



May 4, 2022

Mr. Ben Craven, PLA, ASLA
Mindell Scott & Associates
5151 Jefferson Boulevard
Louisville, Kentucky 40219

Reference: **Oak Grove Subdivision – Karst Survey**
10212 & 10302 Oak Grove Road
Louisville, Jefferson County, Kentucky 40291
ECS Project No. 61-2724

Dear Mr. Craven:

ECS Southeast, LLP (ECS) conducted a karst survey for the referenced site in accordance with ECS Proposal No. 61-P2687, dated April 6, 2021. The karst survey was conducted in general accordance with Chapter 4 Part 9 (Development on Karst Terrain, dated July 2008) of the Louisville-Jefferson County Land Development Code (LDC). The karst survey included the following elements: a visual reconnaissance of site conditions for the karst geologic features defined in the LDC; a review of current and historical aerial photographs; a review of soil survey information; a review of geologic maps; and a review of topographic maps.

Project Information:

The site included approximately 68.57 acres of wooded land and open fields with several residential buildings (residences, barns, etc.), ponds, and remnant structures (abandoned residence, shed, well, etc.). Most of the site will be developed into a subdivision with approximately 180 single-family residential lots, two detention basins, and associated roadways. The western boundary area of the site approaching Cedar Creek is steeply sloped and currently wooded. This portion of the site will likely be developed into an open green space in the future.

Review of Published Documents:

The following geologic information is based on the review of the Jeffersontown and Mount Washington, 24K Quadrangles, Geologic Map, Kentucky, published by the United States Geological Survey (USGS), and information (aerial photos, geologic maps, and topographic maps, etc.) obtained from the Kentucky Geological Survey (KGS) Geologic Information Service website.

No apparent sinkholes or karst features were reported in the historical aerial photographs, soil survey information, and review of topographic maps. Additionally, no apparent features were mapped within the project area, per KGS. However, one (1) feature was reported approximately 400 feet west of the western property boundary.

Geology:

The four (4) formations reportedly underlying the site are "Louisville Limestone", "Waldron Shale", "Laurel Dolomite" and "Osgood Formation and Brassfield Dolomite". The eastern areas of the property, containing existing residences, are underlain by the "Louisville Limestone" and "Waldron Shale" formations. The remainder of the site, including the steeply sloped areas along the western boundary are underlain by the "Laurel Dolomite" formation. Sparse areas to the immediate east of Cedar Creek are underlain by the "Osgood Formation and Brassfield Dolomite" formation.

The majority of the site is reportedly underlain by the "Laurel Dolomite" and "Louisville Limestone" formations, which are designated as having a "Medium" karst potential. The karst potential is based on the tendency for the site to develop or have karst features as shown on the KGS Geologic Map Information Service. Karst potential designation is not definitively indicative of the actual presence or absence of karst activity at the site. According to the KGS

Potential Classification definitions, the development of karst features is variable and dependent on site-specific conditions in formations designated as a “medium” karst potential.

Site Observations:

A site reconnaissance was conducted over two (2) days on April 14, 2022 and April 15, 2022 by Ben Emery of ECS. Most of the site consisted of sparsely to densely wooded areas, interspersed with open fields, existing residences, and remnant structures. One existing residence, 10302 Oak Grove Road, was located on the eastern portion of the site. The site slopes down toward Cedar Creek along the western property boundary. There is approximately 80 feet of fall across the entire site. A tributary stream, mapped on historical topographic maps, was observed roughly perpendicular to Cedar Creek on the western side of the site. Three (3) ponds were observed onsite.

Several remnant structures were observed throughout the site, including an abandoned home, a remnant foundation, an abandoned well, an abandoned shed, and several piles of discarded rubble. Remnant structures were in close proximity to one another in the north-central cleared portion of the site. Several drainage swales were observed extending downslope on the western portion of the site (toward Cedar Creek). Swales ranged from 3 to 10 feet wide and were frequently observed to contain exposed apparent rock and moist soils. Four (4) existing springs were observed in the western portion of the site, approaching Cedar Creek. Springs were typically observed to contain 1 to 2 inches of running water that would subsequently flow downslope from the spring to form additional drainage swales.

Rock outcroppings typically consisted of isolated boulders, gentle slopes, and/or flat, at-grade exposures of approximately 1 to 8 feet in height with defined jointing, fractures, and pitting. Outcroppings were typically observed in areas of steep relief (typically EL 580 to 600). Most outcroppings occurred along ridgelines running parallel to Cedar Creek. Boulder to cobble-sized rocks were observed at the base of most outcrops, and solution channels were observed within the exposed apparent rock faces. Fracturing of the upper geologic formations was also observed throughout the western wooded portion of the site. These fractures within apparent rock outcropping are typical in karst terrain.

Fifty-four (54) possible karst-related features were identified onsite. Refer to the attached **Karst Feature Location Plan** and **Site Photos** for the approximate location of observed site features and photos of selected features. Brief descriptions of the features are provided in the table below. Areas and/or features with multiple designations (A, B, C, etc.) represent a series of linear features which appeared to be related to a common joint or similar lineation.

Feature	Description	Approximate Dimensions	Approximate Depth
F-1	Oval-shaped closed depression containing three (3) smaller closed depressions. Soil sidewalls, no visible throats.	30' Diameter	3'
F-2	Oval-shaped closed depression underlain by an apparent spring. Audible running water observed below soil bottom. Soil sidewalls observed. Three (3) open throats encountered.	35' Diameter	3'
F-3	Trenchlike closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression.	3' Wide 25' Long	3.5'
F-4	Oval-shaped closed depression with soil sidewalls and two partially closed throats encountered at the bottom of the depression. Exposed metal pipes observed at the bottom of the depression.	17' Diameter	2.5'
F-5	Oval-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression. Probe rod extended to apparent rock approximately 3 feet below the bottom of the depression.	7' Wide 17' Long	4'

Feature	Description	Approximate Dimensions	Approximate Depth
F-6	Small opening with rock sidewalls/bottom. Visible water observed at the bottom of the opening.	1' Diameter	> 4'
F-7	Small opening with rock sidewalls/bottom. Visible water observed on the walls of the opening.	2' Diameter	> 4'
F-8	Spring, surrounded by outcropped rock, observed in a hillside. 1-2" of running water observed.	6' Wide 11' Long	3'
F-9	Small opening with soil sidewalls. Visibly wet.	1' Diameter	3'
F-10	Oval-shaped closed depression with soil sidewalls.	2' Diameter	2'
F-11	Spring observed in a hillside. Spring forks into 2 separate drainage channels, which drain to Cedar Creek approximately 40-50 feet to the west. 1'2" of running water observed.	5' Wide 20-30' Long	6'
F-12	Oval-shaped closed depression with soil sidewalls. Outcropped rock visible within the center of the depression.	12' Diameter	4'
F-13	Oval-shaped closed depression with soil sidewalls. Outcropped rock visible within the center of the depression.	16' Diameter	3'
F-14	Oval-shaped closed depression with soil sidewalls. Depression was filled with debris.	22' Diameter	3'
F-15	Oval-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression.	2.5' Diameter	4'
F-16	Small opening with soil and rock sidewalls, with apparent rock probed at the bottom of the opening.	1' Diameter	2'
F-17	Small opening with soil sidewalls. Apparent rock probed at the bottom of the opening.	6" Diameter	1.5'
F-18	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 6 inches below the bottom of the depression.	4' Diameter	2'
F-19	Small opening with soil and rock sidewalls. Probe rod extended to apparent rock approximately 1 foot below the bottom of the opening.	2' Diameter	3'
F-20	Possible oval-shaped closed depression with rock and soil sidewalls. Probe rod extended to apparent rock approximately 6 inches below the bottom of the depression. Evidence of apparent human disturbance with perimeter of depression lined with stone blocks.	9' Diameter	3'
F-21	Oval-shaped closed depression with soil sidewalls and a partially closed throat encountered at the bottom of the depression. Probe rod extended to apparent rock approximately 1 foot below the bottom of the depression.	10' Diameter	2.5'
F-22	Oval-shaped closed depression with soil sidewalls. Depression was filled with debris.	17' Diameter	3.5'
F-23	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 3 feet below the bottom of the depression.	7' Diameter	4'

Feature	Description		Approximate Dimensions	Approximate Depth
F-24	A karst basin that contained two smaller closed depressions.		30' Diameter	3'
	A	Trenchlike closed depression with soil and rock sidewalls. Probe rod extended to apparent rock approximately 2 feet below the bottom of the depression.	4' Wide 22' Long	3'
	B	Oval-shaped closed depression with soil and rock sidewalls.	6' Diameter	4'
F-25	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 3 feet below the bottom of the depression.		7' Diameter	3'
F-26	Oval-shaped closed depression with soil sidewalls and an open throat (1' diameter, > 4' deep) observed at the bottom of the depression. Visible moisture on rock walls of open throat.		10' Diameter	2.5'
F-27	Oval-shaped closed depression with soil sidewalls.		5' Diameter	3'
F-28	Oval-shaped closed depression with soil sidewalls.		6' Diameter	3'
F-29	Oval-shaped closed depression with soil sidewalls. A partially closed throat with rock sidewalls and bottom (6" diameter, 2' deep) was encountered at the bottom of the depression.		6' Diameter	5'
F-30	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 1 foot below the bottom of the depression.		7' Diameter	2'
F-31	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 2 feet below the bottom of the depression. A metal pipe (debris) was observed within the depression.		4' Diameter	2'
F-32	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 6 inches below the bottom of the depression.		5' Diameter	2'
F-33	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 6 inches below the bottom of the depression.		4' Diameter	2'
F-34	Oval-shaped closed depression with soil sidewalls, surrounded by small rock outcroppings. Probe rod extended to apparent rock approximately 1 foot below the bottom of the depression.		24' Diameter	5'
F-35	Apparent spring observed in a hillside. No water observed, rock outcroppings found throughout outlet area.		4' Wide 6-8' Long	2-3'
F-36	Oval-shaped closed depression with soil sidewalls.		9' Diameter	6'
F-37	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 1 foot below the bottom of the depression.		5' Diameter	2'
F-38	Trenchlike closed depression with rock sidewalls. Depression was filled with debris.		4' Wide 38' Long	3'
F-39	Spring observed in a hillside. Rock overhang present at outlet area. Less than 1 inch of running water observed.		4' Wide 5-8' Long	3'

Feature	Description	Approximate Dimensions	Approximate Depth
F-40	Oval-shaped closed depression with soil sidewalls. Depression was filled with debris.	22' Diameter	4'
F-41	Oval-shaped closed depression with soil sidewalls and a partially closed throat observed at the bottom of the depression. Depression was partially filled with debris.	8' Diameter	5'
F-42	Oval-shaped closed depression with soil and rock sidewalls.	6' Diameter	4'
F-43	Oval-shaped closed depression with soil and rock sidewalls. Bottom of depression was visibly wet. A partially closed throat was encountered on the bottom of the depression.	4' Diameter	3'
F-44	Oval-shaped closed depression with soil and rock sidewalls. Probe rod extended to apparent rock approximately 1.5 feet below the bottom of the depression.	5' Diameter	3'
F-45	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 3.5 feet below the bottom of the depression.	7' Diameter	3'
F-46	Trenchlike closed depression with soil and rock sidewalls.	3' Wide 40' Long	2'
F-47	Trenchlike closed depression with soil and rock sidewalls.	2' Wide 7' Long	5'
F-48	Oval-shaped closed depression with soil sidewalls.	4' Diameter	2'
F-49	Trenchlike closed depression with soil and rock sidewalls.	4' Wide 8' Long	3'
F-50	Oval-shaped closed depression with soil sidewalls. Probe rod extended to apparent rock approximately 2.5 feet below the bottom of the depression.	7' Diameter	4'
F-51	Small opening with soil sidewalls and a partially closed throat observed at the bottom of the opening.	1' Diameter	3'
F-52	Oval-shaped closed depression with soil and rock sidewalls and a rock bottom. Walls and bottom of depression were visibly wet.	2.5' Diameter	3.5'
F-53	Oval-shaped closed depression with soil sidewalls. Depression was filled with debris.	7' Diameter	4'
F-54	Oval-shaped closed depression with soil sidewalls. An open throat (6 inches to 1 foot diameter, 3' deep) with a rock bottom was observed at the bottom of the depression.	4' Diameter	3'

No other karst related features were identified during our site reconnaissance. However, the presence of karst features may be obscured by vegetation and other site features (i.e. fill, wooded areas, structures, or debris). The features identified during this survey should be further evaluated during any subsequent geotechnical exploration(s), or the site development and karst feature remediation phase of the project.

Karst Feature Remediation Guidelines:

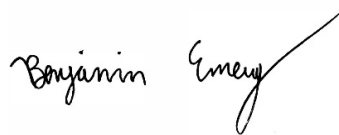
Typically, karst features in this vicinity and similar to those identified in this survey can be stabilized for development, as needed, for the planned future use of the site. Remediation methods vary based on planned use of the specific area where a karst feature is located and the characteristics of each feature. Treatment methods may vary for features where buildings or other improvements are located, in contrast to features in non-sensitive areas (i.e., pavement or landscaped areas). For this project, the objective of the treatment of a feature is to reduce the risk of future subsidence and to decrease surface water infiltration in and around the active karst feature(s).

An experienced and qualified geotechnical engineer or geologist should be present during remediation to evaluate the characteristics as the feature is excavated, and to recommend specific treatment methods for each feature. Remediation of most karst features identified is anticipated to consist of excavation of the closed depression or slot-features to identify the active feature(s) and determine the appropriate stabilization method. Once the active karst throat or weathered apparent rock area is stabilized, an inverted filter (see attached **Karst Feature Remediation Section**) should be constructed within and over the feature(s).

The filter will reduce future loss of soil into the feature, reducing the risk of subsidence. The area can then be backfilled with clay, with the fill mounded above adjacent grade to reduce surface water infiltration. Clay fill placed above the filter constructed in the karst features should meet the requirements for the “CL” classification, according to the Unified Soil Classification System. The fill should be placed in one-foot lifts and compacted to at least 93% of the Standard Proctor maximum dry density, within 2% of the optimum moisture content. Placement and compaction of the fill in limited horizontal lifts will reduce porosity and surface water infiltration. Periodic observations and compaction testing are recommended to confirm the character and continuity of the clay caps. Grading the site to promote surface drainage in all areas and avoiding ponding water is also important in reducing future subsidence of existing karst features (including sinkholes) and reducing the development of additional karst features.

We appreciate the opportunity to serve as your geotechnical consultants for this project. We look forward to continued association with you in future projects.

Respectfully submitted,
ECS Southeast, LLP

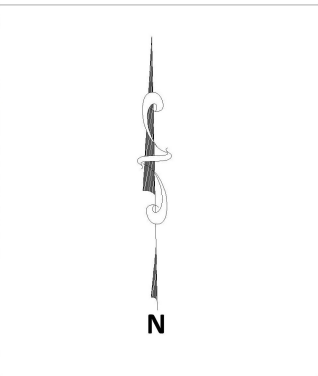
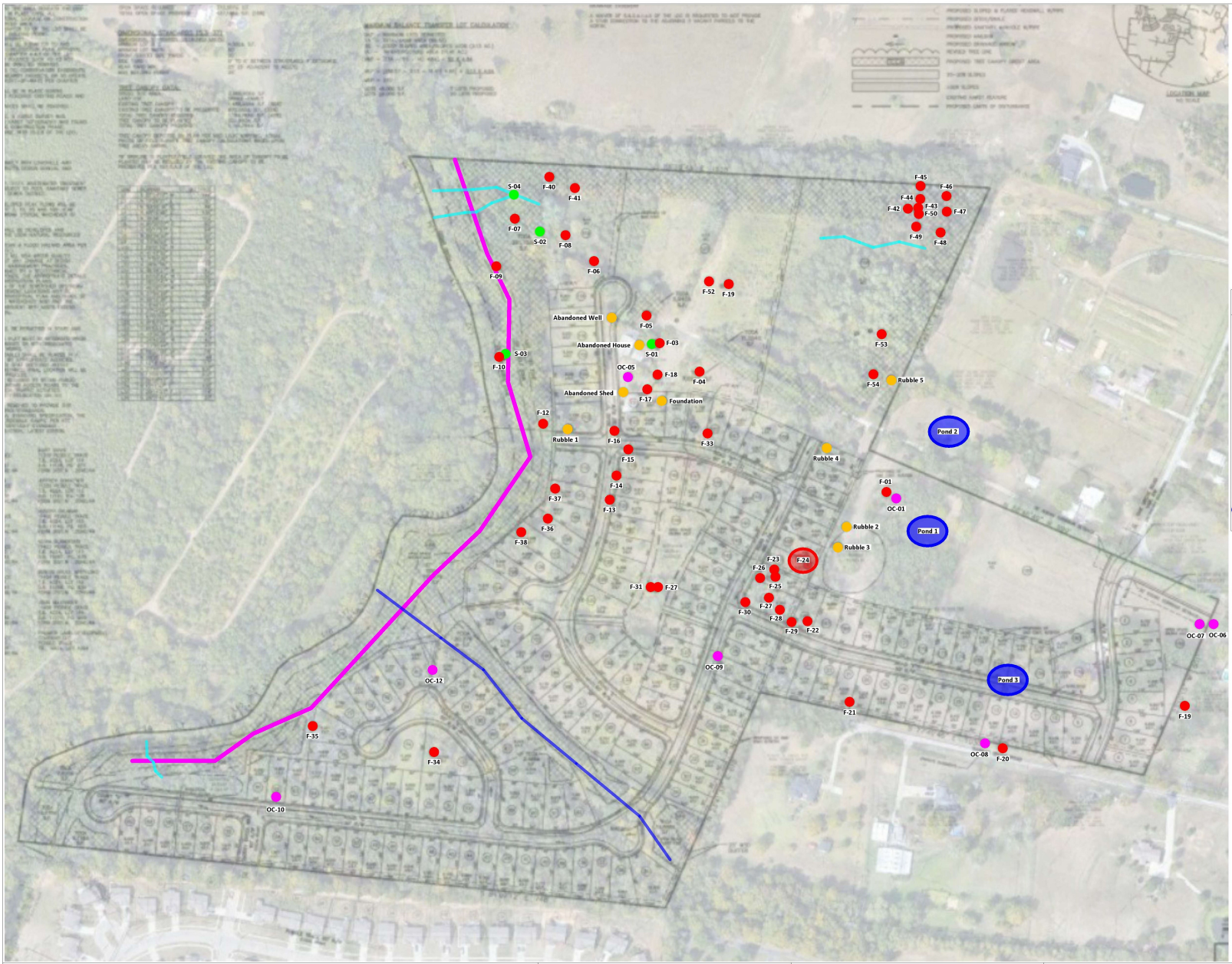


Ben Emery, E.I.T.
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Attachments: Karst Feature Location Plan(s) – 4 pages
Karst Potential Map (obtained from KGS Geologic Map Information Service website) – 1 page
Site Photos – 11 pages
Karst Feature Remediation Section – 1 page

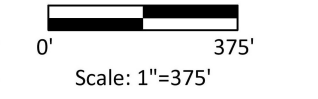


LEGEND

- F-01 - Closed Depression
- OC-07 - Isolated Rock Outcropping
- S-01 - Spring
- R-01 - Remnant Structures
- - Ridgeline Rock Outcropping
- - Drainage Swale
- - Stream
- Pond

NOTES:

- All locations are approximate.
- Image obtained from Google Earth aerial photography, dated 09-02-2019.
- Drawing overlay based on "Detailed Development and Preliminary Plan - Oak Grove Road Subdivision" provided by Mindel Scott and Associates, dated 03-30-2022.



Feature Location Plan - Overview
 Oak Grove Subdivision - Karst Survey
 10212 & 10302 Oak Grove Road
 Louisville, Jefferson County, Kentucky, 40291

Project No.: 61-2724
 Drawing No.: FLP
 Date: 05/04/2022

Drawn By: BCE
 Checked By: FEN
 Scale: As Shown



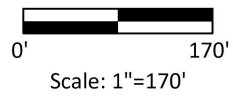
ECS Southeast, LLP
 1762 Watterson Trail
 Louisville, Kentucky 40299
 Tel. (502) 493-7100



LEGEND	
●	F-01 - Closed Depression
●	OC-07 - Isolated Rock Outcropping
●	S-01 - Spring
●	R-01 - Remnant Structures
—	Ridgeline Rock Outcropping
—	Drainage Swale
—	Stream
○	Pond

NOTES:

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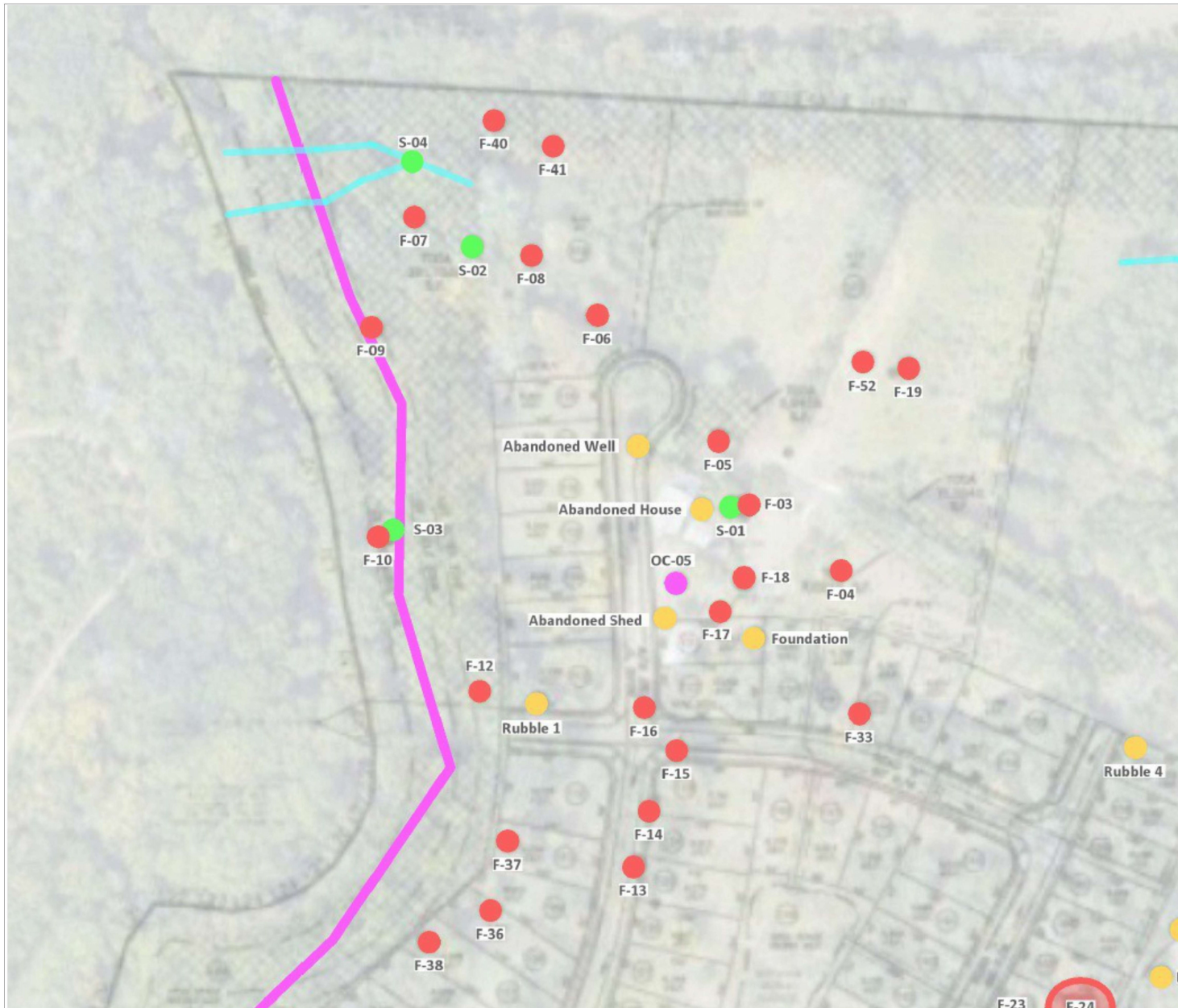
Feature Location Plan - Eastern Detail
 Oak Grove Subdivision - Karst Survey
 10212 & 10302 Oak Grove Road
 Louisville, Jefferson County, Kentucky, 40291

Project No.: 61-2724
 Drawing No.: FLP
 Date: 05/04/2022

Drawn By: BCE
 Checked By: FEN
 Scale: As Shown



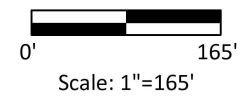
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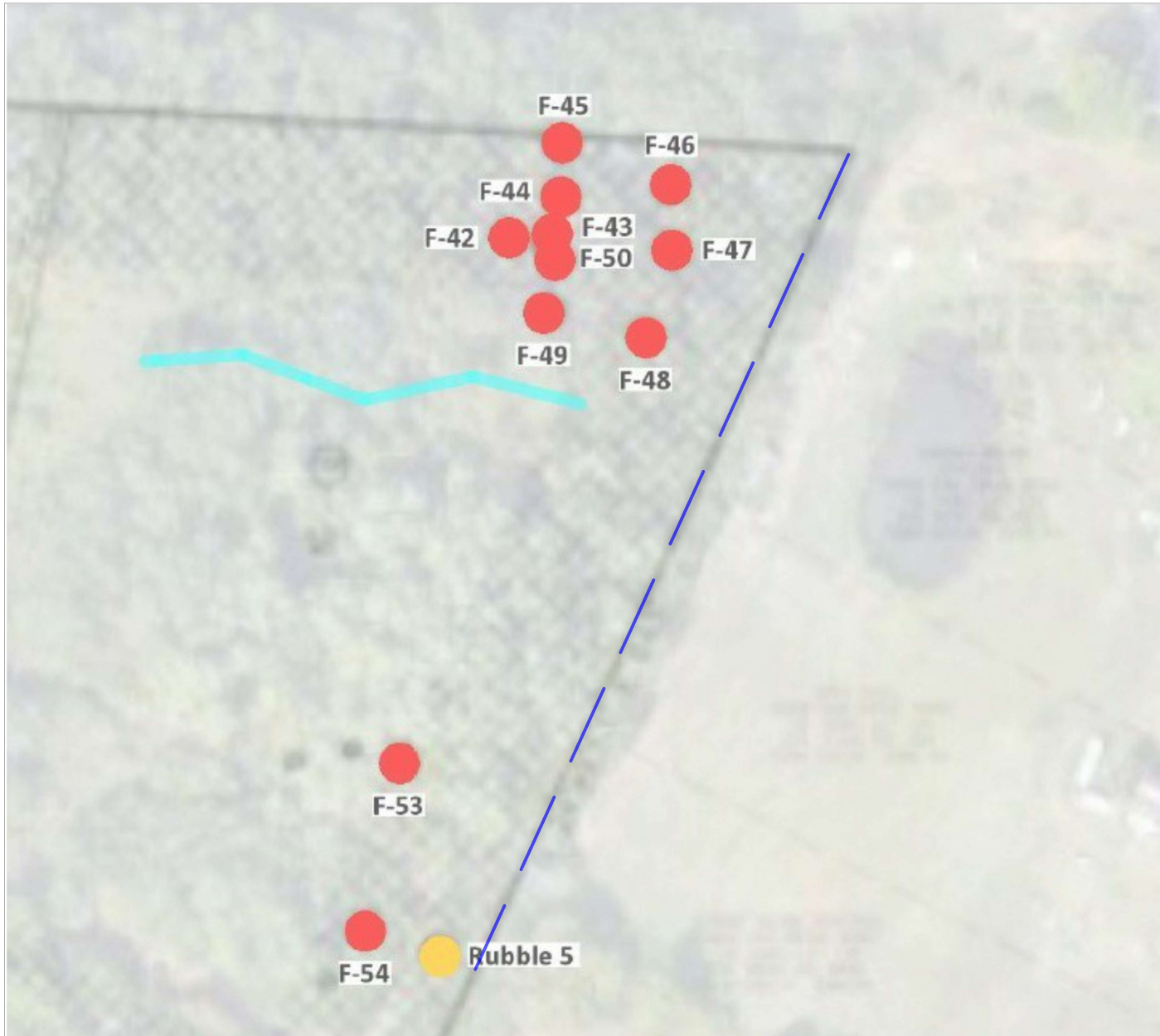
LEGEND	
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—	- Drainage Swale
—	- Stream
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Feature Location Plan - Central Detail Oak Grove Subdivision - Karst Survey 10212 & 10302 Oak Grove Road Louisville, Jefferson County, Kentucky, 40291	Project No.: 61-2724	Drawn By: BCE	 ECS Southeast, LLP 1762 Watterson Trail Louisville, Kentucky 40299 Tel. (502) 493-7100
	Drawing No.: FLP	Checked By: FEN	
	Date: 05/04/2022	Scale: As Shown	



LEGEND	
●	F-01 - Closed Depression
●	OC-07 - Isolated Rock Outcropping
●	S-01 - Spring
●	R-01 - Remnant Structures
—	- Ridgeline Rock Outcropping
—	- Drainage Swale
—	- Stream
○	- Pond

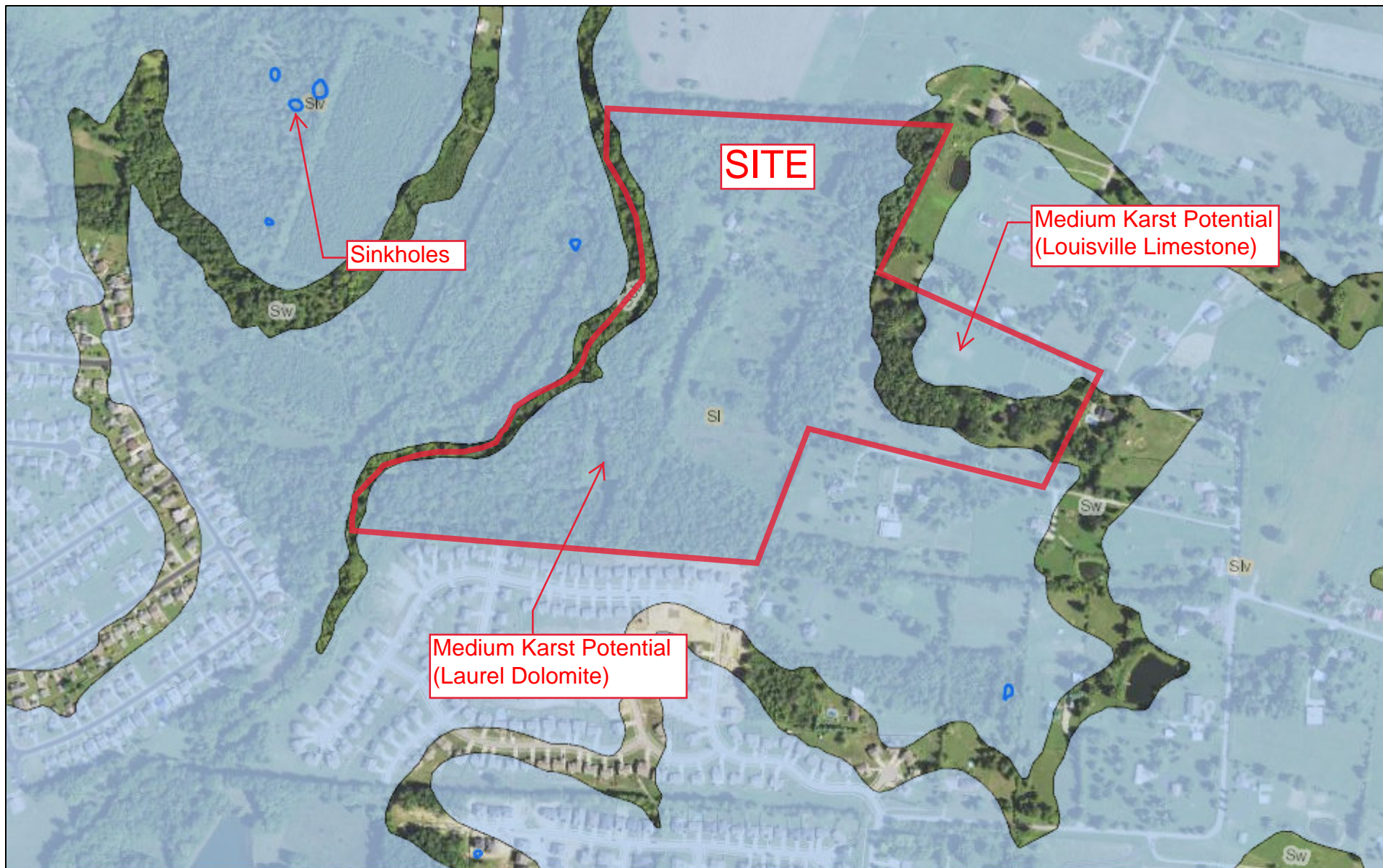
NOTES:

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- Drawing overlay based on "Detailed Development and Preliminary Plan - Oak Grove Road Subdivision" provided by Mindel Scott and Associates, dated 03-30-2022.



Feature Location Plan - Northern Detail Oak Grove Subdivision - Karst Survey 10212 & 10302 Oak Grove Road Louisville, Jefferson County, Kentucky, 40291	Project No.: 61-2724	Drawn By: BCE	 ECS Southeast, LLP 1762 Watterson Trail Louisville, Kentucky 40299 Tel. (502) 493-7100
	Drawing No.: FLP	Checked By: FEN	
	Date: 05/04/2022	Scale: As Shown	

61-2724: Oak Grove Subdivision Karst Survey - KGS Karst Potential Map



LEGEND

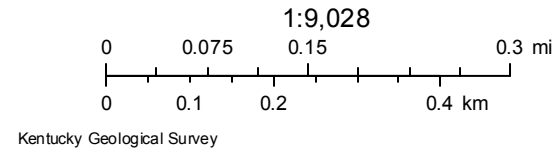
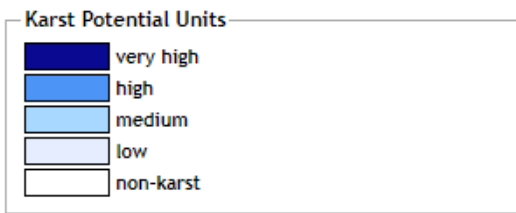




Photo 1 – View of F-1.



Photo 2 – View of F-2.



Photo 3 – View of F-3.



Photo 4 – View of F-4.



Photo 5 – View of F-5.



Photo 6 – View of F-6.

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
10212 & 10302 Oak Grove Road
Louisville, Jefferson County, Kentucky 40291



Photo 7 – View of F-8



Photo 8 – View of F-9



Photo 9 – View of F-10



Photo 10 – View of F-11

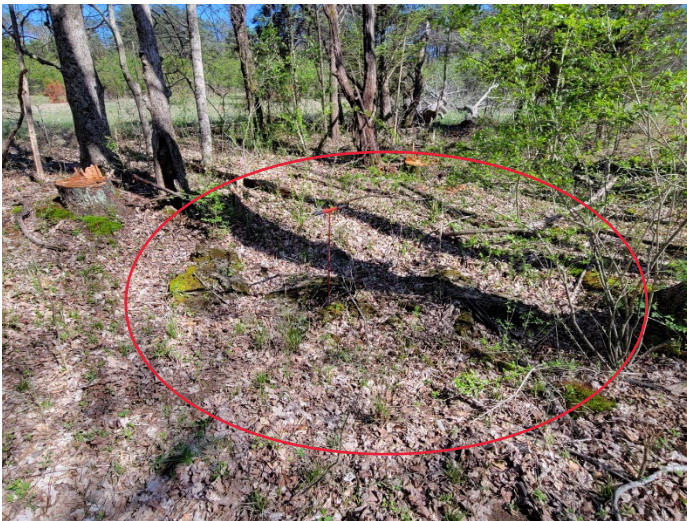


Photo 11 – View of F-12



Photo 12 – View of F-13

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
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Louisville, Jefferson County, Kentucky 40291



Photo 13 – View of F-14



Photo 14 – View of F-15



Photo 15 – View of F-16



Photo 16 – View of F-18



Photo 17 – View of F-19



Photo 18 – View of F-20

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
10212 & 10302 Oak Grove Road
Louisville, Jefferson County, Kentucky 40291



Photo 19 – View of F-21



Photo 20 – View of F-22



Photo 21 – View of F-23

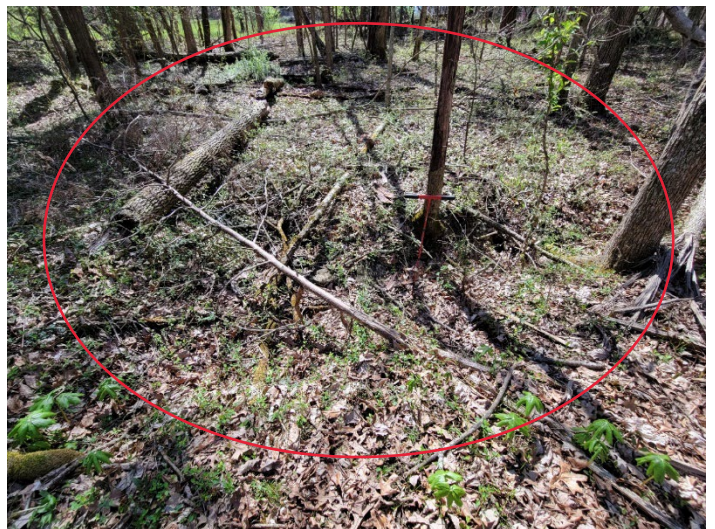


Photo 22 – View of F-24



Photo 23 – View of F-24A



Photo 24 – View of F-24B

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
10212 & 10302 Oak Grove Road
Louisville, Jefferson County, Kentucky 40291



Photo 25 – View of F-25



Photo 26 – View of F-26



Photo 27 – View of F-27

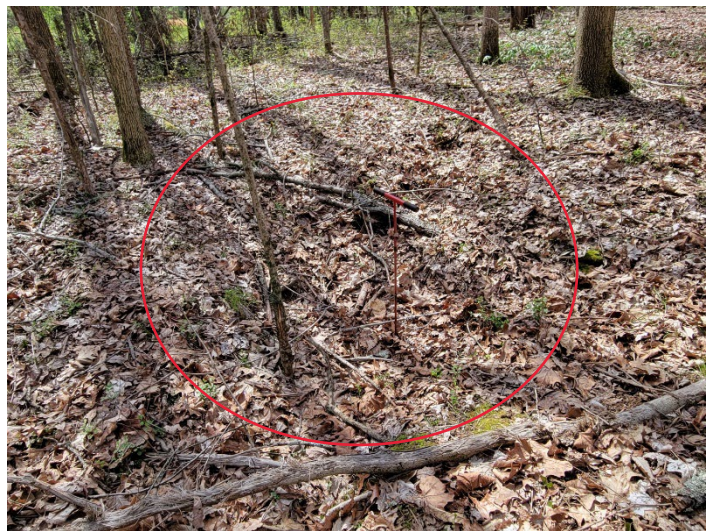


Photo 28 – View of F-28



Photo 29 – View of F-29

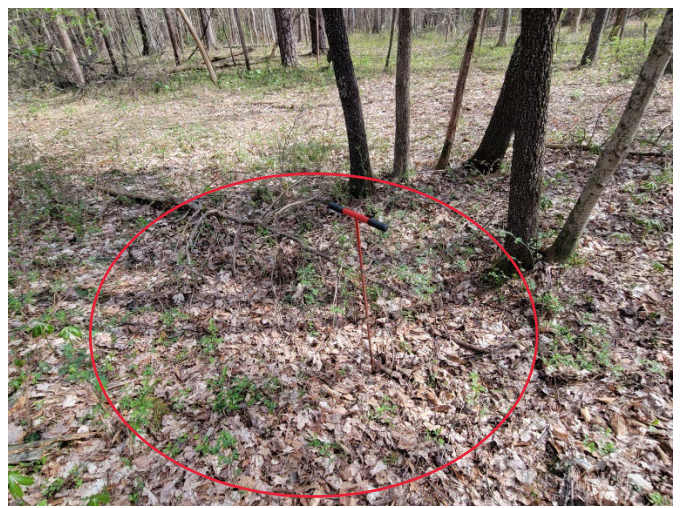


Photo 30 – View of F-30

Site Photos
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Oak Grove Road Subdivision - Karst Survey
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Photo 31 – View of F-31



Photo 32 – View of F-32



Photo 33 – View of F-33



Photo 34 – View of F-34



Photo 35 – View of F-35



Photo 36 – View of F-36

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
10212 & 10302 Oak Grove Road
Louisville, Jefferson County, Kentucky 40291



Photo 37 – View of F-37



Photo 38 – View of F-38



Photo 39 – View of F-39



Photo 40 – View of F-40



Photo 41 – View of F-41



Photo 42 – View of F-42

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
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Louisville, Jefferson County, Kentucky 40291



Photo 43 – View of F-43



Photo 44 – View of F-44



Photo 45 – View of F-45



Photo 46 – View of F-46



Photo 47 – View of F-47



Photo 48 – View of F-48

Site Photos
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Oak Grove Road Subdivision - Karst Survey
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Photo 49 – View of F-49



Photo 50 – View of F-50



Photo 51 – View of F-51



Photo 52 – View of F-52



Photo 53 – View of F-53



Photo 54 – View of F-54

Site Photos
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Photo 55 – View of remnant foundation



Photo 56 – View of remnant house



Photo 57 – View of remnant shed



Photo 58 – View of remnant well



Photo 59 – View of typical rubble pile



Photo 60 – View of outcropping near remnant structures

Site Photos
ECS Project No. 61-2724



Oak Grove Road Subdivision - Karst Survey
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Photo 61 – View of eastern outcropping



Photo 62 – View of outcropping along Cedar Creek



Photo 63 – View of stream



Photo 64 – View of Pond 1



Photo 65 – View of Pond 2

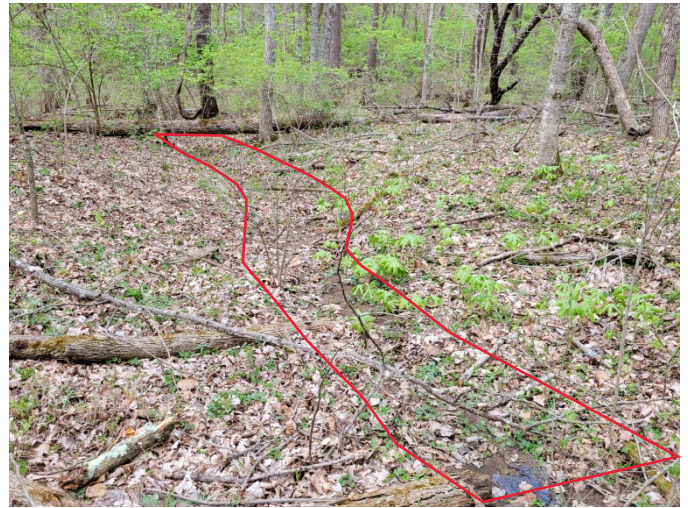


Photo 66 – View of western drainage swale

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SINKHOLE REMEDIATION SECTION (Typical)

