DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Open File 79-1221
(Table 3A of 3B)

TABLE 3. Physical Properties and Engineering Characteristics of Weathered Materials of Igneous and Metamorphic Bedrock, Fairfax County, Virginia

A. Derived from igneous or slightly metamorphosed igneous rocks. (Typically has massive, jointed saprolite, and blocky to rounded core-stones at saprolite/weathered rock contact.)

Surface Materials Map Unit	Surface Materials Map Symbol	Bedrock Map Symbol	Parent Bedrock and Structure	Weathering Profile	Unified Soil Classification of Saprolite and B-Horizon 1/	Total Unit Weight (kilograms force per cubic meter)	Drainage and Natural Moisture Characteristics		Suitability as Compacted Material	Excavation Properties	Erodibility	Shear Strength and Compressibility Characteristics	Allowable Bearing Pressure (kilograms force per square centimeter)	Slope Stability	Road Performance Characteristics
							Surface Drainage	Internal Drainage and Natural Moisture							
Ultramafic	7g	H	Serpentinite, including altered peridotite, pyroxenite, dunite, gabbro; may locally include small bodies of gabbro and other rocks. Massive to locally foliated and tightly folded. Commonly sheared near contact with other rock bodies and along fold limbs, with shear zones at least 1 cm thick containing talc schist of soft to medium consistency. Shear zones possibly much thicker. Joints common, forming 3m thick blocks where massive and 1 cm thick plates where foliated.	Commonly forms very thin, highly plastic clays within upper 0.7 m of ground surface, underlain by weathered rock or by unweathered rock. Transition from clay to unweathered rock is typically very abrupt. Depth to unweathered rock varies from 0-2.7 m, averaging 1 m.	Commonly CH within uppermost 0.7 m.	1700 and higher, generally increasing with depth to unweathered rock.	Water commonly found at surface after rainy season, because of very low permeability of highly plastic clays and shallow or outcropping bedrock.	After rainy season, perched water commonly above unweathered rock. Permeability very low in B-horizon, and generally low in weathered material beneath.	Commonly unsuitable because of plastic clays.	Highly plastic soils and platy weathered rock can generally be excavated with light to moderate power equipment.	Low susceptibility.	Medium to stronger consistency, generally increasing with depth. Shear zones with talc schist may be of soft to medium consistency near ground surface, and highly compressible. Effective friction angle of shear zones probably on the order of 20 degrees.	Commonly 1 to 2 for spread footings embedded to shallow depths into saprolite. Should investigate for weak shear zones and swelling soils. Unweathered bedrock capableof carrying very large loads very near ground surface.	Temporary vertical excavations in saprolite commonly stable to depths at least 2 m, but in small ultramafic bodies and along margins of large bodies weak shear zones and foliated plates make cuts unstable at unpredictable locations. Permanent long slopes rarely unstable at angles less than 27 to 30 degrees in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on presence of defects such as joints and shear zones cutting through rock. Unweathered rock commonly stable at much higher angles.	Highly plastic clays can retain water, weakening the subgrade. Road performance generally poor.
Mafic	7h	G	Metamorphosed igneous rocks, commonly known as "greenstone"; include epidote-chlorite schist, amphibolite, chlorite- actinolite-talc schist, metagabbro, metadiorite, and others. Map unit tends to be massive in interior, and foliated at margins. Typically massive in interior but also banded to foliated, locally with many fractures and joints at different orientations, locally fissile, splitting along 0.1-5 cm thick planes. Locally tightly folded.	On massive rocks in interior of map unit, a very plastic B-horizon commonly 0.7-1.3 m deep on hilltops. Depth to unweathered rock typically very close to base of B-horizon, averaging 1-1.3 m. In foliated rock weathering much deeper, and soils much less plastic, typically slightly micaceous clayey silts; depth to unweathered rock ranges from 0-25 m, averaging about 5 m. Saprolite/weathered rock contact may be very irregular in foliated rocks.	B-horizon: CH, MH-CH, MH saprolite: MH, ML, SM	1300 and higher, lowest in saprolite immediately beneath B-horizon, increasing with depth from saprolite to unweathered rock.	Variable, depending on parent bedrock. Generally good above foliated rocks, and fair to poor above massive rocks.	Weathered material above foliated rocks generally well drained and has low to medium permeability; natural moisture content of saprolite normally less than plastic limit. Above massive rocks, B-horizon commonly very wet after rainy season, drains slowly and has very low permeability; saprolite permeability generally low but higher than B-horizon, with water commonly at shallow depth because of proximity of unweathered rock.	Above foliated rocks, generally fair to good source, but compaction can be sensitive to moisture content. Above massive rocks, commonly unsuitable or poor source of fill because of highly plastic clays or thinness of saprolite.	Where present, saprolite can be excavated with light power equipment to depths of at least 2-3m. Weathered rock requires blasting where massive; where foliated, heavy power equipment possibly suitable for excavation of some weathered rock, but excavation becomes increasingly difficult with increasing depth.	Highly plastic materials and saprolite above massive rocks generally of low susceptibility; above foliated rocks susceptibility much greater, especially where clay content is low and where remolded.	Weathered materials above massive bedrock have properties similar to unit Diabase (below) except saprolite above massive bedrock does not extend to such great depths, and materials are generally stronger and less compressible. Weathered materials above foliated bedrock have properties closely resembling unit Phyllite, and unit Gneiss, Schist, and Metagraywacke.	Commonly 1 to 2 for spread footing embedded shallow depths into saprolite. Allowable bearing load generally increases with increasing depth but possibility of desiccated clay-rich soils above weaker saprolite should be investigated. Should investigate for possibility of shrink-swell problems at depths less than 1.7 m.	Temporary vertical excavations in saprolite commonly stable to depths of at least 2 m, but presence of parting planes and shear zones makes cuts unstable at unpredictable location. Permanent long slopes rarely unstable at angles less than 27 to 30 degrees in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on presence of defects such as joints and shear zones cutting through rocks. Unweathered rock commonly stable at much higher angles.	Highly plastic clays in B-horizon can retain water, weakening the subgrade. Micaceous and silty soils are common and are susceptible to frost heaving and softening; clayey, micaceous, silty soils may be difficult to stabilize with cement, but micaceous silts of low plasticity should be easily stabilized. Road performance generally poor unless design consideration given to frost susceptibility of micaceous silty soils.
Granitoid Rocks	7i	F	Includes granite, adamellite, aplite, pegmatite, tonalite, and granodiorite. Massive to foliated along margins of igneous bodies, where highly foliated schist can be vertically oriented in layers up to 1 m wide. Joints typically 1 m or wider away from margins, with many steeply inclined; has prominent subhorizontal sets. Has numerous quartz pods and lenses.	B-horizon varies from clay-rich sandy soil, as much as 1.3 m thick on hilltops, to silty sand with some clay. Saprolite is typically a silty sand with some clay, sometimes highly micaceous, and sometimes predominantly clay. Saprolite may extend to depth of 20 m on hilltops away from major streams. Saprolite sometimes with 1-2.5 cm thick high angle dikes weathered to highly plastic clay, much weaker than surrounding saprolite or weathered rock. Thickness of weathered rock relatively uniform except where foliated rocks and dikes are encountered.	B-horizon: MH-CH, CL, SM, SC, SM. saprolite: SC, SM, (ML, MH)	1600 and higher, lowest in saprolite beneath B-horizon typically increasing gradually with depth from saprolite to unweathered rock.	Water commonly found at surface above clay-rich B-horizon after rainy season.	Permeability of very clay-rich B-horizon is very low. Permeability of saprolite is much higher, but commonly low because of small amount of clay present throughout saprolite. Natural moisture content of saprolite commonly approaches or exceeds plastic limit; most saprolite is readily dried and wetted.	Generally good source, but compaction of highly micaceous or silty saprolite can be very sensitive to moisture content.	On hilltops, saprolite can be excavated with light power equipment to depths of at least 2-3m. Generally increasingly difficult with increasing depth, but transition commonly gradual. Occassional quartz veins and pods throughout weathering profile may require blasting.	B-horizon: typically of low susceptibility, except where clay content is very low. Saprolite: typically of low to moderate susceptibility, but may be high where silty and micaceous, and where remolded.	B-horizon stiff or stronger; saprolite medium to stiff and typically increasing with depth to unweathered rock. Aplite dikes with fine-grained soil can have strengths much lower than those of surrounding rock. Effective peak friction angle of saprolite commonly 25 degrees to 35 degrees; residual effective friction angle probably 25 degrees or higher, except for fine-grained aplite dikes. Preconsolidation stress slightly exceeds overburden load near ground surface. Saprolite in virgin portion of consolidation curve generally much less compressible than for the unit Diabase and the unit Gneiss, Schist, and Metagraywacke, because granite saprolite is typically more coarse grained.	Commonly 1 to 2 for spread footings embedded to shallow depths. Allowable load generally gradually increases with depth. Should consider investigation for weak, highly plastic dikes.	Temporary vertical excavations in saprolite commonly stable to depths of at least 2 m, but presence of parting planes, shear zones, and aplite dikes makes cuts unstable at unpredictable locations. Permanent long slopes rarely unstable at angles less than 27 to 30 degrees in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on presence of defects such as joints and shear zones cutting through rock. Unweathered rock commonly stable at much higher angles.	Clays in B-horizon can retain water, weakening the subgrade. Saprolite is generally clayey and silty sand, somewhat susceptible to frost heaving and softening; micaceous silty soils very susceptible to adverse frost actions, and should be easily stabilized with cement.
Diabase	7j	J	Intrusive dikes and sills, finely crystalline at margins and coarser in interior; local pegmatite, gabbro, and norite. Joints usually near-vertical, with some subhorizontal joints near surface. Vertical joints commonly 1-3 m apart, can be cms apart near contacts with other rock bodies. Thin dikes may be shattered throughout, with fractures only a few cms apart at random orientations.	B-horizon highly plastic, montmorillonite-rich, sometimes as much as 1.3 m thick, and may be soft where wet. Clayey sand saprolite generally about 1.3 m thick, sometimes extending to depth of 3-8 m. Core-stones of highly variable dimensions encountered throughout profile, but generally increasing in size with increasing depth. Core-stones can be completely surrounded by much weaker saprolite, of consistency from medium and stronger. Weathered rock zone normally varies between 1.3-5 m. Total depth of weathering rarely greater than 10 m, and is deepest over shattered rock. Average depth of weathering about 3 m. Joints in saprolite commonly cemented, but may be coated with montmorillonite clay, washed in from above. Depth to unweathered rock typically highly variable. Boulders often found at ground surface.	B-horizon: CH, MH-CH, CL saprolite: MH, ML, SM-SC, SC	1200 and higher, lowest in saprolite beneath B-horizon. Commonly increases somewhat erratically with increasing depth, from saprolite to unweathered rock; high density values represent remnants of core-stones.	Water commonly found at surface after rainy season, because of highly plastic clays in B-horizon.	Permeability of B-horizon is very low. Permeability of saprolite is much higher than B-horizon, but commonly low because of clay usually present throughout saprolite. Natural moisture content of saprolite highly variable but commonly exceeds plastic limit; most saprolite is readily dried and wetted.	B-horizon commonly unsuitable because of highly plastic clays. Compaction of silty saprolite is sensitive to moisture content. Sandy and grus-like saprolite generally very good as fill material.	B-horizon and saprolite can be excavated with light power equipment, commonly to depths exceeding 3-5m; however, rounded boulders as much as 0.7-1m in diameter commonly encountered at random elevations, completely surrounded by saprolite. Partly weathered rock must be blasted.	B-horizon: typically of low susceptibility. Saprolite: low plasticity silts highly susceptible, especially where remolded; susceptibility decreases with increasing clay content.	B-horizon medium or stronger where dry, but commonly of soft to medium consistency where wet. Fine-grained saprolite may be of medium consistency at depths of as much as 7 m. Strength can be erratic as function of depth, because of core-stones. Effective peak friction angle of saprolite probably 25 degrees or greater; clay-coated joints probably have much smaller effective friction angles. Preconsolidation stress of saprolite commonly as low as 1-2 kgf/cm^2; low preconsolidation values present at depths of as much as 7m; silty saprolite can be extremely compressible in virgin portion of consolidation curve.	Commonly 1 to 2 for spread footings embedded to shallow depths. Allowable load generally gradually increases with depth. Highly plastic B-horizon soils can cause shrink-swell problems. Should investigate for possibility of related problems to depths of 1.7 m.	Temporary vertical excavations in saprolite commonly stable to depths of at least 2 m, but presence of clay-coated joints makes cuts unstable at unpredictable locations. Permanent long slopes rarely unstable at angles less than 27 to 30 degrees in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on presence of defects such as joints and cutting through rock. Unweathered rock commonly stable at much higher angles.	Same as for Mafic Rocks.
Quartz Bodies (Large quartz bodies are shown on the map "Preliminary Bedrock Map of Fairfax County, Va.", Drake and Froelich, 1977.)	Not applicable	K	Veins, dikes, and pods filling fractures in weaker Schist, Gneiss, Phyllite, and Granitic Rocks. Small quartz bodies as much as 0.7 m thick commonly shattered to small fragments, whereas larger bodies commonly have well defined joint sets spaced from 0.7 m to much further apart.	Quartz does not weather sufficiently to develop a weathering profile, and fresh blocks commonly occur at the surface. Large quartz boulders commonly present at the surface. Large quartz bodies commonly occur as the cores of linear hills.											

1 Soils in parentheses are present in secondary amounts.