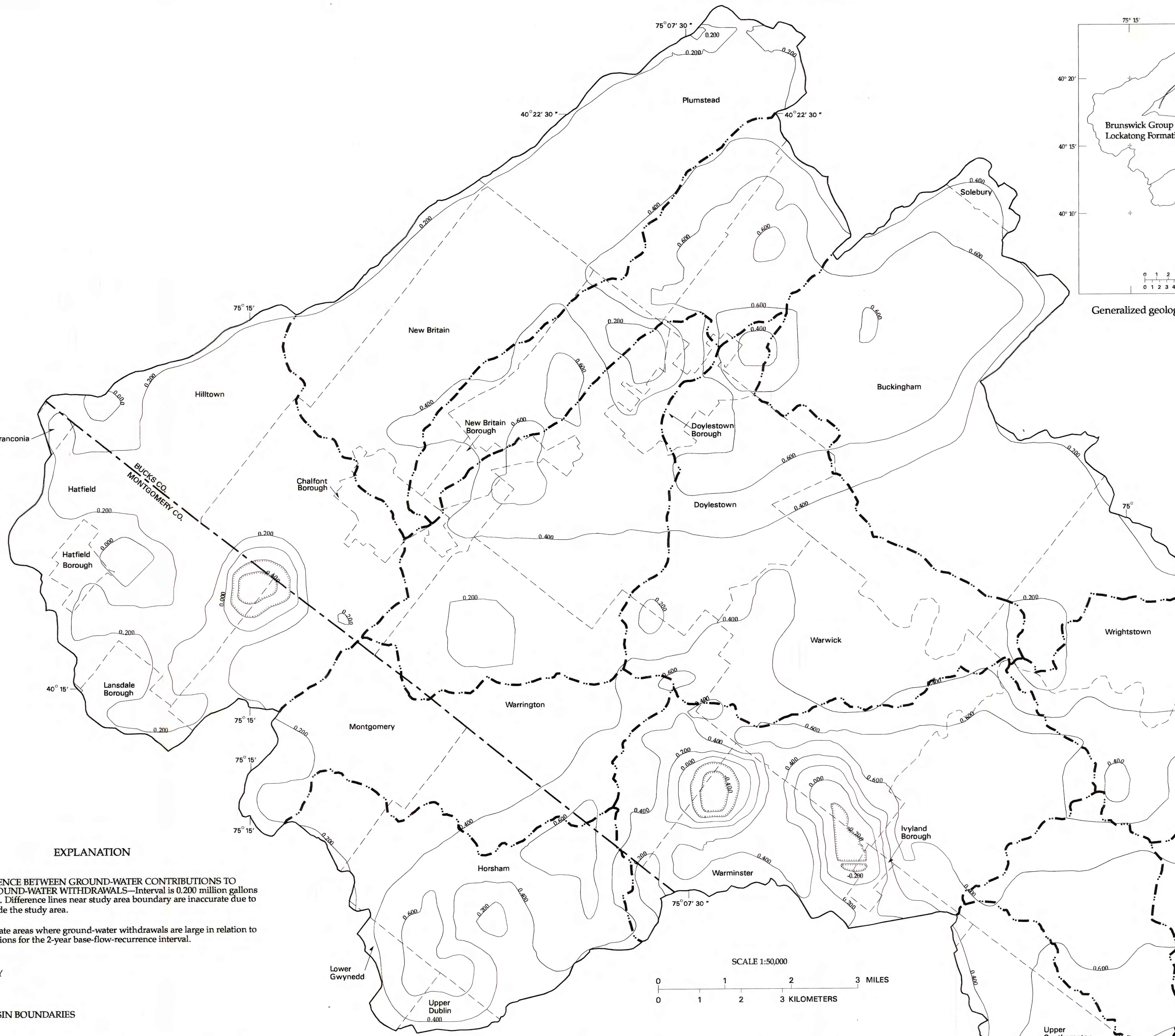
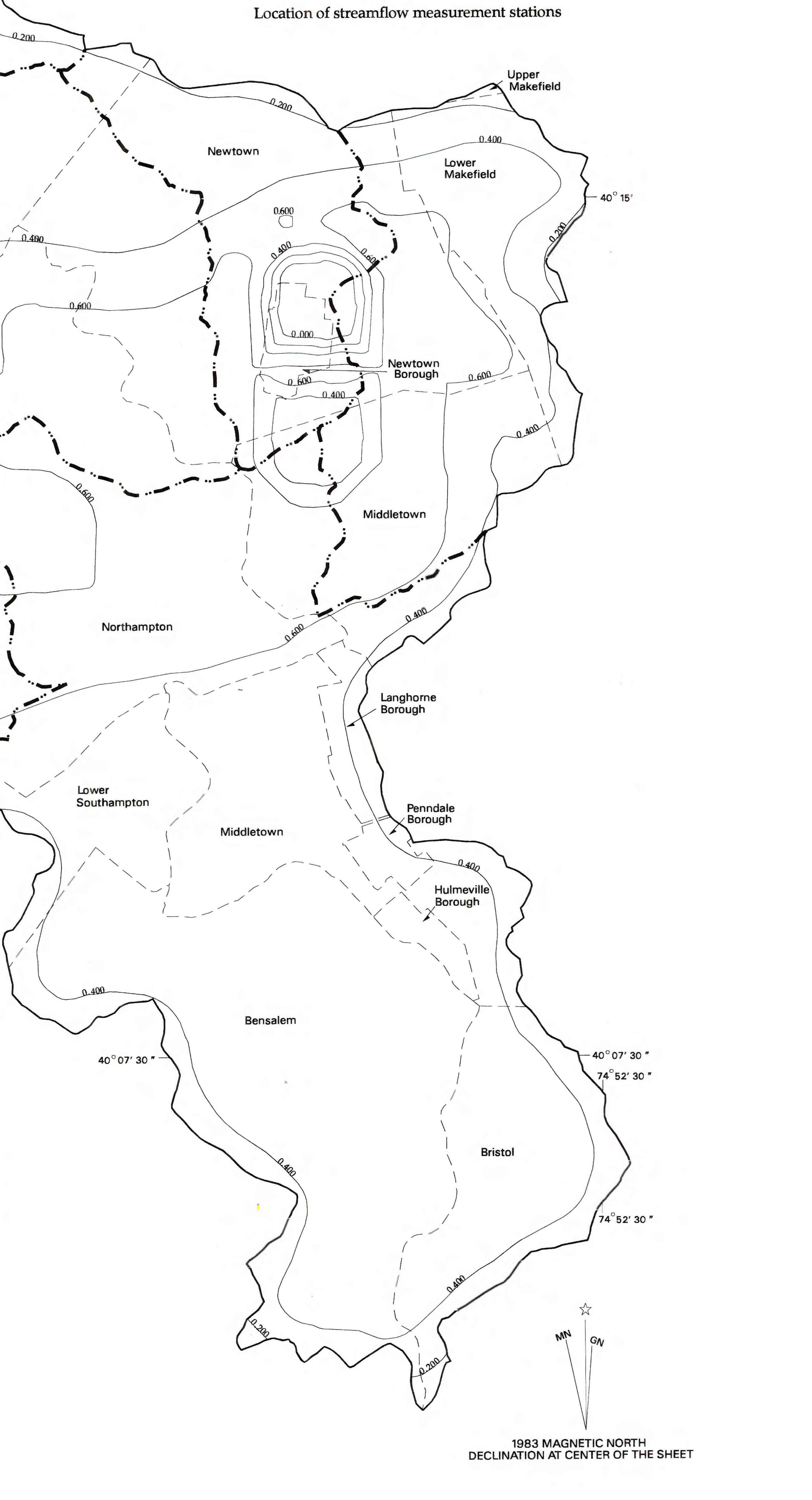
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
DELAWARE RIVER BASIN COMMISSION

OPEN-FILE REPORT 96-359
Map of Difference 2-year base-flow and withdrawals--Plate 1

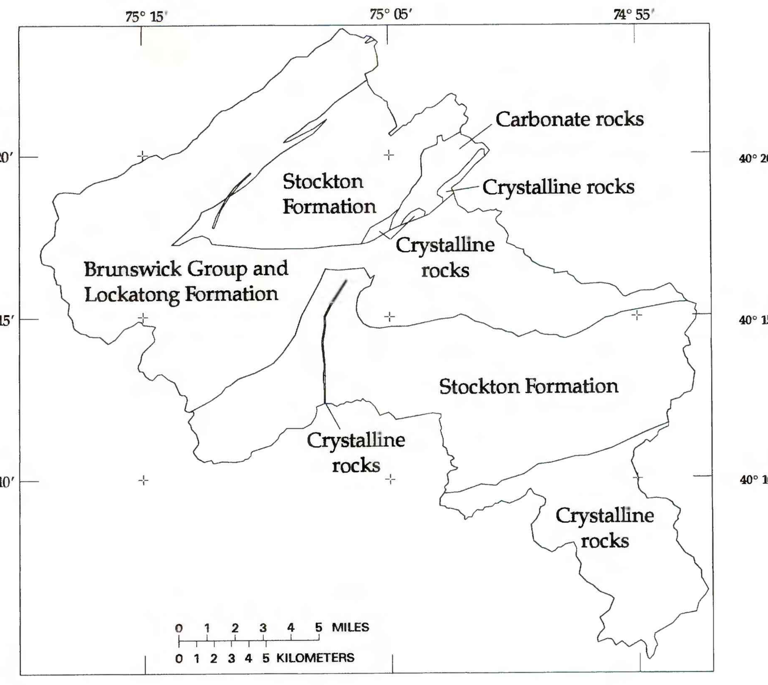




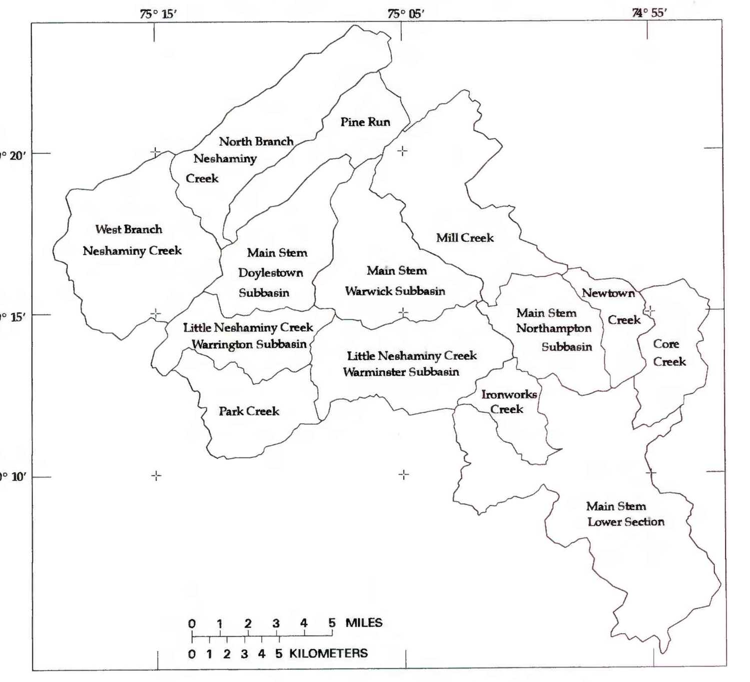
SCALE 1:50,000

0 1 2 3 MILES

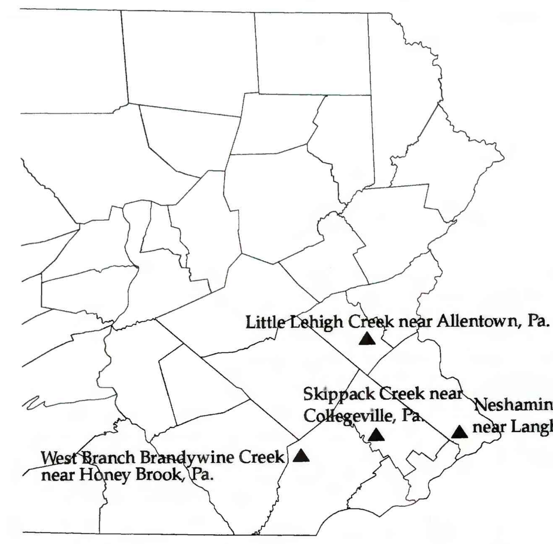
0 1 2 3 KILOMETERS



Generalized geologic map of the Neshaminy Creek Basin



Basin and subbasin locations and names



Location of streamflow measurement stations

EXPLANATION

LINES OF EQUAL DIFFERENCE BETWEEN GROUND-WATER CONTRIBUTIONS TO BASE-FLOW AND GROUND-WATER WITHDRAWALS—Interval is 0.200 million gallons per day per square mile. Difference lines near study area boundary are inaccurate due to no data collection outside the study area.

HACHURED LINES—Indicate areas where ground-water withdrawals are large in relation to ground-water contributions for the 2-year base-flow-recurrence interval.

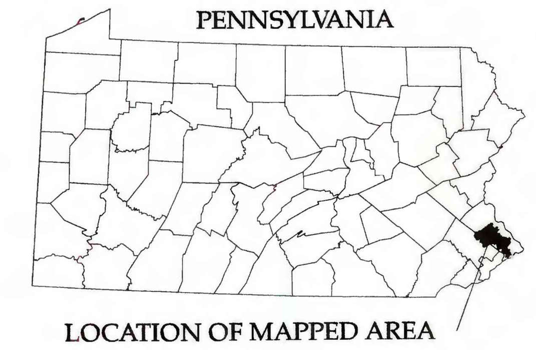
STUDY AREA BOUNDARY

SURFACE-WATER SUBBASIN BOUNDARIES

COUNTY BOUNDARIES

MUNICIPAL BOUNDARIES

PENNSYLVANIA



LOCATION OF MAPPED AREA

Introduction

As part of a cooperative study with the Delaware River Basin Commission (DRBC), the United States Geological Survey has prepared a set of maps for the Neshaminy Creek Basin showing the grid-averaged difference between areally distributed ground-water contributions to base flow at various recurrence intervals and ground-water withdrawals. The maps show areas where ground-water withdrawals are large relative to ground-water contributions for a given base-flow-recurrence interval.

This map was developed for a 2-year-base-flow-recurrence interval. It was constructed by: 1) estimating the annual base-flow contribution for each geologic unit in the Neshaminy Basin for a 2-year recurrence interval, 2) plotting the ground-water withdrawals, and 3) normalizing and contouring the difference between the two quantities in million gallons per day per square mile (Mgal/day/mi^2) by use of a moving-grid method.

Estimates of Base-Flow Contributions

Four major hydrogeologic units comprise the Neshaminy Creek Basin -- crystalline rocks, rocks of the Brunswick Group and Lockatong Formation (shale/siltstone), carbonate rocks, and rocks of the Stockton Formation (sandstone/shale). To compute the ground-water contribution from each hydrogeologic unit in the basin, estimates of annual base flow were used from four streamflow-measurement stations in southeastern Pennsylvania (see insert map). This report uses variables that define the annual base flow having particular recurrence intervals. These variables are determined using the following procedure. At each station, the annual base-flow component of streamflow was estimated by use of the local-minimum method of hydrograph separation (Pettyjohn and Henning, 1979) as applied in the computer program of Sloto (1991). A frequency distribution was then used to determine the annual base flow for the 2-year-recurrence interval at the four streamflow-measurement stations. For example, the base flow that has a 2-year recurrence interval is the annual base flow that would occur, on the average, once every 2 years. The recurrence interval is the inverse of the probability.

Base-flow-recurrence intervals for the period of record (water years 1961-93) for West Branch Brandywine Creek near Honey Brook, Pa., which drains nearly 100 percent crystalline rocks, were used to estimate yields for the crystalline rocks in the Neshaminy Creek Basin. Base-flow-recurrence intervals for the period of record (water years 1967-93) for Skippack Creek near Collegeville, Pa. were used to estimate yields for the Brunswick Group and Lockatong Formation. Base-flow-recurrence intervals for the period of record (water years 1946-93) for Little Lehigh Creek near Allentown, Pa. were used to estimate yields for the carbonate rocks.

To estimate annual base-flow contributions of the Stockton Formation in the Neshaminy Creek Basin, the 2-year-base-flow-recurrence intervals for a common period of record (water years 1966-92) was calculated for the West Branch Brandywine Creek, Skippack Creek, Little Lehigh Creek, and Neshaminy Creek near Langhorne, Pa. The areal percent of each geologic unit above the streamflow-measurement station on Neshaminy Creek at Langhorne was determined using a Geographic Information System (GIS). The estimated base-flow value (Q) for the 2-year-recurrence interval was substituted into equation 1 to solve for the base-flow contribution from the Stockton Formation.

$$\begin{aligned} Q_{\text{Neshaminy}} = {} & (Q_{\text{W. Br. Brandywine}})(\text{Percent Area}_{\text{crystalline rocks}}) + \\ & (Q_{\text{Skippack}})(\text{Percent Area}_{\text{Brunswick/Lockatong}}) + \\ & (Q_{\text{Little Lehigh}})(\text{Percent Area}_{\text{Carbonate rock}}) + \\ & (Q_{\text{Stockton}})(\text{Percent Area}_{\text{Stockton}}) \quad (1) \end{aligned}$$

Ground-Water Withdrawals

Ground-water-withdrawal data for the Neshaminy Creek Basin were provided by DRBC for calendar year 1993 or most recent other year. The withdrawal data included all public, industrial, and commercial supply wells within the basin. The withdrawal data, in the form of an annual quantity of ground water pumped from each well, were plotted at the appropriate location within the basin.

Normalizing and Contouring with Moving-Grid Method

A moving-grid method was used to normalize and contour the difference between ground-water contributions to base flow for a 2-year-recurrence interval and areally normalized ground-water withdrawals. The method was designed to correspond as closely as possible to a method previously used by DRBC (R.E. Wright Associates, Inc., undated). The position of the mapped contours would be altered if the arbitrary grid size or its method of movement were changed.

A 1,500 by 1,500 meter grid was drawn over the basin using a GIS, and the difference between the 2-year-recurrence ground-water contribution and the ground-water withdrawal for each grid cell was calculated and assigned to the center of each cell. The grid was shifted 750 meters, or one-half cell, to the right, and the difference between ground-water contribution and ground-water withdrawal for each grid cell was recomputed and assigned to the center of each right-shifted grid cell. The grid was shifted 750 meters, or one-half cell, downward, and the difference between ground-water contribution and ground-water withdrawal for each grid cell was recomputed and assigned to the center of each downward-shifted grid cell. The downward-shifted grid was shifted 750 meters, or one-half cell, to the left and the difference between ground-water contribution and ground-water withdrawal for each grid cell was recomputed and assigned to the center of each left-shifted grid cell. The data points from each grid-cell were contoured.

References Cited

Pettyjohn, W. A., and Henning, Roger, 1979, Preliminary estimate of ground-water recharge rates, related streamflow and water quality in Ohio: Columbus, Ohio, Ohio State University Water Resources Center, Project completion Report 552, 323 p.

R.E. Wright Associates, Inc., undated, Special groundwater study of the middle Delaware River Basin study area II: Volume I, Chapters one through seven.

Schreffler, C.L., 1996, Water-use analysis program for the Neshaminy Creek Basin, Bucks and Montgomery Counties, Pennsylvania: U.S. Geological Survey Water-Resources Investigations Report 96-4127, 81 p.

Sloto, R.A., 1991, A computer method for estimating ground-water contribution to streamflow using hydrograph-separation techniques: Proceedings of the U.S. Geological Survey National Computer Technology Meeting, U.S. Geological Survey Water-Resources Investigations Report 90-4162, p. 101-110.

MAP OF THE DIFFERENCE BETWEEN GROUND-WATER CONTRIBUTIONS TO BASE-FLOW FOR THE 2-YEAR RECURRENCE INTERVAL AND GROUND-WATER WITHDRAWALS IN THE NESHAMINY CREEK BASIN, PENNSYLVANIA

By
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1996