K-STATE Kansas State University

FARM•A•SYST
Farmstead Assessment System

Fact Sheet 7

Reducing the Risk of Groundwater Contamination by
Improving Animal Waste Management

A major consideration of animal waste management is prevention of pollution. Runoff from animal lots carries manure, soil and other debris, and may contaminate surface and groundwater sources. Results from a recent Kansas farmstead well study have shown animal feeding sites to be a significant source of high nitrates in Kansas farmstead water wells. A system is needed for preventing lot runoff from leaving the owner's property, or entering surface or groundwater, in a contaminated condition.

Along with addressing the potential of animal lots to pollute water, other good reasons for improving management practices include improved animal health, ease of maintenance and quality production.

Waste storage is an important management option available to livestock producers. Handling manure properly ensures the farmer of the maximum fertilizer value from the waste materials, while reducing risks of groundwater and surface water contamination from the over-application of nutrients.

Proper waste storage eliminates the need for land application during winter months when soil is frozen. This saves wear and tear on farm equipment, conserves nutrients contained in the manure and minimizes manure nutrient leaching and runoff. Storage is also valuable during extended periods of bad weather and when crops are actively growing, making application impractical.

1. Location of Animal Lots and Waste-Handling Facilities

The location of animal facilities in relation to any well is an important factor in protecting the farm water supply. Wells should be located in an elevated area upslope of animal facilities so that runoff will not drain into the vicinity of the well.

Distance from well

Kansas regulations require a minimum separation distance of 100 feet for all livestock facilities, but larger distances are strongly recommended. For temporary manure stacks and earthen storage facilities, the minimum separation distance should be at least 250 feet. Results of a farmstead well study indicate that this separation distance must be at least 400 feet in order to assure protection from high nitrates in well water.

While observing these separation distances may help to protect your own well, poorly designed or poorly maintained animal lots and waste storage facilities could still contaminate the groundwater that supplies other wells. Protecting the groundwater resource as a whole can help protect drinking water supplies for future generations. For more information about separation distances, and how the condition of your well might affect the potential for contamination, see Worksheet and Fact Sheet 1, *Drinking Water Well Condition,* and Extension publication MF-970, *Safe Domestic Wells.*

For glossary, see page 2 of Worksheet 7.

Site characteristics

Soil characteristics are one important factor when considering groundwater protection in siting an animal lot. Important soil characteristics include surface and subsoil

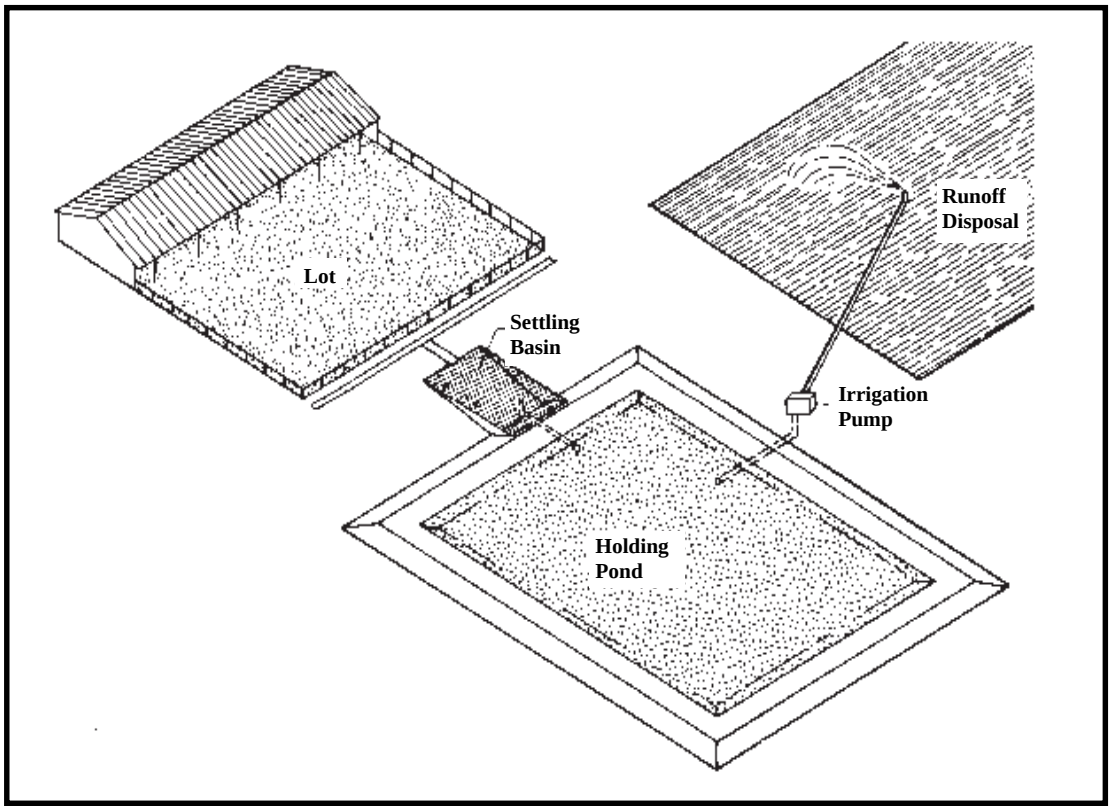

Figure 1: Detention pond for storage of livestock lot runoff. *Source: Dairy Housing and Equipment Handbook, MWPS-7, Midwest Plan Service, Ames, Iowa.*

texture, soil depth, permeability and drainage class. The best site has a deep, well-drained silt loam/clay loam soil with low permeability. A very poor site has shallow soil (a high water table) or a very sandy/gravelly soil with excessive drainage and high permeability. Kansas Department of Health and Environment (KDHE) standards prohibit lots located on fractured bedrock or gravel.

KDHE design standards require at least one foot of compacted clay liner over any rock, gravel or sand material below an earthen waste storage structure. Vertical separation between the lowest elevation of a feedlot or associated waste control structure and the seasonal high water table must be at least 10 feet.

For more assistance in assessing your site's vulnerability to groundwater contamination, see Worksheet 8, *Site Evaluation.*

2. Design and Management of Animal Lots

Good management, such as keeping the lots clean and preventing any runoff from moving towards the well, can help to protect your well water. Contact a specialist for assistance in designing a system to protect groundwater and surface water sources.

Clean water diversion

One way of reducing water pollution from animal lots is to reduce the amount of clean water entering the lot. In all cases, these structures need to be maintained.

- Waterways, small terraces and roof gutters direct water away from animal lots.
- An earthen ridge or diversion terrace can be constructed across the slope upgrade from a animal lot to prevent runoff from entering the lot.
- In some areas, if a diversion terrace is not practical, a catch basin with a tile outlet could be installed above the lot.

Careful site selection can minimize or eliminate the provisions needed to divert clean water away from the lot.

Runoff control systems

An animal lot without a runoff control system typically has an earthen surface compacted by animal traffic. This surface is not shaped for water drainage, so it is sometimes dry and sometimes muddy. Manure typically accumulates on the surface, and decaying manure is mixed into the soil by animal traffic.

Such a lot is difficult to manage, and the absence of runoff controls may lead to water quality problems. Runoff from adjacent cropland, pasture, roads or building roofs can flush manure from the lot, possibly entering nearby bodies of surface water or creating mudholes.

Contaminated runoff from an active feedlot that accumulates in areas adjacent to the lot may flow through the soil and threaten groundwater quality. This risk is particularly high on sites with high infiltration and percolation rates, such as sandy soils and other soils with good to moderate drainage.

Runoff control systems can remedy such problem situations. These systems collect livestock lot runoff, settle out manure solids, and direct the remaining water to holding ponds which collect and store runoff for later land application (Figure 1). Another option is to direct the runoff for even distribution on open grassed areas or filter strips, away from streams, ditches, waterways and areas of permeable soils and creviced bedrock. Figure 2 diagrams a typical livestock lot runoff control system.

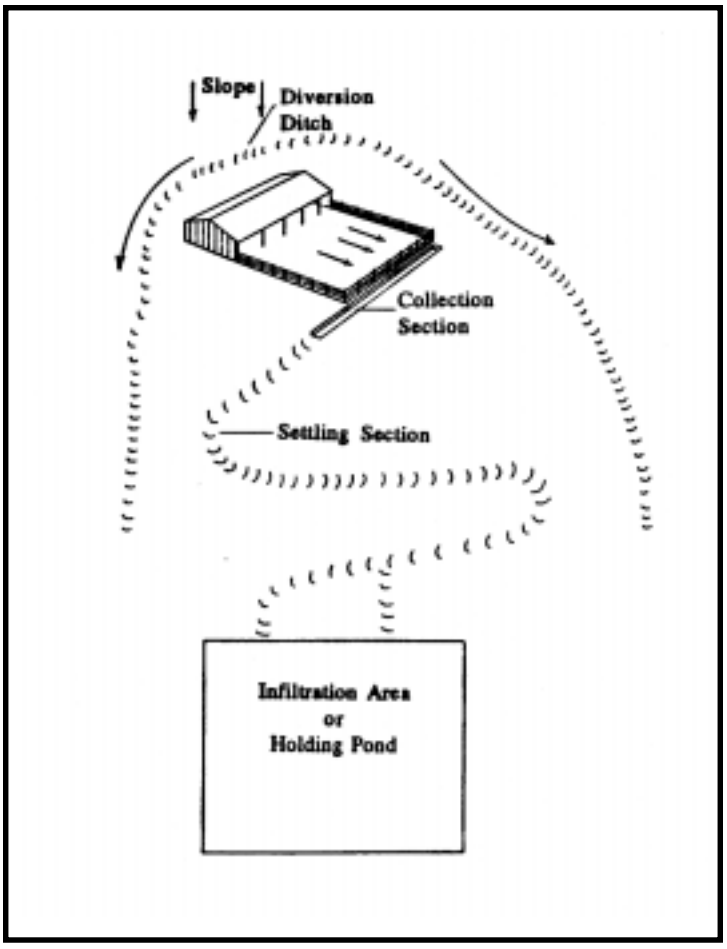

Figure 2: Typical Livestock Lot Runoff Management System. *Source: Livestock Waste Facility Handbook, MWPS-18, Midwest Plan Service, 1985.*

The need for runoff control facilities is dependent on several factors related to the size and type of livestock operation as well as surface characteristics and management practices of the operation. Some operations, due to size and management, may not need structural controls.

The Kansas Department of Health and Environment enforces the registration and regulation of livestock operations which have water pollution potential. No registration is required for operations with less than 300-head capacity unless the operation has pollution potential or a neighboring complaint is issued. Operators are not allowed to have pens adjoining or draining into a road ditch, creek, or other channel without adequate control because of the pollution potential. Frequent cleaning of pens and proper disposal of manure onto cropland or pasture can minimize pollution potential.

More information on registration and regulatory requirements is available by contacting the district KDHE office for your area (see contacts and references).

Animal lot cleaning

The proper approach for manure collection should be that of “manure harvesting” rather than “cleaning pens.” Collect manure from animal lots regularly. The amount of manure on an animal lot depends on the number of animals and the hours per day animals spend on the lot. KDHE recommends scraping of open lots at least twice per year. Heavy concentrations of animals will require manure removal more often. The type of lot surface also affects lot management. Concrete surfaces are easier to scrape than earthen lots. Since earthen lots are scraped when dry, manure may be removed less frequently than is desirable.

Lots should not be cleaned to bare dirt—but often are. When earthen lots are scraped, a thin layer (1 to 2 inches) of manure pack should be left to seal the surface of the lot. Water moves very slowly through this compacted layer, minimizing the potential for leaching of nitrates and bacteria through the soil to groundwater. The only time you need to collect all the manure from a lot is when the lot is either going to no longer be used, or to be left empty for an extended period of time. Lots that are only used seasonally should be scraped clean at least annually. KDHE recommends the lots be cleaned right after each cycle of livestock in the lot.

Type of lot surface

The area needed per animal for minimizing the risk of groundwater contamination depends on the type of lot surface, lot slope, amount of rainfall and other lot management factors. The amount of concrete surface area needed is much less than that required for an earthen lot.

The concrete area needed is a balance between traffic on the lot and resting area provided for animals. Too large an area can result in manure freezing to the surface for long periods, while too small an area will result in animals having difficulty moving about. At least 50 square feet of concrete area per head is recommended for a cattle feedlot. Facilities for growing-finishing pigs in lots with open-front sheds should provide 12 to 15 square feet of outdoor lot space per pig.

For beef cattle operations, open feedlots are usually unpaved. Recommended slopes for good drainage are 2 to 4 percent. Minimum space recommendations are 150 to 250 square feet per head with 4 percent or greater slopes; 250 to 400 square feet with 2 to 4 percent slopes; and 400 to 800 square feet with slopes below 2 percent.

Mounds improve drainage and provide areas that dry quickly. Feedlot mounds should be about 3 to 4 feet high with 5 to 1 side slopes (horizontal to vertical). Mounds can

be built down the center of the lot or at the fence line with half of the mound in adjacent pens. Besides improving drainage conditions, mounds provide a wind break from cold wind.

Lot management involves considerations other than surface and groundwater protection. In addition to decreasing the chance for groundwater contamination, a well drained and dry lot improves animal comfort, health and feed utilization. A combination of lot surfaces offers the most flexibility in adapting to weather conditions. Animal location can be chosen based on the amount of mud in the lot—on concrete in sloppy conditions, on an earthen surface in dry weather, and on a mound in intermediate conditions.

If bedrock is close to the surface where your animal lot is located, pave the surface with concrete, or totally confine livestock.

Abandoned animal lots

With active feedlots, the layer of organic matter mixed with soil at the surface lies over compacted subsurface soil, forming a layer through which water moves very slowly. Therefore, leaching of nitrate and bacteria through the surface seal and compacted layers is not likely within the lot. If lot runoff is discharged to permeable soils or bedrock, leaching may occur. Studies have found little nitrate in the soil beneath active feedlots.

Nevertheless, abandoned lots can pose a particular groundwater contamination risk. As the manure pack breaks up from lack of use, water can leach through and carry nitrates to groundwater.

If you have a permanently abandoned lot, dig it up, spread the manure and soil combination on fields, and refill the former lot with other material. Another option is to till and plant the lot to a high-nitrogen-using crop, which will use the nitrogen released by soil and the manure decomposition process. Remove manure from a lot that will not be used for an extended period. Otherwise, cracks developing in the surface may allow leaching of nitrates.

3. Storage of animal wastes (120-day minimum)

Livestock wastes can be stored either in solid, semi-solid or liquid states.

- Solid facilities use walls and slabs for stacking manure mixed with large amounts of bedding.
- Semi-solid facilities use pumps to move manure into containment areas and may separate solids from liquids.
- Liquid facilities hold manure in tanks, pits or earthen holding ponds.

Liquid and semi-solid storage systems are self-contained. Groundwater contamination can occur if the facility is not properly sealed, allowing waste to seep into the soil. A threat to surface water exists if pits are not emptied frequently enough, allowing wastes to flow over the top of the structure. Liquid storage systems use pipelines and/or pumps to move wastes from the barn or collection area to the storage structure. These must be carefully installed and maintained to ensure that they do not leak.

Each time they are emptied, carefully check **steel and concrete structures** for cracks or the loss of watertight seals. If any breaks are apparent, repair them immediately. Likewise, check the walls of **earthen waste storage pits** when emptied to be certain that liner materials are not cracked or eroded away.

After a period of years, freezing, thawing, wetting and drying, as well as pit agitation, may cause the sidewalls of earthen pits to crack and erode, allowing wastes to seep

into the underlying soil or subsurface geologic material. Groundwater contamination will result if the subsurface materials do not have sufficient ability to break down contaminants contained in the leachate. For this reason, the compacted clay liner should be monitored closely and replaced as needed.

While seepage from inground waste storage facilities is not always easy to recognize, there are some tell-tale signs:

- A properly designed structure has the capacity to handle wastes from a specific number of animals for a known number of days. If a pit designed for 180 days of storage receives designated waste amounts but does not fill to the design level in six months, the pit may be leaking.

- Evaporation from liquid storage pits is minimal during the late fall, winter, and early spring. If additional liquids have to be added before a pit can be agitated and pumped, it may be leaking. During warmer months addition of liquids may frequently be needed for pumping due to evaporation losses. Monitoring wells installed around the pit upslope and downslope would be required to confirm seepage. Seepage rates for all earthen impoundments in Kansas are required to be less than 1/4 inch per day.

Some solid or semi-solid manure storage facilities are designed to allow seepage from the waste stack. In this case, there is both a solid and a liquid waste component. While this type of facility is generally loaded mechanically, such as with a tractor and loader, rainfall and lot runoff may also enter the structure. Three options are available to control seepage—liquid containment or storage structures, vegetative filters, or exclusion of rainfall and runoff.

Liquid containment structures include earth holding ponds and concrete tanks. Pre-fabricated tank-type structures are also available. These minimize the risk of pollution as long as they are properly constructed and seepage from earthen structures can be minimized.

Vegetative filters consist of areas of perennial vegetation, usually grass, that allow liquids to flow slowly through thick vegetation, seep into the soil, and ultimately be used by the vegetation. Nutrients in the liquid are used by the plants. One of the main limitations of this type of system is that liquid wastes are often very concentrated and tend to "burn" and kill the vegetation. Vegetative filters should not be considered where liquid wastes are very concentrated, where there are sandy soils, or where fractured bedrock or water tables are close to the ground surface.

Building a roof over the storage structure, and diverting any drainage away, will exclude rainfall and runoff. Additionally, roofed storage systems require adequate bedding in the waste to absorb and retain the liquid portion of the manure.

4. Temporary stockpiling of animal wastes

Kansas standards require 120-day minimum storage capacity for liquid and solid wastes. Temporary stockpiling, however, allows producers to hold animal wastes during periods of bad weather when spreading may not be feasible, when crops are growing and land is not available for applying manure, or when there is a shortage of crop acres to handle frequent spreading of manure without the threat of runoff.

Many farmers will scrape manure into **piles in the livestock lot** rather than haul it during bad weather or busy work periods. This practice is not recommended because of possible herd health problems and water pollution. The severity of those problems depends on characteristics of the animal lot area where the manure is piled and the

area to which runoff flows. If manure is frequently stacked in lots, it might be appropriate to consider constructing a storage facility.

Storage systems may also be applicable for those farmers who often find themselves having to **stack manure in fields,** particularly during periods of bad weather. This is not a recommended practice. No matter how it is done, it poses a contamination threat to surface water and groundwater.

Many farmers have animal housing, such as pole sheds, where wastes are allowed to accumulate for extended periods of time. Roofs on these structures keep rain and snow off the manure. These structures are relatively safe for water quality if they are protected from surface water runoff, and if adequate bedding is provided to absorb liquids in the wastes. To minimize water quality impacts, **provide adequate bedding to reduce seepage and clean these sheds as frequently as possible**.

5. Milking center wastewater treatment

Wastewater from the dairy milking center includes wastes from the milking parlor (manure, feed solids, dirt) and milkhouse (bulk tank rinse water and detergents used in cleaning). Combining these wastes with manure has the advantage of allowing a common disposal system for both types of waste. A liquid manure storage facility, properly constructed and sized, provides the additional flexibility of storing wastes until they can be applied at the right time to the right sites (Figure 3).
This option is limited, however, to farmers who handle their manure in slurry form. While it adds to transportation and spreading costs, nutrients from dairy wastewater can be used to meet crop requirements, thus reducing fertilizer costs.

Milking center wastewater combined with runoff from solid manure storage or animal lots can be stored in a detention pond (Figure 1). The contents of the pond can be applied to fields when conditions are appropriate.

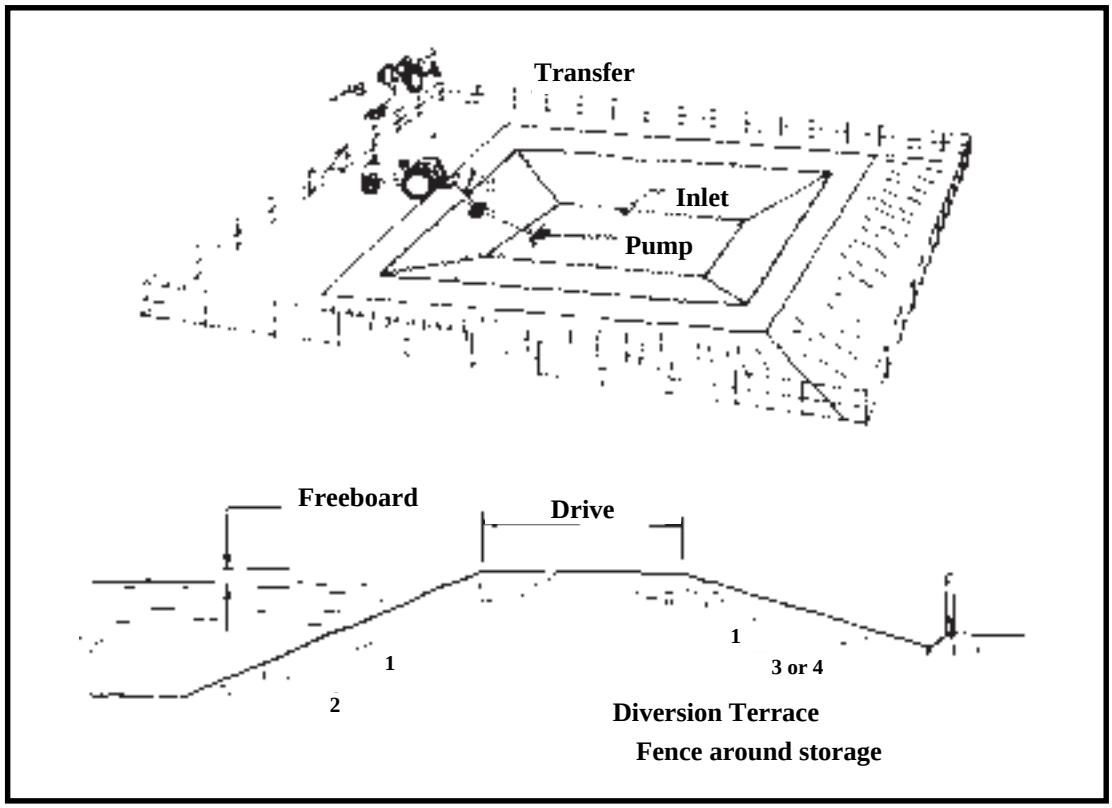

Figure 3: Earth basin for manure storage. *Source: Livestock Waste Facilities Handbook, MWPS-18, Midwest Plan Service, Ames, Iowa.*

6. Land application of animal wastes

Land application is the predominant method of utilization associated with animal waste management systems. When properly managed, land application allows for safe utilization of animal wastes and beneficial use of the nutrients and water by vegetation. Both solid and liquid wastes should be applied to land using rates and methods that prevent surface runoff of pollutants and leaching of pollutants to groundwater.

In Kansas, the days suitable for land application of waste include those on which no precipitation occurs and less than 0.05 inch of precipitation has occured on each of the preceding three days. The temperature during disposal activities should be above 32° F with non-frozen ground conditions and no snow cover.

Application of livestock wastes to cropland at low rates poses little danger to groundwater or surface water due to filtering by the soil or plant uptake of potential contaminants. Wastes should be incorporated whenever possible. If wastes are applied within 200 feet of any watercourse or water body, or within flood plains they should be incorporated within 24 hours. Concentrated liquid wastes are required to be incorporated within 12 hours of application unless they are applied to sites with heavy vegetative cover. Wastewater irrigation sites are required to have runoff control structures installed if the infiltration rate will be exceeded.

Methods involving application of wastes to the land surface should be tied to a soil analysis and a plan for utilization of these wastes by crops. Application rates should not exceed the nutrient or moisture needs of the plants growing or to be grown at the site and applied nutrients should be credited in the fertilizer program for the site.

7. Silage storage

The type of silo on your farm often has less effect on its potential to contaminate groundwater than the condition of the silo. Properly compacted clay soils and concrete floors can limit leachate seepage. Older structures can be relined to be made relatively water tight. Silo caps, covers or bags keep rain water from entering the silage, preserving a quality silage, but also reducing the potential for producing leachate. Horizontal or trench silos should be covered with a plastic sheet. Tires can be used to keep the cover in place.

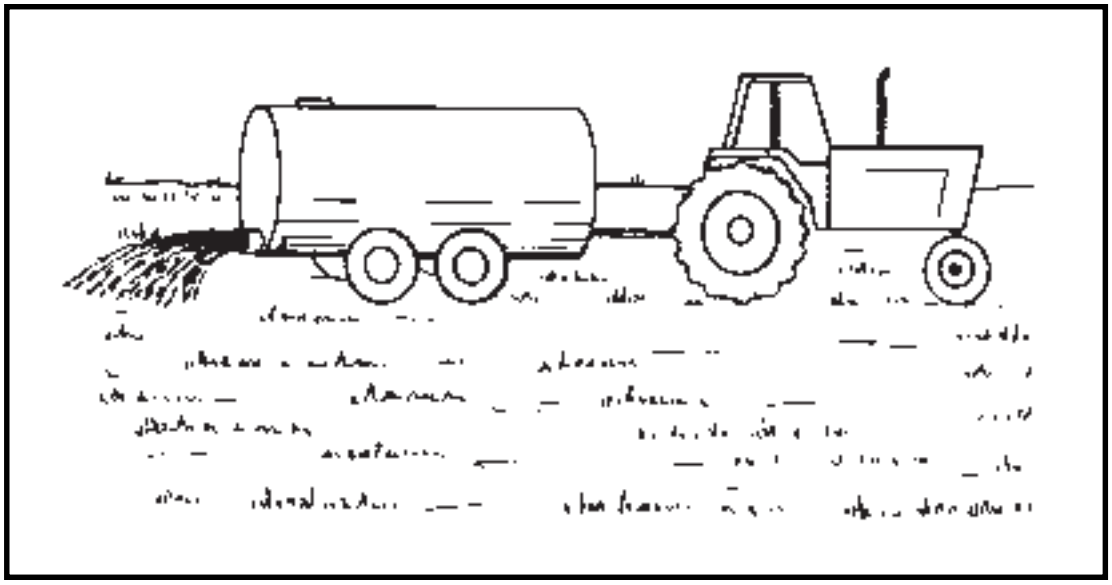

Figure 3: Land-spreading of liquid livestock wastes. *Adapted from Livestock Waste Facilities Handbook, MWPS-18, Midwest Plan Service. Adapted by Andy Hopfensperger, University of Wisconsin-Madison Department of Agricultural Engineering.*

It is important to divert clean water away from new and existing silage storage structures. For both vertical and horizontal silos, diverting clean water away can protect both groundwater and surface water.

8. Other management factors

If animal waste storage causes water contamination, KDHE can issue a notice which will require corrective measures. All animal waste storage structures must meet KDHE standards. Contact your county health department for information about local ordinances, your KDHE district office about state regulations, and your ASCS or Conservation District office about cost-sharing funds.

CONTACTS AND REFERENCES

Who to call about...

Technical standards and design assistance

A private design consultant, your county Extension, Conservation District (CD), or Soil Conservation Service (SCS) office; or the KDHE district office for your area:

Southwest District (Dodge City): (316) 225-0596
South Central District (Wichita): (316) 838-1071
Southeast District (Chanute): (316) 431-2390
Northeast District (Lawrence): (913) 842-4600
North Central District (Salina): (913) 827-9639
Northwest District (Hays): (913) 625-5664

Sources of financial assistance

Financial assistance for animal waste management practices, including waste storage, may be available as part of a priority watershed plan. Contact your local Extension, CD, ASCS, or SCS office; or the KDHE district office for your area (see above).

Animal waste management

Kansas Administrative Regulations 28-18-1 through 28-18-4 contain design standards and accepted animal waste management practices for confined animal feeding operations. Contact the KDHE Bureau of Water, at (913) 296-5502; your KDHE district office (see above); or your county Extension office.

Soil testing and waste analysis

Contact you county Extension agent for a list of individuals or businesses performing these services in your area.

What to read about...

Publications are available from sources listed at the end of the reference section. (Refer to number in parentheses after each publication.)

Groundwater contamination, protection and testing

Nitrates and Groundwater. MF-857. (1)
Managing the Farmstead to Minimize Groundwater and Well Contamination. MF-948. (1)
Groundwater and Well Contamination. MF-932. (1)
Safe Domestic Wells. MF-970. (1)
Ensuring Safe Drinking Water. MF-952. (1)
Suggested Water Tests for Private Systems. MF-871. (1)
Taking a Water Sample. MF-963. (1)
Commercial Laboratories Certified for Water Quality Tests. MF-872. (1)

Registration, permit and certification for livestock waste control facilities

Policy on Registration, Permit and Certification for Confined Livestock Facilities and Related Agricultural Waste Control Facilities. KDHE. (3)

Design criteria and general information

Livestock Waste Facilities Handbook. 1985. Midwest Plan Service. (2)
Emphasizes planning and design of livestock waste facilities and equipment. Chapter discussions include animal waste characteristics, collection and transport to storage, open lot waste handling, land application techniques and waste use. Extensive worksheet helps producers determine application rates for their system.

Beef Housing and Equipment Handbook. Midwest Plan Service. MWPS-6 (2)
Summarizes current agricultural engineering recommendations for beef producers. Discusses building design and operation, and necessary equipment. Includes building construction, manure management, farmstead planning and feed storage.

Sheep Housing and Equipment Handbook. Midwest Plan Service. MWPS-3. (2)
Provides information for planning an efficient sheep system. Sections include materials on managing facilities, building layouts, treating and handling facilities and manure management.

Swine Housing and Equipment Handbook. Midwast Plan Service. MWPS-8. (2)
Complete guide to sine building design, operation and equipment. Includes discussions of site selection, remodeling, and solid and liquid manure handling.

Dairy Housing and Equipment Handbook. Midwast Plan Service. MWPS-7. (2)
Presents dairy facility and equipment planning and design. Includes discussions of milking centers, manure management, silo capacities and basic farmstead planning principles.

Outside Liquid Manure Storages. 1979. Midwest Plan Service. AED-23. (2)
Discusses sizing, emptying and loading earth storage basins and non-earth aboveground storages.

KDHE Design Standards for Confined Livestock Facilities and Related Agricultural Waste Control Facilities. (3)

Circular Concrete Manure Tanks. 1983. Midwest Plan Service. TR-9. (2)

Liquid Manure Tanks: Rectangular, Below Grade. Midwest Plan Service. MWPS-74303. (2)

Land application of livestock waste

Livestock Waste Facilities Handbook. 1985. Midwest Plan Service. (2)
Includes information about animal waste characteristics, collection and transport to storage, open lot waste handling, land application techniques and waste use. Worksheet helps producers determine manure application rates for their system.

Guidelines for Land Disposal of Feedlot Lagoon Water. C-485. (1)

Publications available from...

1. Your county Extension office or directly from Extension Distribution Center, Umberger Hall, Kansas State University, Manhattan, Kansas 66506, (913) 532-5830. There may be charges for publications, postage and sales tax.

2. Your county Extension office or the Midwest Plan Service Secretary, Extension Agricultural Engineering, 237 Seaton Hall, Kansas State University, Manhattan, Kansas 66506, (913) 532-5813.

3. Kansas Department of Health and Environment, Forbes Field, Building 740, Topeka, Kansas 66620, (913) 296-1500; or the KDHE district office for your area.

FARM•A•SYST
Farmstead Assessment System

The Farmstead Assessment System is a cooperative project of the Cooperative Extension Service, Kansas State University, and the Kansas Department of Health and Environment.

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Publications from Kansas State University are available on the World Wide Web at: http://www.oznet.ksu.edu

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