



Appalachian Mining &
Engineering, Inc.



Geolab Materials
Testing

March 10, 2019

Mr. Charles Park, *Executive Vice President*
Louisville MegaCavern
1841 Taylor Avenue
Louisville, KY 40213

***Re: Visual Assessment Louisville Underground Storage Facility and
Louisville Mega Cavern Attraction***

Dear Mr. Park,

The ground subsidence event that occurred on the Louisville Zoo property and the undeveloped and unoccupied section portion of the Louisville Mega Cavern occurred in the early morning hours of March 6th. The subject area affected is less than 1% of the entire area of the Louisville Mega Cavern. At the surface level, the subsided area is immediately downstream from the discharge point of a rip-rap lined channel that discharges the surface runoff from approximately +/- 5-acres of grass and asphalt covered zoo property into a pipe that runs beneath a graveled service road. The pipe discharges uncontrolled flow into an eroded soil channel that is incised directly above the area that subsided and ultimately enters Beargrass Creek. This surface runoff flowed above and into the subsided portion of the mine over the past +/- 25-years. It is noted that in recent years there have been multiple severe storm events resulting in increased runoff and likely increased inflow into the mine.

Water is a significant contributor to the subsidence event. The subsidence event was most likely caused by water infiltrating through the soil and into the limestone strata. The water travels along pre-existing discontinuities (joints and bedding planes) eroding the limestone contact at the extent of the mining and solutioning the calcite veins, mud, and the material that filled the discontinuities within the mine strata.

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This condition is present underground in an area immediately adjacent to the subsidence where the discontinuity planes in the previously competent limestone strata are clearly visible because they are saturated and dripping (dark gray in color) in contrast to the surrounding limestone strata that is dry (light gray). Once water has eroded the material within the discontinuities, the limestone strata deteriorates and is separated into a series of unconnected, isolated blocks that are free to fall as it did in the subsided area.

The subsidence event is unrelated to a 3.4 magnitude earthquake that occurred in Maynardville, TN. on March 5th at 3:56 PM. Furthermore, the event was not likely to have been initiated by karst geology as there;

- are no karst features visible in the side walls of the subsided area,
- no karst topography or sinkholes were present in the subsided surface area prior to the event, and
- no karst features or sinkholes are indicated by the Kentucky Geology Survey in its sinkhole mapping and LiDAR survey of portions of western Kentucky.

The subsidence event affected a specific isolated area of the Louisville Mega Cavern. The remainder of both the Louisville Underground and Louisville Mega Cavern do not appear to be adversely impacted by the subsidence event. A thorough visual inspection of both facilities, where accessible on foot, was conducted on March 6th and 7th by Dr. David Newman, P.E., P.G. of Appalachian Mining & Engineering, Inc. (AME) accompanied by Louisville Mega Cavern employees. On March 8th the area beneath the Louisville Zoo was visually inspected by Dr. Newman and Ms. Mary Knopf, P.E. (Wood Environment and Infrastructure Solutions, Inc.). The conclusion of the visual inspection is that there is no adverse change to the pre-existing ground conditions that affect employees of Louisville Underground and the Louisville Mega Cavern, tenants of Louisville Underground, and guests of the Louisville Mega Cavern. It should be noted that the subsidence area may continue to extend to a joint or other discontinuity that provides a natural breaking point that is within the no-access area.

Please note that the scope of AME's work is solely related to the Louisville Underground and Louisville Mega Cavern facilities, not the Louisville Zoo. Wood Environment and Infrastructure Solutions, Inc. is tasked with this responsibility.

Both the Louisville Zoo and the Louisville Mega Cavern have taken quick and significant action to remediate the subsided area. The Louisville Zoo plugged the discharge pipe from the rip-rap lined channel with clay and constructed a DGA (dense graded aggregate) diversion berm to direct surface runoff into a 24-inch corrugated plastic pipe that routes the runoff to Beargrass Creek along the graveled surface road. The immediate benefit this work is that the runoff from a significant rainfall event on March 9th did not enter the Louisville Mega Cavern. The Louisville Mega Cavern has erected chain link fence barriers with locked gates around the subsidence area so that no employees or guests have access to the area. Signage has also been posted to denote a no trespass area.

Charles, if you, Jim Lowry, or others have any questions or comments regarding this letter, please contact me at 859-263-8899 or by email at dnewman@ame-geolab.com

Sincerely,
Appalachian Mining & Engineering, Inc.

David Newman, Ph.D., P.E., P.G.
President