Geology

The southern half of the Upper Perkiomen Creek watershed is situated within the Newark Basin portion of Triassic Lowland Province, a broad basin within the Northern Piedmont defined by its fairly young (210 million to 250 million year old) sedimentary shale bedrock geology. The eastern third of the watershed includes a broad (8 mile wide) circle of igneous diabase bedrock intrusions, perhaps the most dramatic landform within the Triassic Lowlands, dating to between 175 million and 200 million years ago. The headwaters areas in the northern half of the watershed fall within the Reading Prong, a ridge of Precambrian (> 590 million year old) granitic gneiss and Cambrian Hardyston quartzite trending from the northeast to southwest.

The Unami Creek and Ridge Valley Creek subwatersheds, the steep valley along Deep Creek, and the ridges north of Green Lane Reservoir are almost entirely underlain by diabase bedrock, with small areas of Brunswick shale interspersed. This diabase formation was intruded into the 210 to 240 million-year-old Brunswick shale as molten lava sometime during that time period. The igneous (molten lava) bedrock heated the adjacent sedimentary Brunswick shale to form a more dense, crystalline, metamorphic rock type known as "hornfels", which may appear at the surface as small diabase boulders with a pink or light brown tint. The pattern of diabase and associated hornfels in the Perkiomen Valley forms an unusual, broad circle of ridges with the boroughs of Pennsburg and Red Hill at its Center. This diabase ring could be a caldera, a remnant of an ancient volcano. The Unami Creek Valleys is situated along the broad eastern portion of that diabase formation. The stream valleys within the watershed are generally underlain by softer the hornfels and red shale. **(See Figure 3: Geology)**

Diabase

Diabase is the primary rock type underlying many of the prominent wooded ridges, steep slopes, boulder-strewn hillsides and narrow stream valleys in the Upper Perkiomen. Some of the broadest diabase outcrops in the region occur in the Unami area, with sections along Upper Ridge Road and Hill Road reaching one-half mile or more in width. The formations within the Upper Perkiomen watershed are part of two diabase sheets -- East Greenville (7.1 cubic miles in volume) and the Quakertown pluton (28.6 cubic miles), one of the largest diabase intrusions in the region.

The igneous nature of diabase explains its physical characteristics as a dense, crystalline, erosion-resistant outcrops that weather to form large boulders, occasionally in broad fields of "Ringing Rocks." Boulder fields such as the one along the east side of King Road at Natural Lands Trust's Fulshaw Craeg Preserve in Salford Township are examples of natural features that have become local cultural landmarks. Many generations of local residents have come to climb on the rocks and strike them together

to make the ringing sound associated with sound waves traveling through dense crystalline interior and the almost metallic weathered surface.

Groupings of large diabase boulders along steep slopes form small "caves" in some areas along the Unami Creek, Ridge Valley Creek and Deep Creek. These caves may support nesting habitat for bird species such as Turkey Vulture and Black Vulture, but have not been documented as roosting habitat for bat species in the area. Some of these caves have been documented as the Unami Creek Rock Shelters used by the native Lenai Lenape people up to the 18th century.

In the 19th and early 20th century, diabase in the area was quarried to form "Belgian blocks" that lined major Philadelphia streets such as Broad Street. Drill marks for dynamite can still be seen in boulders on the Fulshaw Craeg Preserve and surrounding areas. Diabase, also known as "black granite" or "trap rock", has been used for headstones and support stones for large engineering projects, but was generally considered too dark to be used as building stone.

Hornfels

The igneous diabase intrusions in the Brunswick formation of the Perkiomen Creek watershed are so pronounced that it is likely that nearly all of the adjacent shale was heated and compressed to form metamorphic hornfels. Therefore, many of the reddish-brown Lehigh, Brecknock and Croton soils adjoining Diabase areas are more likely to be hornfels-based rather than formed from unmorphosed sedimentary Brunswick shale.

Brunswick Formation

The rock types associated with the Brunswick formation are generally reddish brown shales, mudstone and siltstone. These shales are moderately resistant to erosion and weathering. The greatest concentrations of this Triassic rock is centered along Macoby Creek and the Route 29 corridor and the eastern side of the Route 100 corridor, where it provides the parent material for some of the most productive agricultural soils in the Valley. Many of the historic structures in northern Montgomery County and Berks County were made with the reddish-brown stone quarried in the region. Weathering parent material from the Brunswick geology also directly forms the reddish-brown soils of the Lehigh-Brecknock-Croton series.

Precambrian Gneiss and Hardyston Formation

The headwaters streams at the northern limit of the Upper Perkiomen Creek watershed rise in an area underlain by Precambrian Gneiss geology, part of the Reading Prong section of the New England province. At a minimum of 590 million years old, these are among the most ancient rocks in the region. Granodiorite and granodiorite gneiss are included in this formation, and are interspersed with large patches of Cambrian sandstone known as the Hardyston Formation . This geology weathers at varying rates, with more highly erodible areas forming broader, rolling landscapes. The dense, less

erodible Gneiss forms the steeper wooded ridges and valleys in this area, with the even denser Cambrian quartzite known as Hardyston quartzite forming the ridgetops and along the bases of some slopes. The high iron content in some of this bedrock provided the raw material for the 18th and 19th century furnaces and forges in the upper part of the watershed.

Leithsville Formation and other Limestone

Leithsville Formation, a carbonate limestone rock dating to the Cambrian period (500 to 590 million years ago), underlies a small area in the northwestern headwaters area of the watershed. This limestone reaches a thickness of up to 1,000 feet, and is concentrated along the Northwest Branch of the Perkiomen Creek above the village of Dale and along Route 100 north of the village of Bally. This limestone geology is characterized by numerous fractures and solution openings, forming one of the most productive aquifers in the watershed. The Gabel Quarry is located in this area. Additional limestone formations can be found along the east side of Route 100 near Bally and Hereford. The generally soft, erodible nature of this geology defines the broad, flat topography of the "Butter Valley" in relation to the adjacent hills.

Planning Implications

The strong influence of the underlying diabase and gneiss bedrock on the topography and vegetation of the Unami Creek and Deep Creek valleys and the headwaters ridges also provides natural limitations for agriculture and land development. In particular, the steep, rocky nature of the land has historically limited the use of these areas for cultivation. Numerous stone walls and stone house ruins in some sections of these woodlands indicate that small-scale sheep or cattle farming probably represented the pinnacle of agricultural use in these landscapes over 100 years ago. The floodplains in diabase and steeper gneiss ridges were never broad enough or extensive enough to support the larger scale cultivation and pasturing found in more gently rolling portions of the Perkiomen Creek watershed where Brunswick shales and Gneiss is present. These same steep slopes and rocky soils present natural limitations today to large-scale development, road construction, and septic systems and private wells in the Unami Creek and Deep Creek valleys.

The carbonate limestone of the Leithsville Formation and limestone along the east side of Route 100, though limited in area, includes a large capacity for water storage and well supply. The *Upper Perkiomen Creek Watershed Management Study: Technical Report* notes that the numerous joints and fractures in this formation allow for water movement but are often filled with quartz. The thick soils formed over this limestone are an important storage area for groundwater in the first 80 to 150 feet below the surface. The average well depth recorded in the Lehigh County portion of this formation is 200 feet, with yields exceeding 1,000 gpm (Cahill, 1994). The same qualities that produce high well yields in these limestone aquifers also make groundwater contamination and excessive groundwater depletion equally important concerns. Land use practices in these areas

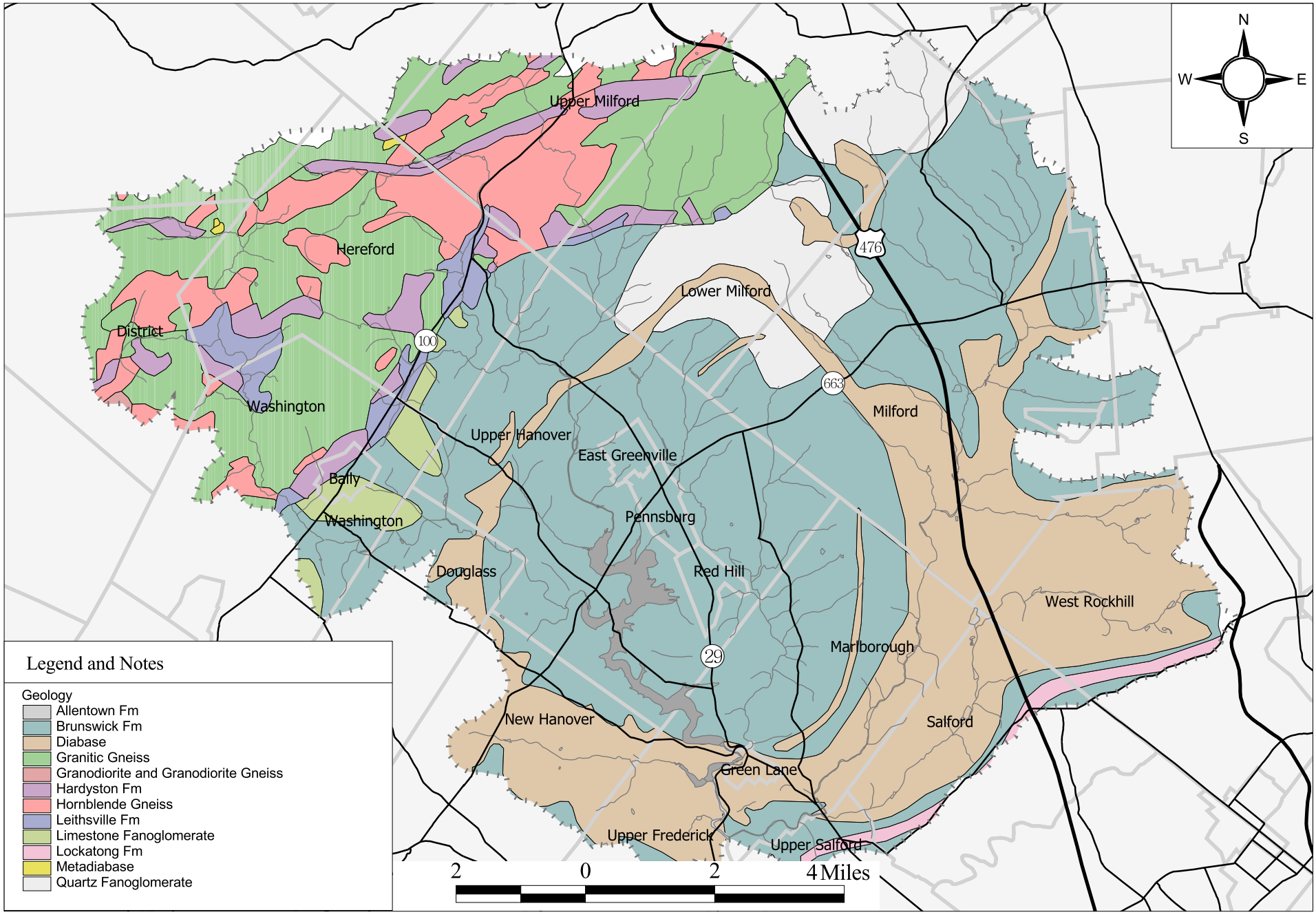
should be limited to those which pose no great threat to the quality or quantity of water in the Leithsville or other limestone aquifers. These areas may also be prone to sinkhole formation, which poses structural concerns for buildings, roads, utility lines and other infrastructure. Careful testing should be done prior to development in limestone areas, and stormwater and septic systems should be designed to avoid concentration of subsurface water – the primary factor leading to sinkholes.

The aquifers of the Brunswick Formation centered along Route 29 are generally the most productive in the watershed. As noted in the *Upper Perkiomen Creek Watershed Management Study: Technical Report,* the Triassic rocks include numerous faults, weathered areas and joints that are "very important for the storage and transmission of groundwater (Longwill and Wood, 1965). The maximum yield of groundwater occurs between 200 and 550 feet below the land surface. The increased yield at 200 feet is due to the way the rock weathers; openings above 200 feet are commonly plugged with clay and silt. The Brunswick Formation is considered a reliable source of groundwater with yields greater than 100 gpm (gallons per minute) in places (Longwill and Wood, 1965) (Cahill, 1994)."

Groundwater found in quartzite areas along the northernmost ridges in the watershed tends to be 200 to 400 feet below the surface, and may yield an average 30 gpm through fractures and fissures. The *Upper Perkiomen Creek Watershed Management Study: Technical Report* documents that the gneiss formation that characterizes much of the northern half of the watershed is more productive for wells. "Primary porosity and permeability within the gneiss metamorphic and igneous rocks of the Reading Prong is low. Therefore, groundwater must be stored and transmitted in the weathered zone near the surface and/or in secondary openings such as fractures, joints, and faults near the surface in the unweathered rock. Generally, water-bearing zones deeper than 150 feet are unusual and rare (Wood, et al., 1972). Despite the seemingly poor hydrologic characteristics, the median yields for wells developed in the granite gneiss is approximately 50 gpm (Cahill, 1994)."

Diabase is considered a poor source of groundwater, with most groundwater only available within the weathered zone to 30 feet deep, and median yields of 5 gallons per minute (gpm) reported (Cahill, 1994). Most of the underlying geology is too dense, and the fractures and fissures too narrow, to provide reliable well water on a large scale. The shallow depth to bedrock through much of the Unami and Deep Creek area presents difficulties for excavation of on-site septic systems, and sand mound systems are commonly used as a way of defeating this natural constraint. Extension sewer lines from municipal or community sewage treatment plants in the vicinity of Green Lane or Sumneytown could mean that geology is taken out of the equation as a limiting factor for wastewater treatment in the area.

Radon gas accumulation in houses should also be considered a potential hazard associated with development on underlying geologic formations in the Upper Perkiomen Valley. Radon gas is a product of radioactivity in certain rock types, and has been linked to human health problems and lung cancer. This problem occurs throughout southeastern Pennsylvania, and has been documented on the geologic formations of the Reading Prong. "In the Reading Prong, high uranium values in rock or soil and high radon levels in houses are associated with Precambrian granitic gneisses commonly containing 10 to 20 ppm (parts per million) of uranium, but locally containing more than 500 ppm uranium." (Shultz, 1999) In fact, the first large-scale radon scare in the world was centered in neighboring Colebrookdale Township, Berks County area in the late 1980's, when an employee at the Limerick nuclear power plant tested for high levels of radiation, and his home was found to support radon levels many times the guidelines set by the Environmental Protection Agency.



Upper Perkiomen
Rivers Conservation Plan

Figure 3:
Geology

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