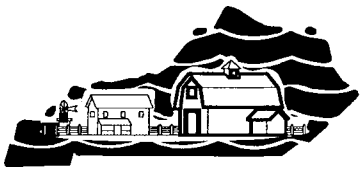


KY•A•Syst

Home and Farmstead
Water Quality Assessment

Assessing and Reducing the Risk of Groundwater Contamination from

SILAGE STORAGE

Why should I be concerned?

Kentucky's groundwater is one of its most vital resources. It supplies drinking water for hundreds of thousands of Kentuckians. Groundwater is the source of water for drinking water wells, springs, and some municipal, or "city," water supplies. All of us do things at our homes every day which can possibly pollute the groundwater. Nobody wants to pollute the groundwater, but if we are not careful and educated about how we manage our day-to-day home or farmstead activities, we can do just that– pollute the groundwater that serves as drinking water for many families. Even if nobody in your community uses groundwater for drinking water, you need to be concerned. This is because groundwater that underlies your home may travel a long way and eventually end up as another family's drinking water.

Silage is an essential feed for livestock-based agriculture. When properly harvested and stored, silage poses little or no pollution threat, but improper handling can lead to a significant flow of silage juices (or leachate) from the silo. Silage leachate is a liquid that results from pressure squeezing fluids from the stored silage or from extra water entering the silo. It is usually a problem only when silage is fresh or just after storage. This loss of leachate represents a major loss of nutrient value from the silage.

Silage leachate is often highly acidic and can be corrosive to concrete and steel. Groundwater contaminated with silage leachate has a disagreeable odor and shows increased levels of acidity, ammonia, nitrates, and iron. Silage leachate can contain such groundwater contaminants as bacteria and minerals. Along with the pollutants found in silage leachate, an even greater potential threat is that the low pH created by the presence of acids in silage leachate can free up and release naturally occurring metals in the soil and aquifer, which can increase their concentrations in groundwater. Leachate from 300 tons of high-moisture silage has been compared to the sewage generated daily by a city of 80,000 people.

The goal of KY•A•Syst is to help you protect the groundwater that supplies drinking water for many families.

How will this publication help me protect the groundwater?

Part I of this publication will help you protect the groundwater by asking you questions about your silage storage practices. These questions will help you identify activities or structures on your property which may put groundwater at a high risk of being contaminated. Part II of the publication will give suggestions on how to reduce the risk of groundwater contamination by improving your silage storage practices.

The KY•A•Syst program is for your benefit only. No information from this publication needs to leave your home. KY•A•Syst does not attempt to offer legal advice or solutions to individual problems but rather to raise general awareness about groundwater protection strategies. Questions about individual problems should be addressed to the appropriate professional.

Part I. *Assessing* the Risk of Groundwater Contamination from Silage Storage

Instructions:
Circle the number in front of the appropriate item that **best** describes your home or farmstead. (Skip and leave blank any categories that don't apply to your home or farmstead.)

At what moisture content do you store silage?

4 Below 65 percent.
3 Between 65 percent and 70 percent.
2 Between 71 percent and 85 percent.
1 More than 85 percent.

Where is your silage stored in relation to any well, spring, sinkhole, or other water resource (stream, pond, river, etc.)?

4 More than 50 feet downslope from any well, spring, sinkhole, or other water resource (upright or tower silo, concrete horizontal silo, and plastic tubes). At least 500 feet downslope (earthen trench). Water drains away from storage to field or pasture.
3 At least 50 feet upslope from any well, spring, sinkhole, or other water resource (upright or tower silo, concrete horizontal silo, and plastic tubes). At least 250 feet downslope (earthen trench). Water drains to field or pasture.
2 Within 50 feet upslope of any well, spring, sinkhole, or other water resource (upright or tower silo, concrete horizontal silo, and plastic tubes). Within 500 feet upslope (earthen trench). Water pools or stands near storage.
1 Within 50 feet of any well, spring, sinkhole, or other water resource (upright or tower silo, horizontal concrete silo, and plastic tubes). Within 250 feet (earthen trench). Water pools on soil surface.

What type of floor does your silo or silage storage area have?

4 Concrete or asphalt surface. No cracks.
3 Concrete or asphalt surface has some cracks.
2 Surface has some permeable soils (silt loam) and some cracks. Compacted soil.
1 Surface has permeable soil (sand). Not compacted.

What is the condition of your silage storage roof or cover?

4 Roof or tight-fitting cover. No leaks.
3 Roof or tight-fitting cover. Minor leaks repaired.
2 Cover, but many large leaks not repaired.
1 No cover or roof.

Do you have a silage runoff collection system? If so, is it maintained?

4 Designed system in place and maintained.
3 Designed system in place but not maintained.
2 No system in place. Runoff moves to waterway.
1 No system in place. Runoff collects in low area.

SITE EVALUATION

What type of soil is on your property?

4 Fine-textured or "heavy" soils (clays).
3 Medium-textured soils (silt loam).
2 Medium- to coarse-textured soils (loam, sandy loam).
1 Coarse-textured soils (sands).

After a 1-inch rain in April, how long do you (or farmers in your area) have to wait to get into the field?

4 More than four days.
3 Four days.
2 Three days.
1 Zero to two days.

How sensitive is your region of the state to groundwater contamination (see map at end of publication)?

4 Low sensitivity.
3 Moderate sensitivity.
2 High sensitivity.
1 Very high sensitivity.

Does your property lie above or near any active/abandoned underground coal mines?

4 No underground mining is being done below or near your property.
3 Underground mining is currently being done.
2 An underground mine was abandoned underneath or near your property more than ten years ago.
1 An underground mine was abandoned underneath or near your property more than twenty years ago.

If your property does lie above or near any active/abandoned underground coal mines, what type of mine is it, and how deep is the mine? (See Part II for more information.)

4 No underground mining is being done below or near your property.
3 Underground mine is more than 400 feet deep.
2 Underground mine is 200 to 400 feet deep.
1 Underground mine is less than 200 feet deep. Mine is a "longwall" type mine.

What do I do with these rankings?

Take a look at your rankings for the individual questions you answered.

For Questions Where You Received A:	The Risk of Contaminating Groundwater Is:
4	Low
3	Low to Moderate
2	Moderate to High
1	High

Use this table to list any questions from Part I where you received a "1" (high risk activity or structure), or that were identified as being against Kentucky regulations. Next, write down the first step that can be taken to better the situation. Then read Part II of this publication, "Reducing the Risk of Groundwater Contamination by Improving Silage Storage." This will help you to improve any problem areas (1's or 2's) which were identified.

Activity or structure identified as high risk ("1")	**What is the first step that can be taken to solve the problem?**
Example: silage stored at a high moisture content which results in excessive runoff.	*Store silage at lower moisture content; allow plant material to wilt in the field for 24 hours.*

Part II. *Reducing* the Risk of Groundwater Contamination by Improving Silage Storage

SILAGE MOISTURE CONTENT

Silage can be made from corn, wheat, rye, clovers, and other forage crops. The amount of leachate (silage juices) produced varies with the type of silage, its moisture content, nitrogen content, and handling and storage conditions. Of these, moisture is the most crucial.

Research indicates that materials stored at 65 percent moisture content or higher can produce leachate. For grass silage, the amount produced varies from a trickle at 75 percent moisture to 79 gallons per ton at 85 percent moisture. About three-quarters of the leachate is produced in the first three weeks of storage, although it can continue to flow for up to three months.

Farmers can use several methods to reduce leachate production from silage. The most effective of these is allowing the material to wilt in the field for 24 hours. Other methods include varying cutting and harvesting times, or adding moisture-absorbent materials to the silage as it is stored. Adding absorbent materials not only reduces leachate, but it also can raise the nutrient value of the silage. Materials that can be used to absorb leachate include oatmeal, dried sugar beet pulp, dried corn cobs, ground corn, and bentonite clay. Most of these materials will absorb from one to three times their weight in water. To be effective, enough must be added to absorb the anticipated leachate.

SILAGE STORAGE

Most harvested silage is characterized as low-moisture silage (L.M.S). The crop is allowed to wilt to the proper moisture content before chopping to ensure proper ensiling. Silage put into horizontal silos is typically at a higher moisture content than in vertical silos. Direct-cut or higher-moisture silage has been reported to produce significant silage juice, especially in upright silos.

Many older silos may have dirt floors, which may allow nitrates to leak into groundwater. Newer silos are built with concrete foundations and floors and prevent such problems. Horizontal, pit, or trench silos on bare ground can threaten groundwater.

SILO LOCATION

To prevent possible groundwater contamination, silos should be located as far away from any well, spring, sinkhole, or other water resource as practical. Plastic storage tubes and upright silos (horizontal silos with concrete floors) should be located at least 50 feet from any well, spring, sinkhole, or other water resource, and earthen trenches or pits should be at least 250 feet away.

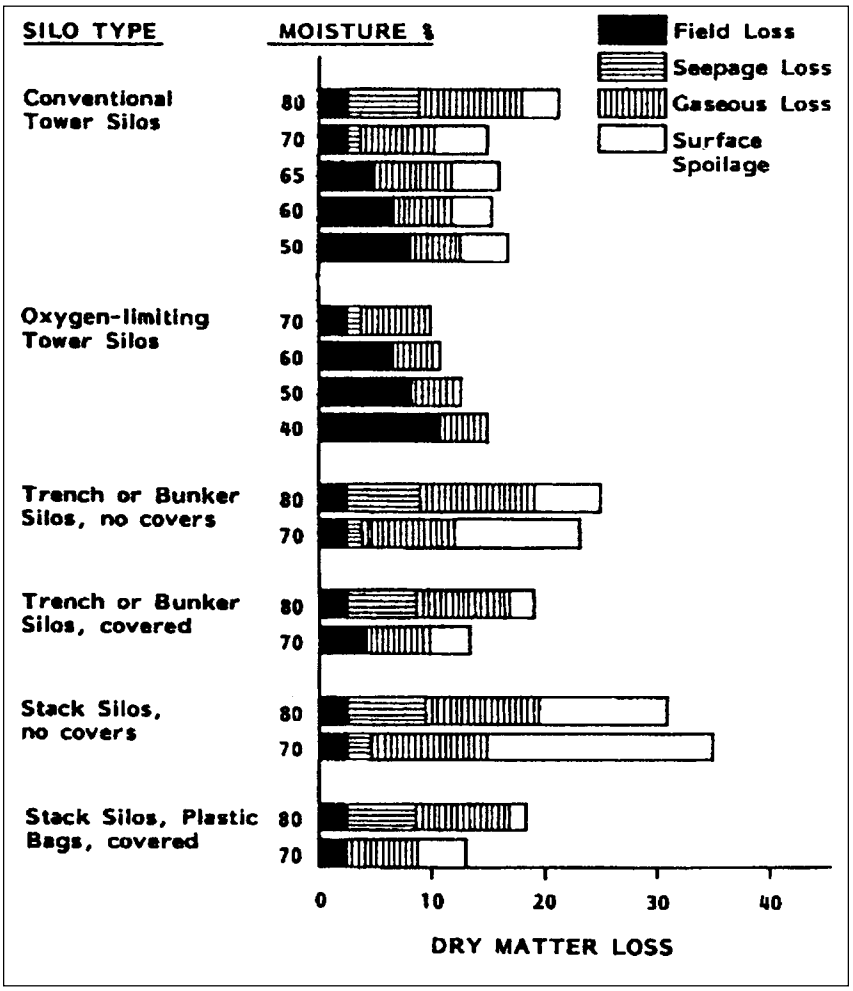


Figure 1. Silage moisture content. *Source:* Beef Housing and Equipment Handbook, *MWPS-6, Midwest Plain Service.*

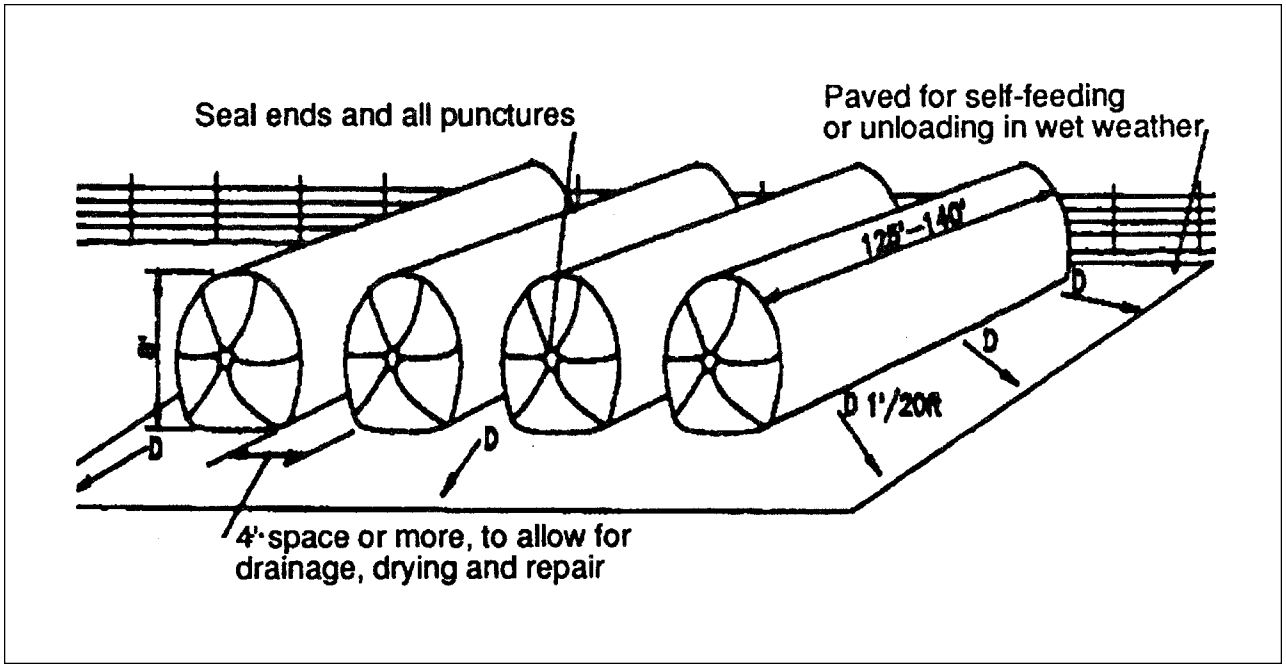


Figure 2. Horizontal Silo. *Source:* Beef Housing and Equipment Handbook, *MWPS-6, Midwest Plan Service.*

SILO DESIGN AND CONSTRUCTION

Most silos being built today have interiors made of concrete or, in the case of oxygen-limiting silos, a glass-like coating over steel. Silage stored in glass-lined silos typically has a lower moisture content and poses a low risk of groundwater contamination. It is possible for some liquid to leak out.

Silo bags generally store silage of higher moisture content. Liquids can pool in the bag and leak out when it is opened.

Horizontal trench silos (bunkers) excavated into the ground can affect groundwater, especially in coarse soils and at locations with shallow water tables. Properly compacted clay soils and concrete floors can limit leachate seepage.

Silo caps or covers keep rainwater from entering the silage–preserving a quality silage–and also reduce the potential for producing leachate. Horizontal silos should be covered with a plastic cover and weights to keep the cover in place.

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 from silage can protect both groundwater and surface water.

LEACHATE COLLECTION AND DISPOSAL

Leachate can be collected from upright and horizontal silos by channeling the liquid into a liquid retention structure, usually a pond lined with concrete, clay, or plastic. Drain tiles around silos can be used to collect any seepage from the silo. Horizontal silos should use channels to direct seepage into a collection area. Consult your local Soil Conservation Service office for help with designing a collection pond.

The most cost-effective disposal method is land-spreading. The nitrogen in leachate has significant fertilizer value if applied during spring or early summer. Because of its high organic content, leachate can burn grasses and remove oxygen from the soil. Farmers who consider land-spreading should consult a soil specialist to determine how much leachate can be safely spread on each field.

A FEW WORDS ABOUT YOUR SITE

The way home or farmstead practices such as home wastewater treatment or pesticide handling affect the groundwater depends in part on the type of soil and bedrock that is on your property.

How do soils affect the potential for groundwater contamination?

Soil characteristics are important in determining whether a contaminant breaks down to harmless compounds or leaches into groundwater. In general, the soil on your property may act as a filter that prevents contaminants from reaching the groundwater. Different soils have different abilities to "filter" contaminants. Areas

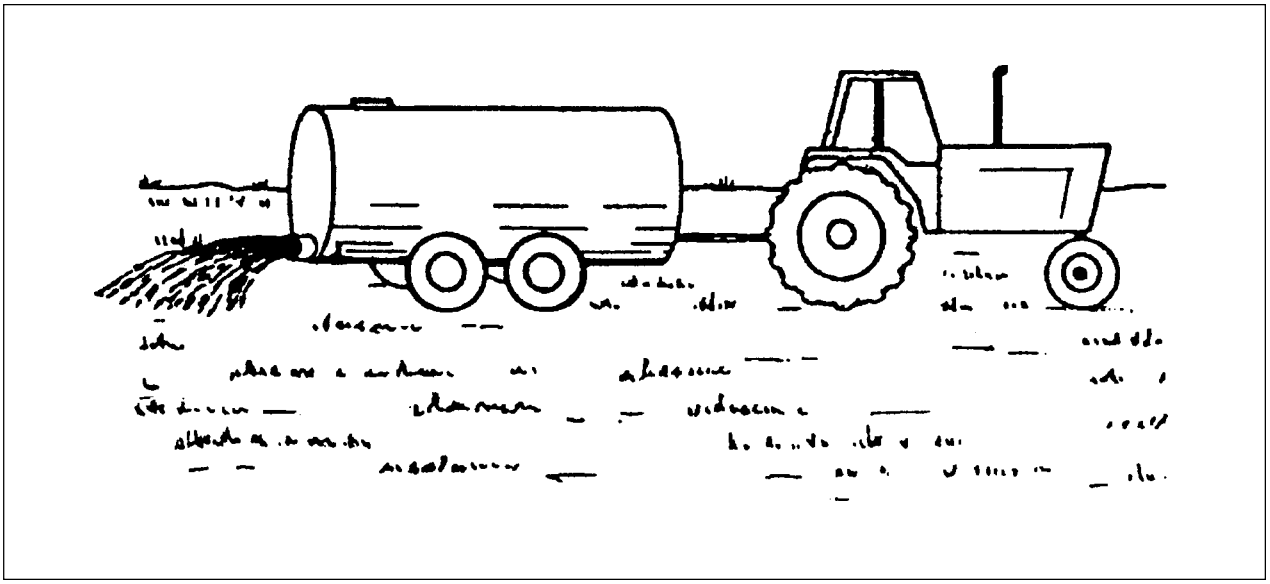


Figure 3. Land-spreading of silo leachate. *Source:* Livestock Waste and Facilities Handbook, *MWPS-18, Midwest Plan Service.*

with soils that let water flow through them quickly have a greater risk of groundwater contamination. This is because the soil doesn't get a long enough chance to absorb or "grip" the contaminant, and it may flow to the groundwater with leaching rainwater. On the other hand, soils that allow water to flow through slowly will do a better job of protecting the groundwater, but pose a higher risk of contaminating streams because the water will run off and may carry pollutants with it.

Sandy soils have large spaces between individual particles and therefore let water pass through quickly. Contaminants from your property can flow with this water. Because of this, sandy soils have a greater potential to pollute groundwater than clays.

Clay soils, on the other hand, have smaller spaces between individual particles and therefore water passes through slowly. Slower-moving water allows contaminants a greater chance to be absorbed by or "grip" onto the soil. Because of this, clays do a better job of protecting the groundwater. Since water moves through a clay soil slowly, there is a higher chance of runoff. This can result in surface water (stream) contamination. In other words, there is a tradeoff between groundwater and surface water protection. If your site has a clay soil, it will do a better job of protecting the groundwater, but you must also look out for surface water contamination.

In Kentucky, the type of bedrock on your property is more important than the type of soil in determining your site's ability to protect the groundwater.

How does the bedrock on your site affect the potential for groundwater contamination?

Bedrock is the rock that lies underneath the soil on your property. Like the soil, different types of bedrock have different abilities to protect (or not protect) the groundwater from pollution. Knowing the bedrock that underlies your property is therefore important, because it can tell you if you live in an area which is sensitive to groundwater contamination. Earlier in this publication, the sensitivity of karst areas to groundwater contamination was discussed. These areas are especially sensitive to groundwater contamination because the bedrock is dissolved by water, and large conduits and caves are formed underground. These conduits and caves allow pollution to flow very quickly from the surface to the groundwater. Basically, karst areas may act like a sewer system that connects your home or farmstead to the groundwater. Look at the map at the end of this publication to see if you live in a region of the state that has a low, medium, high, or very high sensitivity of groundwater contamination. If you live in an area that has a high or very high sensitivity (karst areas), you need to be especially careful with how you manage your home or farmstead pollution sources. This means being very careful around sinkholes and water resources (wells, springs, streams, etc.). **Do not dump garbage into sinkholes, or you will contaminate the groundwater that serves as drinking water for many families.**

Potential effects of underground mining

Underground coal mining done underneath or near your property may result in the subsidence, or settling, of your property. This settling may cause damage to structures as well as put groundwater at risk of being contaminated. The settling causes cracks in the land that can then allow pollution from the soil surface to enter the groundwater. The chance of subsidence occurring on your property depends on when the underground mining occurred, the depth of the mine, and what type of mining was done.

Depending on the type of underground mining done, different precautions are taken by mining companies to prevent subsidence. "Room and pillar" mining leaves pillars in the mines that support the land above when the mine is abandoned. As time passes, there is a greater risk that these pillars can degrade and result in the subsidence, or settling, of the land above. Certain types of "longwall" mines do not provide pillars. Therefore, these mines have a greater chance of resulting in subsidence. The depth of the mining also affects the chance that subsidence will occur. Deeper mines (greater than 400 feet) are less likely to cause subsidence than shallow mines (less than 200 feet). Information regarding the type and depth of underground coal mines may be obtained from the Department of Mines and Minerals at 606-254-0367 (ask for the Map Room). Be prepared to describe the location of your property in as much detail as possible (use a topographical map if possible).

CONTACTS AND REFERENCES

Who to call about...

Silage Storage

County Extension agent . . . . . check local listings
Soil Conservation Service . . . . . check local listings

What is KY•A•Syst?
KY•A•Syst is a series of publications which will help you assess *and improve* how effectively your home or farmstead practices protect the groundwater. The publications ask you about your home or farmstead structures and activities. Your answers will help you see how your practices might be affecting the groundwater. Each publication then gives suggestions about things you can do to improve your home or farmstead practices to better protect the groundwater.

The topics of the program include:
- Drinking Water Well Condition
- Agricultural Chemical Storage and Handling
- Petroleum Product Storage
- Household Waste Management
- Household Wastewater Treatment
- Livestock Waste Storage
- Livestock Yards Management
- Silage Storage
- Milking Center Wastewater Treatment

Some of these topics apply only to people who have farms, and others apply to both farm owners and non-farm owners. ***This program is a completely voluntary program: it is an assessment you can perform in the privacy of your own home. No information from the publications needs to leave your home. The goal of KY•A•Syst is to help you protect the groundwater that supplies drinking water for many families.***

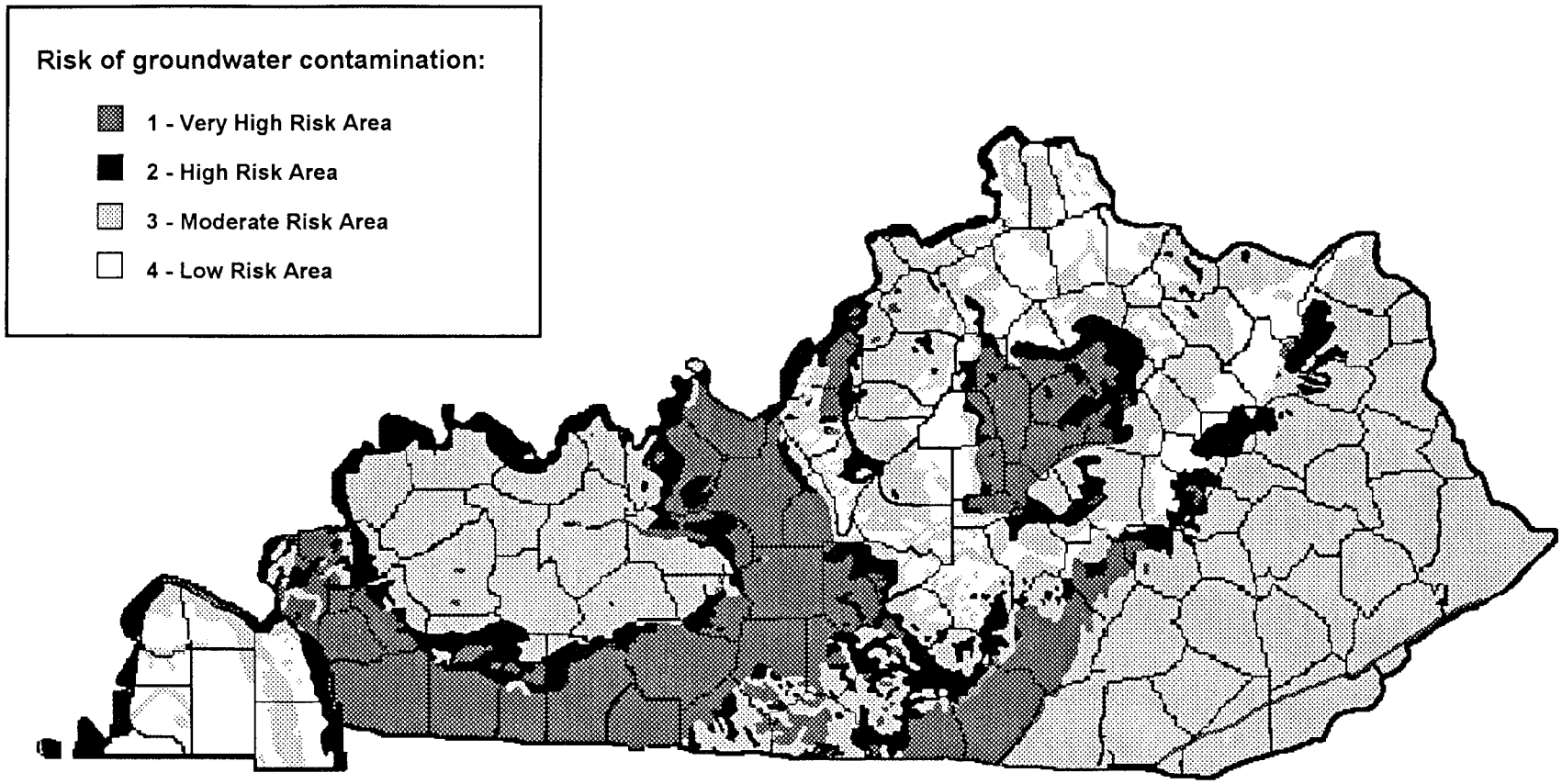
Edited and compiled by Mark Dravillas, former Extension Associate for Water Quality, and Tom Ilvento, former Associate Extension Professor in Sociology, University of Kentucky Cooperative Extension Service. Based on materials from the National Farm•A•Syst Program, University of Wisconsin (author: David W. Kammel, University of Wisconsin, and Nick Houtman, now at University of Maine). Special thanks to Dr. Bill Crist, University of Kentucky, Department of Animal Sciences, University of Kentucky, for technical review and comments.

This project has been funded with Section 319 grant monies from the U.S. Environmental Protection Agency through the Kentucky Cabinet for Natural Resources and Environmental Protection, Division of Water.

The KY•A•Syst project is coordinated by the Kentucky Cooperative Extension Service in collaboration with various Kentucky state and federal organizations and agricultural commodity and environmental groups.

KY•A•Syst publications can be obtained at your county Cooperative Extension Service office. For additional information on the KY•A•Syst program, contact Marla Barnett at (606) 257-2735 or Dr. Curtis W. Absher at (606) 257-1846.

Groundwater Sensitivity Map



Reproduced from a map created by Division of Water - Groundwater Branch : Frankfort, Ky.

This map shows the potential for groundwater contamination in the different areas of Kentucky. Find the county you live in to determine how sensitive your region is to groundwater contamination.