May 30, 2019

Mr. Douglas E. Morris
ISWG, LLC
333 East Main Street, Suite #200
Louisville, Kentucky 40202

Subject: Geotechnical Slope Survey Report
Proposed Washington Green Section 2 Subdivision
6307 & 6503 Mt. Washington Road & 11845 Washington Green Road
Louisville, Kentucky 40229
ECS Project No. 61-2043

Dear Mr. Morris:

A new residential subdivision section is proposed for construction in Louisville, Jefferson County, Kentucky. The site is comprised of approximately 28 acres located north of Mt. Washington Road (KY 2053) and generally east of Pennsylvania Run (waterway). The approximate site location is shown on the attached Site Vicinity Map. The property consisted of wooded hillsides that generally followed Pennsylvania Run along the eastern and southern borders of the site with higher, flatter areas across the central and northern portions of the property. Previous construction (apparently demolished circa 2004) was located near the western border of the property near the intersection of Washington Green Road and Regiment Road. Provided drawings and Google Earth data indicated that existing surface elevations ranged from approximately ~EL 530 to ~EL 540 along Pennsylvania Run to ~EL 610 to ~EL 612 near the west-northwestern portions of the property.

The "Revised Conservation Subdivision Plan, Washington Green Section 2" (Plan) prepared by Mindel Scott, dated 04/08/2019 identified existing 20-30% slopes and >30% slopes on the property. A reduced copy of this drawing is attached. Some 20-30% slopes and >30% slopes shown on the plan could be disturbed by planned home and utility construction. The current Metro Louisville Land Development Code (LDC) 4.7.5 includes requirements for land disturbing activities on slopes greater than 20%. Item B.3 of 4.7.5 states "Land disturbing activities on slopes greater than 20% and less than 30% shall be required to prepare a geotechnical survey report if the staff of the USDA Natural Resources Conservation Service (NRCS) determines such a study is warranted, given the site's soil and geologic characteristics. A geotechnical survey report shall be submitted for land disturbing activities on slopes greater than 30%.

We understand that at present the NRCS is not making the determination of the need for a geotechnical survey report. Accordingly, ECS Southeast, LLP (ECS) was retained to conduct a geotechnical survey report of the site and to determine if additional exploration/testing/analysis would be required to adequately address slope stability concerns. Our evaluation consisted of the following tasks:

- Review the provided Plan
- Review USGS Geologic Quadrangle Map information
- Review USDA NRCS Soil Survey information
- Conduct a visual reconnaissance of selected steep slope areas
- Evaluate the reviewed information and prepare a report of our findings and recommendations





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***USGS Geologic Quadrangle Map Review***

The "Geologic Maps of the Brooks Quadrangle" published by the U. S. Geological Survey and shown on the Kentucky Geologic Map Information Service website indicated that majority of the proposed development area (roughly above ~EL 550 to ~EL 570) was underlain by the Louisville Limestone Formation. The mid-slopes were underlain by Waldron Shale (roughly ~EL 530 to ~EL 550), with the remainder of the site underlain by Laurel Dolomite (roughly below ~EL 530 to ~EL 540).

| | | |
|---|---|---|
| Above | ~EL 540 – 550 | Louisville Limestone |
| | ~EL 530 – 540 to EL 540 – 550 | Waldron Shale |
| Below | ~EL 530 - 540 | Laurel Dolomite |

Slope stability problems have been associated with the Waldron Shale due to its tendency to lose strength when exposed. Waldron Shale was mapped along the southern and eastern edges of the site and appeared to be outside the area of concern for slope stability. The mapped extents of the bedrock formations are shown on Figure 1.

**Louisville Limestone**
Primary Lithology: Dolomitic Limestone and Dolomite.
Reported Thickness: 75' – 95'
Karst Potential: Medium.

Yellowish gray, light olive gray, pale yellowish brown to very pale orange, very fine grained, argillaceous in part; stylolitic, very thin to thin bedded in upper part, very thick bedded near base; irregular rubbly bedding common, typified in exposures along Kentucky Turnpike; locally shaley in 10 foot zone about 20 feet above base; contains calcite filled pockets and thin veinlets of calcite; chert rare in lower beds but common in discontinuous 0.2 foot thick layers in uppermost few feet. Outcrop areas locally marked by narrow, steep walled solution cavities and small sinks; some beds form continuous persistent ledges rimming steep walled stream valleys. Basal contact with underlying shale distinct to gradational over as much as 2 feet.

**Waldron Shale**
Primary Lithology: Shale.
Reported Thickness: 8' – 13'
Karst Potential: Non-karst.

Clay shale, silty, dolomitic, dark greenish gray, pale olive, yellowish gray, or light olive gray, weathers medium light gray to yellowish gray; pyritic, fissile; upper part dolomitic shale that grades laterally to argillaceous dolomite similar to overlying unit. Basal foot also dolomitic. Weathers in gentle slopes to form bench on underlying unit.



**Laurel Dolomite**
Primary Lithology: Dolomite and shale.
Reported Thickness: 47' – 51'
Karst Potential: Medium.

Dolomite in three distinct units, minor clay shale. Uppermost dolomite unit is yellowish gray to very light brown with greenish cast, dark yellowish brown, and olive gray; micro-grained to very fine grained, calcitic, argillaceous and silty; distinguished by fairly continuous beds defined by stylolites ranging from 0.5 to 3.0 feet apart; uppermost 1 to 2 feet


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contains oolites from 1 to 2 mm in diameter; oolitic beds interspersed with one or more thin clay shale seams. Middle dolomite unit is yellowish gray to pale yellowish orange, very fine to fine grained, vuggy owing to dolomitization; irregular wavy lamination; forms massive ledges marked by honeycombed surface stained gray by lichen. Lowest dolomite is yellowish gray to pale yellowish orange, weathers dark yellowish orange and light brown to pale reddish brown; very finely crystalline, argillaceous; beds commonly 0.1 to 0.8 foot thick with wavy laminae; separated from overlying dolomite by 1 to 2 feet of clay shale, light-olive gray, weathers grayish yellow, calcareous and dolomitic. Gradational through interval of 2 to 3 feet with argillaceous dolomite and dolomitic shale of underlying unit. Basal 7 foot thick dolomite unit and overlying shale are equivalent to rocks included with the Osgood Formation in Jefferson County to north by Butts (1915), but because of increasing shale content of Osgood equivalents to the south, the unit has a greater lithologic similarity to the Laurel. Spring line at base promotes slumping of massive blocks of lowest dolomite down shale slopes below.

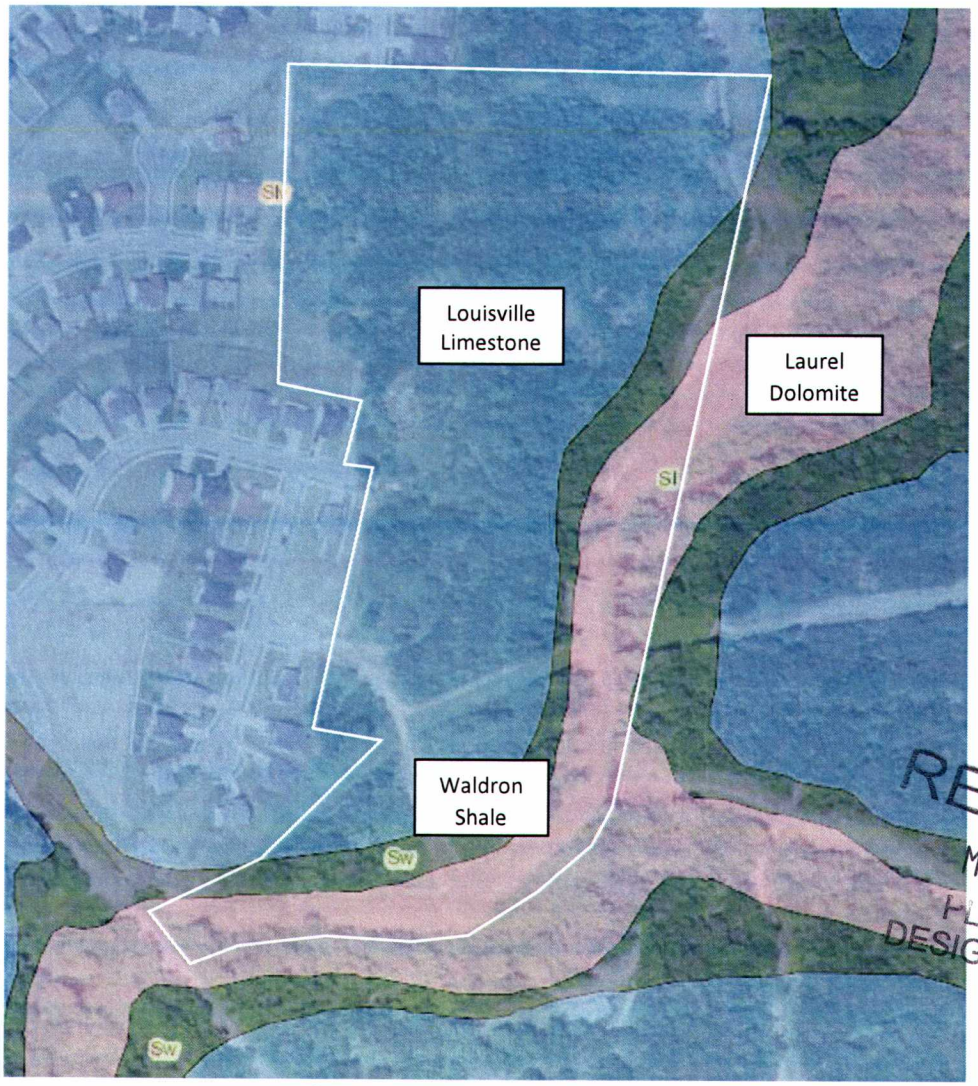




Figure 1: Reported Site Geology



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## ***Soil Conservation Service Soil Survey***

The USDA Natural Resources Conservation Service "Web Soil Survey" website indicated the 5 general soil types at the site as shown in Figure 2. Descriptions of these soil types are summarized below.


Figure 2: Reported Soil Data





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CaD2 Caneyville silt loam, 12 to 25 percent slopes, eroded, very rocky
Parent material: Clayey residuum weathered from limestone.
Typical Profile:
0 to 2 inches: silt loam
3 to 30 inches: silty clay
30 to 40 inches: unweathered bedrock

CrB Crider silt loam – 2 to 6 percent slopes
Parent material – Fine-silty non-calcareous loess over clayey residuum weathered from limestone.
Typical Profile
0 to 9 inches: silt loam
9 to 39 inches: silty clay loam
39 to 79 inches: silty clay

CrC Crider silt loam – 6 to 12 percent slopes
Parent material – Fine-silty non-calcareous loess over clayey residuum weathered from limestone.
Typical Profile
0 to 9 inches: silt loam
9 to 39 inches: silty clay loam
39 to 79 inches: silty clay

No Nolin silt loam – 0 to 6 percent slopes, occasionally flooded
Parent material – Mixed fine-silty alluvium.
Typical Profile
0 to 82 inches: silt loam
82 to 101 inches: loam

ShD3 Shrouts silt loam – 12 to 25 percent slopes – severely eroded - very rocky
Parent material – Clayey residuum weathered from calcareous shale and/or siltstone
Typical Profile
0 to 2 inches: silt loam
2 to 35 inches: silty clay
35 to 45 inches: weathered bedrock



***Visual Reconnaissance of Selected Slope Areas***

Based on our review of the Plan, three areas shown to be either 20-30% slopes or >30% slopes that may be disturbed during development were identified. See attached Visual Slope Reconnaissance Plan for the approximate locations. A visual reconnaissance of these areas was conducted on May 22, 2019. Photos of the conditions observed at these areas are shown below. In general, similar conditions were observed in most areas. Trees with some brush, vines, and other low vegetation were present in the observed areas. Some float stone and several possible springs were observed along the hillsides. A concrete debris pile was observed along the top of the slope in Area 3. An apparent drain pipe was observed in Area 1. Isolated indications of minor erosion were observed. No indications of large scale erosion were


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noted. No visual indications of slope instability were observed. In particular, none of the following were noted: unusual tilting or fallen trees, tension cracks, scarps, displaced soil, or mounds of soil in lower areas.


General view of Area 1 (grass/shrubby area).


Apparent drain pipe observed in Area 1.


Minor erosion near apparent spring in Area 1


General view of Area 1 (wooded area).




Possible spring in Area 1.


General view of Area 2.



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General view of Area 2 (grassy area).


General view of Area 3 (grass/shrubby area).


General view of Area 3.


Concrete debris observed in Area 3.

Based on our review of the above reference information and on our past experience with construction under similar conditions in Jefferson County, our opinion is that the on-site slopes (excluding small, localized erosion features) in the observed areas were stable at the time of our reconnaissance. While evidence of slope instability was not observed, it is possible that the dense ground cover obscured the presence of slope instability in heavily overgrown areas. Once areas where site disturbance for grading and/or utility installation have been cleared of dense vegetation, ECS should be retained to further evaluate those slopes. Slope stability problems have been associated with the Waldron Shale Formation due to its tendency to lose strength when exposed. However, it appears that the Waldron Shale Formation is only present in areas lower in elevation than the planned lots and will not likely be disturbed during development. The current, on-site slope stability likely is related to the following factors:

- Relatively thin depths of soil in slope areas
- Cohesive (clayey) soil matrix





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- Rocky soil texture
- Limestone bedrock in many areas
- Numerous trees and other vegetation

In our opinion, additional geotechnical analyses including soil/rock test borings/coring, shear strength testing of soils, etc. is not required, so long as the planned subdivision configuration does not involve disturbance significantly greater that what was indicated on the Plan, and no significantly different conditions are observed in areas that were heavily vegetated at the time of our visual reconnaissance.

Several measures may be considered to help maintain the stability of the existing and planned slopes during construction of the new subdivision and over the life of the new homes. These measures include:

- Plan grading to minimize changes to existing topography along and adjacent to slopes.
- Minimize disturbance to slopes and vegetation outside new construction areas.
- Avoid significant transverse cuts along or at the toe of existing slopes.
- Avoid significant embankments along or at the crest of existing slopes.
- Maintain the following limits for new embankments without additional geotechnical exploration and analysis:
  - 3:1 (horizontal:vertical) or flatter slopes.
  - Properly strip all vegetation, topsoil, etc. where fill will be placed.
  - Construct embankments with controlled fill compacted to at least 98 percent standard Proctor maximum dry density and within 2 percent of the optimum moisture content.
  - Maximum fill embankment height – 5 feet.
  - Horizontally bench new fill into existing slopes.
- Maintain the following limits for new cuts in soil without additional geotechnical exploration and analysis:
  - 3:1 (horizontal:vertical) or flatter slopes.
  - Maximum cut height – 5 feet.
- Provide adequate erosion and surface water drainage control during construction and over the life of the subdivision.
- Establish permanent vegetative cover as soon as practical.

We appreciate the opportunity to work with you on this project. If you have any questions about this evaluation, or if you need any further assistance, please call us at any time.

Cordially,
ECS Southeast, LLP

Jeremy Hudson, P.E.
Senior Project Engineer

Michael C. Ronayne, P.E.
Chief Engineer

Attachments: Site Vicinity Map
Visual Slope Reconnaissance Plan



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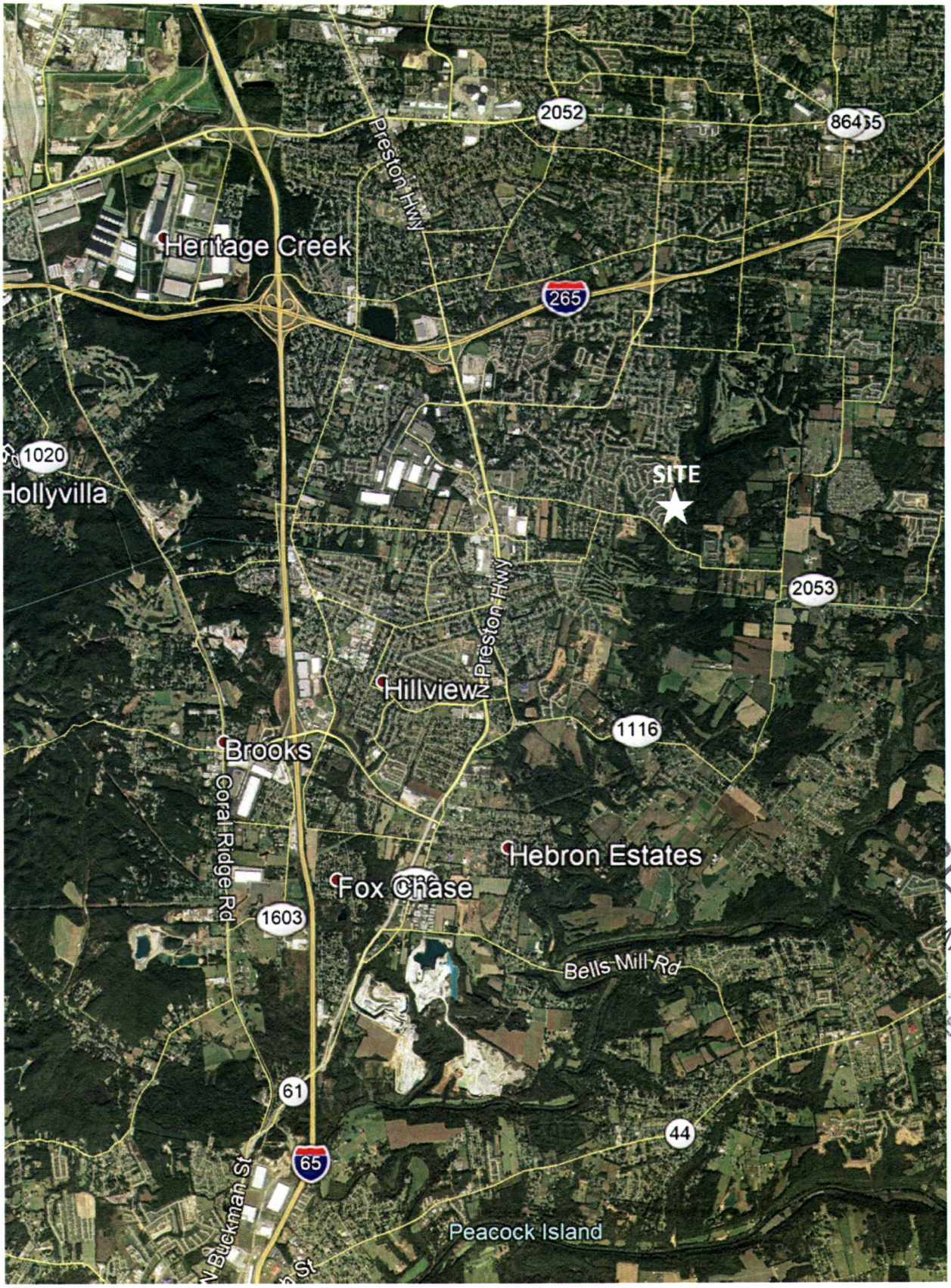


**Site Vicinity Map**

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