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VIRGINIA FARM*A*SYST

Virginia Farmstead Assessment System

Fact Sheet/Worksheet No. 9

Livestock Manure Storage and Treatment Facilities

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Invent the Future

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VIRGINIA STATE UNIVERSITY

INTRODUCTION TO THE VIRGINIA FARMSTEAD ASSESSMENT SYSTEM

Water wells and springs are the most common sources of private household water for rural homesites and farmsteads in Virginia. However, activities related to these environments may contribute to contamination of the groundwater which so many rural residents depend upon for household water. For example, farm facilities such as chemical and fuel storage tanks, livestock and poultry holding areas, irrigation systems, and septic systems are sometimes located near the farmstead well or spring. Retail agribusinesses and enterprises such as nurseries, greenhouses and direct farm markets are unique operations that may have production, storage, and sales areas close to a water well which may be also exposed to the general public. Inadequate maintenance of well-head and farmstead facilities and/or poor farmstead management practices can contribute to contamination of groundwater and drinking water supplies. Rural residents need to be aware of threats to water quality and of measures that will reduce or eliminate contamination of household water supplies.

To meet these challenges, as a part of a nationwide effort, the Virginia Farmstead Assessment System (Virginia Farm *A* Syst) was developed. This voluntary, educational/technical program is mainly a preventive program designed to: (1) provide safe, drinking water and thereby protect the health of Virginia's rural residents; (2) reduce potential land owner liability due to groundwater contamination which may result from farmstead or retail agribusiness activities; and (3) maintain or enhance farm property values throughout Virginia.

The Farm *A* Syst program is designed to guide an individual through a step-by-step evaluation of factors such as soils and geologic properties of the site, well-head or spring condition, and farmstead management practices that may impact the quality of his/her groundwater/drinking water supply. The program participant can identify potential pollution sources, and make an assessment of pollution risks to existing water supplies. Based on identified risks, corrective measures and/or management practices can be selected to reduce the likelihood of contamination.

This assessment is conducted by using a series of fact sheets and worksheets. A fact sheet /worksheet set deals with a specific pollution factor or source such as household wastewater, chemical storage, etc. Fact sheets are explanatory materials that contain background information on factors that affect groundwater quality, and legal requirements which address water quality and environmental protection. Worksheets are provided to determine ranking of potential pollution risks for each problem described in the fact sheets.

Each worksheet consists of a series of questions related to a specific farmstead feature or management practice such as well-head condition, fertilizer/chemical use, soils and geology of the site, etc. Based on the response to each question, a numerical ranking which indicates relative groundwater pollution risks is calculated. These rankings can then be used as a guideline to identify and prioritize corrective measures that will reduce or eliminate the potential for groundwater/drinking water pollution.

Users of this package need only to select those fact sheets/worksheets which are applicable to his/her activities or specific situations. For example, those evaluating rural, non-farm, homesite water supplies may select Fact Sheets/ Worksheets No. I -No. 5. Fact sheets/worksheets that will be important to many agribusinesses are No. 1 - No. 7. Some farming operations may relate to all worksheets. It is strongly recommended that the fact sheet corresponding to each worksheet be reviewed before using the worksheet itself. After developing a good understanding of each fact sheet, it will take about 15-30 minutes to complete each worksheet except for Worksheet No. 1 (Soils and Geology). To accomplish the task one needs only a pencil and a simple calculator. Each worksheet provides directions for completing the task. In addition, all users will need Worksheet No. 13 (Overall Risk Assessment). Fact Sheet/Worksheet No. 14 (Management of Irrigation Systems) was developed as an addendum chapter to the original Virginia Farm *A* Syst package and can be used in a stand alone manner or incorporated into the Overall Risk Assessment (Worksheet No. 13) as part of a complete farm assessment.

The Virginia Farm * A * Syst package contains the following Fact Sheets and Worksheets:

Fact Sheet/Worksheet No. 1 - Site Evaluation: Groundwater, Soils & Geology

Fact Sheet/Worksheet No. 2 - Well and Spring Management

Fact Sheet/Worksheet No. 3 - Household Wastewater Treatment and Septic Systems

Fact Sheet/Worksheet No. 4 - Hazardous Waste Management

Fact Sheet/Worksheet No. 5 - Petroleum Products Storage

Fact Sheet/Worksheet No. 6 - Fertilizer Storage, Handling, and Management

Fact Sheet/Worksheet No. 7 - Pesticide Storage, Handling, and Management

Fact Sheet/Worksheet No. 8 - Livestock and Poultry Yard Management

Fact Sheet/Worksheet No. 9 - Livestock Manure Storage and Treatment Facilities

Fact Sheet/Worksheet No. 10 - Poultry Litter Management and Carcass Disposal

Fact Sheet/Worksheet No.11- Milking Center Wastewater Treatment and Management

Fact Sheet/Worksheet No. 12 - Silage Storage and Management

Worksheet No. 13 - Overall Risk Assessment

Fact Sheet/Worksheet No. 14 - Management of Irrigation Systems

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Livestock Manure Storage and Treatment Facilities

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Storage of livestock wastes involves accumulating manure and wastewater in an environmentally sound manner until they can be applied to land or otherwise utilized. Manure storage facilities allow farmers to spread manure when conditions are right for nutrient use by crops. Storing manure in a concentrated area, however, increases risk to the environment and to human and animal health. Fecal bacteria in livestock waste can contaminate groundwater, causing such infectious diseases as dysentery, typhoid and hepatitis.

Livestock wastes if not properly managed can become a source of nitrate and disease-causing organisms to both surface water and groundwater. Nitrate-nitrogen levels above 10 milligrams per liter (mg/l; equivalent to parts per million for water measure) can pose health problems for infants under 6 months of age, including the condition known as blue baby syndrome (methemoglobinemia). Young livestock are alsosusceptible to health problems from high nitrate-nitrogen levels. Levels of 20-40 mg/l in the water supply may prove harmful, especially in combination with high levels (1,000 ppm) of nitrate-nitrogen from feed sources.

Dry manure can be stored in solid form in stockpiles, and liquid manure can be stored in tanks or earthen basins, or stored and treated in anaerobic lagoons. Manure storage facilities, if not designed or managed properly, can be potential sources of nitrate leaching to groundwater. For example, facilities for liquid manure storage sometimes leak or burst. Seasonal filling and emptying of earthen manure storage pits can cause damage to the organic and physical seal on the bottom and sides of the pit. Short-term solid manure storage and abandoned storage areas can also be sources of groundwater contamination by nitrates.

Regulations of the Virginia Department of Environmental Quality/Water Division (DEQ) apply to storage locations and to minimum standards for seepage control from storage/treatment facilities.

The environmental safety of storing large amounts of manure in one place for an extended period depends on the following:

- location of the storage site with respect to physical and chemical characteristics of the soil.
- subsurface geologic materials.
- design and construction of the storage site or facility including control of seepage.
- proper land application and utilization of the manure once it leaves the storage site or facility at a rate and time compatible with nutrient uptake by crops.

If improper animal waste storage causes water contamination, the DEQ can impose a fine and require corrective measures.

I. LONG-TERM STORAGE

Livestock wastes can be stored long-term (for 180 days or more) either in solid, semi-solid or liquid form.

- Solid storage facilities use walls and slabs for stacking of heavily-bedded manure.
- Semi-solid storage facilities use pumps or scrapers to move manure into containment areas and may separate solids from liquids.
- Liquid storage facilities hold manure in tanks, pits or bermed areas.

Liquid and semi-solid storage systems are self-contained. Groundwater contamination can occur if the facility is not structurally sound, allowing waste materials to seep through the soil. A threat to surface water exists if pits are not emptied frequently enough to prevent wastes from flowing over the top of the structure. Liquid storage systems require the use of pipes and/or pumps for moving wastes from the barn to the storage structure. These must be carefully installed and maintained to ensure that they do not leak. Each time a pit is 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 bottom and sides of earthen waste storage pits and lagoons to be certain the liner materials have not been eroded away by agitation and pumping. Fine textured soil materials become "self-sealed" to a limited degree through clogging of soil pores. However, this seal can be destroyed through mechanical cleaning processes.

After a period of years, weathering, wave action, or wetting and drying cycles may cause the side walls 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 prevent leaching of contaminants.

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

1. A properly designed structure has the capacity to handle wastes from a specific number of animals for a known number of days. For example, if a pit or pond is designed for 180 days of storage and has received designated waste amounts, but has not needed pumping for a year or more, the structure is probably leaking.

2. Evaporation from a liquid manure storage pit is minimal if a crust is formed. If additional liquids need to be added before the pit can be agitated and pumped, the pit may be leaking.

Some facilities for storage of semi-solid manure are designed to allow seepage from the waste stack. In these instances, the structure design must include collection and treatment of the wastes that seep out. These systems should not be considered on sites with coarse-textured soils, fractured bedrock, karst formations, or shallow water tables. The best way to handle seepage is to channel it into a watertight holding pond or storage tank.

If construction of a holding pond or concrete/steel tank is not feasible, another option is to build a covered semi-solid manure storage structure to protect the manure stack from precipitation. Roofed storage systems require adequate bedding to absorb and retain the liquid portion of the waste.

II. SHORT-TERM STORAGE

Short-term storage (usually 60-90 days and in some cases up to 180 days) is an important option available to farmers. It allows the farmer to hold livestock wastes during periods of bad weather when daily spreading may not be feasible, when land to be planted in crops is not available for applying manure, or when there is a shortage of crop acres to accommodate daily hauling and spreading of manure without the threat of runoff.

Short-term storage, which is restricted primarily to solid or semi-solid manure, has the disadvantage of requiring that the manure be handled often. Designs are available for short-term storage structures that facilitate handling and provide effective protection for surface water and groundwater.

Short-term storage systems may be applicable for those operations, such as small dairies, which often have to stack manure in fields, particularly during periods of bad weather or between cropping cycles. Field stacking is not a recommended practice. No matter how it is done, it may pose a contamination threat to surface water and groundwater. If manure is frequently stacked in fields, cover it with plastic sheets or consider constructing a short-term runoff detention pond at the storage site.

Likewise, many farmers and livestock feeders will scrape manure into piles in the open lots as temporary storage during bad weather or busy work periods. Mounds are constructed from dry manure materials that are shaped to accommodate cattle comfort. Regulations governing milk production require frequent manure collection and removal and do not allow milking cows to come in contact with stacked manure.

Many farmers have open housing for young livestock, 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 effective for water quality protection if they are isolated 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.

III. WASTE STORAGE LOCATION

The location of livestock waste storage in relation to water wells or springs is an important factor in protecting the farm water supply. For temporary manure stacks and earthen storage facilities, the minimum separation distance for wells in Virginia is 150 feet.

Minimum separation distances regulate new well installation or the distance from existing wells to new waste storage facility construction. Existing wells are required by law only to meet separation requirements in effect at the time of well construction. However, for your own benefit make every effort to exceed "old regulations," and strive to meet current regulations whenever possible.

Observing these separation distances when siting a new facility is a good way to help protect your drinking water. Locating manure storage sites or facilities downslope from wells or springs is also important for protection of your water supply. (For more information about separation distances, and how the condition of your well or spring might affect the potential for contamination, see Fact/ Worksheet Sheet No. 2, Well and Spring Management.) Depth to seasonal high water table or fractured bedrock, along with soil type at the waste storage location, is another important factor. These characteristics are described in Fact/ Worksheet No. 1.

IV. LINING MATERIALS ON LAGOONS, DETENTION PONDS, OR STORAGE PITS

The Virginia Department of Environmental Quality has responsibility for implementing water quality regulations that govern confined, concentrated livestock operations. In order to protect groundwater from seepage from manure storage facilities, lagoons and holding ponds, DEQ regulations require that all waste retention facilities be constructed of compacted or in-situ soil materials at least 12 inches thick and with a maximum permeability rating of 0.0014 inches per hour. Synthetic liner materials must be of at least 20 mils thickness. If these standards for lagoons and manure holding facilities are met, combined with the benefit of self-sealing caused by manure storage, groundwater can be adequately protected.

V. LAND APPLICATION OF MANURE

Use of manure in combination with row crop production and improved pastures is designed to remove accumulated nutrients through the cropping system. Animal waste is a valuable fertilizer and soil conditioner. When managed properly, the nutrients in manure can be substituted for commercial fertilizers while saving money and protecting groundwater and surface water.

Solid manure can be incorporated by tillage immediately following its application, and liquid manure slurry can be injected into the soil. Manure application should be applied near the time that planting will occur to maximize nitrogen uptake by crops and minimize the loss of nitrogen through runoff or leaching through the soil profile. Liquid manure and lagoon effluent can also be applied to land areas by irrigation over growing crops. Care must be taken, however, to prevent burning of some plants by the waste materials and to avoid excessive runoff.

Stored manure, prior to land application, should be sampled and tested to determine how much nitrogen, phosphorus and potassium it contains. When sampling manure, be sure to obtain as representative a sample as possible. This usually involves taking a number of subsamples (e.g. 10 or more) and mixing the subsamples into one or more combined samples to be analyzed. This information, along with a knowledge of the amount of manure applied per acre, enables a farmer to determine whether or not additional commercial fertilizer is needed to meet crop production goals. A farm nutrient management plan will take all of these factors into consideration.

Land application should not be carried out during extended periods of bad weather which make application impractical or illegal. Virginia Department of Environmental Quality rules discourage application of wastes when the ground is frozen or saturated.

VI. ABANDONED PITS

Abandoned waste storage pits, especially earthen ones, can pose significant water quality as well as safety problems. Any abandoned structure should be completely emptied and the contents utilized. In the case of earthen waste storage facilities, liner materials (to a depth of about two feet) should be removed and spread over croplands. The remaining hole should be filled and leveled. Manure packs from pole barns or sheds no longer in use should also be removed and the wastes applied to cropland. If manure is stacked in fields, it should be appropriately spread as soon as conditions permit.

CONTACTS AND REFERENCES

For additional information consult the VirginiaFarm*A*Syst Resource Directory. Contact your local Virginia Cooperative Extension agent, Natural Resources Conservation Service office, or the Virginia Department of Conservation and Recreation for information about local ordinances, state regulations, cost-sharing funds, and nutrient management programs.

GLOSSARY

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

Earthen basin or pit: Clay-lined manure or wastewater 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 Virginia Cooperative Extension offices. These standards may come from NRCS technical guides, state regulations, or land grant university engineering handbooks or publications.

Filter strip: A gently sloping grass plot used to filter and settle solids from runoff from the livestock yards and some types of solid manure storage systems. 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 plants. Filter strips must be designed and sized to match the characteristics of the livestock yard or storage system, and the expected quantity of runoff.

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

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

WORKSHEET NO. 9 LIVESTOCK MANURE STORAGE AND TREATMENT FACILITIES

Read Fact Sheet No.9, "Livestock Manure Storage and Treatment Facilities," before completing this worksheet.

How will this worksheet help you protect your drinking water?

- It will take you step by step through your drinking water well or spring condition and management practices.
- It will rank your activities according to how they might affect the groundwater that provides your drinking water.
- It will provide you with easy-to-understand rankings that will help you analyze the "relative risk" to your drinking water well or spring.
- 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.

Follow the directions below.

Note: You will probably want to make a print-out of this worksheet to complete it.

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.)
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 rank.

LONG-TERM STORAGE (180 days or more) (See Fact Sheet No. 9, Section I)					
	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RISK NUMBER
Steel, glass-lined (liquid-tight design, above ground) storage	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). Water table deeper than 20 feet.	Leaking tank on coarse-textured soils (sand, sandy loam). Water table or fractured bedrock less than 20 feet.	
Concrete stave (liquid-tight design) storage	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). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sand, sandy loam). Water table or fractured bedrock less than 20 feet.	
Poured concrete (liquid-tight design) storage	Designed and installed according to accepted 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). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sand, sandy loam). Water table or fractured bedrock less than 20 feet.	
Earthen waste storage pit (below ground)	---------	Designed and installed according to accepted engineering standards and specifications.	Not designed to engineering standards. Constructed in medium or fine-textured dense materials (silt loam, silty clay). Water table deeper than 20 feet. Earthen lining eroding.	Not designed to engineering standards. Constructed in coarse-textured materials (sands, sandy loam). Fractured bedrock or water table less than 20 feet. More than 10 years old. Earthen lining perforated.	

SHORT-TERM STORAGE (usually 60-90 days; in some cases, up to 180 days) (See Fact Sheet No.9, Section II)					
	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RISK NUMBER
Stacked in field (on soil base)	---------	---------	Stacked on high ground. Medium- or fine-textured soils (silt loam, loam, clay loam, silty clay). Water table deeper than 20 feet.	Stacked on high ground. Coarse-textured soils (sand, sandy loam). Fractured bedrock or water table less than 20 feet.	
Stacked in yard	Covered concrete yard with curbs, gutters and settling.	Concrete yard with curbs and gutters. Grass filter strips installed and maintained.	Earthen yard with medium- or fine-textured soils (silt loam, loam, clay loam, silty clay). Water table deeper than 20 feet.	Earthen yard with coarse-textured soils (sand, sandy loam). Fractured bedrock or water table less than 20 feet.	
Water-tight structure (designed to accepted engineering standards and specifications)	Designed and installed in clay soils. All liquids retained.	Designed and installed on medium-and fine-textured soils (silt loam, loam; clay loam, silty clay) with clay liners. Water table deeper than 20 feet.	Designed and installed on coarse-textured soils (sand, sandy loam). Fractured bedrock or water table less than 20 feet.	Not properly maintained. Storage facility, 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 meduim- or fine-textured soils (silt loam, clay loam, silty clay), protected from surface runoff. Water table deeper than 20 feet.	Building has earthen floor on coarse-textured soils (sands, sandy loam), subject to surface water runoff. Fractured bedrock or water table less than 20 feet.	Building has earthen floor on coarse-textured soils (sands, sandy loam), subject to surface water runoff. Fractured bedrock or water table shallower than 20 feet.	
Location of livestock waste storage in relation to drinking water well	Manure stack or earthen waste storage pit more than 300 feet downslope from well or spring. Manure storage structure (liquid tight) more than 100 feet downslope from well or spring.	Manure stack or earthen waste storage pit more than 300 feet upslope from well or spring. Manure storage structure (liquid tight) more than 100 feet downslope from well or spring.	Manure stack or earthen waste storage pit less than 300 feet downslope from well or spring. Manure storage structure (liquid tight) more than 100 feet downslope from well or spring.	Manure stack or earthen waste storage pit less than 300 feet upslope from well or spring. Manure storage structure (liquid tight) more than 100 feet upslope from well or spring.	

LAND APPLICATION OF MANURE (See Fact Sheet No. 9, Section V)	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RISK NUMBER
Application site	More than 300 feet downslope from well or spring.	More than 300 feet upslope from well or spring.	Less than 300 feet downslope from well or spring.	Less than 300 feet upslope from well or spring.	
Method of application	Solid manure surface applied.	Solid or liquid manure injected.	Liquid manure surface applied.	Liquid manure irrigated.	
Timing of application	Crops are actively growing or will be planted within several days.	Crop to be planted within 1 month of application.	No crop to be planted for 1-3 months.	Fall or early winter application when crops are dormant, soil is bare, or ground is frozen or saturated.	
Nutrient management plan	Manure applied according to a nutrient management plan.	---------	---------	Nutrient management plan is not followed.	
		Use this total to calculate risk rank:		Rank Number Total:	

CALCULATE RISK RANK

Step 1:

Sum up the rankings for the categories you completed and divide by the total number of categories ranked. Carry your answer out to one decimal point.

Rank Number Total _______ ÷ No. of categories ranked _______ = Risk Rank _______

Risk Categories

3.6-4.0 = low risk
2.6-3.5 = low to moderate risk
1.6-2.5 = moderate to high risk
1.0-1.5 = high risk

This ranking gives you an idea of how your well or spring management practices as a whole might be affecting your drinking water. Later you will combine this risk ranking with other farmstead management rankings in Worksheet No. 13, "Overall Risk Assessment." This ranking should serve only as a very general guide, not a definitive indicator of contamination. 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.).

Step 2:

Look over your ranking for each category:

- 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.

Any individual rankings of "1" require immediate attention. Some concerns you can take care of right away; others could be a major-or costly-project, requiring planning and prioritizing before you take action. Note the activities that you identified as 1's to be listed later under "High-Risk Activities" in Worksheet No. 13.