



**Water Quality &
Waste Management**

Management of Dairy Wastewater

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A manure management system for a modern dairy should be capable of controlling solid or liquid manure and wastewater from milkrooms and parlors, holding areas, open paved feeding areas, freestall barns, heifer and calf barns, and dirt exercise and lounging areas. Unusually wet winters or springs emphasize the point that milking center wastewater and lot rainfall runoff should be handled and controlled separately from the scraped manure. It is important that producers have a selection of options to accommodate varying herd sizes, management and production strategies, farm objectives, locations and climatic factors.

WASTEWATER REDUCTION

Surface Water Diversion Barnyard runoff can be reduced by diverting all surface or clean water around the dairy complex using diversion terraces and subsurface drains. Much of the lot runoff is reduced by the growing usage of totally roofed freestall barns and other lounging and paved areas. Guttering of roofs draining onto paved lots is cost-effective, but gutter maintenance can be difficult. One dairyman reduced the loads of manure that were scraped and hauled by one-third by guttering and preventing mixing of the roof rainwater with manure solids on the lot surface. Spillage and leakage from cow waterers in the lot area should be minimized or eliminated.

All lot runoff should be routed around single-stage manure storages (dry stacks, earthen slurry pits, sumps for above ground tanks, etc.) and handled by a separate wastewater system. Excess water in liquid manure storages increases hauling and spreading costs and tends to hinder the formation of surface mats resulting in greater losses of nitrogen and potential odorous emissions.

Milking Center Water for cleaning the milk center should be reduced to only that quantity essential for sanitation.

Clean water used solely for cooling purposes should be collected and reused for floor cleaning, flushing or to water cows. Dairies using parlor flush tanks for floor cleaning and/or prep stalls or cow wash sprinklers in holding areas require large amounts of clean water greatly increasing the wastewater to be handled. Wastewater generated from the milking center should bypass single-stage liquid manure storage pits or tanks and be routed to a separate wastewater handling system except when dilution water is needed for slurry agitation and pumping.

RETENTION POND - IRRIGATION

Collection All barnyard runoff and milking center wastewater must be collected and delivered to a storage or treatment area. Most dairy lots slope in more than one direction sometimes requiring complex collection systems consisting of regrading, curbs, diversions, open channels, pipes, or even lift pumps.

Retention Pond The conventional method for wastewater management consists of an earthen retention pond to collect and temporarily store all wastewater until it can be land applied by irrigation. This system is especially recommended where large wastewater volumes are generated by flush tanks, cow wash sprinklers, or wide expanses of open lot contributing barnyard runoff. A shallow concrete solids settling basin, similar to NCAES Plan 388, is recommended to intercept wastewater from drainlines prior to the retention pond and trap any manure solids. These solids are easily removed by front-end loader and handled with the scraped manure. Addition of manure solids to a wastewater retention pond increases the likelihood of odorous emissions, sludge buildup, or irrigation equipment problems.

A retention pond should have enough capacity to store a 180-day accumulation of wastewater such that field spreading would not be necessary during winter months. Pond liquid levels should be lowered throughout the spring and summer as time permits and wastewater uses exist. The pond should definitely be lowered as much as possible by late fall to allow enough storage capacity for an extended rainy season.

Second - Stage Lagoon Lot scraped manure should never be added to a retention pond. If an earthen manure storage basin is used for the lot scraped manure, then a second-stage lagoon is desirable for wastewater storage to facilitate removal and spreading.

Irrigation Retention pond wastewater is most economically and efficiently applied to cropland, pasture, or woodland by irrigation at agronomic rates not exceeding the soil infiltration rate. Irrigation should not occur closer than approximately 25 feet to a streambank or property boundary. The solids content of retention pond wastewater without solids separation should be less than 4% and can be applied through moderate pressure portable irrigation systems with nozzle sizes 1/2 to 3/4-inch or larger. Where solids have been separated from the wastewater, permanent or solid-set irrigation systems with 1/4 to 9/32-inch nozzles would be more labor-free. This wastewater could also be applied through low-pressure perforated or gated pipe provided the pipe is moved frequently.

VEGETATIVE FILTER

An alternative to the retention pond - irrigation system is a vegetative filter with a manure solids settling basin. These filters can be pasture, grassed waterways, or even cropland where wastewater is treated by settling, dilution, soil infiltration, and crop uptake of nutrients. Some dairy lots might already have some form of vegetative filter while others could add this component with a minimum of expense and effort.

These systems are planned on the premise that all or a major portion of the lot runoff and wastewater infiltrates into the ground with the remaining runoff filtered to a degree that would have minimal impact on surface waters. Since these filters have infrequent discharges, the state regulatory agency has taken a wait-and-see attitude before giving a blanket stamp of approval. Intensive monitoring of a North Carolina dairy farm vegetative filter treatment system as well as performance results from other states indicate that over 95% of the nutrients, solids, and oxygen-demanding materials are removed from the wastewater.

Settling Basin A settling basin to separate manure solids from the wastewater is essential to prevent the upper side of the vegetative filter from clogging with solids and reducing soil infiltration. The most common type of settling basin

is a shallow, reinforced concrete structure with a sloping entrance ramp to permit equipment access for solids cleanout (NCAES Plan 388). Wastewater flows into the top of the basin where solids settle by gravity and liquid either overflows or filters through an outlet. This outlet should be 3 feet or more wide, the full depth of the basin, and located in a side wall near the bottom of the access ramp. The outlet may consist of removable boards placed in side wall slots. By remaining in place the boards hold water in the basin allowing liquids to gradually overflow the top of the outlet. Just prior to solids cleanout, the boards are slowly lifted allowing the basin to dewater as much as possible. Solids are removed by tractor front-end loader and field spread with other solid manure. Another outlet type consists of an expanded metal or woven wire screen with 1/2-inch grid openings. This outlet allows continuous dewatering of the basin. All basin outlets are troublesome to some extent, and should be planned to be easily cleaned. Two basins allow one to be used while the other is drying out for cleaning.

Design criteria for basin sizing are based on retaining wastewater in the basin for at least 30 minutes during peak inflow plus a one-foot depth for solids storage between cleanouts. A 1-year, 1-hour rainfall intensity is suggested for determining the feedlot area peak runoff rate. Performance data from a North Carolina dairy suggests a basin manure solids accumulation rate of 0.05 cubic foot per cow per day. Solids should be removed from the basin monthly or after each heavy rainfall event. Proper construction and management of the settling basin is essential to the success of the vegetative filter.

Vegetative Filter Vegetated areas receiving settling basin liquid overflow consist of either an overland flow plot or a shallow grassed channel or waterway. These areas should be bermed or terraced so that all surface water outside the infiltration area is diverted.

Overland Flow The overland flow system is a wide (up to 100 feet), mildly sloping area in which wastewater is evenly distributed across the filter width and allowed to flow down the length of the filter surface. Filter cross slopes should be relatively flat. Slopes lengthwise should not be flatter than 1% and in most cases not greater than 4%. If the filter slopes more than 4%, then cross terraces dividing the total filter length into four equal flow segments reduce flow velocities and redistribute the wastewater across the filter width allowing more opportunity for infiltration. Water tends to pond behind these cross terraces eventually infiltrating. Over a period of time, the soil in these areas will likely seal and need renovation.

Distribution The method of distributing liquid overflow from the settling basin across the overland flow filter width is critical. Several methods have been used, all of them, however, requiring some degree of maintenance. The greater the number of discharge points, the better the distribution system operates. One method consists of multiple pipes fanning out from the settling basin with tee outlets at the filter area. Another method utilizes a pipe split in half lengthwise forming a semi-circular trough, laying it level across the filter width, and allowing liquid to fill and overflow this trough uniformly across the filter. Sections of level gated pipe across the filter width can also be used.

Size The size of the overland flow area depends on soil characteristics and generally ranges from 1 to 2 times the feedlot area draining into the filter.

Channelized Terrace The second type of vegetative filter is a channelized flow or grassed infiltration terrace. These terraces have a trapezoidal cross-section with a one-foot depth and a level bottom width of 6-10 feet. The first quarter of the channel length should be sloped approximate 2% to move wastewater away from the settling basin outlet, the second quarter sloped 1%, and the last half sloped 0.5% or just enough to prevent ponding. Successful channel filter treatment lengths in North Carolina have been at least 4 feet per cow. Dual channels allow alternate dosing and drying. These channels should not outlet directly into a stream or drainageway.

Construction Extreme care should be taken during construction of a vegetative filter. Since infiltration is most important, every effort should be made to maintain soil integrity and permeability. Clay soils, in particular, should not be worked or compacted when wet. If it is impossible to use these precautions during construction, then a subsoiler should be used to break up hardpans or impermeable layers followed by seeding with a grass that has a deep root system. Mulching, fertilizing, liming, and even watering should be utilized to establish a healthy sod as soon after seedbed preparation as possible to prevent soil erosion.

Management Vegetative filter areas should be prepared and seeded at least one growing season before use. A forage combination of fescue and reed canary grass is suggested. When the forage height reaches 12 inches, it should be

clipped to about 6 inches and removed from the filter area. Avoid cutting and harvesting when the filter area is too wet. Also do not remove late fall forage to allow a tall forage growth to aid in filtering winter and spring runoff. Cattle should be fenced out of the wettest portions of the filter area.

Alternate dosing and drying of the upper end of the filter appears to be important to maintaining vegetative growth. The settling basin outlet should be managed to release a portion of the liquids into the filter area on a 3-4 day schedule. The outlet then should be closed allowing the filter area to dry between dosings. Soil samples should be analyzed from the filter area periodically to monitor buildups of nutrients, salts or other constituents which might become detrimental to forage growth.

Economics Vegetative filters are not adaptable to operations having large amounts of paved feedlot area draining into the filter or to facilities using large amounts of water in the milking center. However, they can provide a satisfactory, low-cost, low-management means of controlling barnyard runoff and milking center wastewater for many small and medium-sized dairies. These systems can be constructed for less than \$100 per cow for most dairies compared to 3 to 5 times that amount for conventional retention pond-irrigation systems.

Given the economy, simplicity and treatment potential of vegetative filters, they are likely to be more readily adopted by dairymen than conventional systems resulting in up to 95% reduction of dairy wastewater inputs to streams.

SUMMARY

Dairymen should objectively survey their operations and determine ways of inexpensively reducing wastewater inputs to nearby streams or drainageways. After weighing the important advantages and disadvantages of available wastewater management techniques, a dairyman must make a decision, then commit to providing the attention and management necessary to make that system function. No system will take care of itself. When faced with regulatory action, a proper functioning manure and wastewater management plan becomes just as important as feeding and milking the cows.

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