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September 6, 2019

Mr. Kevin Young, RLA
Land Design and Development, Inc
503 Washburn Avenue, Suite 101
Louisville, KY 40222

SUBJECT: GEOTECHNICAL SLOPE RECONAISSANCE
CAUDILL FARM
OLD STAGE COACH ROAD
METRO LOUISVILLE, KENTUCKY
PROJECT NUMBER 19-200G

Dear Mr. Young:

Attached are recommendations for construction on existing slopes in conjunction with residential construction at the above referenced subdivision. These recommendations include discussion of benching into existing slopes for fill placement, trimming slopes, etc. There is no evidence of slope instability across the site.

If you have any questions in regard to these findings, please call.

Sincerely,

GREENBAUM ASSOCIATES, INC.

Sandor R. Greenbaum

Sandor R. Greenbaum, P.E.
Principal Engineer

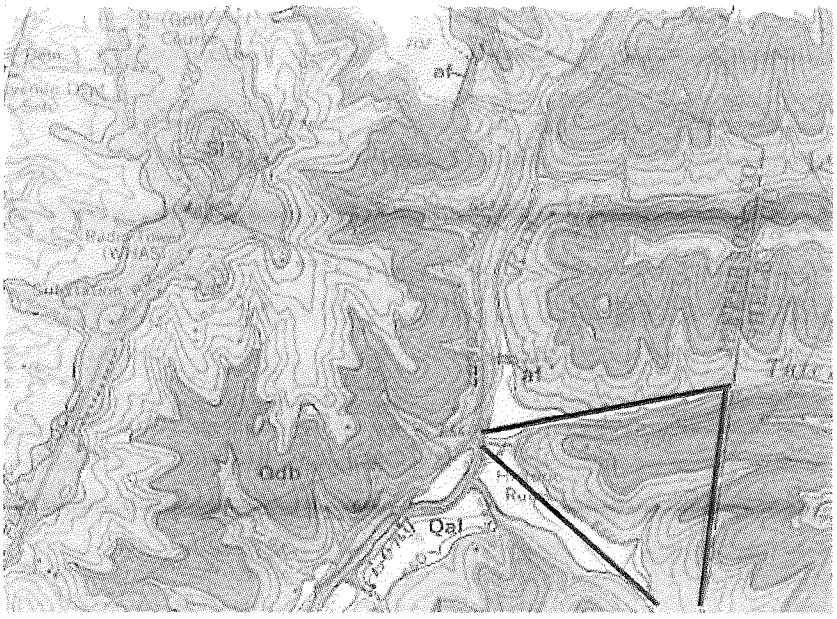
Introduction

Land Design and Development, Inc. has been retained to design a new residential subdivision, Caudill Farm, to be constructed on a ±104.8-acre parcel located at 16110 Old Stage Coach Road in Metro Louisville, Kentucky. This parcel of land has very gentle relief with the level areas planted in soybeans and the sloping areas covered by woods. Lots 75 through 97 are in an area that slopes at a 10- to 15-percent grade and lots 121 to 132 are in an area that that slopes more steeply and backs up to a 20- to 30-percent slope down to Tater Run Creek. This latter area is the one addressed by this report. Site reconnaissance was performed on September 5th, 2019, by Mr. Sandor R. Greenbaum, P. E.

We were contracted by Land Design and Development, Inc. to determine the stability of slopes with gradients of 30-percent or greater and to provide means of construction on and adjacent to such slopes in a manner that maintains their stability. Work was coordinated through Mr. Kevin Young, RLA of Land Design and Development, Inc.

General Geology

Soils at this site are shown by the Kentucky Geological Survey to be residuum, the residual product of weathering of the local bedrock. Some alluvium is present to the north of the subject property, in the low area in the vicinity of Tater Run Creek, and in the southern portion of the property that is not planned for development.



In the section taken from the Crestwood Geologic Quadrangle, included at the bottom of the previous page, the red lines approximate the property boundaries as straight lines. The bedrock on the higher ground (reddish brown) is the Bardstown Member of the Drakes Formation and the bedrock at lower elevation (light brown) is the Rowland Member of the Drakes Formation. The area shown in yellow at yet lower elevation is alluvium, soils deposited by the streams that cross those areas.

The Kentucky Geological Survey describes the Bardstown Member as:

Limestone and shaly mudstone: Limestone, medium to olive gray, is of two main types: shaly limestone (mud supported), and coquinoid limestone (grain supported). Shaly limestone is fine to very fine grained, contains sparse to abundant coarse grains and fossil fragments; grades locally to calcareous shale. Coquinoid limestone is characterized by abundant broken and whole fossils in a sparry to muddy matrix; bluish cast common where fresh, weathers yellowish gray, dark yellowish orange, and light olive gray. Beds of both types commonly 0.1 to 0.3 foot thick, generally irregular, rubbly-surfaced, and discontinuous, some even, smooth surfaced, and continuous. Shaly mudstone, generally as thin beds, is mainly calcareous, olive gray to greenish gray; locally dark brownish gray to olive black where carbonaceous, especially in beds 0.1 to about 1 foot thick near top and base of unit.

The Kentucky Geological Survey describes the Rowland Member as:

Limestone and shale: Dominant limestone is medium and greenish gray to medium bluish gray calcisiltite; weathers pale olive to yellowish gray; dolomitic and argillaceous (marly); streaked with irregular burrows(?) filled with dusky yellowish-green glauconitic(?) material which weathers out readily to form holes and pitted bed surfaces; thin to thick bedded in continuous but poorly defined planar beds; internal bedding and bedding surfaces poorly preserved owing to bioturbation. Dense bluish gray limestone near base contains abundant colonial corals and inter-bedded carbonaceous shale; this zone is continuous with the Fisherville coral reef. Dominant shale is olive gray, light olive gray, greenish gray, and dark greenish gray; weathers yellowish gray to light gray; calcareous; in beds as much as 3 feet thick near upper and basal contacts.

Lots with or adjacent to 20- to 30-Percent Slopes

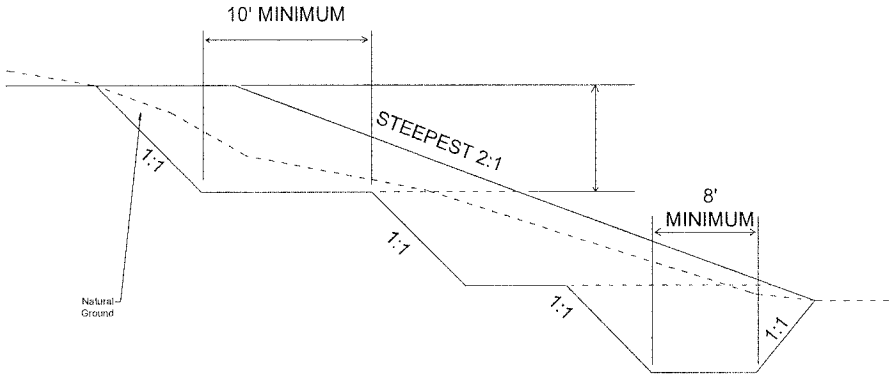
Lots with or adjacent to 20- to 30-percent slopes include a single line of lots, lots 121 through 132. Two photographs of the slope in that area are included at the top of the following page.

This area slopes downward to the north at between 20- and 30-percent grade in the area behind, to the north of, lots 121 through 132 and in the backyard of several of the lots. This slope crosses Old Stage Coach Road and makes its way to Tater Run Creek to the north of the property. There is no evidence of slope movement, i.e. no scarp, leaning trees consistent with a slide, tension cracks, etc. There are a couple areas where erosion has occurred as water runs down the slope as concentrated flow. There is one location where the farmer has a couple steel pipes at the edge of the soybean field directing water down the slope and one of the minor erosion channels occurs below these pipes.

Site Preparation and Earthwork

Site design will need to take into account runoff from the development and provide for drainage off the property in such a way that it does not cause erosion of the slope. Drainage channels running down the slope must be lined or water must be redirected such that it doesn't run down the slope as a concentrated flow. Flow must also be controlled to protect the slope during construction.

When fill is to be placed on an existing slope it is imperative that the existing slope be benched as shown in the diagram below to prevent the formation of a plane of weakness along which a slope failure can develop. Benching will have to be adjusted as necessary, in consultation with this office, where limestone bedrock is encountered that prevents benching as shown from being achieved.



All fill should be placed in lifts not exceeding 8 inches in uncompacted thickness and must be compacted to at least 98 percent of the soils maximum dry density as determined by the Standard Proctor (ASTM D-698). Soil moisture content should be within 2 percent of optimum as determined from the Standard Proctor.

Soil from any off-site borrow sources should be tested and approved by this office prior to being used on the site. Satisfactory borrow materials are those falling in one of the following classifications: GC, SM, SC, ML, or CL. Soil types MH, CH and OH soils and peat are unsatisfactory borrow materials.

The face of an inclined embankment cannot be compacted as densely as the interior fill because the outer slope deforms more elastically under load. This low-density zone tends to foster plant growth. Unfortunately, a heavy mat of vegetation is often formed with greater permeability than the underlying fill that can result in shallow slips of the vegetated surface downward. To prevent this from occurring one of three procedures must be followed in finishing the fill slope.

These are: 1) trimming; 2) embedment of geotextile; or 3) emplacement of deep rooting woody vegetation.

Trimming requires that the fill be placed 18 inches beyond the final fill point. Once fill is complete the top 18 inches of soil must be bladed-off the slope to be removed for use as fill elsewhere.

Embedment of geotextiles requires that a woven-geotextile of uniaxial geogrid be placed vertically every two feet along the outer edge of the fill. This slope reinforcement must extend at least five feet in from the outer edge of the slope.

Soil fill must be no steeper than 2-horizontal to 1-vertical in order that it remain stable. Where there is a sharp angle in the slope, such as near the corner of a building or pavement corner, the slope must be no steeper than 2.5 to 1. If the slope is to be mowed with normal lawncare equipment, it should be no steeper than 3 to 1.

Significant transverse cuts along existing or immediately below existing slopes should be avoided. Disturbance of vegetation on existing slopes should be avoided and any disturbed slopes must be replanted with vegetative cover with temporary erosion protection until that vegetative cover develops.

The placement of compacted fill should be carried out by an experienced excavator with the proper materials. The excavator must be prepared to adapt his procedures, equipment and materials to the type of project, to weather conditions, and the structural requirements of the engineer. Methods and materials used in summer may not be applicable in winter; soil used in proposed fill may require wetting or drying for proper placement and compaction. Conditions may also vary during the course of a project or in different areas of this site. These needs should be addressed in the project drawings and specifications.

During freezing conditions, the fill must **not** be frozen when delivered to the site. It also must not be allowed to freeze during or after compaction. Since the ability to work the soil while keeping it from freezing depends in part on the soil type, the specifications should require the contractor to submit a sample of his proposed fill before construction starts, for laboratory testing. If the soil engineer determines that it is not suitable, it should be rejected. In general, silty sand, clayey sand, and cohesive/semi-cohesive soils should not be used as fill under freezing conditions. All frozen soil of any type should be rejected for use as compacted fill.

It is important that compacted fill be protected from freezing after it is placed. The excavator should be required to submit a plan for protecting the soil. The plan should include details on the type and amount of material (straw, blankets, extra loose fill, topsoil, etc.) proposed for use as frost protection. The need to protect the soil from freezing is ongoing throughout construction and applies both before **and** after concrete is placed, until backfilling for final frost protection is completed. Foundations placed on frozen soil can experience heaving and significant settlement, rotation, or other movement as the soil thaws. Such movement can also occur if the soil is allowed to freeze **after** the concrete is placed and then allowed to thaw. The higher the percentage of fines (clay and silt) in the fill, the more critical is the need for protection from freezing.

The contractor should be required to adjust the moisture content of the soil to within a narrow range near the optimum moisture content (as defined by the applicable Proctor or AASHTO Test). In general, fill should be placed within 2% of optimum moisture. The need for moisture control is more critical as the percentage of fines increases. Naturally occurring cohesive/semi-cohesive soil are often much wetter than the optimum. Placing and attempting to compact such soils to the specified density may be difficult. Even if compacted to the specified density, excessively wet soils may not be suitable as pavement subgrades due to pumping under applied load. This is especially true when wet cohesive/semi-cohesive soil is used as backfill in utility trenches and like situations. Excessively wet soil in thick fill sections may cause post-construction settlement beyond that estimated for fill placed at or near (±2%) the optimum moisture content.