

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

KARST SINKHOLE TREATMENT

(No.)

CODE 527

DEFINITION

The treatment of sinkholes in karst areas to reduce contamination of groundwater resources, and/or to improve farm safety.

PURPOSE

This practice may be applied as part of a conservation management system in karst topography, which is an area underlain by solutioned carbonate bedrock with sinkholes and caverns. The practice supports one or more of the following purposes:

- Improve water quality
- Improve farm safety

CONDITIONS WHERE PRACTICE APPLIES

On any land surface or in conjunction with any existing practice where the soils and geologic conditions are characterized by sinkholes or karst topography.

Karst sinkholes are located primarily within three geographic regions the Gypsum Hills of western Oklahoma, the Ozark Mountains in northeast Oklahoma, and the Arbuckle Mountains in south-central Oklahoma.

Sinkholes developed in the Gypsum Hills are formed in highly soluble gypsum substratum while sinkholes developed in the Arbuckle and Ozark Mountains are formed in karst limestone and dolomite bedrock.

Limestone and dolomite formations in south-central Oklahoma overlie the Arbuckle Aquifer, Oklahoma's only sole source aquifer, and therefore, any potential contamination must be avoided.

This practice does not apply to erosional or collapse features caused by failure or leakage of underground pipes or constructed surface

drainage features (e.g., canals), or due to piping of unstable soil materials, or due to poorly compacted or poorly constructed features.

This practice does not apply to sinkholes that may appear in or beneath structures or in flowing streams. Treatment of sinkholes in these areas will be determined through engineering investigations and structural design solutions.

CRITERIA

General Criteria Applicable to all Purposes

The installation and operation of karst sinkhole treatment(s) will comply with all Federal, State, and local laws, rules, and regulations. The owner or operator is responsible for securing any required permits.

A geologic investigation of the potential impact of the treatment on groundwater, surface water run-in, and the karst features will be conducted by an individual who meets the minimum requirements for the title of Certified Professional Geologist as defined by the American Institute of Professional Geologists.

Trash and other material will be removed from the sinkhole and disposed of in an environmentally sound manner.

Excess surface water caused by construction activities will be diverted from the sinkhole area in accordance with the Oklahoma NRCS Diversion (362) standard, or guidance from other applicable conservation practice standards.

The type of treatment selected will be based upon the resource protection need and the outlet conditions, and may include surface water control measures, and direct sinkhole treatment.

Nutrient and pest management plans will be developed for the drainage area of the sinkhole controlled by the landowner.

Vegetative Treatment. Subsurface conditions vary greatly due to solution activity in response to groundwater, particularly in sinkholes within the Gypsum Hills of western Oklahoma. For this reason, minimum dimensions described below may vary with local conditions. Since farm safety is essential, caution should be exercised to ensure that any equipment used near the sinkhole is safely beyond the sinkhole rim.

All sinkholes treated will have a vegetated buffer established and/or maintained. The buffer will be a minimum of 25-foot wide measured from the rim of the sinkhole. The buffer area may be extended to prevent concentrated flow channels from occurring and entering the sinkhole. The width of the vegetated buffer will be established and maintained in accordance with the type of buffer chosen. The sinkhole and surrounding buffer area will be fenced in accordance with the Oklahoma NRCS Fence (382) standard.

Existing vegetation may be used for the buffer area provided all other criteria in this standard are met. In areas where vegetation is to be established, the buffer strip will be planted to a native grass mixture. Guidance for establishing native grass vegetation is addressed in the Oklahoma NRCS Critical Area (342) standard.

Nutrients, herbicides, pesticides, and animal waste will not be applied within an established buffer. Only mechanical treatments shall be used for needed weed control.

Livestock will be excluded from the vegetative buffer except when grazing would be beneficial to maintenance of the buffer.

Appropriate erosion and sediment control measures will be used to reduce the amount of sediment entering sinkhole openings during the establishment of the vegetative buffer.

Surface Water Control. Changes to the volume of surface water that enters a sinkhole may disturb the underground hydrology. To the extent possible, the surface water flow should be maintained at historic (or predevelopment) volumes.

Pre-existing concentrated flow channels will be stabilized but should not otherwise be altered. If a plug or inverted filter is used, the area to be protected will be characterized by a qualified geologist to enable a suitable design. Concentrated flow caused by construction

activities will be dispersed with a suitable spreading or diversion technique.

Sinkhole Treatment/Closing. Adequate protection of most sinkhole and sinkhole areas can be achieved by the use of vegetative buffers and livestock exclusion.

If an open sinkhole is a safety hazard, it may be treated with a rock filter, gabions, or other methods approved by the State Conservation Engineer or delegated authority.

Sinkholes to be treated or closed via a reverse filter or plug shall be excavated to stable, unweathered bedrock, if possible, prior to construction.

Sinkholes that open into caves shall not be filled under any circumstances. Gated openings may be used for safety reasons.

CONSIDERATIONS

Current and planned land use should be considered. In particular, structures, septic drain fields, wells, feedlots, ponds, and animal waste storage systems should not be located over a sinkhole site or within the impact area.

Sinkholes may be natural conveyances of organic material and nutrients important to cave fauna.

For a sinkhole receiving contaminated overland flow, every effort should be made to first treat the source of the contamination prior to sinkhole treatment. Although it is important to maintain the hydrology of the karst system, it may be more beneficial to the groundwater quality to divert the contaminated water away from the sinkhole. In some cases, it may be necessary to completely plug a sinkhole with sealing materials rather than treat it with an inverted filter. Acceptable sealing materials are provided in ASTM D 5299, part 6.4. An example of this would be a sinkhole in a feedlot or a site that is difficult to protect by any other method.

The sinkhole treatment should not result in excessive surface water ponding or high soil moisture conditions over an extended period of time.

When filling a sinkhole, mounding of the fill material may be needed to offset future settlement due to consolidation and migration of the fill material into subsurface voids. Additional fill may be required as treatment ages.

Treatment of one sinkhole may have an effect on other sinkholes or solution features in the vicinity.

The use of a conservation easement for the buffer and sinkhole should be considered.

PLANS AND SPECIFICATIONS

Plans and specifications for Sinkhole and Sinkhole Area Treatment will be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose.

Plans and specifications shall include the following:

- Plan view showing sinkhole and sinkhole area Include topographic information and photographs
- The geologic investigation will include a study of potential impacts on the karst resource
- Depth to stable, unweathered bedrock
- Description of planned treatment measures
- The drainage area of sinkhole delineated on a topographic map
- Availability of safe outlet for surface water, if applicable
- Operation and Maintenance requirements
- Special safety requirements
- Environmental Assessment

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan will provide specific instructions for maintaining the sinkhole and sinkhole area treatment, including reference to periodic inspections and the prompt

repair and/or replacement of damaged components.

REFERENCES

1. American Institute of Professional Geologists, 1400 W. 122nd Avenue, Suite 250, Westminster, Colorado 80234, 303-412-6205 • Fax: 303-253-9220 • aipg@aipg.org
2. *Arbuckle-Simpson Hydrology Study, 2007 Annual Report*, U.S. Bureau of Reclamation, February 2008.
3. *Estimating Runoff and Peak Discharges*, USDA-NRCS, Engineering Field Handbook, Chapter 2, August 1987.
4. *Urban Hydrology for Small Watersheds*, USDA-NRCS, Technical Release 55, June 1986.
5. *Graded Riprap Stone, Quarried Stone for Erosion and Sediment Control*, National Crushed Stone Association, June 1978.
6. Koerner, R. M., *Designing with Geosynthetics*, Prentice-Hall, Englewood Cliffs, NJ, 1985.
7. *Geology*, USDA-NRCS, National Engineering Handbook, Part 531, Section 8, Chapter 1, 1978.
8. NRCS, Field Office Technical Guide, Section IV.
9. *Geology*, USDA-NRCS, National Engineering Manual, Part 531.21, September 1999.
10. White, W.B., *Geomorphology and Hydrology of Karst Terrains*, Oxford University Press, Inc., New York, New York, 1988.
11. *Recommended Best Management Practices for Proposed Activities in Karst Areas – Oklahoma*, U. S. Fish & Wildlife Service, June 24, 2003.