

Siting Manure Storage Areas in Minnesota's Karst Region: State Requirements

Water Quality/Feedlots #8.13, Revised November 2005

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Purpose

On October 23, 2000, revisions to state rules governing feedlots and the storage and utilization of manure became effective (Minn. R. ch. 7020). This document provides information to producers, consultants and government officials about state requirements when siting a new feedlot or manure storage area in Minnesota's karst region. Please use this fact sheet along with other Minnesota Pollution Control Agency (MPCA) fact sheets that apply to feedlot construction throughout Minnesota, including 'Feedlot Construction Setbacks from Open Waters and Wells' and 'Liquid Manure Storage Areas' found at MPCAWeb site <http://www.pca.state.mn.us/hot/feedlots.html>

Local ordinances may include more restrictive setbacks than state rules. Where local ordinances are more restrictive than state rules, the local ordinances must be followed.

Water Quality Protection

Much of southeastern Minnesota is considered "karst" (figure 1). Carbonate bedrock in karst regions dissolves over long periods of time to produce solution enlarged cracks. Surface and ground waters in much of southeastern Minnesota are easily polluted because of:

- Shallow depth to highly fractured bedrock;
- Rapid transport of water into and through the subsurface;
- Sinkholes and other openings to the fractured bedrock; and
- Highly interconnected system of surface water and ground water.

Water is generally most susceptible to contamination in areas underlain by less than 50 feet of unconsolidated material above fractured bedrock.

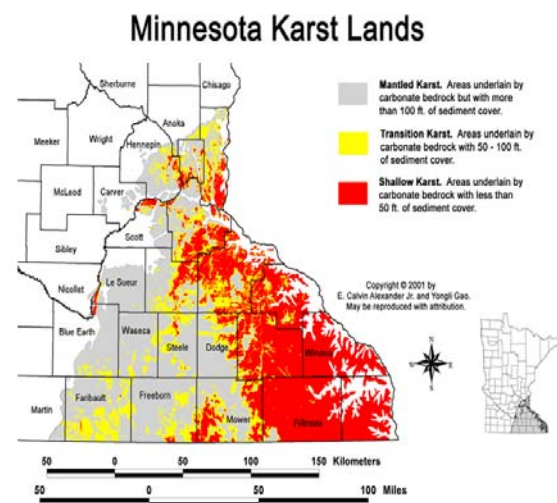


Figure 1. Minnesota karst lands. By Alexander and Gao, 2001.

One environmental concern in karst is the potential for sinkholes to form below manure storage structures, causing contaminants to flow directly into ground water. Excessive seepage from liquid impoundments can wash underlying soil into bedrock fractures, leading to soil collapse or sinkhole formation. Sinkholes have developed under three poorly lined municipal wastewater treatment ponds in southeastern Minnesota and in several unlined cropland runoff retention ponds established for erosion control.



All failures in Minnesota and other states have been associated with earthen storage ponds having either no liner, or a soil liner designed to seep more than current Minnesota requirements for cohesive soil liners.

Ground water contamination problems can also result from seepage of liquid manure moving into fractured bedrock, even without sinkhole formation. Well water was severely contaminated at one farm when liquid manure continuously leaked through a soil liner into fractured bedrock immediately below the earthen basin. Long-term chronic seepage into fractured bedrock can add bacteria, viruses and other potential contaminants to the uppermost bedrock aquifers. The MPCA feedlot siting, design and construction standards were established in karst areas to protect against both chronic and catastrophic types of water quality concerns.

Minnesota Rules for Liquid Manure Storage in Karst

Several parts of Minnesota feedlot rules (Ch. 7020) pertain specifically to liquid manure storage construction in karst, as outlined below. These rules include site investigation requirements, setbacks from sinkholes, separation to bedrock restrictions, and maximum storage capacities in certain areas of heightened risk. An alternative set of standards (outside of those required by rule) may also be followed by feedlot owners if all conditions described on page 4 are met.

Site Investigation Requirements

Site investigations must consist of at least: 1) karst feature identification; and 2) soil profile investigation. These requirements are described below.

Karst Feature Identification

In areas susceptible to soil collapse or sinkhole formation (see definitions), submit a map of the proposed site along with the permit application. The map must show the precise locations of the following features present within 1/2 mile of the site: open and filled sinkholes, depressions, known caves, resurgent springs, disappearing streams, karst windows, and blind valleys (Minn. R. ch. 7020.2100 subp. 4, item A(7)).

To identify karst features, a) examine existing maps, b) walk the land making a careful inspection, and c) prepare a map. Complete Attachment A (pages 6 and 7 of this document) to document your efforts in identifying karst features.

- a) Examine existing maps - Review county geologic atlas sinkhole probability and ground water sensitivity maps, where available. Geologic atlases may be available at county environmental service or zoning offices or from the Minnesota Geologic Survey (612-627-4782). Also check soil surveys and aerial photographs (current and historical).
- b) Walkover survey - Since the maps do not show all types of karst features and many sinkholes are not mapped, field inspections for possible karst features must supplement information found in the geologic atlas.
- c) Prepare a map - Develop a map showing locations of all karst features (e.g. number each feature on a topographic map). Each feature shown on the map should be described in detail. Photographs are optional.

State or county staff may inspect the site after reviewing the submitted information.

Soil Profile Investigation

Soil profile information must be obtained and recorded to represent the range of soil conditions throughout the proposed manure storage area site. At a minimum, provide soil profile information at two locations within the footprint (or immediately adjacent) of the proposed manure storage area for the first one-half acre of surface area and one additional location for each additional acre (Minn. R. ch. 7020.2100 subp. 4, item A(2)).

In areas susceptible to sinkhole formation, record soil conditions to a depth of at least ten feet below the bottom of the proposed liquid manure storage area, or until bedrock is encountered. If the minimum separation to bedrock requirements exceed ten feet (as explained below), then record the soil profile to a depth that allows verification of minimum separation to bedrock requirements (Minn. R. ch. 7020.2100 subp. 4A(3)(4)).

**Setback from sinkholes**

New feedlots or manure storage areas must be constructed more than 300 feet from the outer edge of sinkholes (Minn. R. ch. 7020.2005 subp. 1). Exceptions may be allowed if the feedlot has less than 300 animal units and construction of the storage system is needed to correct an existing pollution hazard (Minn. R. ch. 7020.2100 subp. 2, item C).

Separation to bedrock requirements

Minimum separation to bedrock requirements range from five to fifteen feet for concrete, composite-lined and above-ground systems, depending on the liner type and the number of animal units at the farm. The separation to bedrock requirements range from 20 to 40 feet where only cohesive-soil liners are to be used. Table 1 outlines the minimum separation distance between liquid manure and bedrock. Exceptions may be allowed if the feedlot has less than 300 animal units and construction of the storage system is needed to correct an existing pollution hazard (Minn. R. ch. 7020.2100 subp. 2, item C).

Table 1 – Minimum vertical separation distances between liquid manure and the underlying fractured bedrock (Minn. R. ch. 7020.2100 subp. 2, item B).

Number of Animal Units (AU) contributing to liquid storage on the entire farm	Earthen liners	Composite* liners or concrete liners	1. Composite* liners with an additional foot of compacted clay (3' clay + geomembrane), 2. Above ground storage** or 3. Concrete with a secondary liner under the concrete***
< 300 AU	20 feet	5 feet	5 feet
300 to 999 AU	30 feet	10 feet	5 feet
>1000 AU	40 feet	15 feet	10 feet

* A composite-lined storage system consists of at least two feet of compacted cohesive soil below a geomembrane liner and has a seepage rate less than 1/560 inch per day.

** An above ground concrete or glass-fused metal tank.

*** Concrete-lined systems with an underlying 2 foot cohesive soil liner or geomembrane.

Storage Capacity Limits

The maximum liquid manure storage cell capacity is limited to 250,000 gallons if four or more sinkholes exist within 1000 feet of the proposed manure storage area (Minn. R. ch. 7020.2100 subp. 2, item A). Exceptions may be allowed if the geologic conditions change from the sinkhole area to the proposed construction site, such that the construction site is not in an area “susceptible to soil collapse or sinkhole formation” (see definitions). Exceptions may be allowed if the feedlot has less than 300 animal units and construction of the storage system is needed to correct an existing pollution hazard (Minn. R. ch. 7020.2100 subp. 2, item C).

Alternative Standards for Liquid Manure Storage Construction

After Minnesota Rules chapter 7020 were finalized, the Minnesota Legislature required the MPCA to convene a workgroup to review and propose alternative design standards for areas susceptible to soil collapse and sinkhole formation (Chapter 435, Sec. 13). The workgroup completed their work in January 2001, producing a report with recommended design standards and the considerations and justification for making these recommendations (to see a copy of the report go to <http://www.pca.state.mn.us/hot/legislature/reports/2001/karst>)



Producers siting and constructing new liquid manure storage areas may choose to use the alternative set of workgroup standards if certain conditions are met, as described below. The feedlot rules (Minn. Rules ch. 7020.0405 subp. 1, item B(3) and 7020.0300 subp. 15a) allow alternative standards if a State Disposal System (SDS) or National Pollutant Discharge Elimination System (NPDES) permit is obtained, and environmental results to be achieved are equivalent to technical standards in the rules. The MPCA may issue SDS or NPDES permits to producers who choose the workgroup-proposed *set of standards* instead of those prescribed in rules, if equivalent environmental results are to be achieved. The MPCA will not issue an SDS or NPDES permit in situations where implementation of workgroup standards will not achieve environmental results equivalent to those provided by the rule.

The workgroup intended for the entire set of standards to be used, rather than picking and choosing only certain elements of these alternative standards.

The workgroup-recommended standards for areas susceptible to sinkhole formation include:

- 300 foot setback from sinkholes;
- 3 million gallon capacity limit per storage cell in all areas susceptible to sinkholes;
- No use of earthen liners alone in areas susceptible to sinkholes (until further study is completed);
- Concrete or composite liners with at least a five-foot separation above bedrock;
- Bedrock separation distances can be less than five feet if concrete liners are underlain by a geomembrane and a drainage outlet to the ground surface is installed;
- Weekly to monthly monitoring of manure levels and annual inspections following manure removal;
- Subsoil inspection during construction for possible karst features;
- Grading and routing water so that freshwater from roof runoff and other precipitation does not

infiltrate near the storage area and is instead directed to a place where it will flow away from the site; and

- Detailed emergency response plans.

Minnesota Rules for Manure Stockpiling and Spreading in Karst Areas

Certain stockpiling restrictions specifically pertain to karst areas. New stockpile sites can not be constructed within 300 feet of sinkholes (Minn. R. ch. 7020.2005 subp. 1). In addition, stockpiling at all sites (new or existing) is prohibited within the following distances to sinkholes, bedrock outcrops, or road ditches that flow to sinkholes and rock outcrops (Minn. R. ch. 7020.2125 subp. 2, item C):

- within 300 feet of flow distance (the pathway runoff water takes as it flows off of a field), and
- within 50 feet straight-line map distance (even where the flow distance exceeds 300 feet).

Manure can not be applied within 50 feet of a sinkhole. In addition, manure must be injected or immediately incorporated when spread on land that is between 50 and 300 feet on the upslope side(s) of a sinkhole. These restrictions do not apply where diversions prevent manure-contaminated runoff from entering the sinkhole. (Minn. R. ch. 7020.2225 subp. 8).

More information about manure stockpiling and manure application restrictions can be obtained from the MPCA Web site <http://www.pca.state.mn.us/hot/feedlots.html>

Environmental Assessment Worksheets in Karst Areas

The Environmental Quality Board established rules (Minn. R. ch. 4410) describing when an Environmental Assessment Worksheet (EAW) must be completed. Proximity to karst features, along with feedlot size, can affect whether a proposed feedlot or feedlot expansion will trigger a mandatory EAW.



New Feedlots - An EAW is automatically required when a new feedlot with more than 500 animal units is to be constructed within 1,000 feet of a known sinkhole, cave, resurgent spring, disappearing spring, karst window, blind valley or dry valley (Minn. R. ch. 4410.4300 subp. 29).

Feedlot Expansions - An EAW is automatically required when a feedlot is to expand by more than 500 animal units and the feedlot is within 1,000 feet of a known sinkhole, cave, resurgent spring, disappearing spring, karst window, blind valley or dry valley (Minn. R. ch. 4410.4300 subp. 29).

All other statewide rules governing when an EAW is required are applicable in the karst region, as described in Minn. R. ch. 4410.

Definitions

Areas Susceptible to Sinkhole Formation

This term is used in Minnesota rules Ch. 7020 and the alternative standards developed by the karst workgroup. The term is not defined in rules, but was later defined by the karst workgroup as follows:

“Areas susceptible to sinkhole formation” exist where the conditions under either A or B are met, as described below:

A. *Shallow depth to carbonate bedrock*

1. Depth to carbonate bedrock is less than 50 feet, AND
2. Uppermost bedrock is carbonate materials or other geologic conditions where soil collapse or sinkhole formation occurs including the New Richmond Sandstone and basal St. Peter Sandstone

OR

B. *Presence of Nearby karst features*

1. Karst features exist within 1000 feet of the proposed site (sinkholes, blind valleys, mapped caves, springs, or karst windows,),
AND
2. Geologic conditions near the karst features are similar to those of the proposed site.

Bedrock Outcrop

Exposed consolidated rock that has not been moved out of place by erosion.

Blind Valley

A valley that terminates abruptly at a point where its stream sinks, or once sank, underground. Blind valleys are completely enclosed valleys that water can not flow out of on the surface. Disappearing streams often sink in Blind valleys.

Cave

A feature generally formed by solution of limestone containing a natural underground room or series of rooms and passages large enough to be entered by people.

Disappearing Stream

Surface streams that run into holes in the ground and partially or completely cease flowing on the surface.

Karst

A landscape created on soluble rock with efficient underground drainage. Karst is characterized by caves, sinkholes, a lack of surface drainage and other climatically controlled features, and is mainly, but not exclusively, formed on limestone.

Karst Window

A depression that reveals a part of a subterranean river flowing across its floor, or an unroofed part of a cave.

Sinkhole

A surface depression caused by a collapse of soil or overlying formation above fractured or cavernous bedrock.

Additional Information

Inquiries regarding feedlots, new construction, state rules, and regulations in the karst region can be directed to the MPCA Rochester office compliance staff at 1-507-285-7343 (toll-free 1-800-657-3864) or Jim Lundy, Feedlot Program hydrogeologist, 1-651-296-7822.

Attachment A: Karst Feature Inventory Reporting Form (for Proposed Liquid Manure Storage Sites)

This form is a supplementary reporting form to be used in conjunction with MCPA factsheet entitled "Siting manure storage areas in Minnesota's karst region: state requirements."

The purpose of this form is to provide information needed evaluate Minn. R. ch. 7020.2100 subp. 4, item A(7), which requires a map showing the proposed liquid manure storage areas and all karst features identified within ½ mile from the site. Additional follow-up inspections may be needed by qualified individuals to assess potential karst features. The map is required in all areas susceptible to soil collapse or sinkhole formation (see definitions in the above referenced fact sheet). Submit this form in the permit application along with your plans and specifications for liquid manure storage.

SECTION A: GENERAL INFORMATION

Proposed manure storage area location:

County: _____
Township: _____
Section & ¼ section _____

Feedlot Owner

Name: _____
Phone: _____

Person preparing this form

Name: _____
Organization: _____
Phone: _____

SECTION B: KARST FEATURE MAPPING (Complete each part 1 – 4)

1. I have reviewed all existing sinkhole probability maps published by the Minnesota Geological Survey (612-627-4782) for my county, and I have attached a photocopy of the map showing the sinkholes within ½ mile from the proposed manure storage structure.
___ **yes** (if yes, skip item 2 and go to item 3)
___ **no**, sinkhole maps exist for my county (complete items 2, 3 and 4 below)
___ **no**, other reason, explain: _____
2. If no sinkhole probability maps have been developed, I have reviewed soil surveys and aerial photos for the presence of karst features, and I have attached a photocopy of all soil surveys and aerial photos showing karst features within ½ mile from the proposed manure storage structure. Indicate the date of the survey or aerial photographs (review photos from different time periods to also identify filled sinkholes).
___ **Not needed** - sinkhole probability maps exist for my county and I therefore did not review the soil surveys and aerial photos
___ **Yes**, I have reviewed the soil survey and other aerial photographs and I did not find any evidence of karst features from these photographs.
___ **Yes**, I have reviewed the soil survey and aerial photographs and the karst features are shown on the attached aerial photos.
___ **No**, I have not reviewed or attached this information
3. I have conducted a visual inspection of the land within ½ mile from the proposed site, traversing the land closely enough to identify small sinkholes or other karst features as defined in the fact sheet.
___ **Yes**, and I have attached a map or aerial photo showing all areas inspected for karst features.
Name of person(s) conducting inspection: _____
Date of inspection: _____
Field conditions (eg. snowcover, vegetative cover, etc.): _____
___ **No**, I have not conducted a visual inspection of the land. Please explain: _____

4. I have attached a copy of an enlarged topographic map which shows all open and filled sinkholes, depressions in the landscape, known caves, springs, disappearing streams, and blind valleys within ½ mile of the proposed manure storage area, and I have described each feature in the table below (each number on the map should correspond with the number in the table).

☐ Yes ☐ No

Karst feature map number	Type of feature	Source of information	Feature size and description	Other information
Example	Depression in the landscape	Walk-over survey	12 feet in diameter and 1-2 feet deep	Located 500 feet from proposed storage site
#1				
#2				
#3				
#4				
#5				
#6				
#7				
#8				
#9				
#10				

SECTION C: SITING REQUIREMENTS

Check the box under “yes” or “no” in response to the questions in each row. For more information about these requirements see **MCPA factsheet entitled “Siting manure storage areas in Minnesota’s karst region: state requirements”** found at www.pca.state.mn.us/hot/feedlots/publications/wq-f8-13.pdf.

	Yes	No
Are any open or filled sinkholes less than 300 feet from the proposed liquid manure storage area (LMSA)?	(not permitted)	
Are four or more sinkholes located within 1000 feet from the LMSA?	(not permitted if over 250,000 gallons)*	
Is the depth to bedrock less than allowed on table 1 of “Siting manure storage areas in Minnesota’s karst region: state requirements”	(not permitted)*	
Is the proposed site within 1000 feet of a karst feature and more than 500 animal units are added at once or part of a phased expansion?	(EAW needed)	

* Alternative standards may potentially be used if meeting karst workgroup developed guidelines and obtaining an SDS or NPDES permit.