

In cooperation with the Pennsylvania Department of Environmental Protection

Selected Ground-Water-Quality Data in Pennsylvania— 1979-2006

Data Series 314

**U.S. Department of the Interior
U.S. Geological Survey**

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By Dennis J. Low, Douglas C. Chichester, and Linda F. Zarr

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U.S. Department of the Interior
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U.S. Geological Survey
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Conversion Factors, Datums, and Abbreviations

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi ²)	259.0	hectare (ha)
square mile (mi ²)	2.590	square kilometer (km ²)
Volume		
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m ³)
Radioactivity		
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C}=(^{\circ}\text{F}-32)/1.8$$

Horizontal coordinate information is referenced to either the North American Datum (NAD 1927) or the North American Datum of 1983 (NAD 83).

Water-Quality Units

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L). A milligram per liter is a unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water. One-thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million. Bacterial concentrations are reported in units of colonies per 100 milliliters (col/100 mL). Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C). Turbidity is reported in nephelometric turbidity units (NTU).

Radioactivity Units

A commonly used unit of measure for radioactivity is the picocurie. One Curie is the activity of one gram of radium-226, which is equal to 3.7×10^{10} atomic disintegrations per second; a picocurie is 10^{12} Curies, which is about equal to 2.2 atomic disintegrations per minute. Activity refers to the decay of a radioactive substance, which is measured by the number of particles emitted by a radionuclide per unit of time. The rate of decay is proportional to the number of atoms of a radioactive substance present, and inversely proportional to its half life, which is the time necessary for the substance to lose half its radioactivity. Activity is defined as being equal to $n \times I$, where n is the number of atoms of a radionuclide and I is the decay constant. The decay constant, I is equal to the natural logarithm of 2 divided by the half-life of the radionuclide.

Selected Abbreviations

305b – Pennsylvania Department of Environmental Protection 305b Network

Act537 – Pennsylvania Department of Environmental Protection Act 537

CV – Borough of Carroll Valley

CCHD – Chester County Health Department

MCHD – Montgomery County Health Department

NCRO – Pennsylvania Department of Environmental Protection – North-Central Region Bureau of Water Supply Management

PADWIS – Pennsylvania Drinking Water Information System

FSN – Pennsylvania Department of Environmental Protection – Ambient and Fixed Station Network

PennAg – Pennsylvania Department of Agriculture

SCRO – Pennsylvania Department of Environmental Protection – South-Central Region Waste Management Section

PAGS – Pennsylvania Topographic and Geologic Survey

SRBC – Susquehanna River Basin Commission

USEPA – U.S. Environmental Protection Agency

USGS – U.S. Geological Survey

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Abstract

This study, by the U.S. Geological Survey (USGS) in cooperation with the Pennsylvania Department of Environmental Protection (PADEP), provides a compilation of ground-water-quality data for a 28-year period (January 1, 1979, through December 31, 2006) based on water samples from wells and springs. The data are from 14 source agencies or programs—Borough of Carroll Valley, Chester County Health Department, Montgomery County Health Department, Pennsylvania Department of Agriculture, Pennsylvania Department of Environmental Protection 2002 Pennsylvania Water-Quality Assessment, Pennsylvania Department of Environmental Protection Agency Act 537 Sewage Facilities Program, Pennsylvania Department of Environmental Protection-Ambient and Fixed Station Network, Pennsylvania Department of Environmental Protection-North-Central Region, Pennsylvania Department of Environmental Protection-South-Central Region, Pennsylvania Drinking Water Information System, Pennsylvania Topographic and Geologic Survey, Susquehanna River Basin Commission, U.S. Environmental Protection Agency, and the U.S. Geological Survey. The ground-water-quality data from the different source agencies or programs varied in type and number of analyses; however, the analyses are represented by 11 major analyte groups: antibiotics, major ions, microorganisms (bacteria, viruses, and other microorganisms), minor ions (including trace elements), nutrients (predominantly nitrate and nitrite as nitrogen), pesticides, pharmaceuticals, radiochemicals (predominantly radon or radium), volatiles (volatile organic compounds), wastewater compounds, and water characteristics (field measurements, predominantly field pH, field specific conductance, and hardness). For the USGS and the PADEP-North-Central Region, the pesticide analyte group was broken down into fungicides, herbicides, and insecticides.

Summary maps show the areal distribution of wells and springs with ground-water-quality data statewide by source agency or program. Summary data tables by source agency or program provide information on the number of wells and springs and samples collected for each of the 35 watersheds and analyte groups.

The number of wells and springs sampled for ground-water-quality data varies considerably across Pennsylvania. Of the 24,772 wells and springs sampled, the greatest concentration of wells and springs is in the southeast (Berks, Bucks, Chester, Delaware, Lancaster, Montgomery, and Philadelphia Counties) and in the northwest (Erie County). The number of wells and springs sampled is relatively sparse in north-central (Cameron, Elk, Forest, McKean, Potter, and Warren Counties) Pennsylvania. Little to no data are available for approximately one-fourth of the state. Nutrients and water characteristics were the most frequently sampled major analyte groups—43,025 and 30,583 samples, respectively. Minor ions and major ions were the next most frequently sampled major analyte groups—26,972 and 13,115 samples, respectively. For the remaining 10 major analyte groups, the number of samples collected ranged from a low of 24 samples (antibiotic compounds) to a high of approximately 4,674 samples (microorganisms).

The number of samples that exceeded a maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL) by major analyte group also varied. Of the 4,674 samples in the microorganism analyte group, 50.2 percent had water that exceeded an MCL. Of the 4,528 samples collected and analyzed for volatile organic compounds, 23.5 percent exceeded an MCL. Other major analyte groups that frequently exceeded MCLs or SMCLs included major ions (18,343 samples and a 27.7 percent exceedence), minor ions (26,972 samples, 44.7 percent exceedence), pesticides (4,868 samples, 0.7 percent exceedence), water characteristics (30,583 samples, 19.3 percent exceedence), and radiochemicals (1,866 samples, 9.6 percent exceedence). Samples collected and analyzed for antibiotics (24 samples), fungicides (1,273 samples), herbicides (1,470 samples), insecticides (1,424 samples), nutrients (43,025 samples), pharmaceuticals (28 samples), and wastewater compounds (328 samples) had the lowest exceedences of 0.0, 2.4, 1.2, <1.0, 8.3, 0.0, and <1.0 percent, respectively.

Introduction

Ground-water-quality data have been collected in Pennsylvania for more than 100 years. Unfortunately, most data are confined to paper copies, and it is prohibitively expensive to compile the data. However, with the advent of computers and increased storage capacities, most recent (since about 1980) data now reside in electronic databases, making access less expensive. By compiling the electronic data from local, state, and Federal agencies, it may be possible to identify areas where (1) data are sparse and further studies of ground-water quality may be needed, and (2) ground water contains analytes of concern at elevated concentrations.

In 2001, the Pennsylvania Department of Environmental Protection (PADEP) re-oriented its resource-management and

planning strategy to a watershed, as opposed to a political boundary, approach. With this watershed-focused approach, PADEP established 35 watershed teams (fig. 1 and table 1) to address 17 indicators of environmental improvement at a watershed scale.

Pennsylvania is a physiographically and geologically diverse state. Over 200 different geologic formations or members are recognized by the Pennsylvania Topographic and Geologic Survey (PAGS). For this study, geologic formations were consolidated into 13 major aquifer categories on the basis of dominant rock type or geolithologies (table 2). Even with this simplified categorization, however, geology extends beyond watershed and political boundaries (figs. 2 and 3).

This report provides geologic, hydrologic, and geographic information regarding electronically available ground-

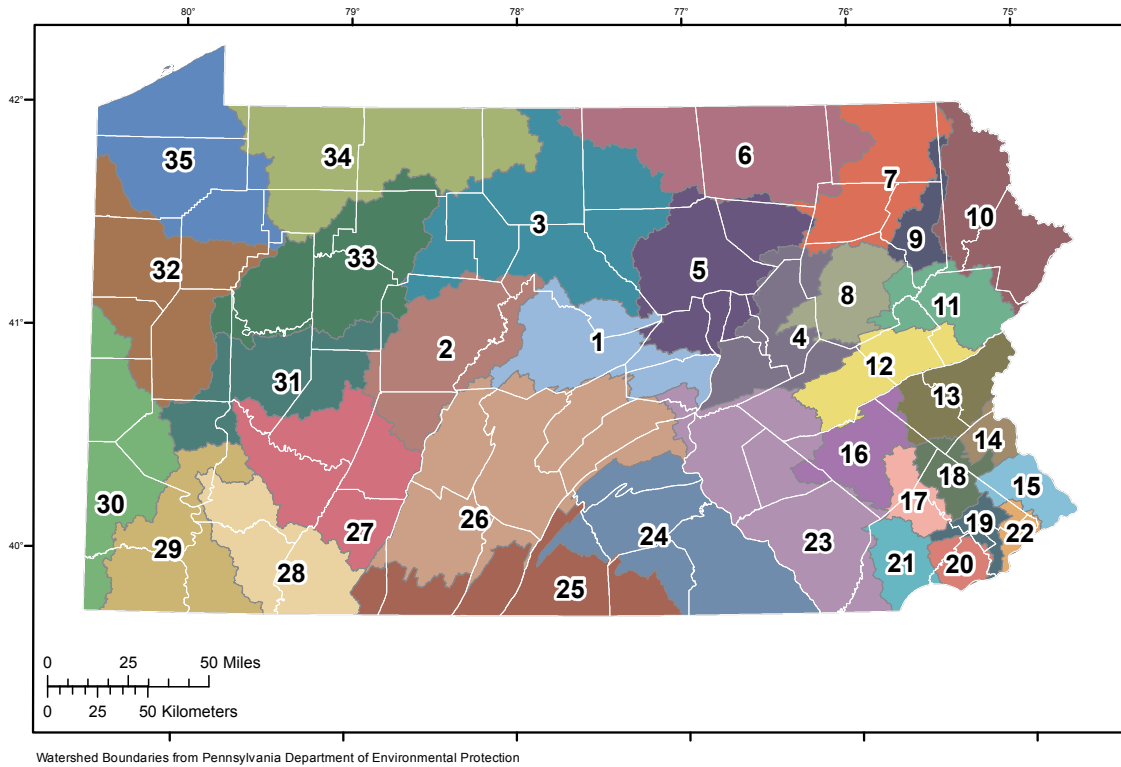


Figure 1. The 67 counties in Pennsylvania and boundaries of the 35 watersheds used by Pennsylvania Department of Environmental Protection to subdivide Pennsylvania for resource management (see table 1 for watershed names) (modified from Pennsylvania Department of Environmental Protection, 2005).

Table 1. The 35 watersheds used by Pennsylvania Department of Environmental Protection to subdivide Pennsylvania for resource management.

Watershed number	Watershed name
1	Central Penn
2	Upper West Branch
3	Susquehannock/Genessee
4	Lower North Branch Susquehanna
5	Big Bend
6	Bradford/Tioga
7	Upper Susquehanna
8	Wyoming Valley
9	Lackawanna
10	Upper Delaware
11	Brodhead/Toby/Tunk
12	Upper Schuylkill/Middle Lehigh
13	Lower Lehigh
14	Delaware River/Tohickon Creek
15	Delaware Common Tributaries/Neshaminy
16	Middle Schuylkill
17	French/Manatawny
18	Perkiomen Creek
19	Wissahickon Creek/Schuylkill River
20	Darby/Chester/Ridley/Crum Creeks
21	Christina River/Elk/North East River/Brandywine Creek/White Clay
22	Pennypack/Tacony
23	Lower Susquehanna East
24	Lower Susquehanna West
25	Potomac
26	Juniata
27	Kiski-Conemaugh
28	Youghiogheny
29	Monongahela
30	Ohio
31	Allegheny
32	Moraine
33	Middle Allegheny
34	Upper Allegheny
35	Lake Erie/French & Oil Creek

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Table 2. The 13 dominant geolithologies and rock-type categories with abbreviations used for this data compilation.

Dominant geolithology	Geo- abbreviation	Dominant rock type
Anthracite coal	acoal	Anthracite coal bearing
Bituminous coal	bcoal	Bituminous coal bearing
Dark crystalline	dkcrys	Intrusive crystalline rocks that are dark in color (for example, diabase)
Light crystalline	lrcrys	Intrusive crystalline rocks that are light in color (for example, granite)
PreCambrian/Ordovician carbonates	pocarb	Precambrian- through Ordovician-age limestones and dolomites (with or without minor siliciclastics)
Quartzite, sandstone, or conglomerate	qscong	Quartz rich, dominantly sedimentary rocks (for example, Tuscarora Formation)
Red sedimentary	redsed	Rocks that are dominantly red in color, excludes Triassic age sediments (for example, Catskill Formation)
Schist	schist	A strongly foliated crystalline rock, formed by dynamic metamorphism, that has a dominant cleavage plane due to well developed parallelism of the minerals (for example, Marburg Schist)
Silurian/Devonian carbonates	sdcarb	Silurian- through Devonian-age limestones and dolomites (with or without minor siliciclastics)
Shale	shale	Dark, fine-grained, sedimentary rocks (for example, Hamilton Group)
Triassic sedimentary	trised	Sedimentary rocks that are Triassic in age (for example, Gettysburg Formation)
Unconsolidated	uncon	Gravels, sands, and clays along the Coastal Plain and Delaware River (for example, Trenton Gravel)
Glacial outwash	ice	Dominantly sand and gravel that were deposited by glaciers or associated fluvial action (for example, outwash)

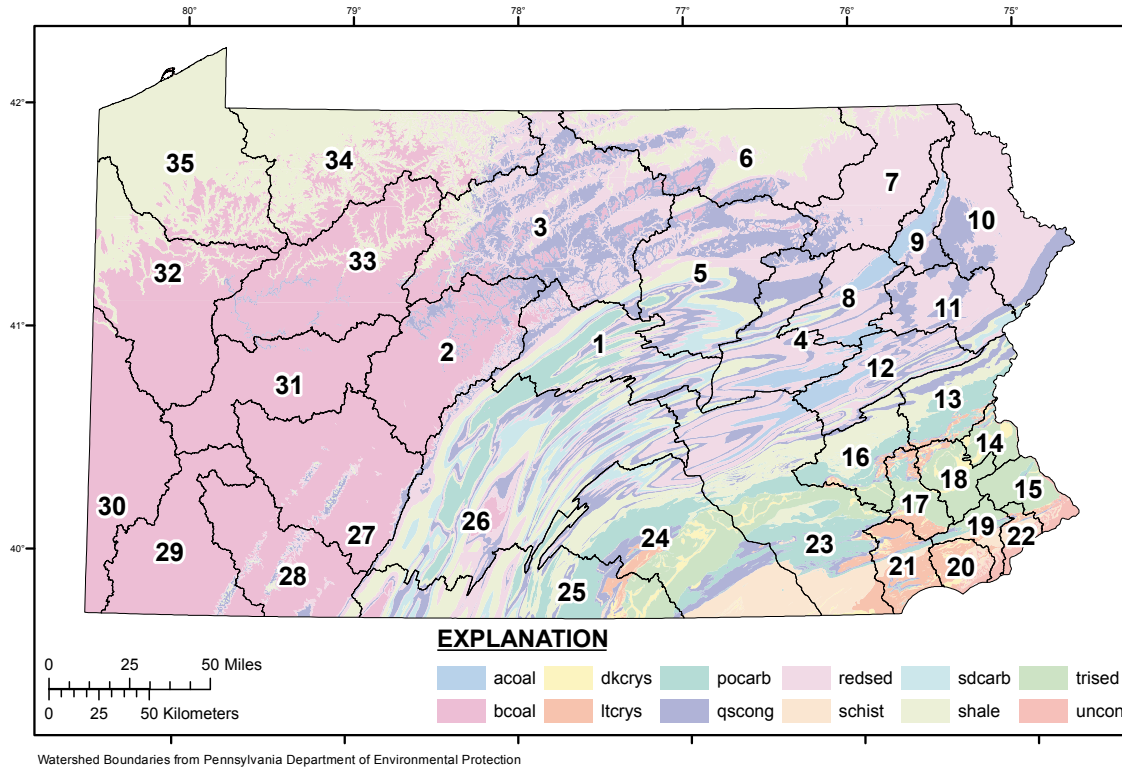


Figure 2. Dominant geolithology (excludes Glacial outwash or “Ice”) and boundaries of the 35 watersheds used by Pennsylvania Department of Environmental Protection to subdivide Pennsylvania for resource management. (Explanation of lithology codes provided in table 2.)

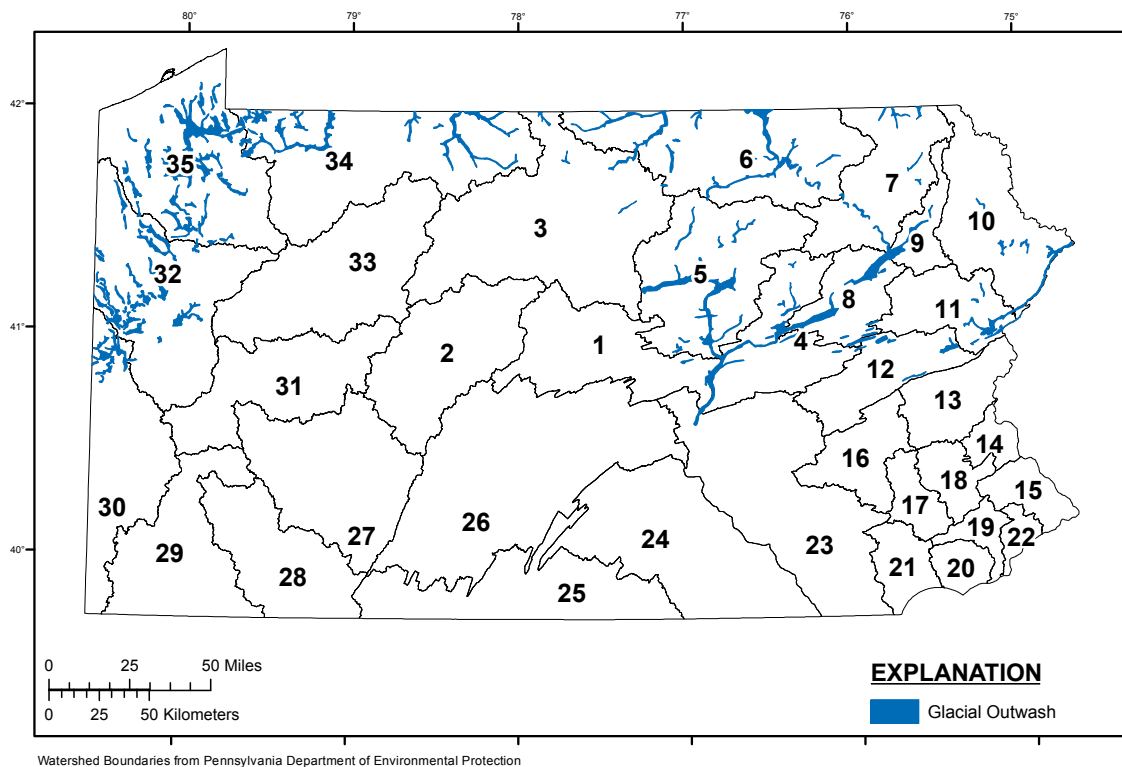


Figure 3. Extent of glacial outwash or “Ice” geolithology and boundaries of the 35 watersheds used by Pennsylvania Department of Environmental Protection to subdivide Pennsylvania for resource management (modified from Sevon and Braun, 2000).

water-quality data in the Commonwealth of Pennsylvania on watershed and statewide scales. This report builds on an earlier effort by Low and Chichester (2006) that incorporated ground-water-quality data from January 1, 1979, through August 11, 2004. This report presents ground-water-quality data from 14 local, state, or Federal source agencies or programs in a standard electronic format. The geographic distribution of the data in the state is presented for each agency or program. Ancillary information, including local well numbers and major geolithologic units, are included by well for each source agency or program. More detailed information, specifically the aquifer sampled and the original scientific or data report in which the water-quality data were released, is provided for individual wells and springs sampled as part of various U.S. Geological Survey (USGS) studies or investigations.

Data-Compilation Methods

The compiled ground-water-quality data vary by (1) number of constituents, (2) frequency of sample collection, (3) source agency or program, and (4) geographic distribution. For example, the Borough of Carroll Valley collects water-quality data on bacteria and nutrients from selected wells within the Borough once every 10 years. The PADEP Ambient and Fixed Station Network (FSN) collects water-quality data (major ions, minor ions, trace elements, and nutrients) from across the state at individual wells. Although the USGS collects ground-water-quality samples across the state, the geographic distribution may vary from several wells at a field research site to a large number of wells in major river basins. A specific contaminant of concern, such as arsenic, may lead to a geographic distribution that is confined to specific geologic formations and members. Geographic distribution of data collection also may be restricted to areas with certain land uses.

Data Sources

Despite the widespread use of computers and related software, electronic archival or storage of ground-water-quality data is limited when compared to what is available in hard copy. Many local and county agencies as well as universities contacted for this study still maintain paper copies as the final repository format for ground-water-quality data, making the data inaccessible for widespread dissemination and data analysis.

The bulk of the ground-water-quality data presented in this report were presented in Low and Chichester (2006). Following publication of that report, new data files were obtained from the PADEP 2002 Pennsylvania Water-Quality Assessment (305b), the PADEP Act 537 Sewage Facilities Program (Act537), the PADEP North-Central Regional Office (NCRO) Water Supply Management Program, the PADEP South-Central Regional Office (SCRO) Waste Management Program, the

PAGS, the U.S. Environmental Protection Agency (USEPA), and USGS projects conducted in 2005 and 2006. Data from state and Federal agencies or programs dominate the data presented in this report. Information on the source of the ground-water-quality data collected for this and the previous report and reasons for data collection are presented in table 3.

About every 10 years, as part of their Act 537 Sewage Facilities Program (Carl Bower, Borough of Carroll Valley, oral commun., 2004), the Borough of Carroll Valley (CV) evaluates the effectiveness of the community's onlot septic systems. This is done by collecting water-quality samples from domestic wells for analysis of nitrate as nitrogen and bacteria (fecal and total coliform). CV tries to obtain a representative sample from about 10 percent of the domestic wells.

Since 1984, the Chester County Health Department (CCHD) has required that recently drilled and completed domestic wells be sampled and tested for a fixed group of analytes. Although the number of analytes tested is extensive, only a small part of the data is stored electronically (water characteristics, major ions, and nutrients).

Since February 1, 1997, the Montgomery County Health Department (MCHD) has required that recently drilled and completed domestic wells be sampled and tested for a fixed group of analytes. These analytes include bacteria, water characteristic, major ions, minor ions, nutrients, trace elements, volatile organic compounds, and wastewater compounds.

The Pennsylvania Department of Agriculture (PennAg) has long been interested in monitoring for pesticides in ground water. As a result, PennAg has sampled wells in agricultural areas to determine occurrence and distribution of pesticides in ground water; the most recent sampling was directed at an assessment of concentration trends.

Section 305(b) of the Federal Clean Water Act requires states, territories, interstate basin commissions, and some tribes to submit a biennial report on water-quality conditions and their water-quality management program. The PADEP 2002 Pennsylvania Water-Quality Assessment, also known as the 305(b) report, is transmitted to USEPA Region III on even-numbered years. The nutrient data collected for the 305b report were collected for various water-quality-management programs throughout the state.

The Act 537 Sewage Facilities Program requires local or joint-local agencies to manage the permitting program for individual onlot disposal systems and community onlot systems with design flows of 10,000 gal per day or less. The nutrient and microorganism data collected for this program are used to correct existing sewage-disposal problems and prevent future problems.

PADEP is charged with determining the ambient ground-water quality of water in Pennsylvania. PADEP addresses this effort through the FSN. The FSN consists of a large number of wells in selected basins generally in the eastern or western parts of Pennsylvania.

The NCRO collects water-quality data (biological, field, major ions, minor ions, trace elements, nutrients, volatile organic compounds, pesticides, and radiochemicals) as part

Table 3. Data sources and reason(s) for data collection.

Data sources	Source abbreviation	Reason(s) for data collection
Borough of Carroll Valley	CV	Act 537 (sewage facilities program)
Chester County Health Department	CCHD	Permitting of domestic wells
Montgomery County Health Department	MCHD	Permitting of domestic wells
Pennsylvania Department of Agriculture	PennAg	Pesticides in ground water
Pennsylvania Department of Environmental Protection—2002 Pennsylvania Water-Quality Assessment	305b	Section 305b of the Federal Clean Water Act requiring a biennial report on water-quality conditions and water-quality management programs
Pennsylvania Department of Environmental Protection—Act 537 Sewage Facilities Program	Act537	Permitting for individual onlot disposal systems and community onlot systems
Pennsylvania Department of Environmental Protection—Ambient and Fixed Station Network	FSN	Monitoring of ground-water quality by ground-water basin
Pennsylvania Department of Environmental Protection—North-Central Region	NCRO	Monitoring of ground-water quality prior to permitting of well or spring
Pennsylvania Department of Environmental Protection—South-Central Region	SCRO	Monitoring of ground-water quality near landfills via upgradient wells
Pennsylvania Drinking Water Information System	PADWIS	Permitting of public and non-community wells (self-reporting system)
Pennsylvania Topographic and Geologic Survey	PAGS	County-wide ground-water resources study
Susquehanna River Basin Commission	SRBC	Permitting of public, industrial, and commercial water-supply wells
U.S. Environmental Protection Agency	USEPA	Various water-quality, water-resource, and hydrogeologic investigations
U.S. Geological Survey	USGS	Various water-resources and water-quality studies

of their community and non-community well-compliance requirements. The water-quality data are collected during long-term (24- to 48-hour) discharge or aquifer tests prior to permitting of the well or spring.

The SCRO has collected ground-water-quality data (field, major ions, minor ions, trace elements, nutrients, volatile organic compounds, pesticides, and wastewater) as part of their monitoring of hazardous sites and landfills. The 20 wells included in this report are upgradient of their respective monitoring sites and provide information on long-term changes in ground-water quality and chemistry. The frequency of the data collection varies from annually to quarterly, with a period of record as great as 20 years.

PADEP also is responsible for assessments of ground-water quality for community and non-community water systems to determine whether ground water meets the primary drinking-water standards. One method utilized by PADEP to meet this directive is through the Pennsylvania Drinking Water Information System (PADWIS). Through PADWIS, raw (unfiltered) ground-water samples are collected from non-private wells and submitted to private water-quality labs for analysis. The resulting data are then reviewed and entered into PADWIS.

The PAGS collected ground-water-quality data (field, major ions, minor ions, and nutrients) as part of a county-wide ground-water resources study of Somerset County. Data were collected at 207 wells and springs throughout the county.

The Susquehanna River Basin Commission (SRBC) issues permits for large supply wells (wells that yield more than 100,000 gal per day). Water-quality data are a part of the data that SRBC collects.

The USEPA Storage and Retrieval database (STORET) known as Legacy began archiving data in 1960 and ended on December 31, 1998. The data were collected by state environmental groups, USEPA, other Federal agencies, universities, and citizens and consisted of water quality, biological, and physical data for surface and ground water. The quality of the data in Legacy is undocumented.

The USGS has collected data through various water-resources and water-quality studies. Much of the data reported in Low and Chichester (2006) was obtained from analysis of water samples from domestic wells. The USGS project work conducted in 2005 and 2006 concentrated on the presence of arsenic in the ground water of eight northern-tier counties—Potter, Tioga, Bradford, Susquehanna, Wayne, Pike, Sullivan, and Wyoming. The study by Low and Galeone (2007) was driven by (1) increased recognition of the health risks associ-

ated with arsenic, (2) a reduction of the USEPA Maximum Contaminant Level (MCL) from 50 to 10 µg/L (U.S. Environmental Protection Agency, 2001), and (3) previous work (Williams and others, 1998) that indicated arsenic commonly was found in ground water.

Categories of Analytes

The source-agency data files are subdivided into 11 analyte groups described below. These analyte groups represent subfiles or folders. Some source agency or program files, such as the CV, consisted of two subfiles—microorganisms and nutrients. Others, like the USGS, consisted of 13 subfiles. Because some source agencies such as the USGS collect a large amount of pesticide data, it was necessary to further divide this analyte group into fungicides, herbicides, and insecticides.

- Antibiotics—Antibiotic group. Tetracycline and erythromycin are among the most common analytes.

Source agency—USGS: 28 analytes; 24 samples
(0 samples exceeded an MCL)

- Major Ions—Major cations and anions group. Chloride, calcium, and iron are among the most common analytes.

Source agency—MCHD: 4 analytes; 971 samples
(357 samples exceeded an MCL)

Source agency—FSN: 11 analytes; 10,591 samples
(2,380 samples exceeded an MCL; 2,509 samples exceeded an SMCL)

Source agency—NCRO: 14 analytes; 330 samples
(132 samples exceeded an MCL; 108 samples exceeded an SMCL)

Source agency—SCRO: 16 analytes; 637 samples
(335 samples exceeded an MCL; 424 samples exceeded an SMCL)

Source agency—PAGS: 10 analytes; 207 samples
(0 samples exceeded an MCL; 130 samples exceeded an SMCL)

Source agency—SRBC: 8 analytes; 724 samples
(187 samples exceeded an SMCL)

Source agency—USEPA: 33 analytes; 8,420 samples
(413 samples exceeded an MCL; 3,313 samples exceeded an SMCL)

Source agency—USGS: 31 analytes (including filtered and unfiltered); 5,269 samples
(5 samples exceeded an MCL; 1,812 samples exceeded an SMCL)

- Microorganisms—Bacteria, viruses, and other microorganisms group. Total coliform and fecal coliform are the most common bacteria analyzed. Enteric and coliphage are the most common viruses analyzed. *Clostridium* and enterococci are some of the other microorganisms analyzed.

Source agency—CV: Total and fecal bacteria; 124 samples
(23 samples exceeded an MCL)

Source agency—MCHD: Total, fecal, and *Escherichia coli* (*E. coli*) bacteria; 971 samples
(412 samples exceed MCL)

Source agency—PennAg: Total and *E. coli* bacteria; 269 samples
(160 samples exceeded an MCL)

Source agency—Act537: Total and fecal bacteria; 162 samples
(157 samples exceeded an MCL)

Source agency—NCRO: Total, fecal, *giardia lamblia*, and *Cryptosporidium*; 324 samples
(149 samples exceeded an MCL)

Source agency—PADWIS: Total, fecal, and *E. coli* bacteria; 360 samples
(91 samples exceeded an MCL)

Source agency—USEPA: Total, fecal, and streptococci bacteria; 1,188 samples
(538 samples exceeded an MCL)

Source agency—USGS: 13 methods or organisms including viruses; 1,356 samples
(934 samples exceeded an MCL)

- Minor Ions—Minor cations, anions, and trace elements group. Aluminum, arsenic, and lead are common analytes.

Source agency—MCHD: 4 analytes (trace elements); 75 samples
(9 samples exceeded an MCL)

Source agency—FSN: 8 analytes (trace elements); 7,675 samples
(571 samples exceeded an MCL; 16 samples exceeded an SMCL)

Source agency—NCRO: 16 analytes; 322 samples
(14 samples exceeded an MCL; 121 samples exceeded an SMCL)

Source agency—SCRO: 29 analytes; 232 samples
(25 samples exceeded an MCL; 128 samples exceeded an SMCL)

- Source agency—PADWIS: 12 analytes; 36 samples (26 samples exceeded an MCL)
- Source agency—PAGS: 8 analytes; 120 samples (15 samples exceeded an MCL; 33 samples exceeded an SMCL)
- Source agency—SRBC: 6 analytes (trace elements); 706 samples (33 samples exceeded an MCL; 63 samples exceeded an SMCL)
- Source agency—USEPA: 34 analytes; 3,444 samples (486 samples exceeded an MCL; 743 samples exceeded an SMCL)
- Source agency—USGS: 49 analytes (including filtered and unfiltered); 3,662 samples (511 samples exceeded an MCL; 1,004 samples exceeded an SMCL)
- Nutrients—Nutrient group. Nitrate, nitrite, and total organic carbon are among the most common analytes.
 - Source agency—CV: Nitrate; 124 samples (3 samples exceeded an MCL)
 - Source agency—CCHD: Nitrate; 849 samples (19 samples exceeded an MCL)
 - Source agency—MCHD: Nitrate; 971 samples (31 samples exceeded an MCL)
 - Source agency—PennAg: Nitrate, nitrite; 269 samples (92 samples exceeded an MCL)
 - Source agency—305b: Nitrate; 10,926 samples (155 samples exceeded an MCL)
 - Source agency—Act537: Nitrate; 4,124 samples (650 samples exceeded an MCL)
 - Source agency—FSN: 5 analytes; 10,594 samples (993 samples exceeded an MCL)
 - Source agency—NCRO: 4 analytes; 314 samples (5 samples exceeded an MCL)
 - Source agency—SCRO: 6 analytes; 613 samples (3 samples exceeded an MCL)
 - Source agency—SRBC: Nitrate, orthophosphate, and total organic carbon; 702 samples (41 samples exceeded an MCL)
 - Source agency—PAGS: Nitrate; 206 samples (8 samples exceeded an MCL)
 - Source agency—USEPA: 28 analytes (including filtered and unfiltered); 6,042 samples (905 samples exceeded an MCL)
 - Source agency—USGS: 28 analytes (including filtered and unfiltered); 7,488 samples (680 samples exceeded an MCL)
 - Pesticides—Pesticide group. Atrazine, Cyanazine, and Simazine are among the most common analytes.
 - Source agency—PennAg: 10 analytes; 273 samples (7 samples exceeded an MCL)
 - Source agency—SCRO: 65 analytes; 6 samples (0 samples exceeded an MCL)
 - Source agency—PADWIS: Carbofuran, and 2,4-D; 2 samples (0 samples exceeded an MCL)
 - Source agency—USEPA: 22 analytes; 371 samples (5 samples exceeded an MCL)
 - Fungicide—Fungicide group. Chlorothalonil and cis-1,3-Dichloropropane are the most common analytes.
 - Source agency—NCRO: DBCP, hexachlorobenzene; 67 samples (1 sample exceeded an MCL)
 - Source agency—USGS: 17 analytes (including filtered and unfiltered); 1,215 samples (15 samples with detection levels greater than the MCL)
 - Herbicide—Herbicide group. Atrazine, Alachlor, and Cyanazine are among the most common analytes.
 - Source agency—NCRO: 12 analytes; 69 samples (2 samples exceeded an MCL)
 - Source agency—USGS: 152 analytes (including filtered and unfiltered); 1,431 samples (16 samples exceeded an MCL)
 - Insecticide—Insecticide group. Carbaryl, Dieldrin, and Lindane are among the most common analytes.
 - Source agency—NCRO: 10 analytes; 69 samples (1 sample exceeded an MCL)
 - Source agency—USGS: 108 analytes (including filtered and unfiltered); 1,365 samples (4 samples exceeded an MCL)

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- **Pharmaceuticals—Pharmaceutical group.** Acetaminophen and codeine are among the most common analytes.
Source agency—USGS: 13 analytes; 28 samples (0 samples exceeded an MCL)
- **Radiochemicals—Radiochemicals (radionuclides) group.** Radon-222 and uranium are the most common analytes.
Source agency—NCRO: 7 analytes (including gross alpha, gross beta, radon); 50 samples (21 samples exceeded an MCL)
Source agency—PADWIS: 6 analytes; 19 samples (12 samples exceeded an MCL)
Source agency—USEPA: 4 analytes; 137 samples (20 samples exceeded an MCL)
Source agency—USGS: 22 analytes (including filtered and unfiltered); 1,671 samples (128 samples exceeded an MCL)
- **Volatiles—Volatile organic compounds group.** Benzene, toluene, styrene, and xylenes are among the most common analytes.
Source agency—MCHD: 25 analytes; 971 samples (54 samples exceeded an MCL)
Source agency—NCRO: 43 analytes; 73 samples (14 samples exceeded an MCL)
Source agency—SCRO: 89 analytes; 561 samples (1 sample exceeded an MCL)
Source agency—PADWIS: 27 analytes; 183 samples (121 samples exceeded an MCL)
Source agency—USEPA: 70 analytes; 4,215 samples (1,959 samples exceeded an MCL)
Source agency—USGS: 105 analytes (including filtered and unfiltered); 1,331 samples (181 samples exceeded an MCL)
- **Wastewater—Wastewater and pharmaceuticals group.** Methylene blue active substance and caffeine are among the most common analytes.
Source agency—MCHD: Trihalomethanes; 5 samples (1 sample exceeded the MCL)
Source agency—SCRO: 13 analytes; 3 samples (0 samples exceeded an MCL)
- **Water characteristics—Field measurement group.** pH and specific conductance are the most common analytes.
Source agency—CCHD: Turbidity and pH; 833 samples (411 samples exceeded an MCL, 235 exceeded an SMCL)
Source agency—MCHD: pH; 971 samples (93 samples exceeded an SMCL)
Source agency—FSN: lab pH, lab alkalinity, and total hardness; 10,590 samples (1,843 samples exceeded an SMCL)
Source agency—NCRO: alkalinity, color, pH, total hardness, specific conductance; 329 samples (78 exceeded an SMCL)
Source agency—SCRO: alkalinity, bicarbonate, pH, specific conductance; 604 samples (149 samples exceeded an SMCL)
Source agency—PAGS: 7 analytes; 207 samples (62 samples exceeded an SMCL)
Source agency—SRBC: 4 analytes; 681 samples (101 samples exceeded an SMCL)
Source agency—USEPA: 21 analytes; 8,003 samples (3,184 samples exceeded an SMCL)
Source agency—USGS: 27 analytes; 8,471 samples (35 samples exceeded an MCL, 1,897 samples exceeded an SMCL)

Formats, Naming Conventions, and Abbreviations Used in Data Files

The appendix contains files for each data source. The data format is Microsoft Excel 2003 (Excel); supporting documents are in Portable Document Format (PDF). Each file is identified by the source agency and month and year (mm_YYYY) last modified. For example, the file prefixed MCHD contains information compiled from the Montgomery County Health Department. Each file contains a specific analyte group. For example, the Excel file titled MCHD.Volatiles.11_2005.xls contains the water-quality data for volatile organic compounds collected by the Montgomery County Health Department and the file or data were last modified or appended November 2005. Also included in this file are ancillary data such as local well number, site identifier (site ID), latitude, longitude, and

geolithologic unit. Information regarding an exceedence of a USEPA MCL or SMCL is presented in an adjacent column and cell. Analyte results for MCHD and CCHD also contain numeric qualifiers. Data files from the USGS also contain analyte remark codes such as less than, estimated, and missing, as well as information on the study for which the samples were collected. The USGS data files also contain a seven or eight length alphanumeric code that details a specific geologic formation or unit.

MCHD.Comments.Microorganisms.11_2005.pdf is a PDF file that provides supporting information on the water-quality measurements (in this case, information about bacteria and viruses), including analytes, definitions, and USEPA contaminant levels on samples collected by or for the Montgomery County Health Department.

USGS.CrossReferenceNumbers.09_2007.xls is an Excel table that presents the abbreviated author and report citation for the scientific or data report in which the data were originally published. This allows the interested reader a means to locate the study and determine the purpose for which the data were collected. It is an aid in locat-

ing the complete citation listed in the Selected References, which also lists the abbreviated report citation in bold. USGS.MicroorganismsReport.09_2007.xls is an Excel file that lists the abbreviated citations for bacteria and virus studies and includes local well numbers, site IDs, latitudes, longitudes, watersheds, geolithologic units, and geologic formations.

Maps and Tables Summarizing the Ground-Water-Quality Data

The maps generated for this study (accessed through hyperlinks in the appendix) are PDF images. The 14 images pre-fixed by “Statewide” show the distribution of wells with water-quality data by source agency.

Summary tables (also accessed through hyperlinks in the appendix) are included within each source-agency file. For example, SRBC.Summary.11_2005.pdf (table 4) presents information on the number of (1) wells sampled by watershed,

Table 4. Summary table of Susquehanna River Basin Commission (SRBC) ground-water-quality studies by major river basins and analyte groups (data last modified November 2005).

[PADEP, Pennsylvania Department of Environmental Protection; MCL, U.S. Environmental Protection Agency Maximum Contaminant Level; SMCL, U.S. Environmental Protection Agency Secondary Maximum Contaminant Level]

PADEP watershed	Sites	Major ions		Minor and trace elements		Nutrients		Water characteristics (Field measurements)	
		Number of samples	Number of samples with concentration exceeding MCL or SMCL	Number of samples	Number of samples with concentration exceeding MCL or SMCL	Number of samples	Number of samples with concentration exceeding MCL or SMCL	Number of samples	Number of samples with concentration exceeding MCL or SMCL
Ohio and St. Lawrence River Basins									
31	1	2	0	2	0	2	0	2	0
Delaware River Basin									
12	6	13	4	14	4	13	0	13	8
Lower Susquehanna River Basin									
23	123	289	73	278	27	287	34	267	25
24	61	147	14	145	22	143	3	144	23
26	18	40	3	39	6	35	3	33	2
Upper Susquehanna River Basin									
1	23	39	9	38	5	36	0	37	1
2	10	35	15	35	5	32	0	33	7
3	1	2	0	3	0	2	0	2	0
4	14	21	12	21	5	22	0	21	7
5	24	44	12	41	3	42	0	43	10
6	17	33	23	32	8	30	0	31	0
7	3	7	0	6	1	7	0	6	1
8	28	52	22	52	7	51	1	49	17

(2) samples collected by analyte group, and (3) samples that exceeded USEPA contaminant levels.

lytes. The summary data are organized by PADEP watershed and major analyte group.

Statewide Summary Map

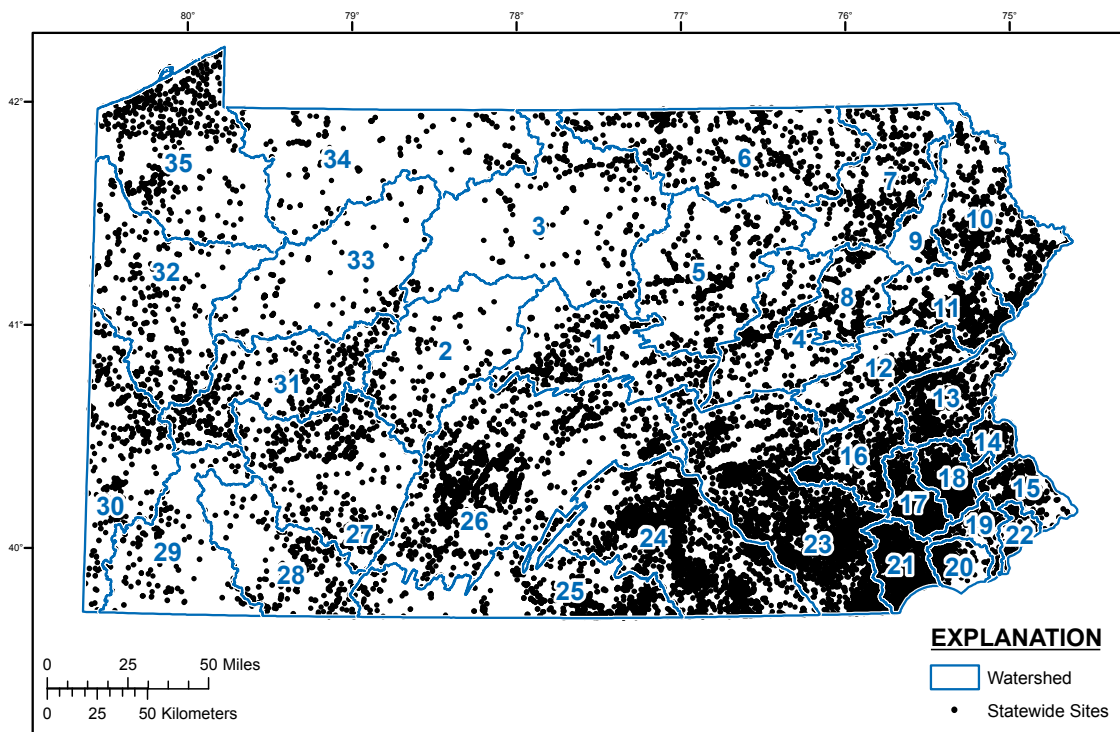
The distribution of the 24,772 wells and springs from the 14 source agencies or programs is shown in figure 4. The watersheds with the greatest number of wells and springs with water-quality data are 18 (1,304 wells and springs), 23 (3,721 wells and springs), 24 (3,105 wells and springs), and 26 (1,671 wells and springs) of southeastern and south-central Pennsylvania. The part of watershed 35 that has been extensively sampled is in Erie County. Four of the watersheds in Pennsylvania (watersheds 29, 33, 9, and 2) have fewer than 200 wells and springs with water-quality data.

Summary Tables by Source Agency

As an example, the ground-water-quality data collected by the SRBC and contained within the various Excel data spreadsheet files listed for the SRBC in the appendix are summarized in table 4. This and similar summary files for the other source agencies also are available through hyperlinks in the appendix. Each summary table presents information on the number of sites sampled, the number of samples collected, and the number of exceedences for USEPA MCL and SMCL ana-

Summary

This study, by the U.S. Geological Survey (USGS) in cooperation with the Pennsylvania Department of Environmental Protection (PADEP) provides detailed ground-water-quality data from January 1, 1979, to December 31, 2006, on 24,772 wells and springs for 35 watersheds throughout Pennsylvania. Fourteen source agencies or programs—Borough of Carroll Valley (CV), Chester County Health Department (CCHD), Montgomery County Health Department (MCHD), Pennsylvania Department of Agriculture (PennAg), Pennsylvania Department of Environmental Protection 2002 Pennsylvania Water-Quality Assessment (305b), Pennsylvania Department of Environmental Protection Agency Act 537 Sewage Facilities Program (Act537), Pennsylvania Department of Environmental Protection-Ambient and Fixed Station Network (FSN), Pennsylvania Department of Environmental Protection-North-Central Region (NCRO), Pennsylvania Department of Environmental Protection-South-Central Region (SCRO), Pennsylvania Drinking Water Information System (PADWIS), Pennsylvania Topographic and Geologic Survey (PAGS), Susquehanna River Basin Commission (SRBC), U.S. Environmental Protection Agency (USEPA), and USGS provided the



Watershed Boundaries from Pennsylvania Department of Environmental Protection

Figure 4. Well and spring locations with ground-water data compiled from 14 source agencies or programs representing the period 1979-2006 for Pennsylvania.

data in various electronic formats that were suitable for editing and compiling. The resulting ground-water-quality data were divided, by source agency or program, into 11 major analyte groups—antibiotics, major ions, microorganisms (bacteria, viruses, and other microorganisms), minor ions (including trace elements), nutrients (predominantly nitrate and nitrite as nitrogen), pesticides, pharmaceuticals, radiochemicals (predominantly radon or radium), volatiles (volatile organic compounds), wastewater compounds, and water characteristics (field measurements, predominantly field pH, field specific conductance, and hardness). For the USGS and the NCRO, the pesticide analyte group was broken down into fungicides, herbicides, and insecticides.

For each source agency or program, Microsoft Excel files and Portable Document Format files were created. The Excel files (for example, CV.Microorganisms.11_2005.xls) contain ground-water-quality data, and the PDF files (for example, SRBC.Summary.11_2005.pdf) contain a summary of the results by watershed and analyte group. As a result of the large number of independent studies conducted by the USGS, additional Excel files (for example, USGS.MicroorganismsReport.09_2007.xls) that contain an abbreviated reference to the original citation listed in Selected References were created. This allows the interested reader a means to locate the study and determine the purpose for which the ground-water-quality data were collected.

A series of PDF images were created to show the 13 geolithologic units that were used to represent the complex geology of Pennsylvania and the distribution of 24,772 wells and springs with ground-water-quality data by source agency or program.

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Joseph J. Lee, Jr., and Patrick Bowling of the Pennsylvania Department of Environmental Protection Bureau of Watershed Management, Larry Conrad of the Pennsylvania Department of Environmental Protection—North-Central Regional Office, and Tim Long of the Pennsylvania Department of Environmental Protection—South-Central Regional Office Waste Management Program provided technical assistance and/or review of the report along with Dennis W. Risser, Kim L. Otto, and Kevin J. Breen from the USGS.

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Appendix—Files of Comments, Data, and Map Images by Source

["Click" on filename in lists below to link to the file]

Borough of Carroll Valley

Comment Files

Portable Document Format

[CV.Comments.Microorganisms.11_2005.pdf](#)

[CV.Comments.Nutrients.11_2005.pdf](#)

[CV.Summary.11_2005.pdf](#)

Data Spreadsheet Files

Microsoft Excel Format

[CV.Microorganisms.11_2005.xls](#)

[CV.Nutrients.11_2005.xls](#)

Map Image Files

Portable Document Format

[Statewide_Wells.CV.09_2007.pdf](#)

Chester County Health Department

Comment Files

Portable Document Format

[CCDH.Comments.Field.11_2005.pdf](#)

[CCDH.Comments.Nutrients.11_2005.pdf](#)

[CCDH.Summary.11_2005.pdf](#)

Data Spreadsheet Files

Microsoft Excel Format

[CCDH.Field.11_2005.xls](#)

[CCDH.Nutrients.11_2005.xls](#)

Map Image Files

Portable Document Format

[Statewide_Wells.CCHD.09_2007.pdf](#)

Montgomery County Health Department

Comment Files

Portable Document Format

[MCHD.Comments.Field.11_2005.pdf](#)

[MCHD.Comments.MajorIons.11_2005.pdf](#)

[MCHD.Comments.Microorganisms.11_2005.pdf](#)

[MCHD.Comments.MinorIons.11_2005.pdf](#)

[MCHD.Comments.Nutrients.11_2005.pdf](#)

[MCHD.Comments.Volatiles.11_2005.pdf](#)

[MCHD.Comments.Wastewater.11_2005.pdf](#)

[MCHD.Summary.11_2005.pdf](#)

Data Spreadsheet Files

Microsoft Excel Format

[MCHD.Field.11_2005.xls](#)

[MCHD.MajorIons.11_2005.xls](#)

[MCHD.Microorganisms.11_2005.xls](#)

[MCHD.MinorIons.11_2005.xls](#)

[MCHD.Nutrients.11_2005.xls](#)

[MCHD.Volatiles.11_2005.xls](#)

[MCHD.Wastewater.11_2005.xls](#)

Map Image Files

Portable Document Format

[Statewide_Wells.MCHD.09_2007.pdf](#)

Pennsylvania Department of Agriculture

Comment Files

Portable Document Format

[PennAg.Comments.Microorganisms.11_2005.pdf](#)

[PennAg.Comments.Nutrients.11_2005.pdf](#)

[PennAg.Comments.Pesticides.11_2005.pdf](#)

[PennAg.Summary.11_2005.pdf](#)

Data Spreadsheet Files

Microsoft Excel Format

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[PennAg.Pesticides.11_2005.xls](#)

Map Image Files

Portable Document Format

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Pennsylvania Department of Environmental Protection 305b Network

Comment Files

Portable Document Format

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[305b.Summary.09_2007.pdf](#)

Data Spreadsheet Files

Microsoft Excel Format

[305b.Nutrients.09_2007.xls](#)

Map Image Files

Portable Document Format

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Pennsylvania Department of Environmental Protection Act 537 Network

Comment Files

Portable Document Format

Act537.Comments.Microorganisms.09_2007.pdf

Act537.Comments.Nutrients.09_2007.pdf

Act537.Summary.09_2007.pdf

Data Spreadsheet Files

Microsoft Excel Format

Act537.Microorganisms.09_2007.xls

Act537.Nutrients.09_2007.xls

Map Image Files

Portable Document Format

Statewide_Wells.Act537.09_2007.pdf

Pennsylvania Department of Environmental Protection Ambient and Fixed Station Network

Comment Files

Portable Document Format

FSN.Comments.Field.11_2005.pdf

FSN.Comments.MajorIons.11_2005.pdf

FSN.Comments.MinorIons.11_2005.pdf

FSN.Comments.Nutrients.11_2005.pdf

FSN.Summary.11_2005.pdf

Data Spreadsheet Files

Microsoft Excel Format

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FSN.MinorIons.11_2005.xls

FSN.Nutrients.11_2005.xls

Map Image Files

Portable Document Format

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Pennsylvania Department of Environmental Protection—North-Central Regional Office

Comment Files

Portable Document Format

NCRO.Comments.Field.09_2007.pdf

NCRO.Comments.Fungicides.09_2007.pdf

NCRO.Comments.Herbicides.09_2007.pdf

NCRO.Comments.Insecticides.09_2007.pdf

NCRO.Comments.MajorIons.09_2007.pdf

NCRO.Comments.Microorganisms.09_2007.pdf

NCRO.Comments.MinorIons.09_2007.pdf

NCRO.Comments.Nutrients.09_2007.pdf

NCRO.Comments.Radiochemicals.09_2007.pdf

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Data Spreadsheet Files

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NCRO.Radiochemicals.09_2007.xls

NCRO.Volatiles.09_2007.xls

Map Image Files

Portable Document Format

Statewide_Wells.NCRO.09_2007.pdf

Pennsylvania Department of Environmental Protection—South-Central Regional Office

Comment Files

Portable Document Format

SCRO.Comments.Field.11_2006.pdf
SCRO.Comments.MajorIons.11_2006.pdf
SCRO.Comments.MinorIons.11_2006.pdf
SCRO.Comments.Nutrients.11_2006.pdf
SCRO.Comments.Pesticides.11_2006.pdf
SCRO.Comments.Volatiles.11_2006.pdf
SCRO.Comments.Wastewater.11_2006.pdf
SCRO.Summary.11_2006.pdf

Data Spreadsheet Files

Microsoft Excel Format

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Map Image Files

Portable Document Format

Statewide_Wells.SCRO.09_2007.pdf

Pennsylvania Drinking Water Information System

Comment Files

Portable Document Format

PADWIS.Comments.Microorganisms.11_2005.pdf
PADWIS.Comments.MinorIons.11_2005.pdf
PADWIS.Comments.Pesticides.11_2005.pdf
PADWIS.Comments.Radiochemicals.11_2005.pdf
PADWIS.Comments.Volatiles.11_2005.pdf
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Data Spreadsheet Files

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PADWIS.Radiochemicals.11_2005.xls
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Map Image Files

Portable Document Format

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Pennsylvania Topographic and Geologic Survey

Comment Files

Portable Document Format

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PAGS.Comments.MinorIons.09_2007.pdf
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Data Spreadsheet Files

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Map Image Files

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Susquehanna River Basin Commission

Comment Files

Portable Document Format

SRBC.Comments.Field.11_2005.pdf
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SRBC.Comments.MinorIons.11_2005.pdf
SRBC.Comments.Nutrients.11_2005.pdf
SRBC.Summary.11_2005.pdf

Data Spreadsheet Files

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SRBC.Nutrients.11_2005.xls

Map Image Files

Portable Document Format

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U.S. Environmental Protection Agency

Comment Files

Portable Document Format

USEPA.Comments.Field.09_2007.pdf
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USEPA.Comments.Pesticides.09_2007.pdf
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USEPA.Comments.Volatiles.09_2007.pdf
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Map Image Files

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U.S. Geological Survey—Pennsylvania Water Science Center

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USGS.AntibioticsReport.09_2007.xls
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Pennsylvania Geology

Map Image Files

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Pennsylvania Well Locations

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