Swine production operations, particularly high-density large-volume units, must be planned as a total system beginning with site selection. With increasing emphasis on a cleaner environment, more attention must be given to methods of manure management. Location, land use patterns, size of operation, labor resources, soil type, land availability, crop scheduling and climate are factors entering into the decision of which waste system is the most efficient and environmentally acceptable. The system that works best for one operator with a particular set of constraints may not necessarily be best for another with different circumstances, management capabilities, or farm objectives.

PRODUCTION SYSTEM PLAN

Planning a group of buildings and their surroundings to present a wholesome image is as important as planning for productive efficiency. When the public sees a swine farm, they see much more than buildings and grounds. They see an attitude - an attitude of pride in the business or an attitude of indifference. They see an environmental protector or an environmental polluter. Farm operators who take pride in maintaining the farmstead are generally better managers than those who practice poor housekeeping. Employees take more pride in their jobs and work output improves (Morris et al., 1973).
Production Effects from Manure

Production advantages are also likely to be realized by proper in-house manure management. Manure anaerobic decomposition produces more than 40 different gases which may be detrimental to animal health and productivity, unhealthy to workers or offensive to neighbors. The levels of ammonia and other gases in swine housing has been closely associated with ventilation and manure management. Animal respiratory diseases such as rhinitis and chronic pneumonia are aggravated by the continuous breathing of ammonia. Ammonia also causes a loss of appetite resulting in slower gains. Hydrogen sulfide, when rapidly released during agitation of stored manure, is toxic and can kill in a matter of seconds. Dried manure on floor surfaces contributes to dusty conditions inside a production facility which can also damage an animal's respiratory structure.

Objectives:

Therefore, proper consideration should be given to the manure management system in the planning stages both from a production and environmental standpoint for:

- prevention of the direct discharge of manure or wastewater into surface waters or onto adjacent neighbors' land. Water pollution control laws declare that it is illegal to discharge untreated wastewater without a permit.
- enhancement of the operational efficiency of the production facility. Advisory personnel must be familiar with management and production needs and maintain close communication with the pork producer.
- collection and utilization of manure and wastewater as fertilizer. The best way to reduce the costs of waste handling is to recognize that regardless of the collection, storage, or pretreatment process, the final step in the overall system is land application.
- prevention of nuisance conditions. Nuisance is defined as anything that interferes with the normal use and enjoyment of property such as odors, rodents, flies or mosquitoes.

PRODUCTION UNIT LOCATION

Site Selection

When planning new facilities or significant expansion of older ones, avoid selecting sites near residential developments, commercial enterprises, recreational areas, or other prime areas for non-agricultural uses. A site may seem ideal with respect to transportation, feed supply, accessibility or land ownership, but may be inappropriate because of existing or proposed development. When possible, locate production facilities near the center of a tract of land large enough to allow manure to be applied at agronomic rates (table 2). Pollution control and waste treatment facilities should be located as remely as possible from areas of high environmental sensitivity such as drainage ditches, streams or estuaries. Buildings in flat, high water table areas should be built on pads of earth fill excavated from the lagoon. Elevating these buildings several feet above ground routes surface drainage away from them and allows manure to flow by gravity to the lagoon.
Wind Direction and Air Drainage

Refer to wind direction probability diagrams available from most technical agencies to locate facilities downwind of the warm season prevailing winds. The strategic planting of rows of trees or hedges serves both to shield the production and waste management facilities from direct sight and to reduce the wind speed across these facilities allowing odorous gases more opportunity to rise vertically and dissipate into the atmosphere.

Facility Management

An orderly system for manure collection and storage or treatment reduces potential pockets of odor production. All manured surfaces on which animals are maintained should be as clean and dry as possible. Dirty manure-covered animals promote accelerated bacterial growth and odorous gases which are quickly vaporized by animal heat. Adequate ventilation is essential for gas and odor reduction, moisture removal, and temperature control. Underfloor ventilation aids in drying slotted floor surfaces. Exhaust fans and shutters should regularly be cleaned of dust. Building sidewall screens should periodically be cleaned of debris such as dust, spider webs and vines to allow maximum warm season cross ventilation. All components of the total production and waste treatment system should be operated and maintained in good functional order. Accumulations of solids and wastewater should be removed from these systems expediently. Proper disposal of dead animals and good fly and rodent control programs are essential.

PIT RECHARGE SYSTEMS

Advantages

The pit recharge concept is a periodic draining of the pit contents by gravity to a lagoon, then recharging the pit with new liquid. Regular pit draining removes much of the manure solids that would otherwise settle and remain in the bottom of the pit. The regular liquefaction of settled solids increases their likelihood of being removed at the next pit draining. With less raw materials available for bacterial digestion and gas production, a better in-house environment results in improved animal health and performance and better working conditions. Fewer odorous gases are exhausted from the pits to the surrounding building vicinity. Potential disease reservoirs resulting from prolonged pit storage are removed. A reduction of corrosive gases decreases metabolic equipment deterioration. Regular loadings of manure also enhance lagoon performance.

Recycle Pump

Low-pressure, self-priming centrifugal or submersible pumps with enough flow capacity to recharge the largest building pit with 12 inches of liquid in 4 hours or less are recommended. Electric pump housings must be well grounded to reduce the buildup of salt deposits on the housing and impeller. Intakes may be screened with a 1-inch wire mesh fence or basket with a diameter at least 5 times the suction pipe diameter. The pump intake is generally an open-ended suction pipe floating approximately 18 inches beneath the liquid surface of the lagoon. The pump should be located as remotely as possible from the waste input. An underground PVC pipe large enough to maintain a
liquid flow velocity between 3-5 feet per second or a minimum diameter of 1.5 inches is used to transport lagoon liquid from the pump to the buildings.

Example: A grower/finishing building pit has dimensions of 16 ft wide by 160 ft long.

Pit floor area = 16 ft x 160 ft = 2560 sq ft

Volume needed to add one foot liquid to pit = 2560 sq ft x 1 ft = 2560 cubic ft x 7.5 gallons/cubic ft = 19,200 gallons

Pump capacity needed to add liquid volume in four (4) hours = 19,200 gals / 4 hours / 60 min/hour = 80 gallons/minute

Minimum pressure head rating of pump = 50 ft
(This should be checked since actual total pressure head ay need to be greater.)

Pump efficiencies vary from 45% to 65% (0.45 – 0.65)
Electric motor efficiencies vary fro 80% to 90% (0.80 – 0.90)

Approximate motor horsepower = Pumping rate, gpm x Total pressure head, ft
---------------------------------------------
3960 x Pump efficiency x Motor efficiency

= 80 gpm x 50 ft
---------------------------------------------
3960 x 0.55 x 0.90

= 2 hp

Installation

A lateral pipe from the mainline is installed into each pit wall preferably at a location opposite the drain outlet. However, the location of this recharge pipe is not critical since liquid addition to the pit is the objective rather than higher velocity sweeping action. The lateral can either be stubbed directly into the pit wall with a conveniently located and protected butterfly valve outside the building, or it can enter the building wall near ceiling level and drop down to the pit with an inside-the-building valve. The lateral diameter should not be reduced between mainline and outlet.

Design Criteria

The lateral discharge point should be located between the slotted floor and maximum pit liquid level. The recharge system can be managed successfully with a flat pit floor, although a minimum slope of 1 inch in 20 feet is generally recommended to overcome uneven concrete construction. If the entire building is sloped, enough pit depth must exist to cover the upper end of the pit floor with at least 6 inches of liquid while enough storage exists below the air plenum openings on the lower end. Allow for an average depth of 12 inches of recharge liquid and another 12 inches for waste accumulation between pit drainings. The maximum pit liquid level should be at least 4 inches below the air plenum openings or 12 inches below the slats. Generally, a 32-inch pit depth is the minimum recommended between the slotted floor and pit floor.
Drains

A narrow gutter 16 inches wide and a minimum of 4 inches deep across the drain end of the pit floor directs waste to an exterior collection box. This box encloses a removable standpipe seated into a tee or elbow connected to an underground drainpipe. An 8-inch diameter smooth-walled pipe is sufficient for individual pit drainings or 10 inches to drain the entire building. The bottom of the standpipe should be at least 4 inches below the bottom of the cross collection gutter so that water flow to the lagoon will not be restricted. This drainpipe should have a minimum grade of 1%, preferably 2%, extending approximately 25 feet beyond the top edge of the lagoon.

By draining and recharging a pit more frequently, more manure solids will be removed, and gas generation will be lessened. Research data indicates that ammonia and hydrogen sulfide gas evolution begins a significant increase after 5-8 days. Pits, therefore, should be drained and recharged once per week.

LAGOONS

Capacity Unless a producer has adequate supplies of fresh water and is equipped to handle the additional water being added to a lagoon, recycling of lagoon liquid is recommended. Lagoons must be sized properly to achieve odor control and a water quality suitable for recharging. Current North Carolina recommendations are 2 cubic feet of liquid volume per pound of live animal weight for a single anaerobic lagoon. Table 1 gives equivalent volumes per head capacity for finishing units or per sow for farrow-to-feeder and farrow- to-finish units. A two-stage lagoon would have 1.5 cubic feet of volume per pound live weight in the first stage and another 0.5 cubic feet in the second stage. The tendency to expand production capacity adding more manure to an existing lagoon without expanding lagoon treatment capacity should be avoided.

Location

It is suggested that a lagoon be located at least 1000 feet from any residence or inhabited dwelling not owned by the producer. Separation distances should be evaluated on a case-by-case basis. Aggravating factors such as potential for development downwind might increase the separation while mitigating factors such as wooded buffers might decrease the distance. Lagoons should be located on soils of low permeability or soils which seal through biological action or sedimentation to avoid groundwater contamination.

Startup

New lagoons should be filled at least half full with water before manure loading begins to nurture bacteria establishment. When possible, manure loading of a new lagoon should begin in the spring to permit a stable bacterial population to develop during the warm season. Under no circumstances should dead animals, molded feed, plastic gloves, long-stemmed vegetation, or other foreign material be allowed to enter a lagoon. Maintain strict vegetation, rodent and varmint control around lagoon edges.
Lagoons usually fill to capacity within 2-3 years of startup due to the added waste volume and a rainfall excess over evaporation. North Carolina has an annual moisture surplus ranging from 8 inches in the Coastal Plain to 18 inches in the Mountains. While the lagoon is progressing through the filling process, some seepage might be occurring. When the interior soil surfaces have biologically sealed and the lagoon is full, liquid overflow will occur unless the operator is in a position to land apply the excess liquid. Since no overflow is permitted, excess liquids will need to be applied to grassland, cropland, or woodland at rates within the soil infiltration capacity and the fertilizer requirement of the vegetation. Sampling and analysis of the lagoon liquid is suggested to determine its nutrient content. Table 1 provides information on average annual lagoon liquid accumulation rates and estimated available nutrient contents. Table 2 estimates application rates and minimum land areas needed for lagoon liquid application for various cropping schemes.

Lagoons should be pumped down during the warmer growing seasons such that adequate wastewater storage is available during the wetter, colder season. Always maintain at least two-thirds of the liquid volume in a lagoon to allow continuous bacterial digestion of the incoming wastes. If a high groundwater table exists, do not lower the lagoon liquid level below the seasonal water table. Irrigation is the most cost-effective method of applying lagoon liquid to land. Irrigate on days with low humidity and when breezes are blowing away from neighboring residences. Also irrigate in the mornings and early in the week when odors are apt to be least offensive.

**SUMMARY**

After weighing the important points of alternative manure management systems, a producer must decide which system appears best, then commit to providing the attention and management necessary to make the system function. No waste system will take care of itself. The appearance of buildings and grounds on swine farms constantly generates images of the product, good or bad. A poop swgnc una~ helps seU the prodd Portraying an attitude of success is contagious - to employees, to neighbors, to consumers and to the general public (Morris et al., 1973).

**REFERENCE**

### Table 1. SWINE ANAEROBIC LAGOON LIQUID FERTILIZER NUTRIENTS *

<table>
<thead>
<tr>
<th>Type of Production Unit</th>
<th>Animal Equivalent Live Weight</th>
<th>Total Anaerobic Lagoon Liquid Capacity, cub. ft/animal unit capacity</th>
<th>Initial Final Average</th>
<th>Total Lagoon Liquid to be Irrigated, (a) per animal unit/year</th>
<th>Irrigated Soil Incorp. Rate %/animal unit/year</th>
<th>Soil Incorp. Rate %/animal unit/year</th>
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<tbody>
<tr>
<td>Feeding-to per bd</td>
<td>10</td>
<td>70</td>
<td>151</td>
<td>.007</td>
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<td>Feeding-to(s)/per</td>
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<td>320</td>
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<td>Feeding-to(s)/per</td>
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<td>500</td>
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<td>Feeding-to(s)/per</td>
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<td>1000</td>
<td>4710</td>
<td></td>
<td>1000</td>
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</tbody>
</table>

### References:
Depts of Biological & Agricultural Engineering, Animal Science, North Carolina State University; Jan 1990 Agronomic Division, North Carolina Department of Agriculture

1. Estimated total lagoon liquid includes total liquid manure plus average annual rainfall surplus incidental to lagoon surface; does not account for seepage.
2. Irrigated: sprinkler irrigated liquid uncovered for 1 month or longer. Soil incorporated: sprinkler irrigated liquid plowed or disked into soil within 2 days.
3. Assumes 400-lb sow and boar on limited feed, 3-wk old weanling, 50-lb feeder pig, 220-lb market hog and 20 pigs/sow/yr

See next page for Table 2.
Table 2. LAND APPLICATION OF SWINE ANAEROBIC LAGOON LIQUID *

<table>
<thead>
<tr>
<th>Type of Production Unit</th>
<th>Lagoon Liquid Application Rate[a]</th>
<th>Minimum Land Area for Liquid Application[a]</th>
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<tr>
<td></td>
<td>Grain ---</td>
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<tr>
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<tr>
<td># X/ac/yr</td>
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<td>60</td>
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<tr>
<td># P2O5/ac/yr</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

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Potash Institute of North America
(a) N leaching and denitrification and P2O5 soil immobilization unaccounted for.

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