Map Unit Properties Table: Fredericksburg and Spotsylvania County Battlefields Memorial National Military Park

Gray-shaded rows indicate map units in the accompanying GIS data but not mapped within the park.

Age	Map Unit (Symbol)	Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Mineral Resources	Habitat	Recreation	Geologic Significance
QUATERNARY - RECENT	Artificial fill (**af**)	Mostly sand and gravel materials of varying thickness. Local to construction areas such as highways, bridges, roads, dams, and other facilities.	Low	Material is used in development projects	Prone to rockfall, slumps, slides, and other mass wasting if positioned on steep slopes, or undercut by additional construction or natural erosion	Same as source material	May be useful to land-use evolution studies	Same as source material	Habitat for opportunistic plants and animals, including invasive plants along roadways	Used at recreation areas and along roadways	Eventual use for land-use evolution studies
QUATERNARY - HOLOCENE	Sand (**Qs**) Swamp deposits (**Qsw**)	**Qs**—pale gray to light yellowish gray, fine to coarse grained, poorly to well sorted sand, 2–8 m (7–26 ft) thick. Present as low natural levees along the primary channel of the tidal Rappahannock River. Some beaches, sand bars, spits, and deltas developed along tributaries. **Qsw**—mud, muddy sand, muck, and organic material; brownish gray to grayish black color, depending on the amount of decaying material; less than 3 m (10 ft) thick. Typically overlies alluvium.	Very low to low	Unsuitable for most development due to presence of marshy wetlands and saturated, unconsolidated sediments	Prone to erosion and flooding	None documented	May contain historic artifacts and battleground relics	Heavy minerals, peat, and sand	Modern riparian habitat with wetland species. Modern shell fragments and mollusk valves locally present. Leaf, stem material, tree trunks, and pollen.	Unsuitable for most trails and other recreation due to water saturation and proximity to delicate wetland areas	Natural levees. Riparian zone along Rappahannock River is vital natural buffer.
HOLOCENE - PLEISTOCENE	Alluvium (**Qal**)	Fine to coarse gravelly sand, sandy gravel, silt, and clay; mostly medium gray and yellowish gray; grains of vein quartz, quartzite, and other metamorphic rocks; maximum thickness 15 m (49 ft). Present as channel, point-bar, terrace, and floodplain deposits; grades into colluvium along steep slopes	Low	Unsuitable for most development due to presence of saturated, unconsolidated sediments in floodplain areas	Prone to mass wasting. Flood hazard associated with this unit.	None documented	May contain historic artifacts and battleground relics	Metamorphic and other heavy minerals, clay, silt, gravel, sand, and quartzite pebbles	Riverine and floodplain habitats, modern/recent plant debris	Suitable for some stream edge recreation if not regularly flooded	Records Pleistocene to Holocene transition along valley walls
PLEISTOCENE	Tabb Formation, undivided (**Qtu**) Alluvial terrace deposits, undivided (**Qatu**) Shirley Formation, unit 1 (**Qsh**) Chuckatuck Formation (**Qc**) Charles City Formation (**Qcc**)	**Qtu**—sand, gravel, silt, and clay, underlying low terraces along the area's larger rivers **Qatu**—fine- to coarse-grained gravelly sand, sandy gravel, silt and clay lenses in surficial deposits along rivers and tributaries **Qsh**—coarse sand, interbedded with pebbly and bouldery layers, with some light to medium grayish yellow silty fine sand and pinkish sandy silt; 10–20 m (33–66 ft) thick **Qc**—cross-bedded gravelly sand, sandy silt, and light to medium yellowish gray clay; 5–15 m (16–49 ft) thick. Sediments often weather reddish brown. Present in surficial deposits of mid-level estuarine terraces. **Qcc**—fining upward sequences of basal coarse gravelly sand to moderately sorted medium to fine sand, silt, and clay; oxidizes to a brownish color; maximum thickness 18 m (59 ft). Present along high-level terraces.	Low to moderately low for gravel-rich layers	Suitable for most development unless highly permeable and porous. Avoid steep margins of terraces, which may be undercut by rivers.	Prone to mass wasting, especially where steep slopes near waterways are present. Slumping of large blocks is possible.	Coral (*Astrangia*), peat, organic matter, pollen, and trace fossils (i.e., invertebrate burrows)	Cap rock (high ground in the area). Strategic points during battles.	Heavy minerals, gravel, boulders, sand, silt, and clay. Borrow pits along Rappahannock River.	High-level terraces may provide habitat for burrowing animals.	Suitable for most recreation unless undercut or near a cliff face or steep slope	Correlative throughout the region. **Qsh** contains dateable U-Th coral (184±20 ka).
PLEISTOCENE AND (OR) PLIOCENE	Terrace deposits (**QTt**)	Well-bedded, gently sloping deposits of gravel, sand, silt, and clay along large rivers; <1 to 3 m (3.3 to 10 ft) thick and 60 m (197 ft) wide. Present above modern floodplain.	Low	Avoid for most development due to location along rivers and steep valley slopes	Prone to sliding especially if water saturated along valley slopes	None documented	None documented	Greenstone, vein quartz, quartzite, phyllite, hornfels, and diabase cobbles, heavy minerals, gravel, pebbles, sand, silt, and clay	Habitat along major rivers	Good for most recreation unless undercut or water saturated	Records river migration along major waterways during sea-level highstands

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PLEISTOCENE AND PLIOCENE	Colluvium (**QTc**) Windsor Formation (**QTw**) Windsor Formation and (or) Moorings Unit of Oaks and Coch (1973) (**QTmw**)	**QTc**—gravel, sand, and silt, interbedded in lenticular deposits on slopes; clasts are typically subangular and occur in a yellowish-orange to greenish-gray silty sand and clayey silt matrix; up to 6 m (20 ft) thick **QTw**—fine to coarse sand, gravel, silt, and clay in yellowish brown to reddish colored matrix; up to 12 m (39 ft) thick in upper Rappahannock area. Present on terraces. **QTmw**—sand and gravel on high-level terraces	Low to moderately low for gravel- and clast-rich layers	Heterogeneous nature of unit may prove unstable on slopes and when undercut or water saturated.	Prone to mass wasting (e.g., rockfall)	Pleistocene-Pliocene estuarine floral and faunal remains	Chert within units may have been used for early tool material	Greenstone, quartzite, vein quartz, schist, chert and phyllite clasts, and amygdaloidal basalt, diabase, and gneiss cobbles, heavy minerals, sand, silt.	High-level terraces may provide habitat for burrowing animals.	Good for most recreation unless undercut or water saturated	Records migration of Mattaponi River. **QTw** is correlative throughout the region.
TERTIARY - PLIOCENE	Moorings Unit of Oaks and Coch (1973) (**Tm**) Bacons Castle Formation (**Tb**) Sand and gravel (**Tps**) Yorktown Formation (**Ty**)	**Tm**—white, light gray, and grayish yellow quartzose sand and sandy gravel, with clasts of well-rounded pebbles, cobbles, and boulders; 3 to 9 m (10 to 30 ft) thick. Occurs as surficial deposits in high-level terraces along the Rappahannock River. **Tb**—yellowish orange in outcrop; fining upward sequence composed of two primary sediment types: the lower 3 to 6 m (10 to 20 ft) contains medium to coarse gravelly sand and sandy gravel, poorly sorted, with thick cross-beds; upper beds contain gray to pink, poorly sorted, sandy and clayey silt and silt clay, interbedded with fine sand, sandy silt, and clay; as much as 18 m (59 ft) thick. **Tps**—yellowish to brownish gravelly sand, sandy gravel, and fine to coarse grained sand; some clay and silt lenses occur in trough cross-bedded layers; up to 18 m (59 ft) thick. Caps drainage divides. **Ty**—yellowish to orangish gray, fine to coarse grained, poorly to well-sorted quartz and feldspar sands and gravels in planar and cross-bedded, thin to thick beds; some clay and silt occurs as matrix material; 3 m (10 ft) to as much as 25 m (82 ft) thick with several fining upward sequences	Low to moderately low for coarser grained beds	High permeability of units may prove unsuitable for waste-treatment facility development. Heterogeneity of layers may render them unstable along slopes, especially if undercut.	Prone to rockfalls from high-level terraces along the Rappahannock River. Mass movements are likely for units when water saturated.	Trace fossils (*Ophiomorpha nodosa*)	Chert within units may have been used for early tool material. Iron-oxide cements may have been mined in colonial period as "bog iron."	Chert, weathered basalt, metamorphic rock pebbles, ilmenite, and magnetite grains, heavy minerals, gravel, sand, silt, clay, pebbles, and cobbles	High-level terraces may provide habitat for burrowing animals. Present as cliffs along waterways.	Good for most recreation unless undercut or water saturated	Overlapping terraces record migration of several rivers channels. Record Pliocene depositional environments that are correlative throughout the region.
TERITARY - MIOCENE	Sand and gravel (**Tms**) Calvert Formation, undivided (**Tc**)	**Tms**—yellowish orange and brown, fine to coarse gravelly sand, sandy gravel, silt, and kaolinitic clay in beds as much as 10 m (33 ft)thick. Occurs on higher topography throughout the region **Tc**—mostly fine to very fine quartzose sand with some silt and clay layers; thickly bedded, with mappable sand-silt-clay sequences; appears light gray to white, pinkish gray and pale yellowish orange in outcrop. Members of this unit include (from bottom to top): Fairhaven (**Tcf**), Plum Point Marl (**Tcp**), and Calvert Beach (**Tcc**).	Moderately low	Suitable for most development. Avoid pebbly layers for waste-treatment facilities. Avoid expandable clay-rich layers for road and trail development. Avoid **Tc** during construction; it is rich in disseminated pyrite and other iron-sulfide minerals, and quickly produce acid drainage when exposed.	Massive bedding may be prone to large block slides when unit is undercut along rivers and gullies.	Diatoms (including *Rhaphoneis diamantella*), fish teeth, scales, shell fragments, lignitized wood, marine vertebrate bones, silicoflagellates, and dinocysts	Kaolinite may have been used for painting and dyes.	Kaolinite, quartzite, and crystalline etched pebbles, heavy minerals, gravel, sand, kaolinitic clay (diatomaceous and expandable), pebbles (including phosphate), and cobbles	Support ridge-top forests	Good for most recreation	Record Miocene marine depositional environments

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TERTIARY - EOCENE	Nanjemoy Formation, undivided (**Tn**)	Yellowish brown (weathered) to dark olive gray, greenish gray, and olive black glauconitic quartz sand; also fine to coarse, clayey and silty, micaceous and shelly interbeds of silty and sandy clay; lowermost beds are the highly glauconitic Potapaco Member (**Tnp**); upper Woodstock Member (**Tnw**) beds are more micaceous; **up** to 64 m (210 ft) thick	Low	Generally suitable for most forms of development, but locally rich in disseminated pyrite and other iron-sulfide minerals, which quickly produces acid drainage when exposed during construction. Iron-rich nature of sediment generally produces poor groundwater quality.	Glauconite-cemented sand may slide off slopes in large blocks or sheets, especially if water saturated	Trace fossils (bioturbation), shell fragments, and mollusks including *Venericardia poapacoensis, Venericardia ascia, Macrocallista sumimpressa, Corbula aldrichi, Lucina dartoni, Lunatia* sp., and *Cadulus* sp.	Iron sulfide concretions may have provided fire making materials.	Iron sulfide nodules, sand, gravel, silt, clay, and glauconite	None documented	Suitable for most forms of recreation	Records Eocene marine depositional environments
TERTIARY - PALEOCENE	Aquia Formation (**Ta**)	Nearly massive glauconitic quartz sand; thickly bedded, fine to medium sands are interlayered with some clay and silt rich beds, as well as lenses of sandy and shelly limestone; **up to** 35 m (115 ft) thick. Fresh surfaces are dark olive gray and greenish black, whereas weathered exposures are yellowish gray to orange.	Low	Supports an important freshwater aquifer. Suitable for most development unless highly permeable layers are present, or significant heterogeneity exists locally, which may cause unit to be unstable.	Glauconite-cemented sand may slide off slopes in large blocks or sheets, especially if water saturated or undercut along a poorly consolidated shelly layer.	Mollusks (*Cucullaea gigantea, Ostrea alepidota, Crassatellites* sp., and *Dosiniopsis* sp), ophiomorpha-type burrows, gastropod (*Turitella mortoni*), bivalves (*Ostrea sinuosa, Crassatellites alaeformis,* and *Cucullaea* sp.), foraminifera, dinocysts, nannofossils, and pollen	Stone wall along Sunken Road	Sand, glauconite, silt, and clay	Poor cementation may provide burrowing habitat.	Suitable for most forms of recreation	Records marine to terrestrial depositional environment during the Tertiary-Quaternary transition (Thanetian age)
CRETACEOUS	Potomac Formation (**Kp**)	Composed of three main sediment types: (1) fine to coarse feldspathic quartz sand and sandstone, thickly bedded, with some trough cross-beds, in a poorly sorted clay-silt matrix; conglomerate beds present locally; (2) greenish gray to reddish brown silt and sandy clay, clayey silt, and clayey fine sand; some illite and smectite clay-silt plugs are present locally; (3) dark yellowish brown to olive gray lignitic sandy silt, clay, and silty fine sand and sandstone. Thickness <1 m (3.3 ft) to the west, to more than 500 m (1,640 ft) in the subsurface in the eastern part of the region.	Low to moderately low for conglomerate layers	Supports an important freshwater aquifer in sandy layers. Generally suitable for most development, but variations in bedding, sediment, and degree of cementation may render unit unstable on slopes.	Susceptible to slumps and slides. Clay-rich, massive bedded layers may spall in large blocks when unit is exposed on slopes.	Plant stems; silicified coniferous tree trunks; leaf and stem impressions of ferns, cycads, and other gymnosperms; pollen. Barremian?, Aptian, and Albian pollen and leaves	May preserve ancient campsites and relics	Vein quartz, quartzite, illite, smectite clays, sand, gravel, metamorphic rock cobbles and pebbles, silt, boulders (some >1 m [3.3 ft] in diameter)	Supports eastern hardwood forests throughout region	Suitable for most forms of recreation unless present in bluffs along major waterways	Very widespread unit. Records Cretaceous environment along the Atlantic coast.
JURASSIC	Diabase and diabase dikes (**Jd**) Diabase, low-titanium (**Jdql**) Diabase, high-titanium (**Jdqh**) Diabase, late-stage granophyric differentiates (**Jdqhg**)	Crystalline, fine- to medium-grained, dark gray to black diabase rocks; textures are generally intergranular to ophitic; primary minerals include bytownite-augite feldspar, minor biotite, with rare fayalitic olivine. Occur as narrow dikes with chilled aphanitic margins. **Jdql** and **Jdqh**—light to dark gray, crystalline to porphyritic diabase **Jdqhg**—sodic plagioclase, K-feldspar, quartz, and other minerals in small diabase pods	High	Suitable for most development unless highly fractured or weathered (friable). Require blasting for excavation.	Rockfall potential if exposed on slope	None	None documented	Sodium plagioclase, potassium feldspar, quartz, hornblende, biotite, pyroxene, calcic plagioclase, gabbro, granophyre, syenite, aplite, and olivine. Crystalline rocks may provide building material and crushed fill material for construction	May support localized plant species	Suitable for most recreation unless exposed on a slope	Represents Jurassic volcanic activity accompanying Mesozoic extension throughout the region. Radiometric age dates.

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TRIASSIC	Mountain Run Member of the Tibbstown Formation (**TRtmr**) Balls Bluff Siltstone, lacustrine member (**TRbl**) Balls Bluff Siltstone, fluvial member (**TRbf**) Manassas Sandstone, upper unnamed member (**TRmu**) Manassas Sandstone, Rapidan Member (**TRmr**) Hornfels, metagraywacke and metaconglomerate (**TRtm**)	**TRtmr**—conglomerate containing pebble- to boulder-sized greenstones, interbedded with pebbly sandstone and upward-fining sequences; as much as 640 m (2,100 ft) thick. Lower portions contain metavolcanic rocks in a red to pale green clayey sandstone and siltstone matrix. **TRbl** and **TRmu**—siltstone, mudstone, and shale, interbedded as fining-upward sequences. Color varies from reddish brown to dark gray to black and light purple. Mudstone is massive to laminated. **TRbl** is more than 1,000 m (3,280 ft) thick. **TRfl** is 100 to 200 m (328 to 656 ft) thick. **Trmr**—greenish gray to reddish arenitic sandstone, pebbly sandstone, siltstone, and minor shale, in fining-upward sequences. Lower beds consist of conglomerates containing rounded boulders, cobbles, and pebbles of metabasalt and other Piedmont rocks. **TRtm**—dark gray to bluish mauve, fine to coarse grained metasedimentary rocks present as contact aureoles around Jurassic diabase intrusions. Hornfels contains cordierite, epidote, and chlorite in a cooling-outward assemblage. Aureole is 60 to 120 m (197 to 393 ft) thick.	Moderate to moderately high for metamorphic rocks	Suitable for most development unless highly heterogeneous layers are present, or beds are heavily fractured. Avoid areas with high friability (due to weathering of carbonate cements). Swelling clays are locally abundant.	Large boulders and cobbles in **TRtmr** are susceptible to rockfall and mass wasting when exposed on slopes and undercut by local rivers. Clay- and shale-rich layers are susceptible to slumping and sliding, especially when water saturated.	Triassic palynomorphs; **TRbl** contains sporomorphs, root tubes, dinosaur and reptile trackways, stromatolitic limestone, shelly fossils, and paleosols.	Nodules of sulfides may have provided useful materials.	Greenstone pebbles, vein quartz clasts, caliche (carbonate nodules), chlorite, epidote, fragments of quartzite, meta-arkose, marble, and phyllitic schist. Hornfels (cordierite, chlorite, and epidote). Sulfides (iron, copper, zinc, and lead). Hard rock for building materials. Attractive red stones for crushed aggregate and dimension stone.	Support eastern hardwood forests	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Type sections of the Mountain Run Member of the Tibbstown Formation and the Rapidan Member of the Manassas Formation. Manassas Sandstone records fluvial environment following Alleghanian Orogeny.
CARBONIFEROUS	Falmouth Intrusive Suite (**PMfi**)	Masses of fine-grained monzogranite and pegmatitic (coarse-grained) granite, fine-grained granodiorite, and tonalite locally	High	Suitable for most development unless highly weathered or fractured	Susceptible to rockfall if exposed on slope	None	Large crystals may have provided trade material.	Tonalite and coarsely crystalline pegmatite. Attractive building stone material	None documented	May be friable, and unsuitable for climbing. Also may prove to be an unstable base for trails and other visitor facilities if highly weathered.	Dateable material
SILURIAN	Falls Run Granite (**Sf**)	Pale pink to nearly white hornblende and biotite granite gneiss. Composition ranges from monzogranite to granite and is strongly foliated.	High	Suitable for most development unless highly weathered or fractured. Avoid areas of intense preferential compositional weathering (along foliation).	Susceptible to rockfall if exposed on slope	None	None documented	Hornblende and plagioclase. Attractive building stone material	None documented	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Dateable material. Records deformation and metamorphic conditions.
ORDOVICIAN	Quantico Formation (**Oq**) Quantico Formation, quartzite (**Oqq**) Metasedimentary rocks, undivided (**Ou**) Metamonzogranite of Goldvein pluton (**Og**) Phyllite (**Op**) Phyllite with mylonitic rock (**Opm**)	**Oq**—dark gray phyllite and fine- to medium-grained staurolite schist and biotite-muscovite schist. Some calc-silicate interbeds and quartzite lenses present locally. **Ou**—green silty phyllite and gray to white metasiltstone and fine-grained quartzite, fine-grained mica schist, green slate and phyllite with scant quartzite and metagraywacke layers. **Og**—coarse- to medium-grained, mesocratic, foliated metamonzogranite. Green phyllites (Op) may be highly sheared locally to mylonitic textures (**Opm**).	Moderate for highly deformed layers, high for undeformed units	Heterogeneity of units may render them unstable locally for foundation, road, and facilities development.	Susceptible to spalling, rockfall, and other forms of mass wasting if undercut on slopes	None	Mineral inclusions may have provided trade material	Staurolite, garnets, kyanite, quartzite lenses, and altered pink and green feldspar grains. Attractive building stone material (e.g., slate and granite)	Support large tracts of eastern hardwood forests	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Accreted terranes within the Piedmont province

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ORDOVICIAN AND (OR) CAMBRIAN	True Blue Formation (**Oct**) True Blue Formation, Everona Limestone Member (**OCte**) Mine-Run Complex, Melange Zone IV (**OCmIV**) Mine-Run Complex, Melange Zone IV, metasedimentary (**OCmIVq**) Mine-Run Complex, Melange Zone IV, metavolcanics (**OCmIVv**) Mine-Run Complex, Melange Zone III (**OCmIII**) Mine-Run Complex, Melange Zone II (**OCmII**) Mine-Run Complex, Melange Zone I (**OCmI**) Lunga Reservoir Formation (**OCl**) Trondhjemite of the Horsepen Run pluton (**OCtj**) Plagiogranite of the Richland Run pluton (**OCpg**)	**Oct**—calcareous and noncalcareous slate, siltstone, and some argillite; contains bodies of **OCte** as blue gray, fine-grained, metalimestone, which is about 160 m (525 ft) thick. **OCm**—contains four (I–IV) thrust slices of block-in-phyllite mélange. Rocks are gray to green. Zones are commonly phyllite, metasandstone and metasiltstone with some metavolcanic and phyllitic lenticular bodies. Zone III contains Proterozoic amphibolite, ultramafic rocks, biotite gneiss, granite gneiss, serpentinite, and foliated talc. Zones I and II contain Cambrian, felsic and mafic metavolcanic blocks. Mylonites are present locally. **OCl**—mélange consisting of nonstratified graywacke, surrounding blocks of greenstone and metamafic rocks. **OCtj**—granular, fine-grained, granophyric rock with intergrown albite and quartz. **OCpg**—plagiogranites and tonalites, present as metaintrusives, with intense deformation ranging from brittle cataclasis to ductile mylonitization.	Moderate for sedimentary and deformed rocks, high for crystalline intrusions	Suitable for most development unless calcareous layers are weathered, or the mylonites and cataclasites are highly deformed. Mafic rocks weather to clayey soils with high shrink-swell potential.	Contain large blocks separated by deformed zones of rock, which are susceptible to spalling and rockfall hazards on slopes. Carbonate minerals may weather preferentially, increasing the likelihood of failure and mass wasting. Clay (weathered rocks) layers may fail when water saturated.	Some marine fossil remnants possible in sedimentary units	Chert and ironstone may have provided material for tools.	Chert, ironstone, phyllite, mylonite, euhedral magnetite, talc, serpentinite, blue green amphibole, and garnets. Limestone, slate, chips and pebbles of gneiss and schist, and quartz boulders	Widespread and support many habitats	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Accreted, exotic terranes
CAMBRIAN	Chopawamsic Formation (**Cc**) Ta River Metamorphic Suite (**Ct**) Metasedimentary rocks, undivided (**Cm**)	**Cc**—lenses and tongues of metavolcanic and metasedimentary rocks including silicic, intermediate, and mafic varieties, with some breccia and tuff layers present locally. Metasedimentary rock types include schist, meta-arenite, and some gneiss. **Ct**—primarily dark gray to black, foliated amphibolitic gneisses. Some biotite rich areas present locally. **Cm**—mixture of tan, gray and light brown pebbly feldspathic quartzite, layered with purplish metasiltstone and phyllite. Quartzite is fine to coarse grained, with few preserved cross-beds, and deformed by slaty cleavage.	Moderate to high depending on degree of deformation	Foliation and variability of rock types may render the units unstable for heavy development. Mafic rocks weather to clayey soils with high shrink-swell potential.	Slaty cleavage and deformation between large blocks may cause them to be susceptible mass wasting on slopes, especially if undercut by erosion of weathered underlying units.	May contain traces of early life. Some metamorphosed burrows possible.	Caps ridges	Keratophyres, albitic plagioclase, prismatic amphibole, greenstones, pyroxene, biotite, pyrite, sphalerite, and chalcopyrite. Lead and zinc ores, gold, and massive sulfide deposits mined near Mineral, Virginia.	Widespread and support many kinds of habitat	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Accreted, exotic terranes

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CAMBRIAN (?)	Amphibole metagabbro (**Cg**) Felsic metavolcanic rocks (**Cvf**) Mafic metavolcanic rocks (**Cvm**) Altered tonalite and granodiorite granitoid blocks (**Ctg**)	**Cg**—massive, coarse to medium grained, and melanocratic. Some coarse-grained amphibole and epidote are abundant locally. **Cvf**—rare olistoliths **Cvm**—similar to **Cc** (described above) **Ctg**—igneous intrusions of intermediate compositions (tonalites and granodiorites). Feldpsar minerals are preferentially weathered in these blocks.	High unless weathered, then moderate	Suitable for most development unless local blocks or plagioclase groundmass are altered and weathered, rendering the unit friable. Mafic rocks weather to clayey soils with high shrink-swell potential.	Susceptible to spalling, rockfall, and other forms of mass wasting hazards	None	None documented	Olistoliths, coarse grained amphibole, epidote, and quartz	None documented	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Oceanic crust and volcanic-arc material, as part of accreted terranes
CAMBRIAN AND (OR) PROTEROZOIC	Blastomylonitic tonalite and granodiorite gneiss (**CZg**) Amphibolitic xenoliths (**CZa**) Ultramafic rocks (**CZu**) Serpentinite (**Czs**) Massive as well as foliated talc (**CZt**) Biotite gneiss (**CZbg**) Serpentinite and talc (**CZst**) Amphibolite and serpentinite (**CZas**) Amphibolite and talc (**CZat**) Serpentinite and mafic rock (**CZsm**)	Rock types include altered basalts, greenstones (serpentinite), and talc-rich layers. **CZa** contains muscovite-biotite granites. Present in pods and lenses locally throughout the western portions of the park area.	Moderate to high for crystalline blocks	Highly heterogeneous and typically heavily weathered, rendering units rather weak for heavy development. Mafic rocks weather to clayey soils with high shrink-swell potential.	Unstable on slopes. Prone to mass wasting.	Records Precambrian-Cambrian transition	None documented	Talc, serpentinite, amphibole, plagioclase, quartz, epidote, chlorite, and xenoliths	Support species that prefer high iron, magnesium, and calcium soils	Friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Accreted, exotic terranes
CAMBRIAN OR PROTEROZOIC	Holly Corner Gneiss (**CZh**) Garrisonville Mafic Complex (**CZgn**)	**CZh**—foliated hornblende and biotite rich gneiss, dark gray to black, fine to medium grained **CZgn**—fine to coarse grained, massive to foliated amphibolite and hornblendite. Some metapyroxenite, metawebsterite, and metanorite are present locally. Talc-amphibole schist is present near boundaries.	High to moderately low for talc-rich units	Not suitable for development. Typically weather to very clay-rich soils with very high shrink-swell potential. Avoid areas of intense preferential compositional weathering (along foliation).	May be susceptible to rockfall if exposed on slope. Talc and weathered areas may increase likelihood of sliding.	Records Precambrian-Cambrian transition	Mineral inclusions may have provided early trade material.	Andesine, quartz, epidote, diopside, amphibole, talc, and enstatite. Talc. Landscaping material. Attractive building stone.	None documented	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Accreted, exotic terranes

Gray-shaded rows indicate map units in the accompanying GIS data but not mapped within the park.

Age	Map Unit (Symbol)	Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Mineral Resources	Habitat	Recreation	Geologic Significance
PALEOZOIC AND (OR) PROTEROZOIC	Po River Metamorphic Suite, biotite gneiss and schist (**PZZp**) Po River Metamorphic Suite, quartzofeldspathic gneiss (**PZZpm**) Po River Metamorphic Suite, amphibolite and amphibole gneiss (**PZZpa**) Po River Metamorphic Suite, magnetite-bearing biotite gneiss (**PZZpmb**)	**PZZp**—primarily biotite gneiss and schist. Gneiss is dark-colored, layered and foliated, with micaceous materials concentrated in the dark layers, and quartz and feldspar concentrated in the lighter layers. Feldspar augens and hornblende gneiss present locally. Garnetiferous two-mica schist occurs locally. Many pegmatoids occur in tabular bodies forming concordant, sill-like layers that range from less than 2.5 cm (1 in) to as much as 7.6 m (25 ft) thick. **PZZpm**—fine- to coarse-grained, strongly foliated, garnet-muscovite quartzofeldspathic gneiss **PZZpa**—fine- to coarse-grained, weakly to strongly foliated, irregularly layered amphibolite and amphibole gneiss **PZZmb**—quartz-rich, magnetite-bearing biotite gneiss	High to moderate where deformed	Avoid highly schistose layers as well as areas of intense preferential compositional weathering (along foliation). Mafic rocks weather to clayey soils with high shrink-swell potential.	Lenses of resistant rocks in schistose layers susceptible to block and rockfall	None	None documented	Garnets, muscovite, amphiboles, magnetite, and feldspar augens. Landscaping material. Attractive building stone. Garnets for abrasives.	May weather into soils that attract species preferring high sodium, calcium, and aluminum soils	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Po River accreted terrane
PALEOZOIC OR PROTEROZOIC	Diorite gneiss of the Potomac Creek pluton (**PZZd**) Granite gneiss (**PZZpg**)	**PZZd**—gray quartz-plagioclase-biotite-rich diorite gneiss, with strong foliations and lineations; fine to medium grained and contains numerous cross-cutting dikes. **PZZpg**—fine- to medium-grained granite gneiss, ranging in composition to tonalite. Numerous biotite gneiss, biotite schist, and amphibolite layers exist within this tabular to lenticular shaped unit.	High	Highly heterogeneous and interlayered with younger units. Strong foliation creates zones of preferential jointing, which should be avoided for heavy development. May require blasting to excavate. Mafic rocks weather to clayey soils with high shrink-swell potential.	Lenses of resistant rocks in schistose layers may be susceptible to block and rockfall.	None	None documented	Epidote, garnet, and muscovite. Landscaping material. Attractive building stone. Garnet for abrasives.	Present near Fall Line; may correlate with specific species	Suitable for most forms of recreation, unless rocks are friable and weathered (i.e., an unstable base for trails and other visitor facilities)	Part of accreted terrane on the eastern edge of the Piedmont. Record later accretions onto the North American continent.
PROTEROZOIC	Catoctin Formation (**Zc**) Charlottesville Formation of the Lynchburg Group (**Zch**)	**Zc**—dark green metabasalt, ranging in texture from aphanitic to medium-grained and massive. Local interbeds of phyllite and quartzite are present, with concordant slaty cleavage. **Zch**—primarily of miceaceous metasiltstone and massive quartz-muscovite-sericite schist with thin quartzite and brown meta-arkose interbeds; typically very weathered, producing a light brownish gray sandy clay soil.	Moderately high to moderate where unit is highly weathered	Avoid for most heavy development. **Zc** (metabasalts) typically weather to a clay-rich soil with moderately high shrink-swell potential.	Susceptible to failure if exposed on slope or undercut . Rockfall hazard.	None	Greenstone may have been valued as trade material.	Quartz, muscovite, sericite, greenstone, chlorite, and epidote. Clay. Quartzite may provide flagstone material.	Support species that prefer high iron, magnesium, and calcium soils	Friable and weathered (i.e., an unstable base for trails and other visitor facilities)	**Zc** represents portions of ancient flood basalts that are correlative over a wide area. Rocks predate Paleozoic orogenic events and thus contain record of deformation throughout the Paleozoic orogenic cycle.