KARST RECONNAISSANCE SURVEY

HURSTBOURNE APARTMENTS DEVELOPMENT
LOUISVILLE, KENTUCKY

SME Project No. 088601.00
March 7, 2022

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March 7, 2022

Kennedy International, Inc.
c/o ARCO Senior Living Multi-Family
900 North Rock Hill Road
St. Louis, Missouri 63119

Attn: Mr. John Auble – Project Manager

Via E-mail: jauble@arco1.com

RE: Karst Reconnaissance Survey
Hurstbourne Apartments Development
4700 S Hurstbourne Parkway
Louisville, Kentucky
SME Project 088601.00

Dear John:

SME has completed a generalized karst reconnaissance survey for the referenced project.

These services were performed in accordance with Task 1 outlined in SME proposal P00289.22 dated January 31, 2022. Performance of this study was authorized by Mendy Reich with Kennedy International, Inc. on February 3, 2022.

Sincerely,

SME

Wesley J. Hemp, PE, PG (LA), LEED AP
Project Manager

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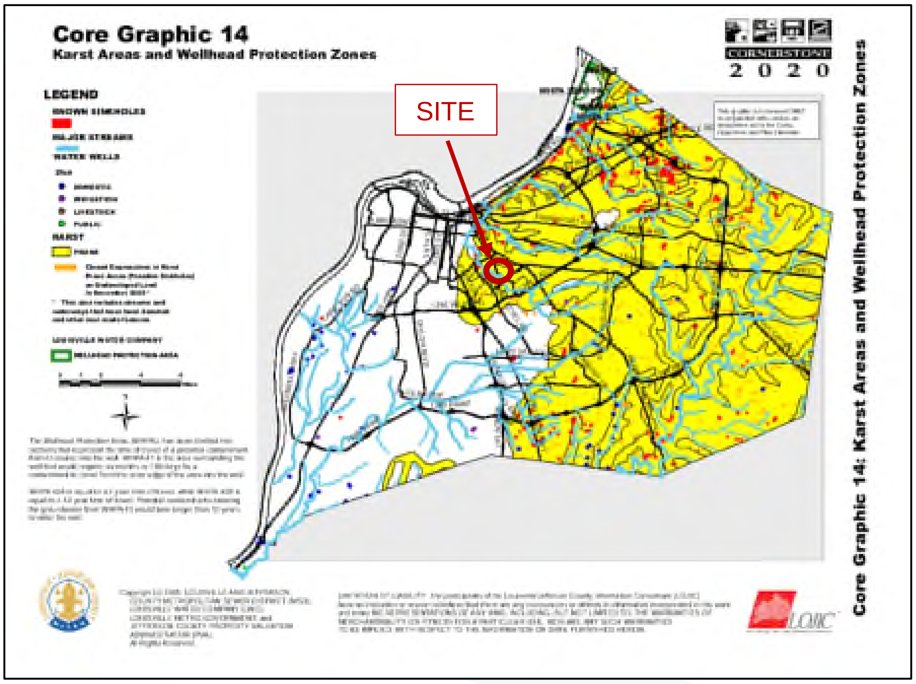
1. INTRODUCTION

This report presents the karst survey performed by SME for the Hurstbourne Apartments project located at 4700 South Hurstbourne Parkway in Louisville, Kentucky. We understand that performance of a karst survey is required for the subject site per the document “Land Development Code for all of Louisville-Jefferson County” (LDC), Chapter 4 Part 9. The image below (extracted from Appendix 4I – “Development on Karst Terrain”) indicates portions of the Louisville Metro area where karst is prevalent, and performance of a karst survey is required (highlighted in yellow). Red shading indicates known sinkholes.

FIGURE 1 - KARST AREAS AND WELLHEAD PROTECTION ZONES [1]



Land Development Code for all of Louisville-Jefferson County Kentucky, Appendix 4I – *Karst Areas and Wellhead Protection Zones*. (March 2006, updated November 22, 2021.) Retrieved from https://www.louisvilleky.gov/planning-design/document/louisville-metro-code-november-2021

This evaluation was conducted in general accordance with the scope of services outlined in SME Proposal No. P00289.22 dated January 31, 2022. This proposal was authorized by Ms. Mendy Reich with Kennedy International, Inc. on February 3, 2022.

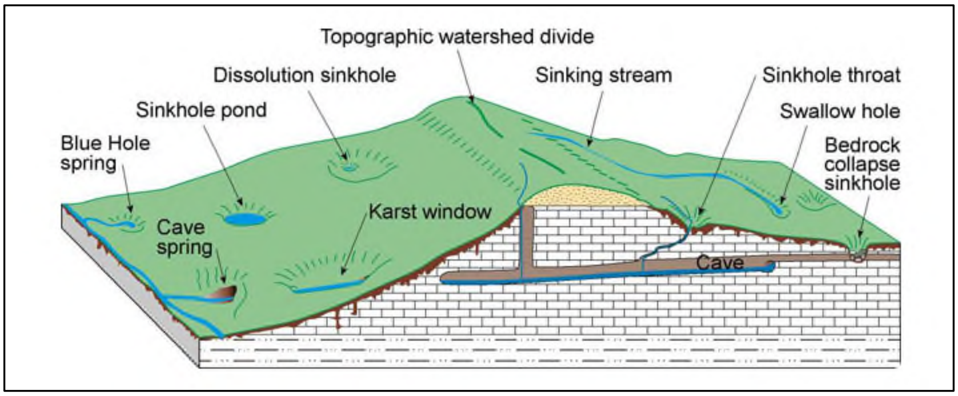
1.1 KARST DEVELOPMENT

Karst topography is characterized by pinnacled, fissured, and/or cavernous bedrock topography caused by dissolution of the rock by chemical weathering. Sinkholes, sinking streams, springs, and caves (among other features) are associated with karst terrain.

In Kentucky, this phenomenon occurs in carbonate rocks (e.g., limestone, dolomite) that are considered relatively dense, and soluble. The overlying soils typically consist of residual clay deposits weathered from the underlying rock, but can be infilled with fine-grained soils via erosion or other transport mechanisms. Buried sinkhole features which have been infilled (naturally or artificially) are difficult to characterize or identify visually from the surface, and can better evaluated by excavation, drilling test borings, and/or geophysical ground imaging. Abundant rainfall within a geographic region over time is required for karst to develop. The actual weathering within the underlying bedrock occurs over thousands or tens of thousands of years, while an actual sinkhole dropout can occur in a short period of time due to washing/raveling of the overburden soils through the fissured bedrock. This raveling may occur due to fluctuations in surface and/or subsurface drainage patterns, or changes in groundwater elevation. Engineering works and site development can result in acceleration of incipient sinkhole development or encourage new sinkhole formation.

Swell and swale topography (e.g., undulating hills intermixed with shallow depression) are also characteristic of karst, with localized depressions typically being the result of subsidence related to sinkhole activity. The figure below is characteristic of features associated with karst terrain.

FIGURE 2 - KARST TERRAIN FEATURES (1)



(1) Kentucky Geological Survey. (2022). Retrieved from https://www.kgs.uky.edu/KGS/karst/

Karst development can also occur within rocks such as chalks and evaporites (e.g., gypsum and anhydrite), although the mechanism and rate of karst development differs when compared to formation in carbonate rock.

1.2 PROPOSED DEVELOPMENT

The project includes construction of a new apartment complex to be located at 4700 South Hurstbourne Parkway in Louisville, Kentucky. The proposed complex will include thirteen (13) multi-family housing buildings, a clubhouse building with an adjacent outdoor pool, associated parking areas and drive, and a stormwater management basin. We assume the multi-family housing buildings will have up to three stories. At this time, we do not have information regarding if the lower level will be slab-on-grade or partially recessed. The clubhouse will be a single-story, slab-on-grade structure. We anticipate the proposed buildings will bear on shallow spread footings and include concrete floor slab on grade.

A grading plan was not provided to us at this time; however, we assume earthwork consisting of cuts of up to 5 feet and fills of up to about up to about 20 feet may be required to achieve final subgrade levels in the proposed building and pavement areas.

1.3 GENERAL SITE CONDITIONS

The project site is located at the physical address 4700 S Hurstbourne Parkway in Louisville, Kentucky.

This project site is approximately 19.5 acres and includes five (5) structures consisting of single-family residential and associated garages/barn structures. The project area is generally grass covered. Based on the topographic information on the provided pre-application/detailed district development plan titled “4700 S Hurstbourne Parkway” dated November 29, 2021, existing topography within the project area is described as rolling. In general, the project slopes downward to the north with ground surface elevations ranging from approximately 594 to 628 feet.

FIGURE 3 – SITE LOCATION MAP

2. EVALUATION PROCEDURES

2.1 MAP AND LITERATURE REVIEW

Our preliminary research for the subject site included review of available geologic maps, geological literature, soils data, and historical topographic maps to develop a better understanding of native soil and rock conditions near the site, along with possible changes in ground surface topography related to development of sinkholes or other karst features. SME also contacted a local cave exploration groups ("cavers") regarding possible documentation of identified cave or cavern features within the project vicinity. Preliminary site research included review of the following items:

- Online Kentucky Geologic Map Service (including detailed geologic unit map, karst potential map, and water well and springs map);
- 7.5-minute series Geological Quadrangle Map (Jeffersontown, 1972) developed by the United States Geological Survey (USGS) in cooperation with the Kentucky Geological Survey (KGS);
- Submission inquiry to the Kentucky Speleological Survey regarding documented cave systems and/or cave openings;
- USDA National Resource Conservation Services (NRCS) web soil survey map;
- Historical aerial photographs obtained between the 1955 to 2022 time period; and
- Historical topographic maps obtained between the 1922 to 2019 time period.

2.2 VISUAL RECONNAISSANCE PROCEDURE

Our visual reconnaissance procedure consisted of a registered professional engineer specializing in geotechnical engineer traverse the project site. This visual evaluation was performed by Mr. Wesley J. Hemp on February 11, 2022. Mr. Hemp initiated the visual survey at the southeast corner of the site. Mr. Hemp traversed the property from east to west and west to east while gradually advancing to the north. Approximate location and dimensions of remarkable visual features (along with GPS coordinates) were recorded on a printed satellite image of the project site.

2.3 DATA INQUIRY REQUEST

SME submitted an inquiry to the Kentucky Speleological Survey (KSS) on February 17, 2022 regarding potential for cave-related activity within the project area. The Kentucky Speleological Survey is a non-profit organization of cavers that function as gathers, archivists, and curators of cave and karst data for the State of Kentucky. We have not received a response at this time to our inquiry.

Please visit www.ksscaves.com for more information regarding KSS.

3. MAP AND LITERATURE REVIEW EVALUATION

3.1 SURFICIAL GEOLOGY

Information obtained from the United States Department of Agriculture (USDA) Web Soil Survey indicates the near-surface natural soils consist predominantly of Crider Silt Loam (CrB, slopes 2-6% and CrC, slopes 6-12%). Crider-series soils, which are residual soils derived from weathering of the underlying rock, are typically red in hue, contain varying quantities of manganese or iron oxide concretions, and are of medium to high plasticity. A lesser amount of Nolin Silt Loam (No), which consists of mixed fine silty alluvium, is also mapped within the project boundaries. Please refer to the USDA Soil Survey Map below for more information.

FIGURE 4 - USDA WEB SOIL SURVEY MAP (1)

(1) USDA Web Soil Survey. (2022). United States Department of Agriculture – Natural Resource Conservation Service. Retrieved from https://www.websoilsurvey.sc.egov.usda.gov.

3.2 BEDROCK GEOLOGY

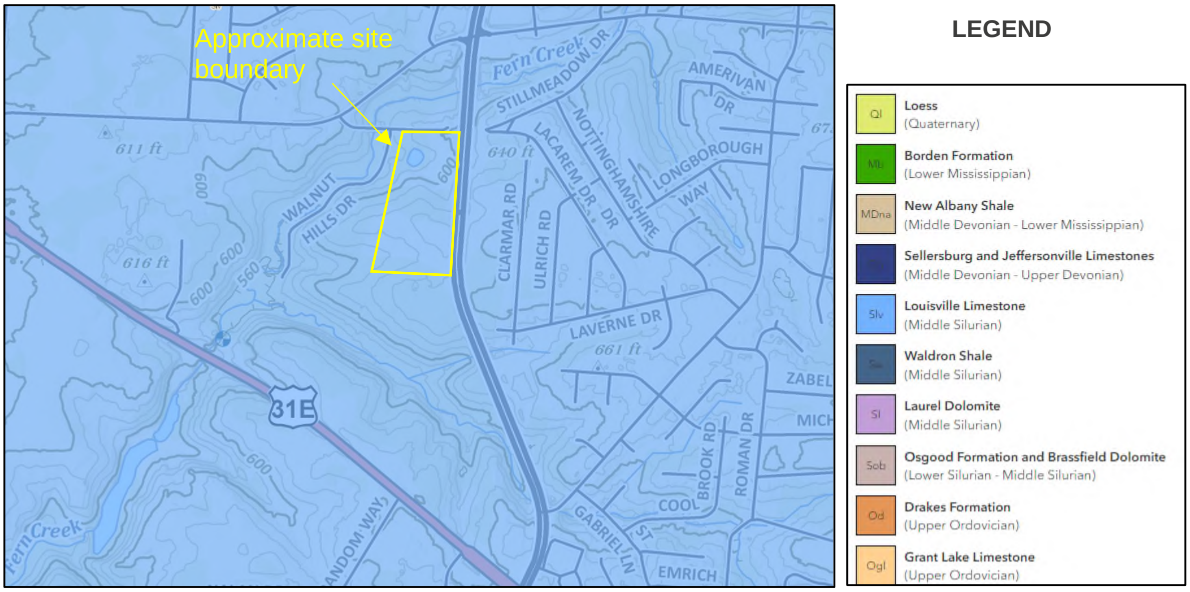
3.2.1 GENERAL BEDROCK GEOLOGY

Our review of the referenced geological literature indicates the project site is in the Blue Grass Physiographic Region, in the Outer Bluegrass Area.

The referenced geologic mapping indicates the underlying rock is composed of Silurian-age dolomitic limestone belonging to the Louisville Limestone Formation. This is formation is described as light-gray to yellowish gray, light brownish-gray in color and weathers to light brown or medium gray; fine-grained; thin to very-thick bedded; and contains chert nodules near the top of the formation. Calcite patches measuring less than 2 inches in diameter are scattered throughout. Sinkholes are commonly observed within the Louisville Limestone. Soil cover consists of residuum and generally is less than 10 feet in thickness.

Please refer to the site geology map obtained from the Kentucky Geological Survey – Kentucky Geologic Map Service below for more information:

FIGURE 5 - GEOLOGIC MAP [1]



(2) Kentucky Geological Survey. (2022). Kentucky Geologic Map Information Service. Retrieved from https://www.kgs.uky.edu.

3.2.2 KARST CONDITIONS

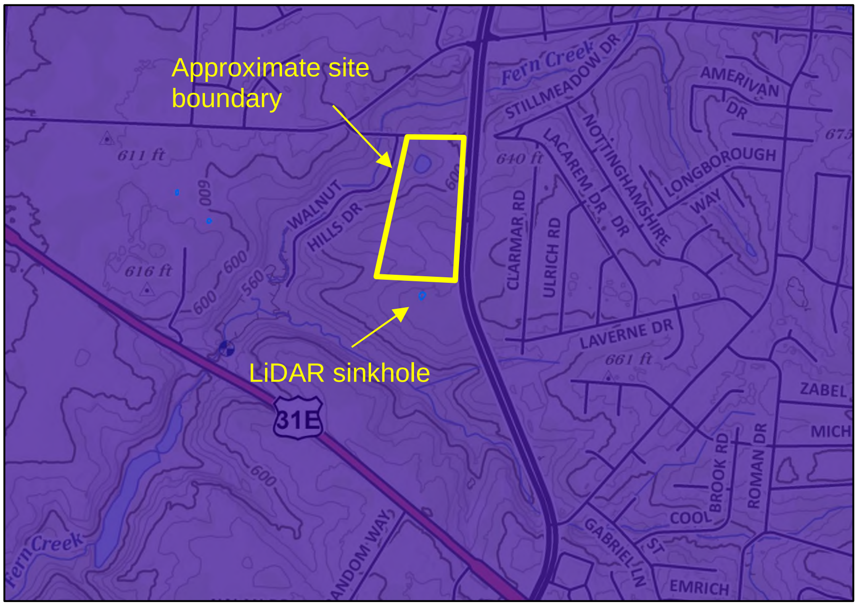
3.2.2.1 KARST POTENTIAL INDEX

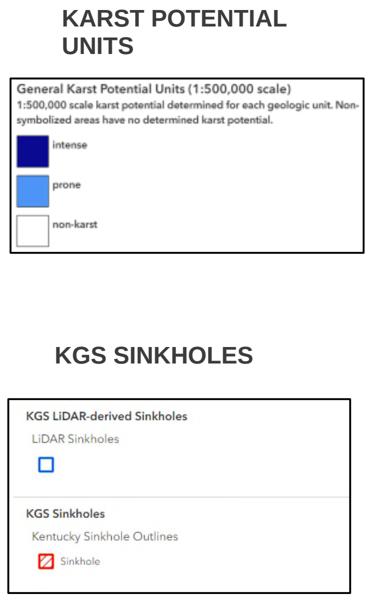
The Kentucky Geological Survey has developed a generalized mapping tool to rate the general karst potential for the state of Kentucky. This tool, which is a feature of the online Kentucky Geologic Map Service, provides a color-coding scheme for relative karst potential. Dark blue/purple indicates areas of “intense” karst potential, while light blue indicates an area “prone” to karst development. White represents areas considered non-karst. This tool can be utilized to rate the general karst potential for a project site for preliminary risk assessment or for use in development of subsurface evaluation programs. Further discussion and application of this tool is discussed below in Section 3.2.2.2.

3.2.2.2 SINKHOLE CONSIDERATIONS

Our review of the referenced geological literature (including the KGS Karst Potential Map – see below) indicates the presence of a singular sinkhole as identified by LiDAR (represented by blue outline) directly adjacent to the southern parcel border. Older, well-defined sinkholes are defined by a red-hashed zone. However, the KGS map is a generalized tool for identifying sinkhole features and should not be considered as a suitable replacement for “boots on the ground” site evaluation.

FIGURE 6 - KARST POTENTIAL MAP [(1)]





(1) Kentucky Geological Survey. (2022). Kentucky Geologic Map Information Service. Retrieved from https://www.kgs.uky.edu.

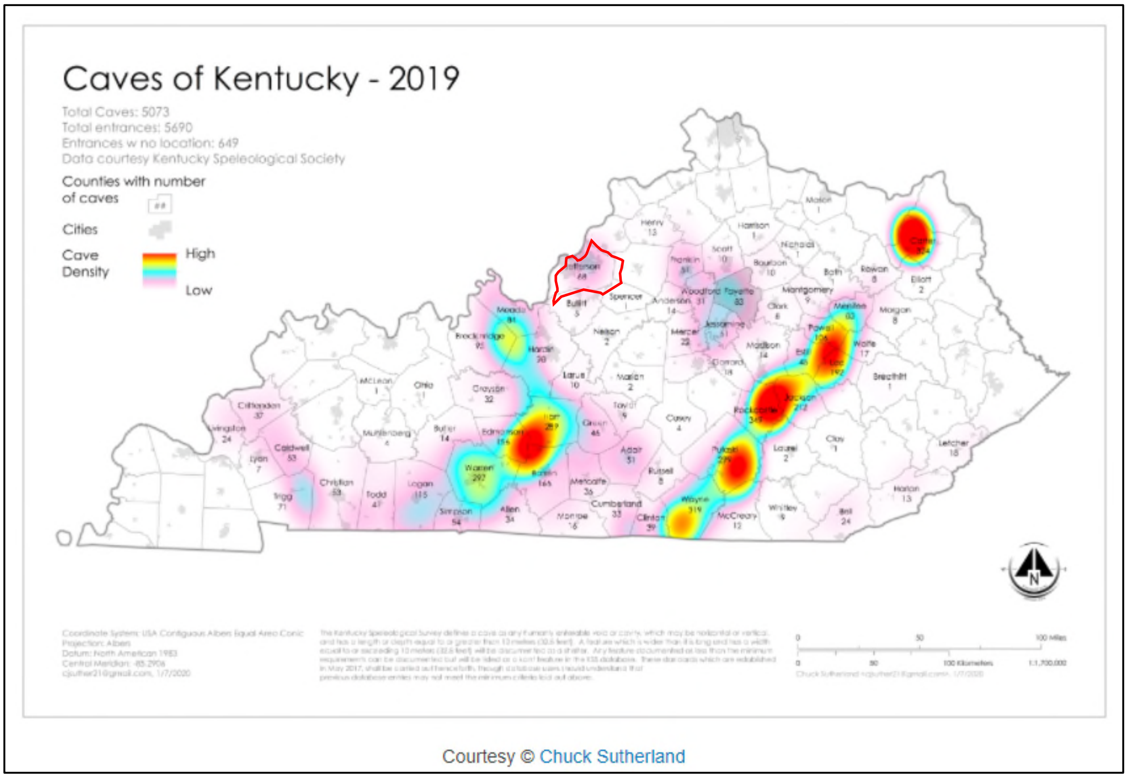
The above-referenced map reflects the generalized existing site topography and documented sinkholes. Changes in site topography, including development of new sinkholes or absence of old sinkholes, may be observed when comparing newer geologic maps to older maps. However, our review of the original site geology map (Jeffersontown, 1972) did not indicate the presence of documented sinkholes within the project boundaries.

3.2.2.3 CAVE CONSIDERATIONS

Caves are defined as a natural void in the ground (e.g., in limestone rock) that is large enough for a person to enter. A cavern is a series of connected caves. In Kentucky, caves exist within the underlying rock mass. However, cave entrances are not always obvious, or may not be present at all. Many caves openings are formed by engineering works, or in some cases, the result of sinkhole roof collapse

We have not received a response for KSS regarding potential cave activity within the project boundaries at the time of this report. However, generalized mapping tools were able from KSS depicting cave density (i.e., number of caves within a certain defined area) and caves per county in Kentucky. Review of the available mapping indicates 68 cave openings have been documented within Jefferson County as of 2019. Please refer to the generalized image below obtained from the KSS website. This figure has been modified from the original version, as the boundary for Jefferson County is highlighted in red.

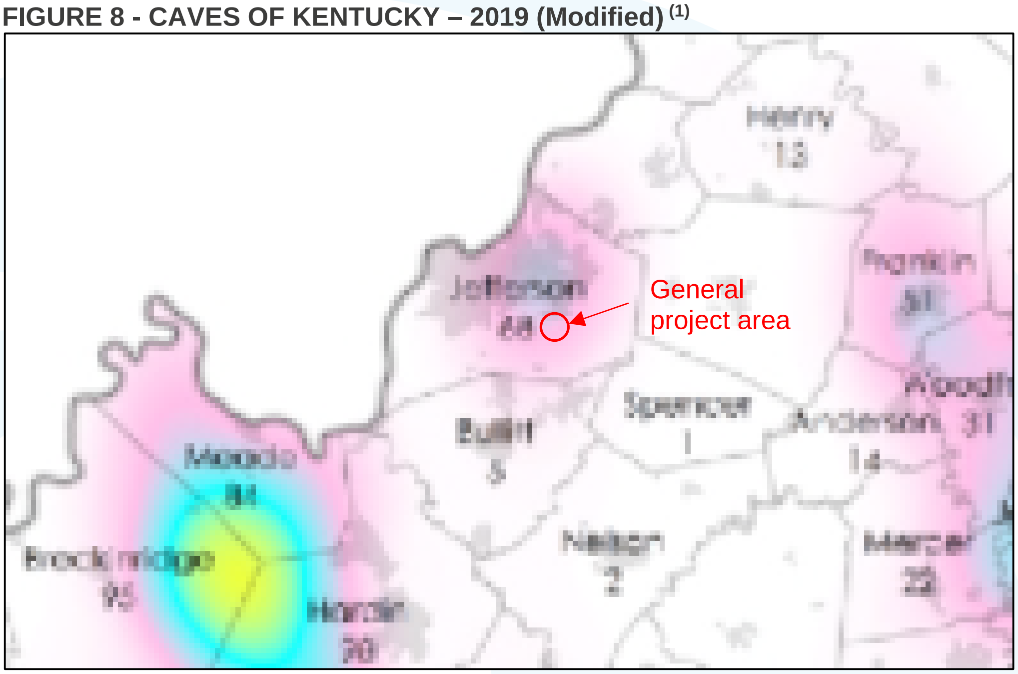
FIGURE 7 - CAVES OF KENTUCKY - 2019 (1)



(1) Kentucky Speleological Survey. (2022). "Caves of Kentucky – 2019". Retrieved from https://ksscaves.com/index.php.caves

Closer review of the image indicates the project site is located within an area identified as having relatively "low" cave density based upon the Site is within the light pink zone. Note that "low" cave density does not necessarily mean low karst potential. Please refer to the figure below for additional information.

FIGURE 8 - CAVES OF KENTUCKY – 2019 (Modified) (1)



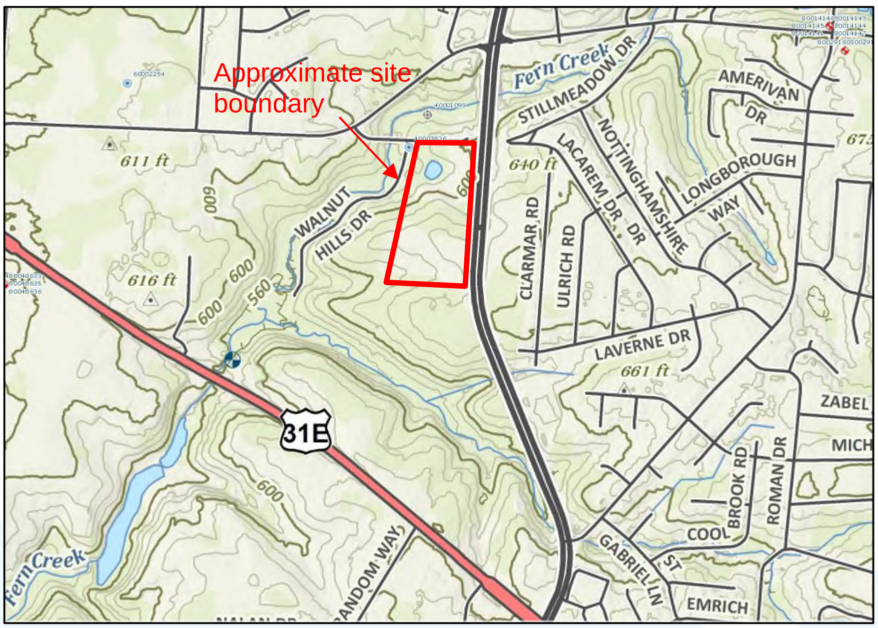
(1) Kentucky Speleological Survey. (2022). Adapted from "Caves of Kentucky – 2019". Retrieved from https://ksscaves.com/index.php.caves

Perhaps the most well-known cave near the project site (and located within Jefferson County) is the Louisville Mega Cavern, which is located approximately 5.3 miles northwest of the project site. This cavern has been modified to accommodate tourist attractions, a recycling center, and underground warehouses among other developments. However, the Louisville Mega Cavern is not a natural cave, as it was formed via mining of limestone rock starting in the early 1930's and through the 1970's.

3.2.2.4 SPRINGS AND STREAMS

Springs, which result from groundwater under hydraulic pressure head (due to change in elevation) are commonly associated with karst topography. The fissured and fractured nature of karst-susceptible rock formations act as conduits for spring water flow. However, our review of the Kentucky Groundwater Repository Water Wells and Springs Map did not reveal the presence of identified spring features on the site. A stream (Fern Creek) oriented northeast to southwest is located near the western boundary of the project site but is not within the project limits. Please refer to the image below for more information. However, the image suggests the suspected wetlands area in the northwest corner of the site is a pond, although the area was not retaining water at the time of our site evaluation.

FIGURE 9 - WATER WELLS AND SPRINGS MAP [1]

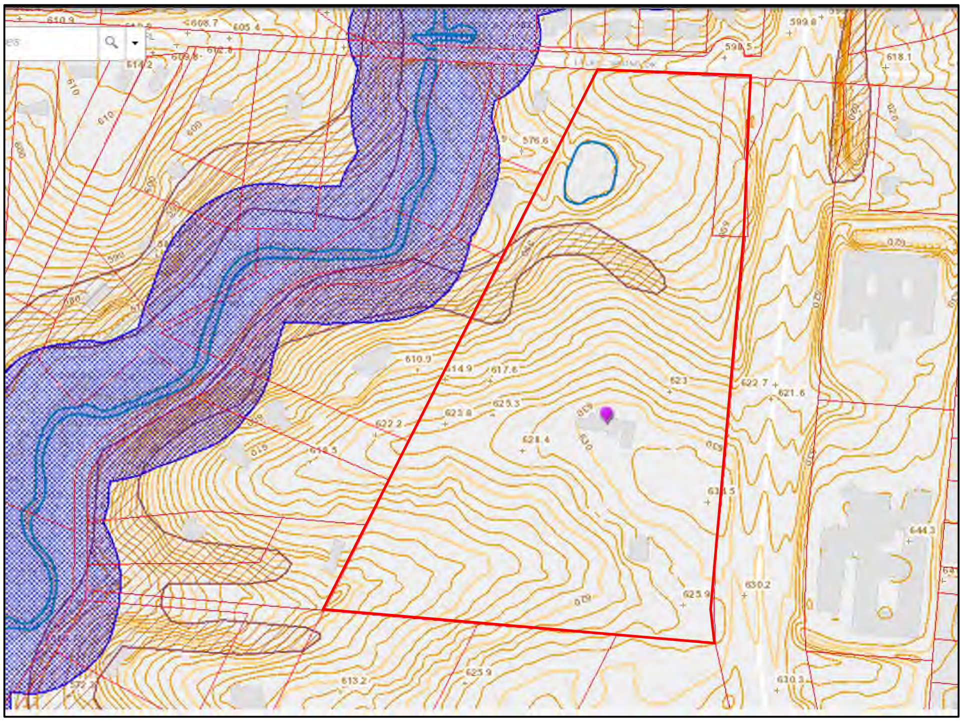


SPRING SYMBOLOGY

(1) Kentucky Geological Survey. (2022). Kentucky Geologic Map Information Service. Retrieved from https://www.kgs.uky.edu.

Our review of the Louisville/Jefferson County Information Consortium (LOGIC) interactive GIS map indicated potentially steep slopes (represented by hatched zone) and identified the pond in the northwestern portion of the site as a "perineal stream". Site topography (represented by 2-ft contour intervals) does not suggest obvious sinkhole activity. However, shallow nuanced karst features are difficult to identify without closer contour characterization. The expanded boundary of Fern Creek (represented by the dark blue lines) represents the flood plain zone.

FIGURE 10 - LOUISVILLE LOGIC MAP [1]



(1) LOGIC online. (2022). Kentucky Geologic Map Information Service. Retrieved from https://www.logic.org/logic-online

3.3 TOPOGRAPHIC MAP AND HISTORICAL PHOTOGRAPH REVIEW

Review of the historical topographic maps from the referenced time periods reflected evidence of typical site development. An access drive to the property from the north from Laurel Springs Drive first appears on the 1951 map. Structures begin to appear in 1951, with one structure located on the subject parcel and other structures on adjacent parcels. A second structure appears on the subject parcel on the 1956 map but is not observed on the less detailed 1951 and 1961 maps. Our review of the maps did not reveal any remarkable changes in the general project site topography, with one exception. The previously discussed perineal stream/pond first appears on the 1972 map. Construction of Hurstbourne Parkway to the east is observed on the 1993 map. Little to no change is observed on the 2013 to 2019 maps. Structures are also absent from the maps between this time period.

Furthermore, a larger pond was observed in imagery obtained between 1971 and 1993 but was not observed in the 2016 image. Additionally, the highway interchange adjacent to the north/west side of Site first appears on the 1971 image. Various other changes attributed to property development were observed upon review of the topographic maps. Please refer below to site topographic map images from various time period maps. Note the approximate site boundary is outlined with hashed blue line.

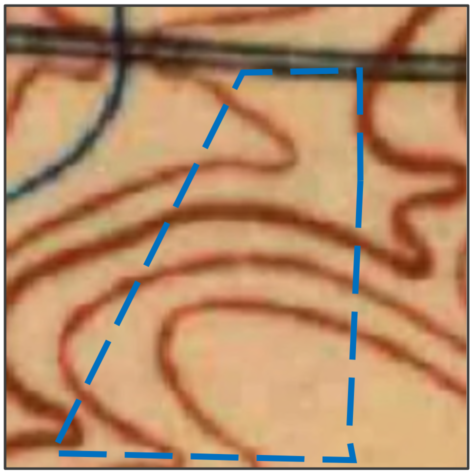


Image 1: 1922 Topographic Map

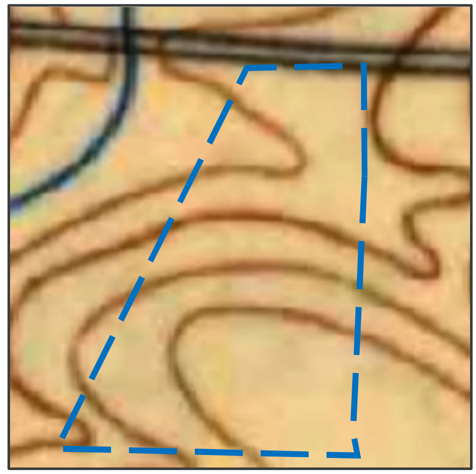


Image 2: 1941 Topographic Map

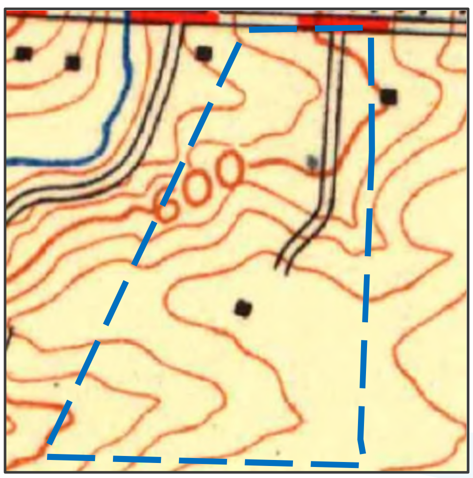


Image 3: 1951 Topographic Map

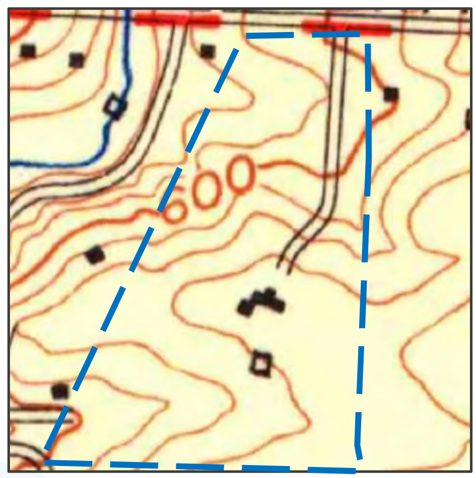


Image 4: 1956 Topographic Map

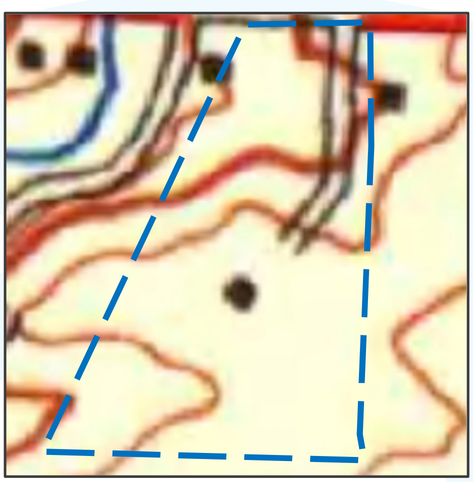


Image 5: 1959 Topographic Map

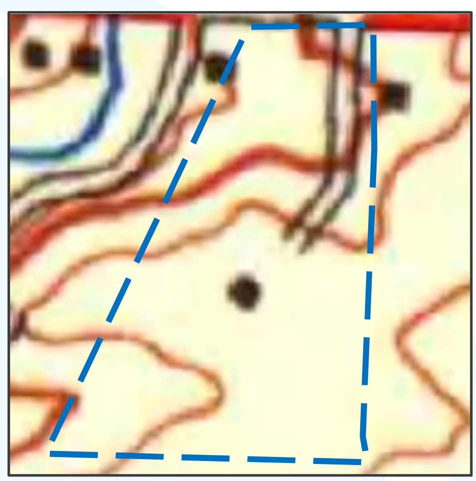


Image 6: 1961 Topographic Map

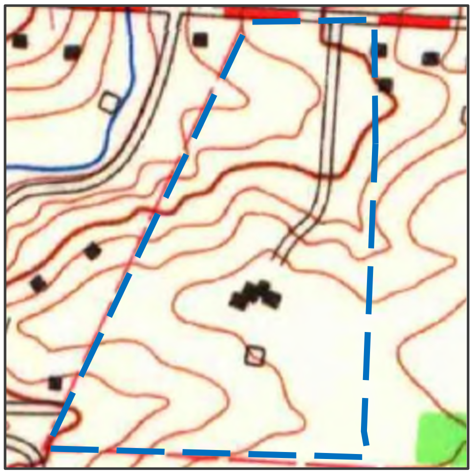


Image 7: 1967 Topographic Map

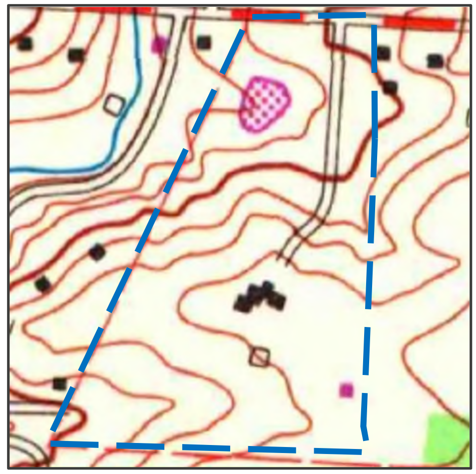


Image 8: 1972 Topographic Map

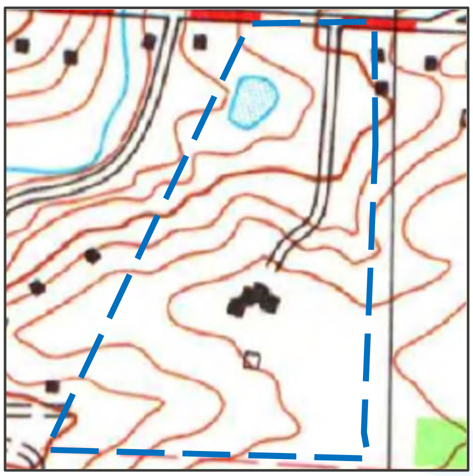


Image 9: 1983 Topographic Map

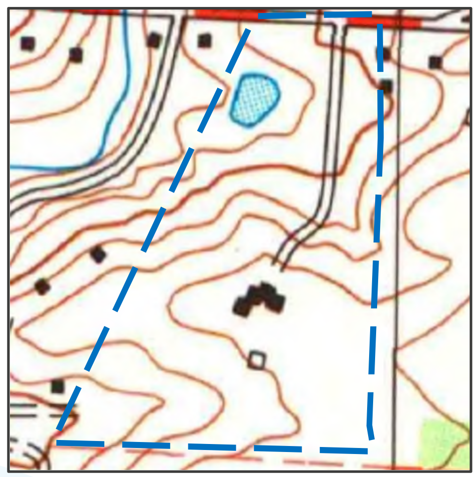


Image 10: 1987 Topographic Map

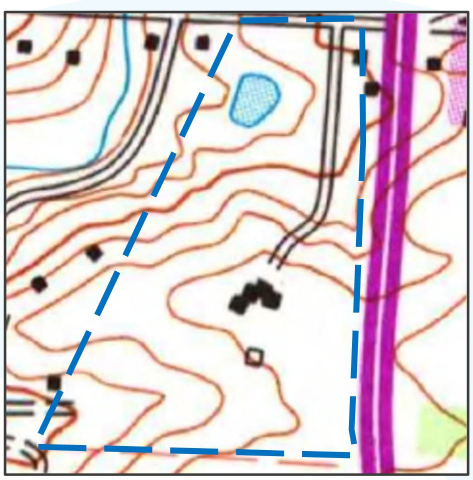


Image 11: 1993 Topographic Map

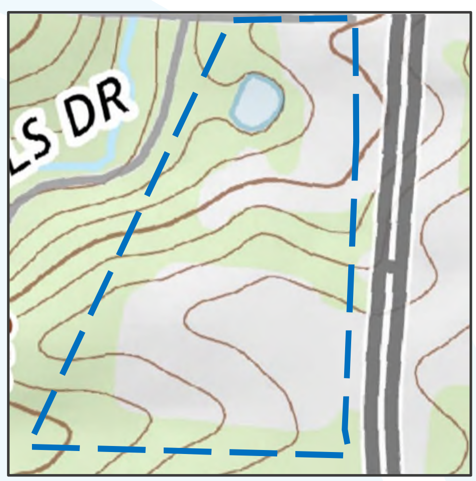


Image 12: 2013 Topographic Map

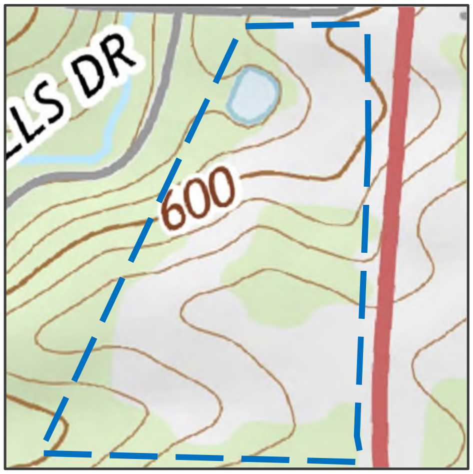


Image 13: 2016 Topographic Map

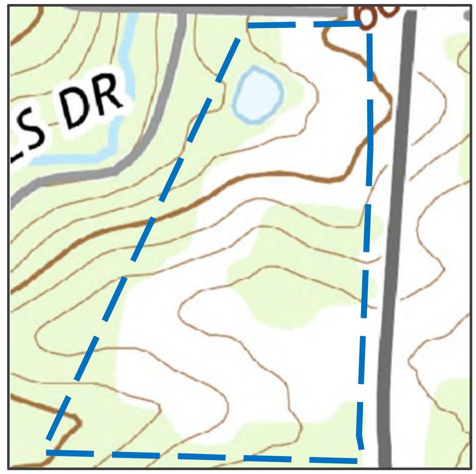


Image 14: 2019 Topographic Map

Review of available historical photography revealed similar information obtained from historical topographic maps discussed above, albeit with some contradictions. The existing pond located near the northwest corner of the property that first appeared on the 1972 topographic map was observed on the 1955 aerial image. The photographs imply possible water level fluctuation of pond over the years or possible between seasons. Vegetation around the pond thickened in the 2004 image, and was noticeably overgrown in the 2010 image. Most of the existing structures were observed in the imagery dating back to 1955, except for a smaller home and a garage structure southeast of the primary residence, which appear in later imagery. Evidence of ground disturbance was observed in the 1983 image, although it does not appear this disturbance is construction related. A clearing south of and adjacent to the project site (in the approximate vicinity of the documented sinkhole per KGS) is overgrown in 2004 imagery. Patches of drier soil (at the location of suspected ground subsidence, per following section) were first observed in the 2018 image along the southern portion of the site, generally near the southeast corner of the site. Please refer to the images below for more information.

Image 15: 1955 Aerial Image

Image 16: 1959 Aerial Image

Image 17: 1971 Aerial Image

Image 18: 1983 Aerial Image

Image 19: 1986 Aerial Image

Image 20: 1993 Aerial Image

Image 19: 1998 Aerial Image

Image 20: 2002 Aerial Image

Image 21: 2004 Aerial Image

Image 22: 2010 Aerial Image

Image 23: 2017 Aerial Image

Image 24: 2018 Aerial Image

Image 25: 2018 Aerial Image

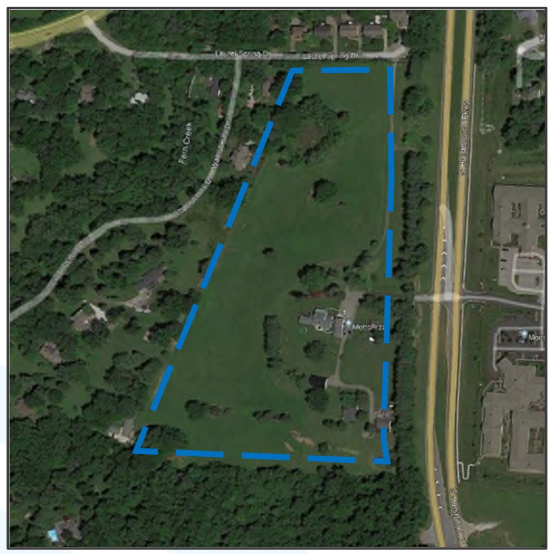


Image 26: 2020 Aerial Image

4. VISUAL RECONNAISSANCE EVALUATION

4.1 VISUAL OBSERVATIONS

In general, the Site primarily consists of rolling, manicured lawn areas with sparse trees, and isolated groves. Five structures (including two residential dwellings along with a barn, garage, and outbuilding) were observed in the southwest quadrant of the Site. Access to the Site is provided via an asphalt-paved drive extending west from Hurstbourne Parkway. A narrow driveway (original site entrance) extends from an entrance on the north side of the site from Laurel Spring Drive. The site is generally surrounded by fencing along the east and northern boundaries. Both site entrances are gated.

An SME representative visited the Site on February 11, 2022 to observe and document surficial conditions within the project site boundaries. The site was generally well maintained, as the grass had been mowed prior to our arrival. Our site walk revealed the presence of at least four visible active sinkhole features as observed by areas of subsidence with open throats and several depressed areas of possible subsidence. Refer to the table below regarding notable feature locations. Listed karst feature dimensions are approximations, as these features are generally irregular in shape.

TABLE 1 – FEATURE LOCATIONS AND DETAILS

FEATURE NO.	TYPE	DIMENSIONS	LATITUDE	LONGITUDE
1	Sinkhole – open throat	8-ft x 5-ft x 4-ft	38.17754° N	85.60777° W
2	Depression with throat	2-ft x 3-ft x 1-ft	38.17754° N	85.60783° W
3	Subsidence area (possible doline)	Irregular dimension	38.17751° N	85.60789° W
4	Sinkhole – open throat	6 to 8-ft diameter x 1 to 2-ft	38.17757° N	85.60766° W
5	Subsidence area (possible doline)	Irregular dimension	38.17760° N	85.60889° W
6	Subsidence area (possible doline)	Irregular dimension	38.17770° N	85.60880° W
7	Sinkhole -multiple throats	10-ft x 15-ft x 5-ft	38.17765° N	85.61028° W
8	Subsidence area (possible doline)	Irregular dimension	38.17842° N	85.60976° W
9	Open throat/ animal burrow	<1-ft diameter	38.17787° N	85.60902° W
10	Open throat/ animal burrow	0.5-ft to 1.5-ft opening	38.17932° N	85.60940° W
11	Surface depression	2-ft diameter x 0.5-ft	38.17841° N	85.60767° W

Two of the sinkhole features, which were located within a small grove/tree cluster south of the garage and near the southeast site corner, appeared to be interconnected (and located directly adjacent to an elongated area of subsidence). An additional sinkhole feature was observed directly east of the referenced feature and adjacent to the eastern fence line. The fourth feature (Feature 7 in the table above) was located in the extreme southwest corner of the site within a tree grove. Multiple throats were observed within this feature in addition various debris. The presence of debris made it impractical to ascertain the feature dimensions, particularly the depth.

An elongated drainage feature extended southwest from the feature and off the project site. Three locally depressed areas (referenced in the previous section) where the vegetative surface cover differed from the adjacent area were observed along the southern portion of the site. These depressed areas may represent early “doline” activity. Doline is a term used to describe sinkholes that form slowly by subsidence of the ground surface. This downward movement can take years to occur before the surficial sinkhole is obvious.

A possible swallow hole or animal burrow was observed within a tree grove in the southern portion of the site. An additional depressed area (possible doline) was observed north of this feature and west of the barn near the western site boundary. An isolated hole was observed along the west-central portion of the site. A depressed area was observed adjacent to the east side of the original entrance drive. The depressed area was filled with leaves, which made the discerning approximate dimensions difficult. However, it is assumed this depressed area is an inlet for a culvert discharging on the west side of the driveway.

The pond (or perennial stream as identified on LOGIC) was mostly dry at the time of our evaluation, although the ground surface appeared to be soft. This area most likely a wetlands or ephemeral pond, which periodically holds water for some time during or following precipitation events. The pond area is relatively shallow, which suggest the area may have been infilled either by natural causes (e.g., erosion or siltation) or man-placed fill. Ponds typically form in low points in karst areas via plugging of the near-surface voids or fracture zones via siltation. However, impounding of water can over time initiate sinkhole activity, which may also explain the lack water within the pond (and in photographs from recent years).

Refer to Figure 11 below for visual representation of significant features observed during our site walk.

FIGURE 11 – IDENTIFIED FEATURES

4.2 CONCLUSIONS AND PROPOSED SITE DEVELOPMENT

At least four sinkholes (or open throats/conduits connected to a sinkhole feature) were identified on the project site. These sinkhole features, while relatively small and shallow, are obvious evidence of karst development at the site. The sinkhole feature identified in southwest corner of the site within a grove is depicted on the proposed site development plan (Feature 7, identified as a closed contour) within the footprint of a proposed 36-unit housing structure. Similarly, it appears two sinkhole and/or conduits (Features 1 and 2) are located within the footprint of a proposed 24-unit housing structure near the southeast corner of the site. Preliminarily, we estimate that sinkhole Feature 4 is outside the proposed footprint of the referenced 24-unit structure but near the east side of the building. Therefore, it will also impact development of this structure.

The sinkhole identified on the geologic map adjacent to the southern property boundary was not observed in the field. However, review of the site survey/development plan indicates a closed depression in this area, which corroborates the geologic map. It is unclear whether the pond has experienced karstification or is at significant risk of a drop out occurring. We recommend avoiding development of structures in the immediate area of the pond. Additionally, subsidence observed at the exiting garage area (as observed by uneven ground contact of the garage bay doors with the ground) suggest karst related subsidence may have occurred in this area.

Do not construct over active or possible sinkholes without further exploration, analysis and remediation (if feasible and where sinkhole features are identified). Where possible, adjust or modify the site plan by shifting proposed structure locations away from identified sinkhole features is preferable. However, this is not always possible without significantly impacting the project. Sinkhole features identified within structural areas (i.e., building or pavements) will require remediation during construction or utilization of alternative foundation systems as directed by the Geotechnical Engineer of Record, assuming the proposed structure locations cannot be shifted. We recommend identified and suspected sinkhole features be evaluated prior to construction (ideally during the planning stage) to determine impacts on the proposed development. Characterization of identified anomalies can be performed by performance of additional test borings (beyond quantity per geotechnical evaluation scope), excavation, and/or geophysical surveys.

There is inherent risk associated with development on karst terrain. Other identified possible karst features that have not yet been identified may require additional characterization prior to construction. General evaluation methodologies were discussed in the preceding paragraph. SME will provide general guidance regarding additional evaluation, sinkhole exploration, and general remedial methodologies in the forthcoming geotechnical evaluation report.

5. SIGNATURES

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APPENDIX A

PHOTOGRAPH LOG
INFORMATION ABOUT THIS GEOTECHNICAL ENGINEERING REPORT
GENERAL COMMENTS

PHOTO NO. 1: Sinkhole in grove south of garage (Features 1 &2)

PHOTO NO. 2: Sinkhole (Feature 1)

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY


PHOTO NO. 3: Surficial swallow hole/ conduit (Feature 2)


PHOTO NO. 4: Shallow sinkhole with throat (Feature 4)

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY

PHOTO NO. 5: Sinkhole conduit/throat (Feature 4)

PHOTO NO. 6: Ground subsidence (Features 5 and 6)

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY

PHOTO NO. 7: Ground subsidence/differing vegetation (Feature 5)

PHOTO NO. 8: Hole at tree (Feature 9)

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY


PHOTO NO. 9: Sinkhole at southwest corner (Feature 7)


PHOTO NO. 10: Conduit/ swallow hole at Feature 7

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY

PHOTO NO. 11: Ground subsidence at garage

PHOTO NO. 12: Dry pond – facing north

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY

PHOTO NO. 13: Dry pond – facing southeast

PHOTO NO. 14: Hole (Feature 10)

SME Project No.	088601.00
Photographs by:	Wesley Hemp, PE
Date:	February 11, 2022
Project:	Hurstbourne Apartments
Location:	4700 South Hurstbourne Parkway, Louisville, KY

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will <u>not</u> likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

GENERAL COMMENTS

BASIS OF GEOTECHNICAL REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

REVIEW OF DESIGN DETAILS, PLANS, AND SPECIFICATIONS

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

REVIEW OF REPORT INFORMATION WITH PROJECT TEAM

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner’s budget, tolerance of risk, and expectations for performance and maintenance.

FIELD VERIFICATION OF GEOTECHNICAL CONDITIONS

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

PROJECT INFORMATION FOR CONTRACTOR

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this site should be made available for review by bidders and the successful contractor.

THIRD PARTY RELIANCE/REUSE OF THIS REPORT

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.