1.9 Aquifer Recharge Areas

Aquifers can receive recharge from several different sources. These include infiltration of precipitation and snowmelt, water diverted from surface water bodies such as streams and lakes, and leakage through confining layers from overlying or underlying aquifers.

Recharge from Infiltration and from Leakage

Most aquifers receive some recharge directly from the infiltration of precipitation. In this case, the precipitation enters the ground and percolates downward through unsaturated material at the surface to the water table. Unconfined aquifers are recharged over their entire lateral extent.

Many confined aquifers consist of dipping strata that are unconfined in their outcrop area (that is, the area where the geological formation intersects the ground surface). The outcrop area of a formation is the area conventionally shown on a geological map (Refer to Plates 1.4.1 and 1.5.1). Typically, the outcrop areas of water-bearing strata are considered their recharge areas. Aquifers that do not crop out at the surface must receive their recharge via leakage through confining layers.

If the aquifer is laterally extensive and generally confined with a small outcrop area, the majority of the water that the aquifer yields to a well may originate as leakage through a confining unit rather than from direct infiltration of precipitation. Hydraulic analyses, including computer simulations, have demonstrated that when pumping from wells alters ground-water flow and hydraulic gradients, the relative proportions of recharge from various sources changes.

Precipitation, Evapotranspiration, and Runoff

Not all the precipitation reaches the water table. Some evaporates or is taken up by plants and transpired. These two processes are often lumped together and called evapotranspiration. In addition, the soils may have a layer that is very poorly permeable due to cementation or high clay content. The infiltrating water will percolate down to this layer, which could be a foot or more below the surface and begin to flow laterally, ultimately discharging to a surface water body or being taken up by plants without actually reaching the water table. Various modifications to the land surface due to human activities also affect the amount of recharge that an aquifer receives. This is especially evident where improvements like buildings and paved surfaces intercept precipitation and divert it to storm-water collection systems.

Estimation of Groundwater Recharge

The New Jersey Geological Survey conducted an investigation into the affects of local climate, soil series, and land use/land cover on the average annual recharge rate for any parcel in the state of New Jersey with an area of 5 acres or greater (Charles *et al*. 1993).

Hoffman and French (1999) used the method to prepare a groundwater recharge map for and area that includes most of WMA 6.

More recently, the method has been used by the NJGS to prepare recharge maps of each county in New Jersey except Hudson and Essex, for which current soil surveys are lacking. As of September 2002, the NJGS has also created recharge maps for the 20 watershed management areas of the state, except those portions of Watershed Management Areas 4, 5, 6, and 7 that are in Essex or Hudson Counties. All of these county and watershed management areas groundwater recharge maps can be downloaded from the NJGS website:

http://www.state.nj.us/dep/njgs/geodata/dgs02-3/dgs02-3.htm

Aquifer Recharge in WMA 6

The surficial groundwater recharge map for the Upper Passaic, Rockaway, and Whippany River watersheds (Hoffman and French 1999) does not provide recharge rates for areas with hydric soils, wetlands, or surface water bodies, because site-specific studies are necessary to determine whether these are discharge areas or whether the provide recharge. Also excluded are those portions of WMA that are in Essex County. This is because the method requires information about the various USDA soil series in the area of interest and there is no USDA Soil Survey available for Essex County.

Surficial recharge in WMA 6 ranges from 0 to 22 inches per year, depending upon the combination of soil series, climate, and land use/land cover at specific locations (Hoffman and French 1999). The areas most amenable to recharge are concentrated in the west-central portion of WMA 6, west of U.S. Highway Route 202 and south of N.J. Highway Route 10, although smaller areas with relatively high recharge rates that may be worthy of consideration for protection are scattered throughout WMA 6.

Upon entering the ground, the recharge may not directly enter an aquifer but be stored in lower permeability units. In the case of glacial till, which blankets most of WMA 6, the surficial, low permeability unit, which received the infiltration, will in turn provide recharge to the underlying aquifer. With respect to fractured rock aquifers, the low storativity of the fracture network would result in poor yields in many areas if it were not for overlying glacial till. Even though the till typically has rather low permeability, it nevertheless has moderate storage capacity, approximately an order of magnitude greater than the fractured rock. Because the till is unstratified, water that infiltrates into it encounters resistance to flow in the lateral direction as well as in the vertical. Consequently, the path of least resistance is often downward. The vertical thickness of the till is typically small in relation to the lateral extent of the underlying aquifer, making the stored water easily accessible to ameliorate the regional impacts of diversion from the aquifer.

The Buried Valley Aquifer System (see Section 1.8) is not exposed at the surface at any point. Consequently, all recharge must travel through adjacent, overlying, or underlying units, which typically have relatively lesser permeabilities. The buried valley aquifers tend to be highly transmissive linear features that are strongly connected where they intersect one another, poorly connected through intervening and overlying materials, and often very well connected to the underlying bedrock aquifer. The primary source of recharge for diversions will be from the more distant parts of the buried valley, possibly from outside WMA 6, and from underlying bedrock. Consequently, protecting the source of the water is more problematic than in the case of surficial aquifers.

The area immediately overlying most of the Buried Valley Aquifer System in the Newark Basin portion of the WMA 6 is a low swampy area that represents a the area formerly occupied by Glacial Lake Passaic. Not only are these areas presently or historically discharge areas, but the soils that have formed on the former lakebed tend to have low permeability (mostly Hydrologic Soil Groups C and D) and stratification, which encourage runoff and lateral movement rather than vertical. In addition, the uplands in the area underlain by the Buried Valley Aquifer System in WMA 6 either correspond to the terminal moraine, which tends to form poorly permeable soils, or are partly urbanized. The portions of the Buried Valley Aquifer System in the Highlands Physiographic Province tend to be low-lying areas that follow, a considerable extent, the present courses of major streams, which also exhibit a significant degree of urbanization.

Urbanization introduces impervious surfaces and storm-water collection systems, both of which greatly reduce the recharge. This is not to say that the areas immediately overlying the buried valley aquifers do not need to be protected. Obviously, the little that does infiltrate can carry dissolved contamination in significant concentrations. In addition, some liquid contaminants, such as chlorinated solvents, can penetrate the overlying materials, if introduced in sufficient quantities, to cause serious contamination in the buried valley aquifers.