Water Quality

FARM•A•SYST
Farmstead Assessment System
Worksheet #7

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Assessing the Risk of Groundwater Contamination From

Animal Manure Management Facilities

Why should I be concerned?

Livestock lots, such as barnyards, holding areas and feedlots, are areas of concentrated livestock wastes. Total confinement facilities also are areas of concentrated livestock waste. These areas can be a source of nitrate and bacteria contamination of groundwater. This is especially true if there is no system to 1) divert clean water flow from the livestock lot, or 2) collect polluted runoff from the lot for diversion to an area where its effect on surface water or groundwater is minimal. The potential for livestock lots to affect groundwater is greatest if the lot is located over coarse-textured permeable soils, if the water table is at or near the surface, if bedrock is within a few feet of the surface or if polluted runoff is discharged to permeable soils and bedrock.

Drinking-water nitrate levels that are above federal and state drinking water standards of 10 milligrams per liter (mg/l; equivalent to parts per million [ppm] for water measure) nitrate-nitrogen can pose health problems for infants under 6 months of age, including the condition known as methemoglobinemia (blue baby syndrome). Nitrate also can affect adults, but the evidence is much less certain.

Young livestock also are susceptible to health problems from high nitrate-nitrogen levels. Levels of 20 mg/l to 40 mg/l in the water supply may prove harmful, especially in combination with high levels (1,000 ppm) of nitrate-nitrogen from feed sources.

Fecal bacteria in livestock waste can contaminate groundwater if waste seeps into nearby wells, causing such infectious diseases as dysentery, typhoid and hepatitis. Organic materials, which may lend an undesirable taste and odor to drinking water, are not known to be dangerous to health, but their presence does suggest that other contaminants are flowing directly into groundwater.

Facilities for storing liquid manure on the farmstead sometimes leak or burst, releasing large volumes of pollutants. Manure in earthen pits can form a semi-impervious seal of organic matter that does limit leaching potential, but seasonal filling and emptying can cause the seal to break down. Short-term solid-manure storage and abandoned storage areas also can be sources of groundwater contamination by nitrates. Manure can contribute nutrients and disease-causing organisms to both surface water and groundwater.

Silage liquid is highly acidic and can be corrosive to concrete and steel. If it enters a stream, its high organic content feeds bacteria that rob the water of oxygen. Groundwater contaminated with silage juices has a disagreeable odor and shows increased levels of acidity, ammonia, nitrates and iron.

Along with the pollutants found in silage leachate, an even greater potential threat is the low pH created by the presence of acids in silage leachate that can cause the release of naturally occurring metals in the soil and aquifer, increasing their concentrations in groundwater.

Milking-center waste water is contaminated with organic matter, nutrients, chemicals and microorganisms. Poorly designed or mismanaged waste-disposal systems can contaminate water with ammonia, nitrate, phosphorus, detergents and disease-causing organisms. If not managed properly, these contaminants can be carried directly to a well or cause groundwater or surface-water contamination. Surface water and groundwater also can be affected by manure, milk solids, ammonia, phosphorus and detergents.

The goal of *Farm•A•Syst* is to help you protect the groundwater that supplies your drinking water.

How will this worksheet help me protect my drinking water?

- It will take you, step by step, through your animal-waste management facilities.
- It will rank your activities according to how they might affect the groundwater that provides your drinking-water supplies.
- It will provide you with easy-to-understand rankings that will help you analyze the "risk level" of each component of your animal-waste facilities.
- It will help you determine which of your practices are reasonably safe and effective and which practices might require modification to better protect your drinking water.

How do I complete the worksheet?

Follow the directions at the top of the chart on the next page. It should take you about an hour to complete this worksheet and figure out your ranking. Complete the questions that apply to your farmstead.

NOTE: If your milking-center wastes receive primary treatment through an aerobic lagoon or aerated septic tank, it may be discharged into your livestock-waste facility.

Animal Manure Management Facilities
Assessing Drinking-Water Contamination Risk

1. Use a pencil. You may want to make changes.
2. For each category listed on the left that is appropriate to your farmstead, read across to the right and circle the statement that **best** describes conditions on your farmstead. (Skip and leave blank any categories that don't apply to your farmstead.)
3. Then look above the description you circled to find your "rank number" (4, 3, 2 or 1), and enter that number in the blank under "your rank."
4. Directions on overall scoring appear at the end of the worksheet.
5. Allow about 15-30 minutes to complete the worksheet and figure out your risk ranking for well-management practices.

Livestock lots

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LOCATION					
Distance from drinking-water well	More than 300 feet.	200-300 feet.	75-200 feet.	**Less than 75 feet***	_____
SITE CHARACTERISTICS					
Soil depth and permeability	Well-drained medium- or fine-textured soils (loam, silt loam, clay loams, clays). With low permeability (silt and clay). More than 40 inches deep with low permeability (silt and clay).	Well-drained or moderately well-drained medium- or fine-textured soils (loam, silt loam, clay loam, clay). 30 inches to 40 inches deep with moderate permeability (loamy).	Moderately well-drained coarse-textured soils (sand, sandy loam). Shallow (20-30 inches) and/or high permeability (sandy).	Excessively well-drained coarse-textured soils (sand, sandy loam) to gravel, and/or somewhat poorly drained soil to poorly drained soils. Very shallow (less than 20 inches) and/or very high permeability (coarse sand).	_____
DESIGN AND MANAGEMENT					
Surface-water diversion	All up-slope and roof water diverted. No lot runoff (either barn or roofed area).	Most up-slope surface and roof water diverted.	No surface water diverted. Some roof water collected and redirected.	All water (surface and roof water) runs through lot.	_____
Lot-runoff control system	No lot (animals confined).	All runoff collected from curbed lot. Solids separated. Water directed onto properly sized filter strip.	**Most of lot runoff collected. Some solids removed. No filter strip.**	**Lot runoff uncontrolled.**	_____
Lot cleaning and scraping practice	No lot. Confined to barn or roofed lot.	Daily.	Once a week.	Once a month.	_____
CONCENTRATION OF ANIMALS ON LOT (square feet per animal, sf/a)**					
Dairy cows		75 sf/a or more on fenced, curbed concrete pad and/or 400 sf/a on graded earthen surface. More than 1,800 sf/a in exercise area.	50 sf/a or more on concrete and/or 200 sf/ a to 300 sf/a on earthen surface. More than 1,200 sf/a in exercise area.	Some concrete (less than 50 sf/a) and earth (less than 100 sf/a).	_____
Dairy replacements	No lot. Confined to barn or roofed lot.	More than 40 sf/a on fenced, curbed concrete pad and/or 150 sf/ a to 200 sf/a on earthen lot.	More than 20 sf/z on concrete and/or more than 75 sf/a on earthen surface.	Less than 75 sf/a on earthen surface.	_____
Beef feeders	No lot. Confined to barn with slotted floor.	Barn and/or paved lot more than 50 sf/a. Earthen lot with mound more than 300 sf/a, or without mound more than 500 sf/a.	No shelter and paved lot 40 sf/ a to 50 sf/a. Earthen with mound more than 150 sf/a or earthen without mound less than 250 sf/a.	Paved less than 30 sf/a, or earthen less than 150 sf/a.	_____
Beef cows/heifers	Barn or roofed lot.	Barn with paved lot more than 60 sf/a. Earthen with mound more than 400 sf/a. Earthen without mound more than 600 sf/a.	Paved lot more than 30 sf/a. Earthen with mound more than 200 sf/a. Earthen without mound more than 300 sf/a.	Earthen without mound less than 200 sf/a.	_____

(continued on following page)

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
CONCENTRATION OF ANIMALS ON LOT (square feet per animal, sf/a)* (continued)					
Hogs/sows	No yard. Confined to barn.	Shed and paved lot more than 30 sf/a.	Shed and earthen lot less than 15 sf/a.	Shed and earthen lot less than 10 sf/a.	
Pigs: growing/finishing	No yard.Confined to barn.	Shed and paved lot more than 15 sf/a.	Shed and earthen lot more than 15 sf/a.	Shed and earthen lot less than 10 sf/a.	

**Animal concentrations derived from Midwest Plan Service publications and other sources.

Animal-waste storage

LONG-TERM STORAGE (180 days or more)					
Steel, glass-lined (liquid-tight design, above ground)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Leaking tank on medium-textured soils (silt loam, loam).	Leaking tank on coarse-textured soils (sands, sandy loam).	
OR					**OR**
Concrete stave (liquid-tight design)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam).	Concrete cracked, coarse-textured soils (sands, sandy loam).	
OR					**OR**
Poured concrete (liquid-tight design)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam).	Concrete cracked, coarse-textured soils (sand, sandy loam).	
OR					**OR**
Earthen waste storage pit (below ground) or Anaerobic Lagoon	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications in areas where clay was brought in for a compacted liner or an artificial liner was used. Properly maintained.	Not designed to engineering standards. Constructed in medium- or fine-textured dense material (silt loam, loam, clay loam, silty clay).	Not designed to engineering standards. Constructed in coarse-textured material (sand, sandy loam).	
SHORT-TERM STORAGE (usually 60 days to 90 days; in some cases, up to 180 days)					
Stacked in field (on soil base)	——	——	**Stacked on high ground. Medium- or fine-textured soil (silt loam, loam, clay loam, silty clay).**	**Stacked on high ground. Coarse-textured soil (sand, sandy loam).**	
Stacked in lot*	Covered concrete lot with curbs, gutters and settling basin. Runoff to approved structure. Effluent applied to soil-plant filter.	Concrete lot with curbs, gutters and approved storage facilities. Grass filter strips installed and maintained.	Earthen lot with medium- or fine-textured soil (silt loam, loam, clay loam, silty clay). Water table deeper than 20 feet.	Earthen lot with coarse-textured soils (sand, sandy loam). Fractured bedrock or water table shallower than 20 feet.	
Water-tight structure designed to accepted engineering standards and specifications	Designed and installed according to engineering standards. All liquids maintained.	Designed and installed according to engineering standards on medium- and fin-textured soil (silt loam, loam, clay loam, silty clay). Water table deeper than 20 feet.	Designed and installed according to engineering standards on coarse-textured soils (sand, sandy loam). Water table or fractured bedrock shallower than 20 feet.	Designed and installed according to engineering standards. Not properly maintained. Water treatment and diversion and terrace structures allowed to deteriorate.	
Stacked in open housing	Building has concrete floor, protected from surface-water runoff. Adequate bedding provided.	Building has earthen or concrete floor on medium- or fine-textured soil (silt loam, loam, clay loam, silty clay), protected from surface-water runoff. Water table deeper than 20 feet.	Building has earthen or concrete floor on medium- or fine-textured soil (silt loam, loam, clay loams, silty clay), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	Building has earthen floor on coarse-textured soil (sand, sandy loam), subject to surface-water runoff. Water table or fractured bedrock shallower than 20 feet.	

(continued on following page)

*Access of dairy animals to stored manure is in violation of Missouri State Milk Board Regulations.

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LOCATION					
Location of livestock-waste storage in relation to drinking-water well	Manure stack or earthen waste-storage pit more than 300 feet down-slope from well. Manure storage structure (liquid-tight) more than 100 feet down-slope from well.	Manure stack or earthen waste-storage pit more than 300 feet up-slope from well. Manure storage structure (liquid-tight) more than 100 feet up-slope from well.	**Manure stack or earthen waste-storage pit less than 300 feet down-slope from well. Manure storage structure (liquid-tight) less than 100 feet down-slope from well.***	**Manure stack or earthen waste-storage pit less than 300 feet up-slope from well. Manure storage structure (liquid-tight) less than 100 feet up-slope from well.***	_____

Land application of animal waste

ANIMAL-WASTE APPLICATION					
Soil testing of waste-application site	Yearly.	Every two years.	Every three years.	Less frequent than every three years.	_____
Application rate	Applied at rate equal to or less than plant needs based on soil test and waste analysis.	Nitrogen application rates 100 lbs. or less without soil test.	Nitrogen application rates exceed 100 lbs. without soil test. Rate may exceed plant needs.	Applied at rate greater than plant needs. Annual application more than 200 lbs. available nitrogen.	_____
Location of waste-application areas	All application areas more than 300 feet from surface water and groundwater sources.	Most application areas more than 300 feet from surface water and groundwater sources.	Several application areas are less than 300 feet from surface water or groundwater sources.	Most application areas within 200 feet of surface water or groundwater sources.	_____
Application timing and site conditions	Incorporated into soil, applied to no-till field or applied at site with heavy vegetation. Never applied to frozen or saturated soil.	Incorporated into soil, applied to no-till field or applied at site with heavy vegetation. Try to avoid application on frozen or saturated soil.	Application based on when can get around to it. May not coincide with cropping season.	Applied to frozen, saturated or snow-covered soil. Applied to tilled soil with no incorporation and little vegetation.	_____

Silage storage

Silage moisture content*	Below 65 percent.	Between 65 percent and 75 percent.	Between 71 percent and 85 percent.	More than 85 percent.	_____
Silage storage location	At least 100 feet down-slope from well. Runoff water drains away from storage to field or pasture.	At least 75 feet down-slope from well. Runoff water drains to field or pasture.	Within 75 feet up-slope of well. Water pools or stands near storage.	**Within 50 feet of well (silos, glass-lined feed storage). Within 250 feet (earthen trench).**** Water pools on soil surface.	_____
Silage storage floor or surface condition	Concrete or asphalt surface. No cracks.	Concrete or asphalt surface has some cracks.	Surface has some permeable soils (silt loam) and has some cracks.		_____
Silage storage cover condition	Cover tight-fitting. No leaks.	Cover tight-fitting. Minor leaks repaired.			_____
Silage storage lining	New or relined in last 5 years.	Relined 6-25 years ago.			_____
Leachate collection system	Designed system in place and maintained.	Designed system in place but not maintained.			_____

*For silage storage, the categories on the left are listed in order, with the most important factor for groundwater-contamination listed first.

(continued on following page)

Extra bold type: Besides representing a higher-risk choice, this practice also violates Missouri law.
**Illegal for new-well installation. Existing wells must meet separation requirements in effect at time of construction.

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
Milking-center wastewater storage					
NO DISCHARGE METHODS					
Milking-center waste water	Waste water delivered directly to liquid-manure storage. No discharge expected*	——	Waste water drains outside to grassy area.	**Waste water drains outside to ditch or area with no vegetation.**	_____
**If using this practice, do not complete the rest of the milking-center questions.*					
Storage/settling-tank liner	Concrete- or plastic-lined	Clay-lined.	Cracked or porous liner.	No liner to prevent seepage.	_____
Settling-tank cleanout	Tank cleaned as needed.	Tank cleaned every 6 months.	Annual cleaning.	Tank never cleaned.	_____
LOCATION OF DISCHARGE					
Distance from drinking-water well	More than 300 feet down-slope from well.	300 feet up-slope from well.	**Less than 75 feet down-slope from well.****	**Less than 75 feet up-slope from well.****	_____

Extra bold type: Besides representing a higher-risk choice, this practice also violates Missouri law.
**Illegal for new-well installation. Existing wells must meet separation requirements in effect at time of construction.

Use this TOTAL to calculate risk ranking below

TOTAL: ☐

What do I do with these rankings?

Step 1: Begin by determining your overall animal-waste management risk ranking. Total the rankings for the categories you completed and divide by the number of categories you ranked:

_____ divided by _____ equals ☐

total of rankings | # of categories ranked | risk ranking*

*Carry your answer out to one decimal place.

3.6-4=low risk
2.6-3.5=low to moderate risk
1.6-2.5=moderate to high risk
1-1.5=high risk

This ranking gives you an idea of how your animal-waste management practices **as a whole** might be affecting your drinking water. This ranking should serve only as a **general guide, not a precise diagnosis.** Because it represents an averaging of many individual rankings, it can mask any individual rankings (such as 1's or 2's) that should be of concern. (See Step 2.)

Enter your boxed animal-waste management risk ranking on page 1 of Worksheet #9. Later you will compare this risk ranking with other farmstead management rankings. Worksheet #8 will help you identify your farmstead's site conditions (soil type, soil depth and bedrock characteristics), and Worksheet #9 will show you how these site conditions affect your risk rankings.

Step 2: Look over your rankings for individual activities:

- **Low-risk practices (4's):** ideal; should be your goal despite cost and effort
- **Low- to moderate-risk practices (3's):** provide reasonable groundwater protection
- **Moderate- to high-risk practices (2's):** inadequate protection in many circumstances
- **High-risk practices (1's):** inadequate; pose a high risk of polluting groundwater

Regardless of your overall risk ranking, any individual rankings of "1" require immediate attention. Some concerns you can take care of right away; others could be major—or costly—projects, requiring planning and prioritizing before you take action.

Find any activities that you identified as 1s and list them under "High-Risk Activities" in Worksheet #9.

Step 3: Read Fact Sheet #7, *Improving Animal Waste Management*, if you haven't already. Consider how you might modify your farmstead practices to better protect your drinking water.

Glossary
Animal Manure Management

These terms may help you make more accurate assessments when completing Worksheet #7. They also may help clarify some of the terms used in Fact Sheet #7.

Concrete stave storage: A type of liquid-tight, animal-waste storage structure. Located on a concrete pad, it consists of concrete panels bound together with cable or bolts and sealed between panels.

Earthen basin or pit: Clay-lined manure-storage facility constructed according to specific engineering standards. Not simply an excavation.

Engineering standards: Design and construction standards available at Natural Resources Conservation Service (NRCS) or your local University Extension center. These standards may come from NRCS technical guides, state regulations or land-grant university engineering handbooks.

Filter strip: A gently sloping grass plot used to filter runoff from the livestock lot. Influent waste is distributed uniformly across the high end of the strip and allowed to flow down the slope. Nutrients and suspended material remaining in the runoff water are filtered through the grass, absorbed by the soil and ultimately taken up by the plants. Filter strips must be designed and sized to match the characteristics of the livestock lot. Filter strips that discharge effluent from the lower end **do not** meet Missouri Department of Natural Resources' (DNR) requirements for no-discharge systems and should be considered only in locations where such discharge will not enter a stream, drainage way or surface-water impoundment. In general, filter strips are applicable only to small waste flows containing little or no solids.

Glass-lined steel storage: A type of liquid-tight, above-ground, animal-waste storage structure. Located on a concrete pad, it consists of steel panels bolted together and coated inside and outside with glass to provide corrosion protection.

Infiltration: The downward entry of water through the soil surface.

Land application: Application of waste water to croplands and pastures by irrigation equipment or a liquid-manure spreader.

Perched water table: The water table of a saturated soil that is separated from a deeper saturated layer by an unsaturated layer of soil.

Percolation: The downward movement of water through the soil.

Poured concrete storage: A type of liquid-tight, animal-waste storage structure. Located on a concrete pad, it consists of poured concrete, reinforced with steel.

Runoff control system: A combination of management practices that can be used together to prevent water pollution from livestock-lot runoff. Practices may include diversion of runoff from the lot, roof-runoff systems, lot shaping, settling basins and filter strips or buffer areas.

Slow surface infiltration: Application of waste water at one end of a gently sloping grass filter strip or terrace so that it is treated as it slowly flows through the plant-soil system. A portion of the flow percolates to groundwater, and some is used by vegetation.

Soil drainage class: The conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soils, as opposed to human-altered drainage. Different classes are described by such terms as *excessively drained, well-drained and poorly drained.*

Soil permeability: The quality that enables the soil to transmit water or air. Slowly permeable soils have fine-textured materials, like clays, that permit only slow water movement. Moderately or highly permeable soils have coarse-textured materials, like sands, that permit rapid water movement.

Soil texture: The relative proportions of the various soil separates (clay, sand, silt) in a soil. Described by such terms as sandy loam and silty clay.

Soil-plant filter: Pasture or cropland that receives the application of livestock-waste storage effluent. Nitrogen application rate is generally the limiting factor. Periodic removal of plant material by grazing or harvesting is required to prevent buildup of harmful elements in the soil.

Surface (overland) flow: The process of allowing waste water to run slowly in a uniform layer over a grass-covered slope and relatively impervious clay soil. There is little percolation into the soil with this method because of the impervious soil. Water eventually flows into runoff-collection ditches (for subsequent discharge).

Water table depth: Depth to the upper surface of groundwater. This depth is sometimes indicated in the county soil survey, but this varies from county to county. This information may be available from your well construction report or from hydrogeological reports and groundwater-flow maps of your area. Your regional University Extension agricultural engineering specialist or NRCS district conservationist may be able to help you gather this information. This information also may be

obtained through a professional engineer or through the Division of Geology and Land Survey (DGLS) at Rolla, Mo. The phone number for DGLS is (314) 364-1752.

There are two types of water table: 1) the water table typically noted in a well log as an indication of usable water supply; and 2) the seasonal high-water table. The seasonal high-water table is important in regard to construction of livestock-manure storage facilities because it may present facility construction problems.

FARM•A•SYST
Farmstead Assessment System

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