System Calibration

Information presented in manufacturer's charts are based on average operation conditions with relatively new equipment. Discharge rates and application rates change over time as equipment gets older and components wear. In particular, pump wear tends to reduce operating pressure and flow. With continued use, nozzle wear results in an increase in the nozzle opening which will increase the discharge rate while decreasing the wetted diameter.

You should be aware that operating the system differently than assumed in the design will alter the application rate, diameter of coverage, and subsequently the application uniformity. For example, operating the system with excessive pressure results in smaller droplets, greater potential for drift, and accelerates wear of the sprinkler nozzle. Clogging of nozzles can result in pressure increase. Plugged intakes or crystallization of mainlines will reduce operating pressure. Operating below design pressure greatly reduces the coverage diameter and application uniformity.

For the above reason, you should calibrate your equipment on a regular basis to ensure proper application rates and uniformity. Calibration at least once every three years is recommended. Calibration involves collecting and measuring flow at several locations in the application area. Any number of containers can be used to collect flow and determine the application rate. Rain gauges work best because they already have a graduated scale from which to read the application amount without having to perform additional calculations. However, pans, plastic buckets, jars, or anything with a uniform opening and cross-section can be used provided the liquid collected can be easily transferred to a scaled container for measuring.

For stationary sprinklers, collection containers should be located randomly throughout the application area at several distances from sprinklers. For traveling guns, sprinklers should be located along a transect perpendicular to the direction of pull. Set out collection containers 25 feet apart along the transect on both sides of the gun cart. You should compute the average application rate for all nonuniformity of the application. On a windless day, variation between containers of more than 30 percent is cause for concern. You should contact your irrigation dealer or technical specialist for assistance.

**Reprinted for Certification Training for Operations of Animal Waste Management Systems Manual*

OPERATION & MAINTENANCE PLAN

Proper lagoon management should be a year-round priority. It is especially important to manage levels so that you do not have problems during extended rainy and wet periods.

Maximum storage capacity should be available in the lagoon for periods when the receiving crop is dormant (such as wintertime for bermudagrass) or when there are extended rainy spells such as a thunderstorm season in the summertime. This means that at the first sign of plant growth in the later winter / early spring, irrigation according to a farm waste management plan should be done whenever the land in dry enough to receive lagoon liquid. This will make storage space available in the lagoon for future wet periods. In the late summer / early fall the lagoon should be pumped down to the low marker (see Figure 2-1) to allow for winter storage. Every effort should be made to ***maintain*** the lagoon close to the minimum liquid level as long as the weather and waste utilization plan will allow it.

Waiting until the lagoon has reached its maximum storage capacity before starting to irrigated does not leave room for storing excess water during extended wet periods. Overflow from the lagoon for any reason except a 25-year, 24-hour storm is a violation of state law and subject to penalty action.

The routine maintenance of a lagoon involves the following:

- Maintenance of a vegetative cover for the dam. Fescue or common bermudagrass are the most common vegetative covers. The vegetation should be fertilized each year, if needed, to maintain a vigorous stand. The amount of fertilized applied should be based on a soils test, but in the event that it is not practical to obtain a soils test each year, the lagoon embankment and surrounding areas should be fertilized with 800 pounds per acre of 10-10-10, or equivalent.

- Brush and trees on the embankment must be controlled. This may be done by mowing, spraying, grazing, chopping, or a combination of these practices. This should be done at least once a year and possibly twice in years that weather conditions are favorable for heavy vegetative growth.

NOTE: If vegetation is controlled by spraying, the herbicide must not be allowed to enter the lagoon water. Such chemicals could harm the bacteria in the lagoon that are treating the waste.

Maintenance inspections of the entire lagoon should be made during the initial filling of the lagoon and at least monthly and after major rainfall and storm events. Items to be checked should include, as a minimum, the following:

Waste Inlet Pipes, Recycling Pipes, and Overflow Pipes -- look for:

1. separation of joints
2. cracks or breaks
3. accumulation of salts or minerals
4. overall condition of pipes

Lagoon surface -- look for:

1. undesirable vegetative growth
2. floating or lodged debris

Embankment -- look for:

1. settlement, cracking, or "jug" holes
2. side slope stability -- slumps or bulges
3. wet or damp areas on the back slope
4. erosion due to lack or vegetation or as a result of wave action
5. rodent damage

Larger lagoons may be subject to liner damage due to wave action caused by strong winds. These waves can erode the lagoon sidewalls, thereby weakening the lagoon dam. A good stand of vegetation will reduce the potential damage caused by wave action. If wave action causes serious damage to a lagoon sidewall, baffles in the lagoon may be used to reduce the wave impacts.

Any of these features could lead to erosion and weakening of the dam. If your lagoon has any of these features, you should call an appropriate expert familiar with design and construction of waste lagoons. You may need to provide a temporary fix if there is a threat of a waste discharge. However, a permanent solution should be reviewed by the technical expert. Any digging into a lagoon dam with heavy equipment is a serious undertaking with potentially serious consequences and should not be conducted unless recommended by an appropriate technical expert.

Transfer Pumps -- check for proper operation of:

1. recycling pumps
2. irrigation pumps

Check for leaks, loose fittings, and overall pump operation. An unusually loud or grinding noise, or a large amount of vibration, may indicate that the pump is in need of repair or replacement.

NOTE: Pumping systems should be inspected and operated frequently enough so that you are not completely "surprised" by equipment failure. You should perform your pumping system maintenance at a time when your lagoon is at its low level. This will allow some safety time should major repairs be required. Having a nearly full lagoon is not the time to think about switching, repairing, or borrowing pumps. Probably, if your lagoon is full, your neighbor's lagoon is full also. You should consider maintaining an inventory of spare parts or pumps.

- Surface water diversion features are designed to carry *all* surface drainage waters (such as rainfall runoff, roof drainage, gutter outlets, and parking lot runoff) away from your lagoon and other waste treatment or storage structures. The only water that should be coming from your lagoon is that which comes from your flushing (washing) system pipes and the rainfall that hits the lagoon directly. You should inspect your diversion system for the following:
    1. adequate vegetation
    2. diversion capacity
    3. ridge berm height

Identified problems should be corrected promptly. It is advisable to inspect your system during or immediately following a heavy rain. If technical assistance is needed to determine proper solutions, consult with appropriate experts.

You should record the level of the lagoon just prior to when rain is predicted, and then record the level again 4 to 6 hours after the rain (assumes there is no pumping). This will give you an idea of how much your lagoon level will rise with a certain rainfall amount (you must also be recording your rainfall for this to work). Knowing this should help in planning irrigation applications and storage. If your lagoon rises excessively, you may have an overflow problem from a surface water diversion or there may be seepage into the lagoon from the surrounding land.

Lagoon Operation

Startup:

1. Immediately after construction establish a complete sod cover on bare soil surfaces to avoid erosion.

2. Fill new lagoon design treatment volume at least half full of water before waste loading begins, taking care not to erode lining or bank slopes.

3. Drainpipes into the lagoon should have a flexible pipe extender on the end of the pipe to discharge near the bottom of the lagoon during initial filling or another means of slowing the incoming water to avoid erosion of the lining.

4. When possible, begin loading new lagoons in the spring to maximize bacterial establishment (due to warmer weather).

5. It is recommended that a new lagoon be seeded with sludge from a healthy working swine lagoon in the amount of 0.25 percent of the full lagoon liquid volume. This seeding should occur at least two weeks prior to the addition of wastewater.

6. Maintain a periodic check on the lagoon liquid pH. If the pH falls below 7.0, add agricultural lime at the rate of 1 pound per 1000 cubic feet of lagoon liquid volume until the pH rises above 7.0. Optimum lagoon liquid pH is between 7.5 and 8.0.

7. A dark color, lack of bubbling, and excessive odor signals inadequate biological activity. Consultation with a technical specialist is recommended if these conditions occur for prolonged periods, especially during the warm season.

Loading:

The more frequently and regularly that wastewater is added to a lagoon, the better the lagoon will function. Flush systems that wash waste into the lagoon several times daily are optimum for treatment. Pit recharge systems, in which one or more buildings are drained and recharged each day, also work well.

- Practice water conservation --- minimize building water usage and spillage from leaking waterers, broken pipes and washdown through proper maintenance and water conservation.
- Minimize feed wastage and spillage by keeping feeders adjusted. This will reduce the amount of solids entering the lagoon.

Management:

- Maintain lagoon liquid level between the permanent storage level and the full temporary storage level.

- Place visible markers or stakes on the lagoon bank to show the minimum liquid level and the maximum liquid level. (Figure 2-1).

- Start irrigating at the earliest possible date in the spring based on nutrient requirements and soil moisture so that temporary storage will be maximized for the summer thunderstorm season. Similarly, irrigate in the late summer / early fall to provide maximum lagoon storage for the winter.

- The lagoon liquid level *should never* be closer than 1 foot to the lowest point of the dam or embankment.

- Don not pump the lagoon liquid level lower than the permanent storage level unless you are removing sludge.

- Locate float pump intakes approximately 18 inches underneath the liquid surface and as far away from the drainpipe inlets as possible.

- Prevent additions of bedding materials, long-stemmed forage or vegetation, molded feed, plastic syringes, or other foreign materials into the lagoon.

- Frequently remove solids from catch basins at end of confinement houses or wherever they are installed.

- Maintain strict vegetation, rodent, and varmint control near lagoon edges.

- Do not allow trees or large bushes to grow on lagoon dam or embankment.

- Remove sludge from the lagoon either when the sludge storage capacity is full or before it fills 50 percent of the permanent storage volume.

- If animal production is to be terminated, the owner is responsible for obtaining and implementing a closure plan to eliminate the possibility of a pollutant discharge.

Sludge Removal:

Rate of lagoon sludge buildup can be reduced by:

- proper lagoon sizing,
- mechanical solids separation of flushed waste,
- gravity settling of flushed waste solids in an appropriately designed basin, or
- minimizing feed wastage and spillage.

Lagoon sludge that is removed annually rather than stored long term will:

- have more nutrients,
- have more odor, and
- require more land to properly use the nutrients.

Removal techniques:

- Hire a custom applicator.

- Mix the sludge and lagoon liquid with a chopper - agitator impeller pump through large - bore sprinkler irrigation system onto nearby cropland; and soil incorporate.

- Dewater the upper part of lagoon by irrigation onto nearby cropland or forageland; mix remaining sludge; pump into liquid sludge applicator; haul and spread onto cropland or forageland; and soil incorporate.

- Dewater the upper part of lagoon by irrigation onto nearby cropland or forageland; dredge sludge from lagoon with dragline or sludge barge; berm an area beside lagoon to receive the sludge so that liquids can drain back into lagoon; allow sludge to dewater; haul and spread with manure spreader onto cropland or forageland; and soil incorporate.

Regardless of the method, you must have the sludge material analyzed for waste constituents just as you would your lagoon water. The sludge will contain different nutrient and metal values from the liquid. The application of the sludge to fields will be limited by these nutrients as well as any previous waste applications to that field and crop requirement. Waste application rates will be discussed in detail in Chapter 3.

When removing sludge, you must also pay attention to the liner to prevent damage. Close attention by the pumper or drag-line operator will ensure that the lagoon liner remains intact. If you see soil material or the synthetic liner material being disturbed, you should stop the activity immediately and not resume until you are sure that the sludge can be removed without liner injury. If the liner is damaged it must be repaired as soon as possible.

Sludge removed from the lagoon has a much higher phosphorus and heavy metal content than liquid. Because of this it should probably be applied to land with low phosphorus and metal levels, as indicated by a soil test, and incorporated to reduce the chance of erosion. Note that if the sludge is applied to fields with very high soil-test phosphors, it should be applied only at rates equal to the crop removal of phosphorus. As with other wastes, always have your lagoon sludge analyzed for its nutrient value.

The application of sludge will increase the amount of odor at the waste application site. Extra precaution should be used to observe the wind direction and other conditions which could increase the concern of neighbors.

Possible Causes of Lagoon Failure

Lagoon failures result in the unplanned discharge of wastewater from the structure. Types of failures include leakage through the bottom or sides, overtopping, and breach of the dam. Assuming proper design and construction, the owner has the responsibility for ensuring structure safety. Items which may lead to lagoon failures include:

- Modification of the lagoon structure -- an example is the placement of a pipe in the dam without proper design and construction. (Consult an expert in lagoon design before placing any pipes in dams.)
- Lagoon liquid levels -- high levels are a safety risk.
- Failure to inspect and maintain the dam.
- Excess surface water flowing into the lagoon.
- Liner integrity -- protect from inlet pipe scouring, damage during sludge removal, or rupture from lowering lagoon liquid level below groundwater table.

NOTE: If lagoon water is allowed to overtop the dam, the moving water will soon cause gullies to form in the dam. Once this damage starts, it can quickly cause a large discharge of wastewater and possible dam failure.

EMERGENCY ACTION PLAN

PHONE NUMBERS

DIVISION OF WATER QUALITY (DWQ) _____
EMERGENCY MANAGEMENT SERVICES (EMS) _____
SOIL AND WATER CONSERVATION DISTRICT (SWCD) _____
NATURAL RESOURCES CONSERVATION SERVICE (NRCS) _____
COOPERATIVE EXTENSION SERVICE (CES) _____

This plan will be implemented in the event that wastes from your operation are leaking, overflowing or running off site. You should not wait until wastes reach surface waters or leave your property to consider that you have a problem. You should make every effort to ensure that this does not happen. This plan should be posted in an accessible location for all employees at the facility. The following are some action items you should take.

1. Stop the release of wastes. Depending on the situation, this may or may not be possible. Suggested responses to some possible problems are listed below.

A. Lagoon overflow - possible solutions are:
   a) Add soil to berm to increase elevation of dam.
   b) Pump wastes to fields at an acceptable rate.
   c) Stop all flow to the lagoon immediately.
   d) Call a pumping contractor.
   e) Make sure no surface water is entering lagoon.

B. Runoff from waste application field-actions include:
   a) Immediately stop waste application.
   b) Create a temporary diversion to contain waste.
   c) Incorporate waste to reduce runoff.
   d) Evaluate and eliminate the reason(s) that cause the runoff.
   e) Evaluate the application rates for the fields where runoff occurred.

C. Leakage from the waste pipes and sprinklers - action include:
   a) Stop recycle pump.
   b) Stop irrigation pump.
   c) Close valves to eliminate further discharge.
   d) Repair all leaks prior to restarting pumps.

D. Leakage from flush systems, houses, solid separators - action include:
   a) Stop recycle pump.
   b) Stop irrigation pump.
   c) Make sure siphon occurs.
   d) Stop all flow in the house, flush systems, or solid separators.

E. Leakage from base or sidewall of lagoon. Often this is seepage as opposed to flowing leaks - possible action:
   a) Dig a small sump or ditch from the embankment to catch all seepage, put in a submersible pump, and pump back to lagoon.
   b) If holes are caused by burrowing animals, trap or remove animals and fill holes and compact with a clay type soil.

c) Have a professional evaluate the condition of the side walls and the lagoon bottom as soon as possible.

2. Assess the extent of the spill and note any obvious damages.

   a. Did the waste reach surface waters?
   b. Approximately how much was released and for what duration?
   c. Any damage notes, such as employee injury, fish kills, or property damage?
   d. Did the spill leave the property?
   e. Does the spill have the potential to reach surface waters?
   f. Could a future rain event cause the spill to reach surface waters?
   g. Are potable water wells in danger (either on or off the property)?
   h. How much reached surface waters?

3. Contact appropriate agencies.

   a. During normal business hours call your DWQ regional office; Phone #, After hours, emergency number: (919) 733-3942. Your phone call should include: your name, facility number, telephone number, the details of the incident from item 2 above, the exact location of the facility, the location or direction of the movement of the spill, weather and wind conditions. The corrective measures that have been under taken, and the seriousness of the situation.
   b. If the spill leaves property or enters surface waters, call local EMS phone number.
   c. Instruct EMS to contact local Health Department.
   d. Contact CE's phone number, local SWCD office phone number and the local NRCS office for advice / technical assistance phone number.

4. If none of the above works call 911 or the Sheriff's Department and explain your problem to them and ask the person to contact the proper agencies for you.

5. Contact the contractor of your choice to begin repair or problem to minimize offsite damage.

   a. Contractors Name: _____
   b. Contractors Address: _____
   c . Contractors Phone: _____

6. Contact the technical specialist who certified the lagoon (NRCS, Consulting Engineer, etc.)

   a. Name: _____
   b. Phone: _____

7. Implement procedures as advised by DWQ and technical assistance agencies to rectify the damage, repair the system, and reassess the waste management plan to keep problems with release of wastes from happening again.

INSECT CONTROL CHECKLIST FOR ANIMAL OPERATIONS

Source	Cause	BMP's to Minimize Odor	Site Specific Practices
		(Liquid Systems)	
Flush Gutters	Accumulation of solids	( ) Flush system is designed and operated sufficiently to remove accumulated solids from gutters as designed. ( ) Remove bridging of accumulated solids at discharge	
_ Lagoons and Pits	Crusted Solids	( ) Maintain lagoons, settling basins and pits where pest breeding is apparent to minimize the crusting of solids to a depth of no more than 6-8 inches over more than 30% of surface.	
Excessive Vegetative Growth	Decaying vegetation	(✓)Maintain vegetative control along banks of lagoons and other impoundment's to prevent accumulation of decaying vegetative matter along water's edge on impoundment's perimeter.	
		(Dry Systems)	
Feeders	Feed Spillage	( ) Design, operate and maintain feed systems (e.g.. bunkers and troughs) to minimize the accumulation of decaying wastage. ( ) Clean up spillage on a routine basis (e.g. 7-10 day interval during summer; 15-30 day interval during winter).	
Feed Storage	Accumulation of feed residues	( ) Reduce moisture accumulation within and around immediate perimeter of feed storage areas by insuring drainage away from site and/or providing adequate containment (e.g., covered bin for brewer's grain and similar high moisture grain products). ( ) Inspect for and remove or break up accumulated solids in filter strips around feed storage as needed.	
Animal Holding Areas	Accumulation of animal wastes and feed wastage	( ) Eliminate low area that trap moisture along fences and other locations where waste accumulates and disturbance by animals is minimal. ( ) Maintain fence rows and filter strips around animal holding areas to minimize accumulations of wastes (i.e. inspect for and remove or break up accumulated solids as needed).	

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Dry Manure Handling Systems	Accumulations of animal wastes	( ) Remove spillage on a routine basis (e.g. 7-10 day interval during summer; 15-30 days interval during winter) where manure is loaded for land application or disposal. ( ) Provide for adequate drainage around manure stockpiles ( ) Inspect for and remove or break up accumulated wastes in filter strips around stockpiles and manure handling areas as needed.

The issues checked ( ) pertain to this operation. The landowner / integrator agrees to use sound judgment in applying insect control measures as practical.

I certify the aforementioned insect control Best Management Practices have been reviewed with me.

_____
(Landowner Signature)

For more information contact the Cooperative Extension Service, Department of Entomology, Box 7613, North Carolina State University, Raleigh, NC 27695-7613.

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SWINE FARM WASTE MANAGEMENT ODOR CONTROL CHECKLIST

Source	Cause	BMP's to Minimize Odor	Site Specific Practices
_ Farmstead	Swine production	( )Vegetative or wooded buffers: ( )Recommended best management practices; ( )Good judgment and common sense	
Animal body surfaces	Dirty manure covered animals	( )Dry floors	
Floor surfaces	Wet manure-covered floors	( )Slotted floors; ( )Waterers located over slotted floors; ( )Feeders at high end of solid floors; ( )Scrape manure buildup from floors; ( )Underfloor ventilation for drying	
Manure collection pits	Urine Partial microbial decomposition	( )Frequent manure removal by flush, pit recharge or scrape ( )Underfloor ventilation	
Ventilation exhaust fans	Volatile gases Dust	( )Fan maintenance; ( )Efficient air movement	
Indoor surfaces	Dust	( )Washdown between groups of animals ( )Feed additives; ( )Feeder covers; ( )Feed delivery downspout extenders to feeder covers	
Flush Tanks	Agitation of recycled lagoon liquid while tanks are filling	( )Flush tank covers ( )Extend fill lines to near bottom of tanks with anti-siphon vents	
Flush alleys	Agitation during waste water conveyance	( )Underfloor flush with underfloor ventilation	
Pit recharge points	Agitation of recycled lagoon liquid while pits are filling	( )Extend recharge lines to near bottom of pits with anti-siphon vents	
Lift stations	Agitation during sump tank filling and drawdown	( )Sump tank covers	
Outside drain collection or junction boxes	Agitation during waste water conveyance	( )Box Covers	
End of drain pipes at lagoon	Agitation during waste water	( )Extend discharge point of pipes underneath lagoon liquid level	
Lagoon surfaces	Volatile gas emissions Biological mixing Agitation	( )Proper lagoon liquid capacity ( )Correct lagoon startup procedures ( )Minimum surface area-to-volume ratio ( )Minimum agitation when pumping ( )Mechanical aeration ( )Proven biological additives	
Irrigation sprinkler nozzles	High pressure agitation Wind draft	( )Irrigate on dry days with little or no wind ( )Minimum recommended operation pressure ( )Pump intake near lagoon liquid surface ( )Pump from second-stage lagoon	

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Storage tank or basin surface	Partial microbial decomposition Mixing while filling Agitation when emptying	( )Bottom or midlevel loading ( )Tank covers ( )Basin surface mats of solids ( )Proven biological additives or oxidants
Settling basin surface	Partial microbial decomposition Mixing while filling Agitation when emptying	( )Extend drainpipe outlets underneath liquid level ( )Remove settled solids regularly
Manure, slurry or sludge spreader outlets	Agitation when spreading Volatile gas emissions	( )Soil injection of slurry/sludges ( )Wash residual manure from spreader after use ( )Proven biological additives or oxidants
Dead animals	Carcass decomposition	( )Proper disposition of carcasses
Dead animal disposal pits	Carcass decomposition	( )Complete covering of carcasses in burial pits ( )Proper location / construction of disposal pits
Incinerators	Incomplete combustion	( )Secondary stack burners
Standing water around facilities	improper drainage maintenance Microbial decomposition of organic matter	( )Farm access road away from facilities
_ Manure tracked onto public roads from farm access	Poorly maintained access roads	( )Farm access road maintenance

Additional Information:	Available From:
Swine Manure Management 0200 Rule / BMP Packet	NCSU-County Extension Center
Swine Production Farm Potential Odor Sources and Remedies, EBAE Fact Sheet	NCSU-BAE
Swine Production Facility Manure Management:Pit Recharge--Lagoon Treatment:EBAE128-88	NCSU-BAE
Swine Production Facility Manure Management:Underfloor Fluse-Lagoon Treatment 129-88	NCSU-BAE
Lagoon Design and Management for Livestock Manure Treatment and Storage; EBAE103-83	NCSU-BAE
Calibration of Manure and Wastewater Application Equipment EBAE Fact Sheet	NCSU-BAE
Controlling Odors from Swine Buildings; PIH-33	NCSU-Swine Extension
Environmental Assurance Program: NPPC Manual	NC Pork Producers Assoc
Options for Managing Odor; a report from the Swine Odor Task Force	NCSU Agri Communication
Nuisance Concerns in Animal Manure Management: Odors and Flies; PR0101, 1995 Conference Proceedings	Florida Cooperative Extension

The issues checked ( ) pertain to this operation. The landowner / integrator agrees to use sound judgment in applying odor control measures as practical.

I certify the aforementioned odor control Best Management Practices have been reviewed with me.

_____

(Landowner Signature)