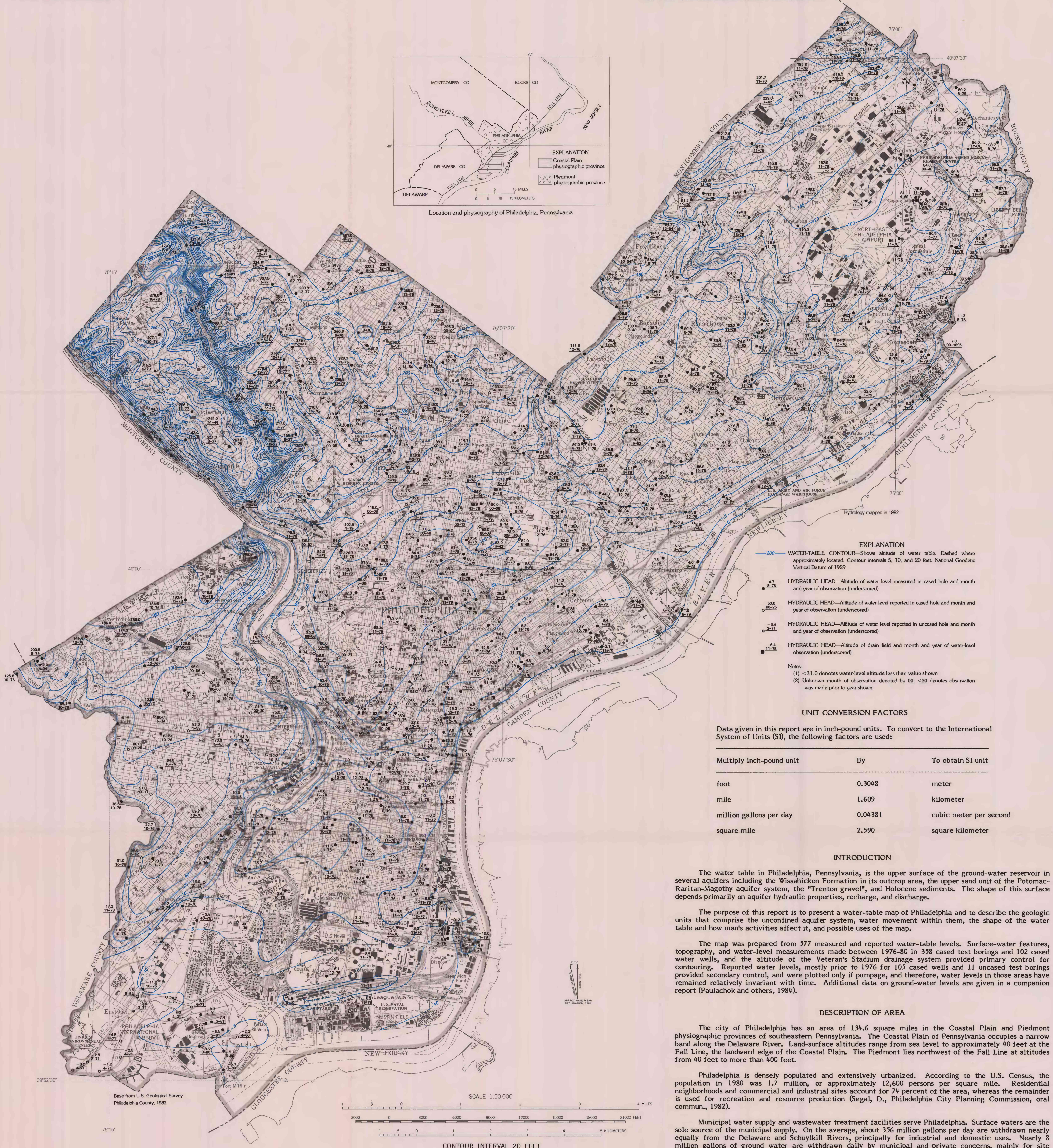
Prepared in cooperation with the
CITY OF PHILADELPHIA WATER DEPARTMENT



Location and physiography of Philadelphia, Pennsylvania

Base from U.S. Geological Survey Philadelphia County, 1982

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

EXPLANATION

—200— WATER-TABLE CONTOUR—Shows altitude of water table. Dashed where approximately located. Contour intervals 5, 10, and 20 feet. National Geodetic Vertical Datum of 1929

● 4.7 / 8–76 HYDRAULIC HEAD—Altitude of water level measured in cased hole and month and year of observation (underscored)

○ 50.0 / 00–25 HYDRAULIC HEAD—Altitude of water level reported in cased hole and month and year of observation (underscored)

o −3.4 / 3–71 HYDRAULIC HEAD—Altitude of water level reported in uncased hole and month and year of observation (underscored)

■ −6.4 / 11–78 HYDRAULIC HEAD—Altitude of drain field and month and year of water-level observation (underscored)

Notes:
(1) <31.0 denotes water-level altitude less than value shown
(2) Unknown month of observation denoted by 00; ≤30 denotes observation was made prior to year shown.

UNIT CONVERSION FACTORS

Data given in this report are in inch-pound units. To convert to the International System of Units (SI), the following factors are used:

Multiply inch-pound unit	By	To obtain SI unit
foot	0.3048	meter
mile	1.609	kilometer
million gallons per day	0.04381	cubic meter per second
square mile	2.590	square kilometer

INTRODUCTION

The water table in Philadelphia, Pennsylvania, is the upper surface of the ground-water reservoir in several aquifers including the Wissahickon Formation in its outcrop area, the upper sand unit of the Potomac-Raritan-Magothy aquifer system, the "Trenton gravel", and Holocene sediments. The shape of this surface depends primarily on aquifer hydraulic properties, recharge, and discharge.

The purpose of this report is to present a water-table map of Philadelphia and to describe the geologic units that comprise the unconfined aquifer system, water movement within them, the shape of the water table and how man's activities affect it, and possible uses of the map.

The map was prepared from 577 measured and reported water-table levels. Surface-water features, topography, and water-level measurements made between 1976-80 in 358 cased test borings and 102 cased water wells, and the altitude of the Veteran's Stadium drainage system provided primary control for contouring. Reported water levels, mostly prior to 1976 for 105 cased wells and 11 uncased test borings provided secondary control, and were plotted only if pumpage, and therefore, water levels in those areas have remained relatively invariant with time. Additional data on ground-water levels are given in a companion report (Paulachok and others, 1984).

DESCRIPTION OF AREA

The city of Philadelphia has an area of 134.6 square miles in the Coastal Plain and Piedmont physiographic provinces of southeastern Pennsylvania. The Coastal Plain of Pennsylvania occupies a narrow band along the Delaware River. Land-surface altitudes range from sea level to approximately 40 feet at the Fall Line, the landward edge of the Coastal Plain. The Piedmont lies northwest of the Fall Line at altitudes from 40 feet to more than 400 feet.

Philadelphia is densely populated and extensively urbanized. According to the U.S. Census, the population in 1980 was 1.7 million, or approximately 12,600 persons per square mile. Residential neighborhoods and commercial and industrial sites account for 74 percent of the area, whereas the remainder is used for recreation and resource production (Segal, D., Philadelphia City Planning Commission, oral commun., 1982).

Municipal water supply and wastewater treatment facilities serve Philadelphia. Surface waters are the sole source of the municipal supply. On the average, about 356 million gallons per day are withdrawn nearly equally from the Delaware and Schuylkill Rivers, principally for industrial and domestic uses. Nearly 8 million gallons of ground water are withdrawn daily by municipal and private concerns, mainly for site dewatering and industrial uses. A 3,000-mile network of sewers transports waste surface and ground waters to three treatment plants. Ultimately, treated wastewater is discharged to the Delaware River.

DESCRIPTION OF AQUIFERS

Philadelphia is underlain by crystalline rocks and by the younger unconsolidated sediments of the Coastal Plain. The crystalline rocks, chiefly of the Wissahickon Formation of Late Proterozoic and early Paleozoic age, crop out in the Piedmont and their surface slopes southeastward, forming the basement beneath the Coastal Plain sediments. The deepest Coastal Plain sediments in ascending order are the Potomac Group and Raritan and Magothy Formations of Cretaceous age, which form the Potomac-Raritan-Magothy aquifer system. The Potomac-Raritan-Magothy aquifer system has been subdivided into the following units: lower sand, lower clay, middle sand, middle clay, upper sand, and upper clay. Generally, the Cretaceous sediments are overlain by Pleistocene sediments, chiefly the informally-named "Trenton gravel" (as used by Owens and Minard, 1979), which in turn may be veneered by fine-grained Holocene sediments.

The Potomac-Raritan-Magothy aquifer system is the stratigraphic equivalent of the Raritan Formation, and the Trenton gravel is the equivalent of Pleistocene sediments of Wisconsin age described by Greenman and others (1961) in their report on the ground-water resources of the Philadelphia area.

The water table occurs within the geologic units that comprise the unconfined aquifer system. This system has two principal components: (1) The Wissahickon Formation in its outcrop area; and (2) unconsolidated sediments including the upper sand unit of the Potomac-Raritan-Magothy aquifer system, the Trenton gravel, and Holocene sediments. Water levels presented in this report represent conditions specifically in these geologic units.

The Wissahickon Formation consists chiefly of schist that is believed to represent a thick accumulation of arkosic and argillaceous sediments that were metamorphosed into dense hard foliated rock. These rocks typically exhibit well-developed cleavage and jointing.

The upper sand unit of the Potomac-Raritan-Magothy aquifer system is composed of medium to coarse sand and minor amounts of very fine to fine sand. In parts of south Philadelphia, the upper sand unit attains a thickness of over 50 feet, but generally the thickness does not exceed 35 feet (Greenman and others, 1961, p.42).

The Trenton gravel consists of sand and gravel and minor amounts of clay. The water-bearing properties of the sediments vary greatly from place to place according to their thickness and physical character. The Trenton gravel attains a maximum thickness of about 80 feet; the typical thickness, however, is about 40 feet (Greenman and others, 1961, p.44).

The Holocene sediments are composed of mud, silt, and fine sand. These sediments are nearly 80 feet thick in parts of south Philadelphia near the Delaware and Schuylkill Rivers, but elsewhere the thickness rarely exceeds 28 feet, and is usually less than 10 feet (Greenman and others, 1961, p.48).

In the outcrop area of the Wissahickon Formation, ground water commonly occurs under unconfined conditions in openings along bedding and schistosity planes, and fractures.

In Philadelphia, the upper clay unit of the Potomac-Raritan-Magothy aquifer system has limited areal extent. Consequently, the upper sand unit commonly forms a hydraulically continuous unit with the overlying Trenton gravel and Holocene sediments, and these three geologic units function as a single aquifer. The Holocene sediments are generally much less permeable than the underlying sediments and locally may constitute a leaky confining bed.

RECHARGE AND DISCHARGE

The unconfined aquifers are recharged by precipitation, surface-water sources, and leakage from sewers and water pipes. Fifty-two percent of the collector system consists of brick sewers which commonly have deteriorated mortar joints. When the water table is below the sewers, leakage from sewers adds to recharge. The quantity of such leakage, however, is unknown. Leakage from water pipes averages about 80 million gallons per day (Romano, R., City of Philadelphia Water Department, oral commun., 1982) and provides some additional recharge, although most of this leakage is thought to infiltrate directly into sewers that lie beneath the water pipes.

Water from the unconfined aquifers discharges to the atmosphere and to surface-water bodies and deeper aquifers. Local infiltration to sewers and withdrawals for site dewatering also drain the aquifers. When the water table is above the sewers, ground water drains into them through cracks and defective joints. Infiltration to sewers averages about 135 million gallons per day during periods of high water table (City of Philadelphia Water Department, 1975, sec. 13). Continuous dewatering of tunnels for three subway systems and pumping of sumps for foundation dewatering in central and south Philadelphia removes about 3.6 million gallons daily and controls water-table levels within the area of dewatering influence.

THE WATER TABLE

The water table in Philadelphia is represented by the contour map. The map shows the water table as of 1976-80, and is based principally on measurements made during that period.

The accuracy of the water-table contours is such that 80 percent of all water-table levels can be expected to fall within one-half of the contour interval except in areas of very high topographic relief.

In unstressed ground-water systems, the water-table profile generally resembles the land-surface profile. Consequently, the altitude of the water table is highest under the highest areas of land surface, such as hilltops and ridges, and is lowest in valleys where it may intersect the land surface at streams, ponds, or marshes. In Philadelphia, however, the altitude and shape of the water table has been altered significantly by human activities. Water-table levels throughout much of the area are influenced more by dewatering and leakage from sewers and water pipes than by topography; consequently, short-term and seasonal fluctuations are dampened to a narrow range in areas affected by dewatering and leakage.

Although pumpage and water-table levels were fairly stable during 1976-80, any significant change in the location or intensity of pumping can cause a commensurate change in the altitude and shape of the water table. The altitude of the water table can also change when leaky brick sewers are replaced by relatively watertight sewers constructed of other materials.

Several prominent hydrologic features in south Philadelphia are shown on the map. The widespread area of negative head results from pumping, principally in New Jersey, from the lower sand unit of the Potomac-Raritan-Magothy aquifer system. This sustained withdrawal has produced significant vertical differences in head between aquifers. Due to these head differences, water flows downward from the unconfined aquifers through the intervening clay units to the lower sand unit, causing head to decline locally below sea level in the unconfined aquifers. Where ground-water levels are lower than surface-water levels, streams commonly lose water to the aquifers.

Two localized cones of depression are also shown. The cone near Greenwich Point results from intensive pumping of the Coastal Plain aquifers by local industries; consequently, heads in observation wells have been lowered to approximately 20 feet below sea level. The cone near Eastwick is caused by several factors including ground-water flow to sewers and pumping of nearby dewatering wells, and is also influenced by the water level in Mingo Creek, which is continually maintained by pumping at about 6 feet below sea level. An earthen dam at the mouth of Mingo Creek hydraulically separates the Creek from the Schuylkill River, in which water levels average about 1 foot above sea level.

The elongated mound north of the U. S. Naval Base is about 10 feet above the regional water table and may be due to hydraulic effects produced by underlying low-permeability layers, or caused by leakage from sewers and water pipes.

Beyond the area of negative head, ground-water levels are typically at or above water-surface levels in adjoining streams, so that most streams receive ground-water discharge. Tidal streams receive ground-water discharge during low tide when stream levels are lower than ambient ground-water levels; some surface water flows to aquifers, however, and is retained as bank storage during high tide when stream levels are higher than ambient ground-water levels.

POSSIBLE USES OF THIS REPORT

This map provides information on water-table levels useful in identifying the source of seepage to structures and for delineating areas of high water table that may cause excessive infiltration to sewers. The map may be used to estimate the depth of the water table at an excavation site by subtracting the local hydraulic head from the prevailing land-surface altitude. The map also provides information useful for determining flow directions (and therefore, paths followed by transported contaminants); for estimating aquifer hydraulic properties and the quantity of ground-water flow; and for locating recharge and discharge areas.

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WATER–TABLE MAP OF PHILADELPHIA, PENNSYLVANIA, 1976–1980

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