid manure his herd would produce in one month, so that he would have enough holding capacity in the liquid tank for 30 days if he could not apply the wastes on the land during this period due to saturated soil. In some areas a 60-day storage capacity is provided for in liquid tanks.

Overflow water from stock waterers should be piped underground and emptied into a stream or

**Table 4. Water Run-Off by Area and Rainfall**

| | Inches of Rainfall | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* | *gal.* |
| 500 sq. ft. | 311 | 623 | 934 | 1246 | 1557 | 1869 | 2177 | 2488 | 2799 | 3110 |
| 1000 sq. ft. | 623 | 1246 | 1869 | 2492 | 3115 | 3738 | 4361 | 4984 | 5607 | 6230 |
| 1500 sq. ft. | 934 | 1869 | 2802 | 3736 | 4670 | 5604 | 6538 | 7472 | 8406 | 9340 |
| 2000 sq. ft. | 1246 | 2492 | 3738 | 4984 | 6234 | 7480 | 8726 | 9972 | 11,218 | 12,460 |
| 2500 sq. ft. | 1557 | 3114 | 4671 | 6228 | 7785 | 9342 | 10,899 | 12,456 | 14,013 | 15,570 |
| 3000 sq. ft. | 1869 | 3738 | 5607 | 7476 | 9345 | 11,214 | 13,083 | 14,952 | 16,821 | 18,690 |

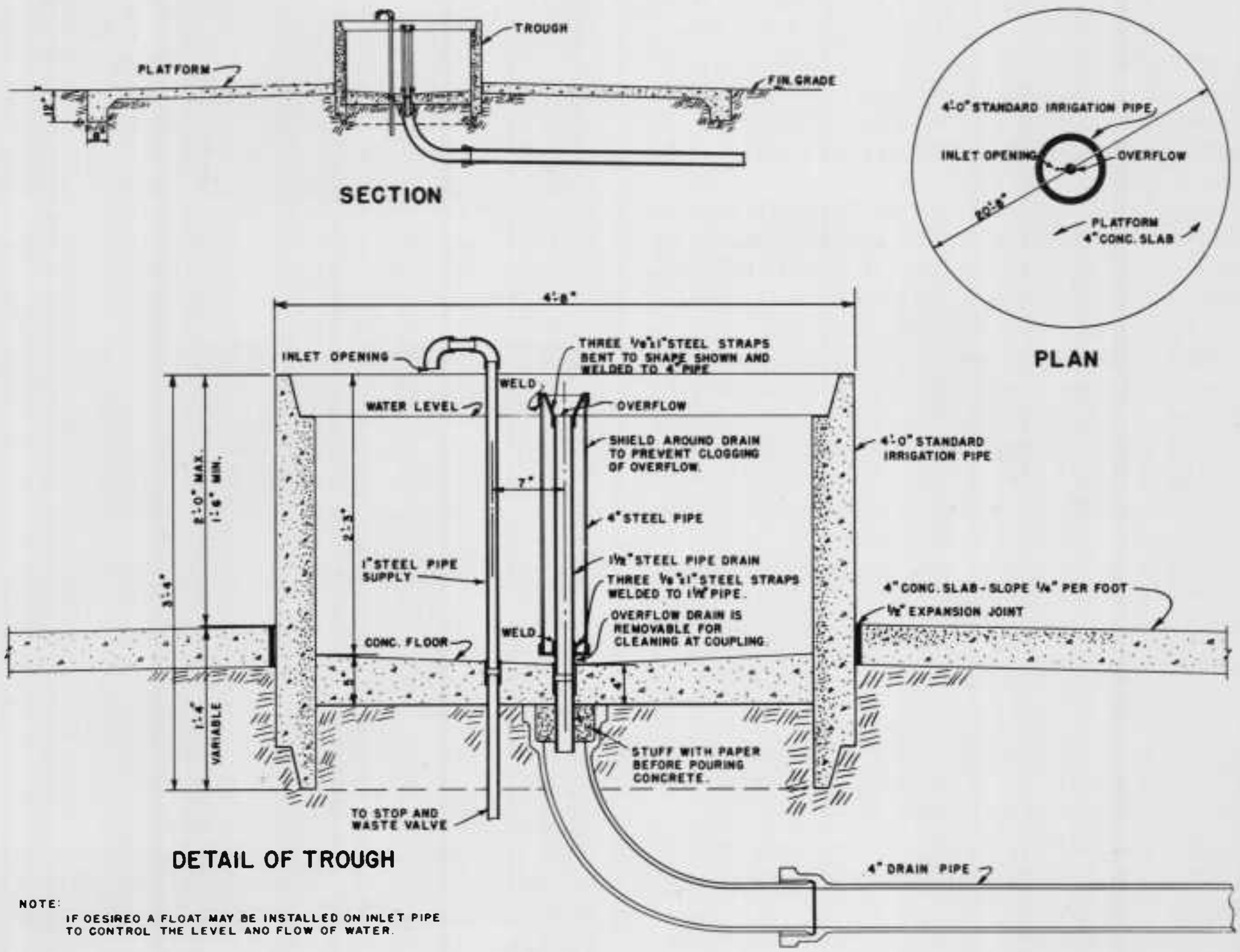


Figure 15. A good design for a stock watering tank.

at some point below the feedlot (Figure 15). Such overflow water will not be allowed to flow unchecked on the ground surface of the feedlots.

On some sites the topography allows flood runoff from adjacent lands to flow over or through the feedlot. In these situations the use of diversion ditches is recommended.

In some areas of Oregon, engineers for the Department of Environmental Quality may require beef feedlot operators to excavate catch or debris basins to store manure runoff during unseasonable weather. This temporary storage prevents runoff from entering nearby water sources. The material is then removed from the catch basins for final disposal on the land.

## Health Aspects

When drainage or runoff from animal production units reaches a water course, a potential chain reaction for the spread of disease has been initiated. Although documentation of water-borne disease transmission from animal to man is rare, such transmission has been noted. Many Iowa people were affected with leptospirosis while swimming downstream from an area where leptospirosis-infected cattle had access to the river. A similar situation occurred in central Washington where youngsters were swimming in an irrigation canal which was polluted by infected cattle.

Many infections of farm livestock are spread in their excreta. The disease potential inherent in the use of manure slurry systems to dispose of wastes on farm land is unknown. It is possible that under certain circumstances, the use of such systems could increase the disease hazard to man and animals.

Soil can act as an excellent bacteria filter. Percolation experiments at Wisconsin in 1969 revealed that soil can act as a good filter for the removal of bacteria Escherichia coli and enterococci found in animal waste. Using a silt loam soil, they found that over 50 percent of the coliform and enterococci were removed in the first 6 inches of the soil, over 90 percent was removed in the first 10 inches, and 95 percent in the first 14 inches.

Some experimental work shows that nitrate moves through the soil and into the ground water supply under both feedlots and irrigated fields in crops, excluding alfalfa. Although much larger amounts of nitrate are present under feedlots per unit area, indications are that irrigated lands are contributing more total nitrate to the ground water. Feedlots, however, are usually located near the homestead and may have a pronounced effect on the water quality from domestic wells. Water under feedlots frequently has a very offensive odor.

Liquids seeping from stockpiles of silage or of by-product feeds must be confined so that they do not flow into water sources. The concern here, also, is to prevent high concentrations of nitrates from entering the water. Nitrogen in water can be a problem due to the toxicity of nitrates to babies and livestock and due to the stimulation of aquatic plants in receiving waters.

Periodic testing of nitrate levels in rural wells selected to represent various geological regions and soil types throughout the state could indicate adverse conditions and permit effective corrective measures to be taken.

## Odors

Good management plays an important role in the control of offensive odors. The effect on neighbors should always be considered. Good relationships with neighbors can help to prevent the possibility of being declared a nuisance in the eyes of the law.

When sprinkling manure on the land and the wind is blowing, make sure it is blowing away from nearby roads and neighbors. Whenever possible, always flush newly-applied liquid wastes with water to wash materials into the soil. Many farmers operate their sprinkler or field distribution systems early in the morning with highly successful results.

Agitate liquid-solids in holding tanks for at least 30 minutes daily. Beating air into the material helps to prevent working of anaerobic bacteria. Without agitation, anaerobic bacteria prevail and they are the type largely responsible for offensive odors.

Poultrymen find it easier to control odors in buildings by cleaning them daily. Wastes are either stockpiled for short periods before being disposed of on fields or else they are applied directly to the land on a daily basis.

Chemical formulations which control offensive odors are available. Such chemicals have been used for many years by industry. The use of counter-odorants is drawing the attention of some livestock and poultry operators to neutralize the odor exhausted to the outside air. When no winds prevail, chemicals can be sprayed on lagoons to suppress odors. These chemicals have an oil base which forms a film over the surface.

## Laws

Success in animal production and management will depend upon the producer's awareness of his surroundings and his ability to:

1. Recognize the need for improvements.
2. Plan improvements well in advance, and obtain qualified design assistance.
3. Obtain all necessary approvals prior to construction of improvements.
4. Recognize the limitations of a particular location for expansion.

It is important to become familiar with laws and regulations pertaining to water and air pollution control and solid waste management. The Department of Environmental Quality can supply copies of pertinent laws and regulations upon request and has a qualified staff to assist in their interpretation or application to individual situations.

The basic intent of water pollution control laws, regulations, and policies is to prevent the discharge of manure, silage liquor, or contaminated drainage, or the release of organic solids, dead animals, etc., into any waters of the state. All discharges of contaminated water must be in accord with a waste discharge permit issued by the Department of Environmental Quality, which requires the best practicable treatment prior to discharge. Since drainage contaminated with animal waste or silage liquor is so very costly to treat to a quality acceptable for discharge, prevention of discharge is the preferable course to follow in almost all cases.

The intent of solid waste management laws, regulations, and policies is to utilize or dispose of manure, spoiled feed, dead animals, and other waste solids without water pollution or development of health hazards or nuisance conditions. There is steadily increasing emphasis on utilization or processing for gainful use of all types of waste solids. It is advisable for the producer to seek knowledgeable advice on waste solids management alternatives whenever considering waste handling and disposal improvements.

The Department of Environmental Quality has adopted Regulations Pertaining to Location, Construction, Operation, and Maintenance of Confined Animal Feeding and Holding Operations, and Guidelines for the Design and operation of Animal Waste Control Facilities. The producer should be familiar with these regulations and guidelines, and should obtain a copy for frequent reference whenever planning waste handling and disposal improvements.

## Summary

Problems of animal waste disposal, control of manure odors, and control of flies attracted by manure will continue to be important factors in livestock operations, particularly in the location of large-scale enterprises, whether dairy, beef, poultry, or swine.

Animal waste handling, treatment, and disposal will cost something. This must be understood by those who produce the animals and the public who consumes animal products. The cost of satisfactory waste treatment will be related to the desires of the public to minimize pollution from these sources, to the willingness of the consumer to accept higher meat prices to pay for the treatment, and to the ingenuity of those in professional fields in developing suitable treatment systems.

No one treatment process or treatment system will be the solution for all animal production units. A variety of management and treatment systems will be developed. Sanitary engineers, agricultural engineers, economists, agronomists, animal husbandry people, and others interested in the problem will need to closely coordinate activities. Research and demonstration projects are sorely needed.

Pollution caused by animal production facilities can be as detrimental to a receiving water body as wastes from any other industry. Many production facilities and confinement feeding operations have been developed with little planning and concern for the nuisance and pollutional characteristics inherent in the facilities. Many of the most obvious cases of pollution could have been prevented if the facilities were located in areas less susceptible to runoff and to accidental release of wastes directly into receiving streams. The economics of pollution and nuisance control in animal production is an important factor and may mean the difference between success and failure for the facility.

Livestock operators are urged to keep informed of current regulatory policies of the Department of Environmental Quality through their district offices located in several sections of the state or their headquarters in Portland. Likewise, the Cooperative Extension Service can be helpful in planning expansion or dealing with animal waste disposal problems.


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