Open File Report 76-273

PRELIMINARY GEOLOGIC AND ENGINEERING REVIEW OF THE FRANCONIA AREA, FAIRFAX COUNTY, VIRGINIA

Introduction

The Franconia area of eastern Fairfax County, Virginia lies less than 10 miles (16 km) south of the center of the District of Columbia. It is mainly a flat to gently undulating plateau-like upland that is capped by gravels and pocked by abandoned gravel pits. The margins of the upland are sharply incised by steeply sloping wooded ravines and gullies. The slopes of the eastern scarp of the plateau are formed partly on expansive clays with a history of recurrent failures by landslides and poor foundation stability. The gravel-capped plateau offers pleasant vistas with many unobstructed views south and eastward across the Coastal Plain to the broad Potomac Estuary, and glimpses of the rolling, wooded hills of the Piedmont to the west.

With respect to existing land use, part of the area is urbanized, part is rural, and much of it currently is pitted vacant wasteland, resulting from gravel extraction. The northern part of the region is transected by Route 495, the east-west Capital Beltway, and the central part is crossed from north to south by the Richmond, Fredericksburg and Potomac Railroad and Interstate Route 95.

Proximity to the Nation's Capital, coupled with relative east of access, make this site ideal for moderate density residential use. Such a use also harmonizes with the zoning and the land use plan for this sector of Fairfax County, provided that rational development is feasible and practicable without irreparable and recurrent harm to potential homeowners and to the environment. The enclosed geologic and engineering information can be used by planners and engineers to help insure that land use decisions are environmentally sound and economically feasible.

The following list of maps and engineering data summarizes the present understanding of the physical setting of the Franconia area:

Fig. 1 - Landforms Map
2 - Geologic Map
3 - Block Diagram
4 - Base of Saprolite Map
5 - Surface Materials Map
6 - Table of Selected Engineering Properties
7 - Sequences Map
8 - Slope Stability Map

Figure 1. Landforms Map

This map shows landforms by three major subsivisions: lowlands (units 1a and 1b), uplands (Units 3a, 3b, and 3c), and the valley walls (Units 2c and 2d). The landform categories are closely related to general slope; thus, categories designated by "a" have slopes generally less than 3%, "b" indicates slopes generally from 3% to 8%, "c" indicates those from 8% to 15%, and "d" indicates slopes generally more than 15%.

The Franconia area lies in two physiographic provinces - the Piedmont and the Coastal Plain; the boundary between tham, the Fall Line, extends northeast-southwest. The map permits a rapid evaluation of terrain suitability for specific uses. Valley bottoms, steep slopes, or flat uplands all have markedly differing potential for land use. For example, the uplands (Units 3a, 3b, and 3c) may be suitable for building construction, but the flood plains of Unit 1a are obviously not. The map gains added utility when used in conjunction with maps of other aspects of the environment.

References

Rogers, Henry G., 1975, Landforms Map of Annandale quadrangle, Virginia: U.S. Geol. Survey Open File Map 75-157.

Figure 2. Geologic Map

The geologic map of the Franconia area (Fig. 2) shows the areal distribution of the materials that underlie the soils. Hard crystalline metamorphic rock of the Wissahickon Formation (Wm, Wd) and the Occoquan granite (Gr) crop out along Accotink Creek, and soft red-brown saprolite (Wms, Wds, Grs) occurs at the surface in the northwestern and western part of the area. Saprolite is a porous, residual, clay-rich material derived by chemical weathering of crystalline bedrock in which the structure of the original rock is preserved.

Saprolite is overlain unconformably along the Fall Line zone by poorly consolidated sediments of the Coastal Plain, which consists of the Cretaceous Potomac Group. The wedge of Potomac Group sediments dips gently southeasterly parallel to the slope of the base of saprolite, but at progressively gentler angles up-section and to the southeast, as shown on the cross-section in A-A[1] and the schematic block diagram, Fig. 3.

The Potomac Group has been informally subdivided into two units, one which is predominantly sand with minor quartz pebbles and clay clasts (Kps), the other being mainly silty or sandy clay (Kpc). Each unit grades laterally into the other, with the Potomac sand unit (Kps) containing interbedded lenticular sandy clay beds and the clay unit (Kpc) having thin interbeds of sand. As the sand units (Kps) commonly fill channels and are crossbedded (Weir, 1976), the average direction of cross beds is shown as an indication of the probable direction of maximum permeability. Should the Franconia area be evaluated on the basis of ground-water availability, cross bed directions may indicate the principal trends of subsurface migration of water.

Upland gravels (Ugu) of Cenozoic age unconformably overlap the Potomac Group sediments and rest directly on saprolite in the western part of the Franconia area (Fig. 3). The upland gravels blanket the surface forming the top of the plateau at an average elevation of 250 feet, with the underlying units exposed mainly along the dissected margins. The gravels have been extensively dug and extracted in the recent past, and the sites of abandoned pits were regraded.

Low-level terrace gravels (Qt) that locally include thin deposits of colluvium flank deposits of stream valley alluvium (Qal). Disturbed ground (Dg) and fine-grained sediment pond fill (As) occur near abandoned gravel pits, and artificial fill (Af) is present in low areas along railroads and highways.

References

Huffman, A. C., Froelich, A. J., and Force, L. M., 1975, Preliminary Geologic Map of Annandale quadrangle, Virginia: U.S. Geol. Survey Open-File Report 75-254.

Weir, G. W., 1976, Crossbedding of the Potomac Formation in Fairfax County, Virginia: U.S. Geol. Survey Open-File Report 76-193.

Figure 3. Block Diagram

The schematic block diagram shows a perspective view of the general geologic setting in the Franconia area. The diagram shows that the Potomac Group sediments that overlie saprolite consist of gravelly sands (Kps) and silty or sandy clay (Kpc) that interfinger in a complex manner. These sediments were deposited in a fluviatile environment, and as a consequence, the sands often fill old channels while the clays and silts are associated overbank floodplain deposits, natural levees and ox-bow deposits (Weir, 1976).

Under some conditions thick porous sands may serve as aquifers for groundwater, whereas the impermeable clays act as confining beds. An outstanding characteristic of clays that is of concern to planners is the susceptibility of the clay to slump and creep, even on very low angle slopes. Some of the sand beds may aggravate the landslide problem, as they may act as source areas where water is discharged into the slopes. A related characteristic of the clay beds is high shrink-swell properties due to the presence of montmorillonite.

Soils on the upland gravel locally have a shallow hardpan near the ground surface which impedes downward percolation of rainwater and locally protects the slippage prone clays from moisture.

Reference

Weir, G. W., 1976, Crossbedding of the Potomac Formation in Fairfax County, Virginia: U.S. Geol. Survey open-file report No. 76-193.

Figure 4 - Contours on the Base of Saprolite

The map showing contours on the base of saprolite (Fig. 4) depicts a generalized configuration of the irregular top of the unweathered bedrock surface. In general, the hard rock surface slopes southeasterly about 100 feet per mile (19 m/km). The approximate location and elevation of all known drill holes and outcrops of this horizon are shown, as well as drill holes which did not penetrate to hard rock. Selected drill hole and outcrop data pertaining to the top 50 feet of geologic materials show the vertical sequence present at specific localities.

Reference

Froelich, Albert J., 1975, Base of Saprolite Map, Annandale quadrangle, Virginia: U.S. Geol. Survey Open File 75-154.

Figure 5 - Surface Materials Map

The Surface Materials map (Fig. 5) is extracted from the Geologic map, but the definition of significant map units is based largely on engineering characteristics. For example, different geologic map units such as Occoquan granite (Gr) and Wissahickon Formation metagraywacke (Wm) are grouped together as a single unit of bedrock, as their engineering properties are similar to one another and radically different from other mapped units. By using the Surface Materials map in conjunction with the Table of Selected Engineering Characteristics (Fig. 6), derivative maps dealing with specific properties relevant to solving different types of problems are possible. For example, a potential mineral resource map of the Franconia area might show available surface sources of sand and gravel (Unit 4), sand (Unit 5b), crushed stone or building stone (Unit 7) and delineate only those units. In addition, a map focused on shallow foundation conditions in the Franconia area might define the high shrink-swell clay (Unit 5a) and saturated alluvium (Unit 2) as "low strength", sand and gravel (Units 4 and 5b) as "moderate strength" and bedrock (Unit 7) as "high strength".

Reference

Force, L. M., and Froelich, A. J., 1975, Preliminary Surface Materials Map of Annandale quadrangle, Virginia: U.S. Geol. Survey Open File Report 75-255.

Figure 6 - Table of Selected Engineering Properties

The engineering properties for the table were taken primarily from a report submitted to the Washington Metropolitan Area Transit Authority (Mueser and others, 1970). The purpose of the report was to summarize engineering properties of different geologic units encountered in construction of the Metro system.

While the properties listed in the table serve as a guide to the anticipated range in engineering properties in the Franconia area, detailed engineering studies of the site are required for design purposes.

Reference

Mueser and others, Final Report, Subsurface Investigation, I-66 Route, Table 8, "Soil Properties for Design," November, 1970; report submitted to Washington Area Transit Authority.

Figure 7 - Sequences Map

The map showing major Sequences (Fig. 7) is obtained by combining the Surface Materials map with selected drill hole data. This map shows relevant subsurface, third-dimensional information to a depth of 50 feet (15 m) in areas blanketed by soils and the underlying upland gravel deposits or concealed by debris filling abandoned gravel pits. If the entire Upland gravel deposit could be peeled from the underlying materials, the exposed distribution of saprolite, Potomac Group sand (Kps) and clay (Kpc) would appear as shown on the Sequences map. By using the column in the engineering table relating to bearing strength, a general assessment of the confined foundation conditions for materials concealed beneath the Upland gravel is possible. Site specific information, of course, would require engineering studies at a much more detailed scale.

Figure 8 - Slope Stability Map

The Slope Stability map shows the areal distribution of materials of different relative natural and cut slope stabilities in four categories: (1) high stability, (2) moderately high stability, (3) moderately low stability, and (4) low stability. The relative stability in the Franconia area is determined by combining the Landforms map with the Surface Materials map, based on the assumption that different materials are stable on different slopes. These relative categories relate to the probability of future problems both in natural slope and in man-made cuts parallel to the natural slope. Site-specific information requires engineering studies at a much more detailed scale.

Area of high stability are generally level or gently sloping regardless of the type of underlying material, or moderate slopes underlain by strong material such as bedrock.

Areas of moderately high stability generally include clays on gentle slopes, sands on moderate slopes, and saprolite and rock on very steep slopes. Failures in the bedrock would be in the forms of rockfalls, and failures in the saprolite would probably be controlled by joints or foliation. Failures in clays and sands would probably occur as local slumps or creep, except where gentle slopes are over-steepened by construction.

Areas of moderately low stability are either sands or steep slopes or clays on moderate slopes. Naturally occuring slumps and progressive failure by creep are commonplace in areas in this category.

Areas of low stability are where clay occurs on steep slopes. Naturally occurring slumps over a very significant part of this area, of the order of 20 percent or more, and many are of recent origin. The great majority of the slides are shallow, perhaps not greater than five to ten feet deep, and are of limited areal extent. Almost all of the slopes in this category appear to be affected by creep, as evidenced by the tilting of large trees.

Even though the slides in clay initially are often shallow and of limited areal extent, they can eventually enlarge and destroy or cause serious damage to homes. Existing slides near home sites should be stabilized to prevent the possibility of growth of the slide.

Stabilization of creep and slides on clay slopes can be achieved in some cases by installing drainage systems, providing that groundwater is drained by the system, but many areas are such that internal drainage is ineffective. Retaining walls can be used with good results on short steep slopes, but normally are ineffective or are not cost effective for stabilizing steep slopes longer than 100 feet.

Slides can also be stabilized by loading the toe or unloading the head, but in densely urbanized areas adequate space for these measures may not be available.

Another problem due to the impermeable nature of the clays is slumping that can occur years after construction is completed. This problem of delayed failure occurs most often in areas of thick, non-fissured clay strata that contain few permeable sand lenses. When cuts are made in these clays, they tend to swell and weaken, but the rate of weakening is very slow because of the impermeability.