SUSQUEHANNA RIVER BASIN COMMISSION
NY ▪ PA ▪ MD ▪ USA
NOVEMBER 2023

OPTIMAL GROUNDWATER RECHARGE LOCATIONS & CRITICAL AQUIFER RECHARGE AREAS

RECHARGE 101

Maintaining or preserving groundwater recharge is the primary means of ensuring water is available in aquifers for water supply and as baseflow to streams. Recharge is addition of water from the land surface to underground water-bearing zones (Figure 1). The natural capacity of a landscape to infiltrate water may be disrupted by the removal of forest cover and from urban development. With increased runoff, drought conditions may be intensified as less water reaches underground aquifers, including those that support streamflow (as baseflow) during dry periods. Baseflow is the non-runoff portion of streamflow sustained by groundwater, and is often used as an approximation of recharge.

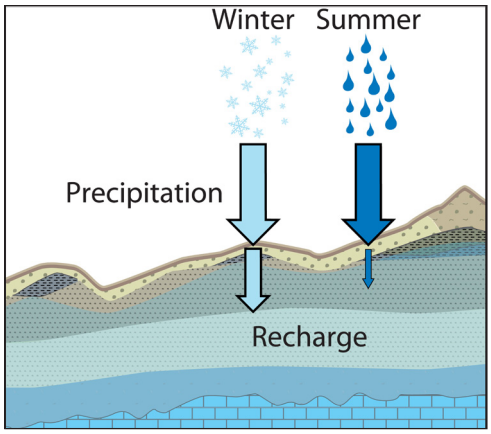

Figure 1. Diagram of Generalized Groundwater Recharge (Bates and Jackson, 1984)

PURPOSE

An objective in the Commission's Comprehensive Plan is to identify and promote the protection of open space and other land uses that provide for increased groundwater recharge. Different geologic materials, topography, and land uses all influence the amount of water than can reach underlying aquifers. The Susquehanna River Basin's diversity in these factors leads to considerable variations in recharge potential across the landscape. The goal of this study was to analyze a range of variables using a Geographic Information Systems (GIS) framework to identify areas of greater and lesser recharge potential throughout the basin.

The best recharge areas, which are responsible for a large fraction of groundwater replenishment, are referred to as Critical Aquifer Recharge Areas (CARAs) by SRBC. The identification and protection of CARAs is increasingly important as water supply becomes more stressed with increased urbanization. With the identification of CARAs, Commission staff and stakeholders can identify actions to ensure the sustainability of water resources during periods of drought, particularly in areas that could have the most potential for impact.

THE STUDY

In 2023, the Commission published the study *Identifying Optimal Groundwater Recharge Locations and Critical Aquifer Recharge Areas within the Susquehanna River Basin* authored by Hydrogeologist Pierre MaCoy, P.G. and Hydrologist Graham Markowitz, P.G. Groundwater recharge potential was assessed relative to surrounding areas and is independent of precipitation, temperature, evapotranspiration, climate variability, and/or water use.

The authors used impervious cover, land surface slope, percent sand and clay content in soils, depth to bedrock, drainage density, karst density, and fault density to describe recharge potential in the basin. The GIS framework allows for each input variable to be weighted according to its importance or percent influence. The authors used this weighting approach as some variables are known to influence recharge more than others (Table 1).

Variable selection and weighting was determined through an iterative process of comparing outputs from various models to areas with known, high recharge rates and/or baseflows. For a composite output, the cell/pixel value for each GIS input layer is multiplied by the weight, and values are summed for each overlapping cell/pixel. The resulting output, in the form of a GIS raster, illustrates recharge potential on a scale of 100 (low) to 500 (high) (Figure 2) at a spatial resolution of 30 by 30 meters.

TABLE 1.
BASINWIDE RECHARGE POTENTIAL
Input Criteria and Weighting Assignments

Variable Category	Variables	Weight
Land Cover / Terrain	Impervious Area	25
	Land Surface Slope	15
Shallow-Subsurface Geology	Percent Sand	15
	Percent Clay	2.5
	Depth to Bedrock	2.5
Structural / Bedrock Geology	Drainage Density	25
	Karst Density	10
	Fault Density	5

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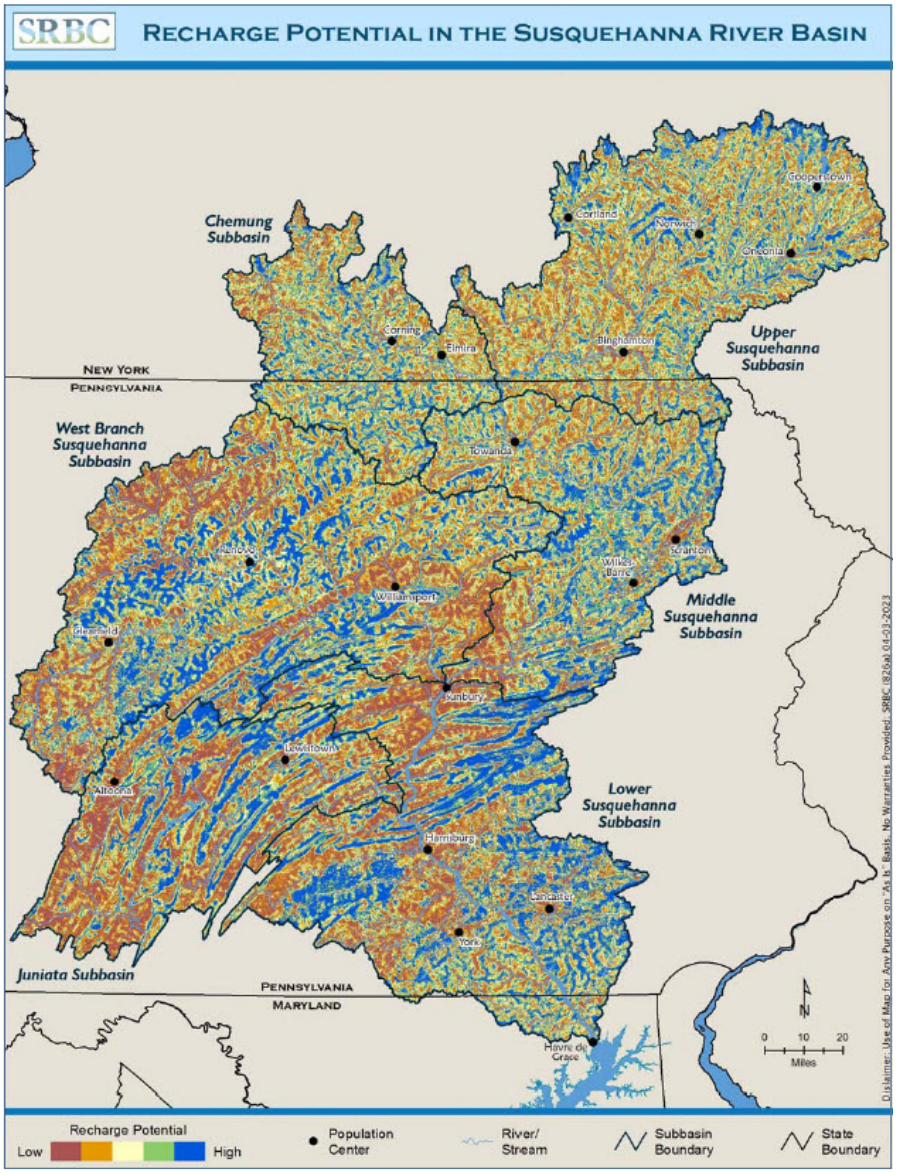

Figure 2. Recharge Potential in the Susquehanna River Basin

TOOL USES

The GIS framework can be applied at a basinwide scale and local scale based on user needs. The basinwide output may assist with planning and prioritizing activities over potentially large jurisdictions. The local application allows the user to identify areas of higher recharge potential within locations that may otherwise have limited recharge potential. The tool can also aid with analyzing productive and sustainable groundwater sources or avoiding development in potentially over-utilized areas with limited water availability. Areas where the utilization of groundwater resources has approached or is exceeding the sustainable limit were selected for the identification of CARAs. An example CARA delineation is provided for the Spring Creek Watershed in Figure 3. In these locations, preservation, restoration, or enhancement projects may be prioritized.

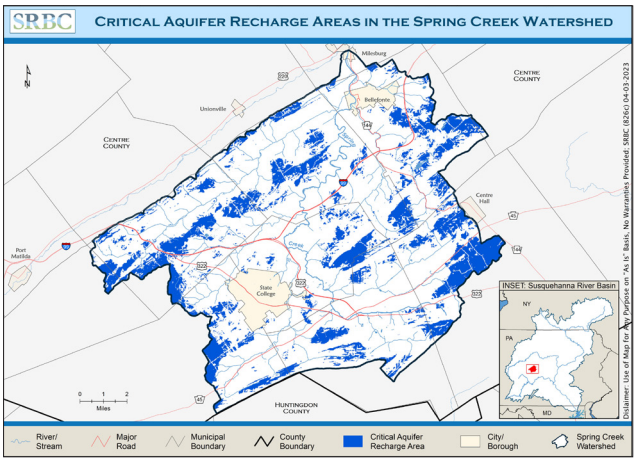

Figure 3. Critical Aquifer Recharge Areas, Spring Creek, Centre County, Pa.

NEXT STEPS

Commission staff look forward to working with partners to utilize mapped coverages of high recharge potential areas to inform a variety of water management actions, including agricultural and forested land preservation activities, aquifer/stormwater recharge enhancement projects, and abandoned mine land/drainage reclamation efforts. Commission staff have also attempted to document existing protected lands accessible to the public, such as State Forests and Game Lands, that have high recharge potential and plan to conduct outreach to responsible agencies to raise awareness of the added value of their assets.

WHERE CAN I FIND IT?

All recharge datasets were compiled and stored in an ArcGIS Geodatabase and are available for download on the Pennsylvania Spatial Data Access (PASDA) geospatial data portal. If a local assessment of recharge potential in any region, county, watershed, or other scale is desired, a request can be made with the Commission through its website.