

Definitions related to karst terrain to be included in Chapter 1 Part 2 of the Land Development Code (LDC):

- CAVE DRIPLINE:** The beginning of a cave defined as a line on the ground at a cave entrance formed by drips from the rock above at the outermost point of the entrance's overhang.
- CLOSED DEPRESSION:** A karst geologic feature, a distinct bowl-shaped depression in the land surface; size and amplitude are variable; drainage is internal. Naturally occurring closed surface depressions found within karst landscapes are called sinkholes (see below).
- GEOLOGIC FORMATION:** the basic or fundamental rock stratigraphic unit in the local classification of rocks, consisting of a body of rock (usually a sedimentary stratum or strata but also igneous or metamorphic) generally characterized by some degree of internal lithologic homogeneity or distinctive lithologic features (such as chemical composition, structures, textures, gross aspect of fossils or time of deposition); typically used for mapping the geology of an area.
- GEOLOGIC MEMBER:** a rock stratigraphic unit which is subordinate (a subject) of a formation; this unit is not necessarily mappable and is usually a unified subdivision of local extent that may or may not be contained in more than one formation.
- GROUNDWATER DRAINAGE BASIN:** An area of the landscape that drains through the subsurface to a spring or other component of a karst drainage system such as a cave stream or karst window. This term is analogous to "catchment" for surface drainage systems, in which case it denotes an area of the landscape that drains to a river confluence or other point in a surface drainage system. In contrast to surface catchments, karst groundwater drainage basins generally cannot be determined by topographic maps, and thus must be delineated by other methods, primarily dye tracing.
- EPHEMERAL LAKE:** a body of standing water occurring in a sinkhole of a karst region that is usually visible after sufficient precipitation has occurred. They may form from slow permeability of soils, rises in the water table or the development of a natural liner of slow permeable clays or soils.
- KARST:** A terrain, generally underlain by limestone or dolomite, in which the topography is chiefly formed by the dissolving of rock and which may be characterized by sinkholes, sinking streams, subterranean drainage, and caves.
- KARST FEATURE BUFFER:** a buffer area around a sinkhole collapse feature, the extent of which is established in the field by a licensed geotechnical engineer. The purpose of the buffer is to minimize the exposure of impervious surfaces such as structures to sinkhole subsidence.
- KARST GEOLOGIC FEATURES:** Geologic features that develop on karst terrain. Examples of karst geologic features are sinkholes, caves, sinking streams, and karst springs.
- KARST SPRING:** The discharge points for underground streams.

KARST SURVEY: A survey of property located with karst prone areas of Jefferson County as depicted on the karst prone areas map. The survey of a property within this area is required prior to development review.

SINKHOLE: Any closed depression in soil or bedrock formed by the erosion and transport of earth material from below the land surface, which is circumscribed by a closed topographic contour and drains to the sub-surface. The sinkhole boundary is described as an area bounded by a projected line demarcating a change in slope from toward the center of the sinkhole to away from the sinkhole which represents a local drainage divide. Precipitation falling on the surface sloping toward the sinkhole is likely to run into the sinkhole throat, or infiltrate the soil and move through subsoil conduits to the throat. This includes areas which contribute surface water to a sinkhole via streams.

SINKHOLE COLLAPSE FEATURE: Sometimes called “cover collapse sinkhole”, a relatively steep-side, “throat-like” sinkhole typically within a larger sinkhole and typically with rock or soil walls, formed by the erosion and transport of earth materials into the subsurface in a manner such that the expression of this transport has propagated to the surface.

SINKHOLE WATERSHED: An area bounded by a projected line demarcating a change in slope from toward the center of the sinkhole to away from the sinkhole which represents a local drainage divide. Precipitation falling on the surface sloping toward the sinkhole is likely to run into the sinkhole throat, or infiltrate the soil and move through subsoil conduits to the throat. This includes areas which contribute surface water to a sinkhole via streams.

SINKING STREAM SINKPOINT: The location where a surface stream disappears into the subsurface karst aquifer, either at a discrete point such as a cave entrance, or gradually along the reach of a stream channel.

STRATIGRAPHIC UNIT: a stratum or body of strata recognized as a unit in the classification of the rocks of the earth's crust with respect to any specific rock character, property, attribute or for purposes such as description, mapping, and correlation.

4.9.1 Purpose & Intent

The purpose of this part is to guide development in karst terrain areas consistent with Cornerstone 2020 Comprehensive Plan guidelines, to protect natural areas and features and to locate development, where possible, in areas that do not have severe environmental limitations. The intent of this part is to regulate karst terrain development in order to protect the public health, safety and welfare by regulating the development and use of environmentally constrained lands to proceed in a manner that promotes safe and appropriate construction, storm water management and ground water quality. More specifically, these regulations are intended to:

- A. Maintain property values and avoid property damage and/or safety concerns due to development in karst terrain areas;
- B. Incorporate geotechnical engineering practices to promote the stability and environmental quality of karst terrain areas;

- C. Preserve or enhance the beauty of the landscape by encouraging the retention of natural topographic features including sinkholes, springs, caves, and natural plant communities;
- D. Protect ground water by minimizing pollution caused by development on karst terrain;
- E. Protect downstream development from flooding caused or exacerbated by development activity in karst terrain areas, and
- F. Promote building stability by limiting the location of buildings in karst terrain areas and by incorporating geotechnical engineering techniques into construction activity.

4.9.2 Applicability & Exemptions

A. Applicability

This part shall apply to all land disturbing activity, including new development and subdivision, proposed on karst terrain.

B. Land Disturbing Activity

Land disturbing activity includes the following:

1. Clearing of more than 5,000 square feet of forested area for development;
2. Grading, excavation, construction of foundations, footings or retaining walls, or alteration of the ground surface, except for activities defined as agricultural operations in KRS 224.71-100 through 140;
3. The installation of utilities, including but not limited to water, sewer, natural gas, electric, telephone and cable.

C. Exemptions

This part shall not apply to the development activities listed in 4.6.1.B. In addition to 4.6.1.B, major and minor subdivisions, category 2 and 3 reviews and plan certain development reviews approved prior to the effective date of this regulation shall be considered exempt from this part.

4.9.3 Identification of Karst Terrain Features

- A. Where the proposed land disturbing activity is located within the Karst Prone area of Jefferson County as indicated on the Karst Prone Area Map located within Appendix 4, the applicant shall conduct a karst survey of the property and shall identify on plans all karst geologic features (see Section 4.9.4) The karst survey shall be conducted by a geologist or engineer licensed in the State of Kentucky with experience in the review

in the review and analysis of karst geologic features or by an individual Registered with PDS. Registration requirements include the completion of an approved training course in the identification of karst geologic features for the purpose of conducting a karst survey. The karst survey shall include at least one field site inspection as well as the use of other materials as needed such as:

1. Existing and historical aerial photographs
 2. Soils report (available from the National Resource Conservation Service)
 3. Geological maps and reports (available from the United States Geological Survey and the Kentucky Geological Survey)
 4. Caves (based on existing data obtained from groups including the Kentucky Geological Survey, Kentucky Division of Water, the Kentucky Speleological Survey, and other local cave groups)
 5. Related available data (e.g. previous development plans, neighborhood plans, LOJIC data, etc.).
- B. A note shall be included on all required plans indicating the person(s) who conducted the mandatory site inspection for the karst survey of the property and when it was performed.

4.9.4 Karst Geologic Features

- A. The following is the list of karst geologic features to be identified as part of the karst survey and identified on all required plans. * identifies those features requiring a karst feature buffer as required in Section 4.9.5):
1. Sinkhole Collapse Feature*
 2. Sinkhole
 3. Surface drainage that flows into ground
 4. Ephemeral lakes after rainfall
 5. Cave Entrance(s)*
 6. Subsurface cave passages as determined by preexisting cave maps obtained from organizations including the Kentucky Geological Survey, local cave organizations, and the Kentucky Speleological Survey.
 7. Springs - Evidence of standing water (rings of mud or organic debris in the low areas of closed surface depressions) following rains.
 8. Sinking Stream Sink Point*
- B. The following are a list of requirements specific to certain Karst Geologic Features that shall be identified on all required plans when one of these features have been identified:
1. Sinkholes – Location and limits of the area of the sinkhole depression, including topographic boundary of the entire closed depression, any significant breaks in slope, and vertical rock or soil surfaces.

2. Sinkholes shown on required plans shall also show the location and elevation of the lowpoint.
3. Caves – Diameter and description of cave opening, including description of whether water flows into the subsurface prior to development, either perennially or intermittently.
4. Springs - the first emergence of a spring and the surface stream downstream from this point.
5. Sinkhole Collapse Feature
6. Calculation of predevelopment and post-development surface drainage volumes directed toward the low point of the sinkhole, or the sinkhole collapse feature or cave entrance.

4.9.5 Karst Geologic Feature Performance Standards

- A. The following standards apply to construction within sinkholes and over karst springs:
 1. The Planning Director or designee may approve the construction of impervious surfaces (such as structures, parking areas and driveways) over sinkholes and springs in accordance with the following requirement:
 - a. The applicant shall obtain the services of an engineer (geotechnical engineer) licensed in the State of Kentucky with experience in the review and analysis of karst geologic features practicing in accordance with KRS 322 to conduct a geological assessment report to recommend treatment and construction method. The Planning Director or designee may confer with other appropriate agencies (USGS (United States Geological Survey), KGS (Kentucky Geological Survey), Hoffman Environmental Research Institute (Western Kentucky University), NRCS (National Resource Conservation Service), MSD (Metropolitan Sewer District)) in determining the significance of the feature(s) in question as well as the appropriateness of the proposed treatment. If the proposed treatment and construction method is approved then the licensed geotechnical engineer shall be on the construction site to observe and verify that the correct treatment was applied during construction. The licensed geotechnical engineer shall submit a letter to Planning and Design Services stating that the approved treatment method was applied.
- B. The following standards apply to sinkhole collapse features (including sinking stream sink-point and cave entrances):
 1. The Planning Director or designee may approve the construction of impervious surfaces (such as structures, parking areas and driveways) with the exception of principal residential structures over sinkhole collapse features in accordance with the following requirement:
 - a. The applicant shall obtain the services of an engineer (geotechnical engineer) licensed in the State of Kentucky with

experience in the review and analysis of karst geologic features practicing in accordance with KRS 322 to conduct a geological assessment report to recommend treatment and construction method. The Planning Director or designee may confer with other appropriate agencies (USGS (United States Geological Survey), KGS (Kentucky Geological Survey), Hoffman Environmental Research Institute (Western Kentucky University), NRCS (National Resource Conservation Service), MSD (Metropolitan Sewer District)) in determining the significance of the feature(s) in question as well as the appropriateness of the proposed treatment. If the proposed treatment and construction method is approved then the licensed geotechnical engineer shall be on the construction site to observe and verify that the correct treatment was applied during construction. The licensed geotechnical engineer shall submit a letter to Planning and Design Services stating that the approved treatment method was applied.

2. Karst Feature Buffer: Where sinkhole collapse features are retained the applicant's engineer (geotechnical engineer) licensed in the State of Kentucky with experience in the review and analysis of karst geologic features practicing in accordance with KRS 322 shall determine the appropriate karst feature buffer based on their analysis of the particular collapse feature. At a minimum this analysis shall take into account surrounding evidence of instability such as surrounding soil subsidence. The karst feature buffer shall be measured starting from the last closed contour line of the sinkhole collapse feature or from the downstream-most point of the sinking stream, or from the cave entrance dripline as determined in the field by the applicant's licensed engineer or geologist. The filling of sinkhole collapse features may be approved by the planning director or designee based on an approved filling method designed by the applicant's engineer (geotechnical engineer) licensed in the State of Kentucky with experience in the review and analysis of karst geologic features practicing in accordance with KRS 322. No activities are permitted within the karst feature buffer except for regular maintenance of landscaping. Buffers located downslope of construction areas shall be physically screened with soil erosion and sediment controls approved by MSD. The buffer shall include ground cover and tree plantings as follows;
 - a. Trees listed on the preferred planting list may be planted within the buffer with approval from Planning Commission staff landscape architect.
 - b. Native Ground cover in accordance with the preferred planting list (non-invasive) shall be planted within the buffer.
- C. The following standards apply to Sinkholes (Sinkhole Watershed Areas):

1. Flow of surface water into a sinkhole low point or sinkhole collapse feature shall not be increased from predevelopment conditions as calculated within the geologic assessment report.
 2. The applicant shall ensure to the satisfaction of the Metropolitan Sewer District that there will be no increase in soil erosion and sediment pollution directed toward any cave entrance, sinkpoint of a perennial or intermittent sinking stream, or sinkhole collapse feature.
 3. Stormwater drainage from a land use that stores, manufactures, processes or distributes hazardous or potentially hazardous materials shall not be directed toward a sinkhole.
 4. Stormwater drainage from streets, parking lots, loading and unloading areas and fuel service stations shall not be directed toward a sinkhole unless the water is pretreated prior to entry into a sinkhole or the drainage is part of a Low Impact Development (LID) plan approved by MSD for the site.
- D. If utilities are to be constructed within a sinkhole the utilities shall be so constructed so as not to permit the flow of water along the utility line trench, and shall be imperviously diked at thirty (30) foot intervals.
- E. Cave entrances shall not be modified except for the placement of a bat accessible gate to prevent human access.

4.9.6 Waivers

All performance standards within this part may be waived in accordance with the LDC waivers provisions located within Chapter 11, Part 8.

4.9.7 Discovery of Karst Geologic Features During Site Disturbance and Construction

- A. The discovery of karst geologic features such as sinkholes, springs, sinkhole collapse features and caves shall be reported to the Planning Director or designee. All work within the area shall discontinue until such time as the applicant's engineer (geotechnical engineer) licensed in the State of Kentucky with experience in the review and analysis of karst geologic features practicing in accordance with KRS 322 has reported to the Planning Director or designee and the Planning Director or designee has approved the continuation of site disturbance and construction. In no case shall the construction of residential principal structures over sinkhole collapse features be approved except through the LDC waiver process as outlined in Chapter 11, Part 8.
- B. The Planning Director or designee may require revisions to all associated plans based on the location of the newly discovered geologic feature and its proximity to impervious surfaces, underground utilities, and stormwater drainage features (e.g. detention and retention basins). The plan revisions shall be made in accordance with the standards outlined within Section 4.9.5.