APPENDIX A

GROUND WATER IN NORTH CAROLINA

Ground Water in North Carolina

North Carolina may be divided into two hydrogeologic zones pertaining to ground water occurrence, availability, and protection. One zone consists of the *Coastal Plain*, and the other consists of the *Piedmont Plateau* combined with the *Appalachian Mountains*. For this discussion, this zone is termed the *Piedmont and Mountains*.

<u>Coastal Plain Ground Water System</u>

The Coastal Plain includes nearly one-half of the area of the state and extends west from the Atlantic Ocean to the *fall line*. The fall line is a zone 30 to 40 miles wide that is marked by discontinuous rapids. Here, major streams have removed thin layers of unconsolidated Coastal Plain sediments where they overlap Piedmont rocks near the Piedmont-Coastal Plain boundary.

Ground water in the Coastal Plain occurs in layers of sand, silt, clay, and limestone. The layers comprising the Coastal Plain ground water system are primarily unconsolidated, consisting of loose aggregations of rock particles. Layers of sand and limestone serve as aquifers. Layers of clay and interbedded silt and clay are confining beds. Ground water occurs in the irregular -shaped pore spaces between rock particles. The layers of unconsolidated sediment increase in thickness eastward from the fall line to the coast, where they reach a thickness of about 10,000 feet at Cape Hatteras. From the fall line to the coast, the depth below land surface to the different rock layers in the Coastal Plain increases at about 15 feet per mile. The thickness of silt and clay layers also increases towards the coast so that the sand and limestone aquifers are covered by increasingly thick confining beds towards the coast.

With respect to source water protection, the most important unit of the Coastal Plain ground water system is the *surficial layer*. This is the layer of sediment that directly underlies the land surface. The surficial layer is the youngest rock layer and is also the layer through which all recharge and most contaminants enter the system. The surficial layer may consist of permeable sands such as those underlying the Sand Hills, Outer Banks, and other areas. It may also consist of clays and impermeable decomposed organic matter in the swamp areas of the outer Coastal Plain.

All of the Coastal Plain aquifers, and especially those below the Castle Hayne, contain numerous thin clay and silty clay layers that diminish vertical movement of water and contaminants. These relatively-impermeable layers within the aquifers combine with the confining beds to reduce the potential for contamination of the deeper aquifers from pollutants originating on the land surface.

Piedmont and Mountains Ground Water System

The ground water system in the Piedmont and Mountain area differs in several important aspects from that in the Coastal Plain. In most of this area, it consists of a surficial layer of unconsolidated granular material overlying fractured consolidated rock. The surficial layer was formed during the chemical and physical disintegration (i.e. weathering) of the underlying consolidated rock. The term *regolith* is commonly used to refer to the surficial layer. The consolidated rocks that underlie the regolith are composed of igneous and metamorphic crystalline rocks having a very wide range in mineral composition which has been used to separate them into several dozen units for the purpose of mapping their occurrence. It is convenient to refer to all of these consolidated rocks as *bedrock* or *crystalline rocks*. Water-bearing openings in the bedrock consist of fractures which commonly occur in two nearly vertical sets that cross roughly at a right angle and a third set that approximately parallels the land surface.

Ground water in the Piedmont and Mountains occurs both in the pore spaces between the rock particles comprising the regolith and in the network of interconnected fractures in the bedrock. Because of the narrow width of the openings along the fractures and the relatively wide spacing of the fractures (several inches to several feet), the amount of water contained in the openings in the bedrock is relatively small. Conversely, the water in storage in the regolith is relatively large, amounting to about one-fifth of the saturated volume. Conceptually, the regolith serves as the reservoir of the Piedmont and Mountain ground water system, and the bedrock fractures serve as an intricate network of small pipes connecting the regolith reservoir to pumping wells.

Nearly all of the bedrock formations that underlie the Piedmont and Mountains contain feldspar and other minerals which tend to break down chemically to form clays. Because the regolith is formed from the underlying bedrock, the degree of breakdown of the minerals comprising the bedrock increases upward from the bedrock surface. Therefore, the soil zone developed in the upper part of the regolith tends to be clay-rich and relatively impermeable. The clay-rich soil zone, where it has not been removed by erosion or excavation, protects ground water by slowing contaminant movement from the land surface into the ground water system.

Below the clay-rich soil zone in the Piedmont and Mountains, the regolith retains many of the textural characteristics of the underlying bedrock from which it is derived. This zone is termed *saprolite.* It grades downward to the bedrock surface through a *transition zone* that is less chemically altered than the rest of the saprolite and, therefore, contains fewer clay-size particles. The transition zone is more permeable than the remainder of the saprolite, and where it is sufficiently thick, it is the zone through which most of the lateral ground water movement in the regolith takes place. The relative ease with which water moves through the transition zone is important in water movement from the regolith into bedrock fractures.

The Triassic Basin Areas

The preceding discussion of the geology and ground water conditions in the Piedmont and Mountains does not apply to the three areas underlain by rocks of Triassic age. These rocks are mostly sandstones and shales that partially fill three down-faulted structural basins. The sandstones and shales originated as sediments delivered to the basins by streams flowing from the adjoining areas of crystalline rocks. The sandstone layers are brittle and therefore tend to be broken along relatively closely-spaced fractures. The interbedded shales, on the other hand, are relatively soft and do not tend to retain water-bearing openings along fractures. It is suspected that most water-bearing openings in the Triassic rocks consist of very small fractures developed along bedding planes between the sandstone and shale layers.