



# Locating Feedlots and Manure Storage Areas in Minnesota's Karst Region

Many areas of southeastern Minnesota are underlain by bedrock that is susceptible to karst. Carbonate bedrock in karst regions dissolves over long periods of time to produce solution enlarged cracks, which creates a heightened risk of groundwater impacts from all kinds of activities on the surface including manure storage and application. In general, the greatest concern arises when there is less than 50 feet of soil cover over the karst susceptible bedrock.

One specific concern in karst is the potential for sinkholes to form below manure storage structures, causing a catastrophic failure and allowing 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.

The location, design, and construction standards of Minn. Rule Ch. 7020, summarized in this fact sheet, were established to protect against both chronic and catastrophic types of water quality concerns in Minnesota's karst region.

## Karst Susceptible Areas

Minn. Rule Ch. 7020 uses the term "susceptible to soil collapse or sinkhole formation" to refer to the areas of Minnesota that are most vulnerable to water quality impacts related to karst. The MPCA has shortened this phrase to "karst susceptible areas" and considers a facility to be in a karst susceptible area when either:

- A. Land, within ½ mile of the facility, has a depth to bedrock of less than 50 feet and the uppermost bedrock is carbonate materials or other geologic conditions where soil collapse or sinkhole formation occurs including the New Richmond Sandstone and St. Peter Sandstone; or,
- B. Karst features exist within 1,000 feet of the facility (sinkholes, blind valleys, mapped caves, springs, or karst windows) and geologic conditions near the karst features are similar to those of the proposed site.

Generally, a feedlot facility is considered to be within a karst susceptible area when it is located within the shallow karst (red) area of figure 1.

Site specific information on separation to bedrock can be obtained from the Minnesota Geological Survey County Geologic Atlases available at: [http://www.mngeo.state.mn.us/county\\_atlas/countyatlas.htm](http://www.mngeo.state.mn.us/county_atlas/countyatlas.htm).

Site specific information on the location of karst features can be obtained from the Minnesota Karst Features Database available as GIS data at: <https://gisdata.mn.gov/dataset/geos-karst-feature-inventory-pts>.

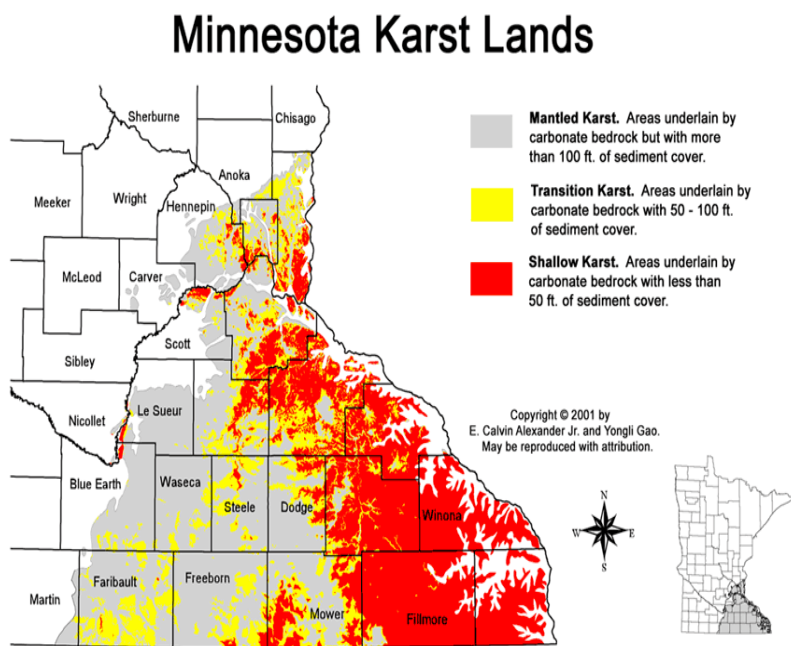


Figure 1: Minnesota Karst Lands  
(E. Calvin Alexander Jr. & Yongli Gao)

## Karst Inventory Survey

A karst inventory survey involves an examination of maps and physically walking the surrounding land to document the presence of karst features. A karst inventory survey is required whenever a liquid manure storage area (LMSA) is proposed in a karst susceptible area. The only exclusion is when the LMSA qualifies for an exemption afforded to small concrete structures or settling basins (*see Minn. Rule 7020.2100 Subp. 1 item D*). When required, the karst inventory survey must be submitted with the design plans and/or permit application.

Although not specifically required, a karst inventory survey is also recommended when construction of an animal holding area or a permanent manure stockpile is proposed in a karst susceptible area. Be aware that the MPCA may require a karst inventory survey, in accordance with Minn. R. 7020.0505 subp. 4 item E, in order to evaluate compliance with karst feature setbacks required by state rule for animal feedlots or manure stockpiles.

Completion of a karst inventory survey involves three steps.

- 1) Examine existing maps - Review county geologic atlas sinkhole probability and ground water sensitivity maps, where available. GIS information including topographic maps, LiDAR maps, and the Minnesota karst features database are very valuable resources to consult. Also check soil surveys and aerial photographs (current and historical) for evidence of karst features. Karst features include open and filled sinkholes, closed depressions, known caves, resurgent springs, disappearing streams, karst windows, and blind valleys. It should be noted that “sinkholes” include closed depressional features that have not yet fully collapsed and do not resemble the classic conical shaped sinkhole.

This part of the karst inventory survey must, at a minimum, be conducted on all land within ½ mile of the construction site.

- 2) On-site investigation - 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 available from the map resources. On-site investigations must be completed by an experienced individual when the land surface is visible since a closed depression that has not yet fully collapsed may not be evident when snow or significant vegetation covers the landscape. The best time to complete the on-site investigation is early spring before extensive vegetation



*Photo from MNGS*

becomes established or after crop harvest for farmed areas. If the on-site investigation is done at a poor time (e.g. mature standing crops, excessive snow depth) another investigation, at an appropriate time, may be required. Karst landscape is a dynamic, ever changing landscape and therefore the on-site investigation must be done as close to the time of construction as possible.

This part of the karst inventory survey must, at a minimum, be conducted on all land within 1,000 feet of the construction site.

- 3) Document results – Develop a map showing locations of all karst features (e.g. number each feature on an aerial photo). Each feature shown on the map must be described in detail using the MPCA standardized form available at the end of this fact sheet. Photographs are encouraged. State or county staff may inspect the site after reviewing the submitted information.

## Requirements for Liquid Manure Storage Areas

Several parts of Minn. Rule Ch. 7020 pertain specifically to LMSA construction in karst including site investigation requirements, setbacks from sinkholes, separation to bedrock restrictions, and maximum storage capacity. This information (summarized below) is also discussed in more detail within the LMSA handbook available on the MPCA website at: <http://www.pca.state.mn.us/index.php/view-document.html?gid=3699>.

### Soils investigation

Most LMSA construction projects must complete a sub-surface investigation prior to construction. The requirements for a soils investigation for LMSAs in a karst susceptible area are the same as LMSAs located elsewhere except for one difference in the depth of the investigation. In a karst susceptible area, the soils investigation must advance to a depth of at least ten feet below the bottom of the proposed LMSA, or until bedrock is encountered. Additionally, in situations where a minimum separation to bedrock is required (see Table 1 below) the investigation must be completed to a depth that verifies this separation is achieved.

### Locational restrictions

Sinkholes - When it is determined that a sinkhole exists near a proposed LMSA location, the following restrictions apply.

- LMSAs must be constructed more than 300 feet from the outer edge of any sinkhole.
- When 4 or more sinkholes exist within 1,000 feet of a LMSA, the maximum volume of any cell of the LMSA is limited to no more than 250,000 gallons.<sup>2</sup>

Bedrock separation – Based upon the type of LMSA liner material and the size of the facility, a varying degree of separation to the underlying bedrock is required. The following chart summarizes the required separation distances.<sup>2</sup>

**Table 1.** Summary of separation distance to karst susceptible bedrock requirements

Type of LMSA Liner	Number of animal units (AU) on the entire farm		
	Less than 300	300 – less than 1000	1000 or more
Non-concrete (i.e. earthen, plastic, GCL)	20 ft	30 ft	40 ft
Concrete	5 ft	10 ft	15 ft
Composite*	5 ft	10 ft	15 ft
Composite with an extra foot of compacted soil	5 ft	5 ft	10 ft
Aboveground	5 ft	5 ft	10 ft
Concrete with a secondary liner**	5 ft	5 ft	10 ft

\* A composite-lined storage system consists of at least 2 ft of compacted cohesive soil below a geomembrane liner and the overall liner system has a seepage rate less than 1/560 inch/day.

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

<sup>2</sup> Based upon site specific circumstances, the MPCA may grant an exception to these restrictions when geologic conditions directly below the LMSA differ substantially from nearby areas that cause the overall area to be considered karst susceptible.

### Bedrock removal

Removal of bedrock in order to achieve the required separation distance is prohibited unless specifically approved by the MPCA according to six criteria with Minn. R. Ch. 7020. While bedrock removal is not a practice the MPCA wishes to encourage, in some limited situations the MPCA may allow removal of highly weathered bedrock material. In all cases of bedrock removal an individual NPDES or SDS permit will be required that contains site specific conditions to authorize the removal of bedrock and LMSA construction.

## Requirements for Solid Manure Storage Areas (Stockpiles)

A solid manure storage area is commonly called a stockpile. Manure is considered to be a solid product when the manure can be piled at a three-to-one horizontal-to-vertical ratio **and** the manure has, at least, a 15 percent solids content. All manure that is not solid is considered liquid and storage must take place in a LMSA. The following stockpile requirements are specific to karst susceptible areas and karst features:

- A stockpile (permanent or short-term) cannot be located within 300 feet of a sinkhole.
- Manure cannot be stockpiled for any length of time on exposed bedrock.
- A short-term stockpile cannot be located within 50 feet of a bedrock outcropping
  - The short-term stockpile must also be located so that at least 300 feet of flow distance exists between the stockpile and the bedrock outcrop.

## Requirements for Animal Holding Areas

A new animal holding area (barn, open lot, etc.) cannot be constructed within 300 feet of a sinkhole. There are no setback requirements applicable to pastures. Even though there is not a specific requirement for separation to bedrock from the surface of an animal holding area, consideration should be given to having a separation distance of at least 5 feet or having an impermeable (e.g. concrete) surface on the animal holding area.

## Exception from LMSA Location Restrictions for Pollution Abatement

Minn. R. 7020.2100 subp. 2 item C provides an exemption to the locational restrictions where construction or modification of a liquid manure storage is required to correct a pollution hazard at an existing facility holding fewer than 300 AU. Construction or modification must not result in an expansion of the animal feedlot capacity to hold more than 300 AU or the manure storage area capacity to hold the manure produced by 300 AU or greater. If you would like to invoke this portion of the rule please contact the regional MPCA staff in your area to discuss the specifics of the proposed project.

## Other Considerations

Consideration should be given to locating feed storage areas in the same manner as animal holding areas. These areas can produce high strength leachate and large volumes of runoff. Feed storage areas can be determined to be a pollution hazard leading to fixes that may have been avoided with proper planning.

Consideration should also be given to performing a karst feature survey on cropland designated for land application or temporary manure stockpiles. The presence of sinkholes influences the placement of temporary stockpiles and land application practices; therefore, it is beneficial to identify sinkholes with a karst feature survey to prevent rule violations.

## Environmental Review

Proximity to karst features, along with feedlot size, can affect whether a proposed feedlot or feedlot expansion will trigger mandatory environmental review via preparation of an environmental assessment worksheet (EAW). An EAW is required prior to construction or expansion, within a three year period, of a feedlot with a capacity of 500 AU when located within 1,000 feet of a karst feature. More information on the environmental review program can be found on the MPCA website at: <http://www.pca.state.mn.us/clyp699>.

## Requirements Not Influenced by Karst

Be aware that this fact sheet only presents requirements that are specific to Minnesota's karst region. There are additional regulations that apply to all areas of the state including karst susceptible areas.

## For More Information

For more information about the feedlot program in Minnesota, please visit the MPCA website at [www.pca.state.mn.us/feedlots](http://www.pca.state.mn.us/feedlots).

# Karst Feature Inventory Reporting Form

## For a Proposed Liquid Manure Storage Area (LMSA)

The purpose of this form is to provide documentation regarding all karst features identified within ½ mile from the facility. Additional follow-up inspections may be needed by qualified individuals to assess potential karst features. Submit this form and required map(s) along with your plans and specifications for the LMSA.

### Proposed LMSA Location

County: \_\_\_\_\_ Township: \_\_\_\_\_ Sect.: \_\_\_\_\_ ¼ Sect.: \_\_\_\_\_

Facility Owner Name: \_\_\_\_\_ Phone: ( ) \_\_\_\_\_

### Inspector Information

Name: \_\_\_\_\_ Date of Field Inspection: \_\_\_\_\_

Company/Organization: \_\_\_\_\_ Phone: ( ) \_\_\_\_\_

Field Conditions (snow cover, vegetation, etc.): \_\_\_\_\_

### KARST FEATURE INVENTORY DOCUMENTATION

The inspector must review existing map resources for all land within ½ mile of the proposed site and must also conduct a visual on-site inspection of the land within 1,000 feet of the proposed site, traversing the land closely enough to identify small sinkholes or other karst features. The following documentation is required.

1. Where sinkhole probability maps exist, attach a copy of the map showing the location of the LMSA and all sinkholes within ½ mile.
2. Attach a copy of an aerial photograph showing the location of the LMSA and all karst features within ½ mile. Number each Karst feature on the aerial photograph and provide a description in the table below:

Feature Sketch ID and Description	Source of information	Feature size and description	Distance from LMSA & Other information
<i>Ex. Depression in the landscape</i>	<i>Walk-over survey</i>	<i>12 ft. in diameter and 1-2 ft. deep</i>	<i>Located 500 ft. from LMSA</i>
#1			
#2			
#3			
#4			
#5			
#6			
#7			
#8			