

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. 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

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.

A geologic investigation of the potential impact of the treatment on groundwater, surface water run-in, and the karst features will be conducted by a qualified geologist.

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

Provide for public safety in and around sinkholes.

Excess surface water caused by construction activities will be diverted from the sinkhole area.

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

Vegetative Treatment. 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. A grassed buffer area around the sinkhole shall follow the Filter Strip Standard and Specification (PA393).

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

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

On disturbed areas and/or sinkholes (as applicable), determine the appropriate vegetation to be established based on site conditions and planned land use. Follow the conservation practice standards for Conservation Cover (PA327), Critical Area Planting (PA342), Riparian Herbaceous Cover (PA390), Riparian Forest Buffer (PA391), or Pasture and Hay Planting (PA512), as appropriate.

Do not use plants listed on the Pennsylvania noxious weed list. Schedule construction so that

completion occurs during periods suitable for the establishment of vegetation.

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. However, 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.

Standard Drawings NRCS PA-073, PA-074, and PA-075 provide guidance for designing a pervious cover, soil cover, and an impervious cover, respectively, for sinkholes. These drawings may be adequate for many situations, however special conditions may require a site-specific design.

CONSIDERATIONS

The practice should work in conjunction with conservation cropping systems, pest and nutrient management, and practices that control sheet, rill and gully erosion.

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.

The treatment should be planned with consideration given to the following:

- Land use
- Existing and planned land treatment.
- Sinkhole drainage area.
- Dimensions of sinkhole opening.
- Safe outlet for diverted surface water.
- Environmentally safe disposal site for sinkhole "cleanout" material.
- Availability and quantity of inverted filter material.
- Safety of equipment operators and laborers during practice installation.

Caution should be taken when working around or operating equipment near the rims of active unstable sinkholes.

For a sinkhole receiving contaminated overland flow, every effort should be made to first treat the source of the contamination. 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. The contaminated water could then be treated. 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 Karst Sinkhole 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

OPERATION AND MAINTENANCE

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

periodic inspections and the prompt repair and/or replacement of damaged components.

At a minimum, the following items shall be included in the O & M plan, as applicable:

1. Inspection of the treatment should be made after periods of heavy runoff, since some material may run further into the sinkhole voids causing a surface depression.
2. Appurtenances such as filter strips, diversions, structures, and other conveyance systems shall be kept free of trash and repaired when needed.
3. Mow herbaceous plantings as necessary to promote vigorous growth.
4. If fences are installed, they should be maintained to prevent unauthorized entry.
5. Maintain all safety practices associated with sinkholes.

REFERENCES

Koerner, R.M. *Designing with Geosynthetics*, Prentice-Hall, Englewood Cliffs, NJ, 1985.

USDA-NRCS. *Geology, National Engineering Handbook, Part 531, Section 8, Chapter 1*, 1978.

USDA-NRCS. *Geology, National Engineering Handbook, Part 531.21*, September 1999.

White, W.B. *Geomorphology and Hydrology of Karst Terrains*, Oxford University Press, Inc., New York, NY. 1988.