

Groundwater Monitoring

Delaware Water Gap National Recreation Area

Introduction

Delaware Water Gap National Recreation Area encompasses about 69,000 acres along a 41-mile segment of the Delaware River where it forms the border between Pennsylvania and New Jersey (Figure 1). The northern boundary of the park is about 3½ miles south of Port Jervis, NY (or about 3 miles north of Milford, PA) and extends downstream to just below the Delaware Water Gap, where the river cuts through a gap in the Kittatinny Ridge of the Appalachian Mountains. The park is largely limited to the valley of the Delaware River, in most areas extending only a mile or two on either side of the river.

Shallow groundwater underlying the park has its source in the upland areas adjacent to the park. Recharge occurs by infiltration of rainfall and snowmelt in the upland areas. Groundwater then flows toward, and discharges to, the adjacent stream valleys. Local groundwater flow systems may have flowpaths as short as a mile or less, with recharge on the upland areas and discharge in the nearest small creek. Small creeks flow into larger creeks and eventually to the Delaware River. Most of the streams that are tributary to the Delaware River have their headwaters and the majority of the drainage basin upstream of the park boundary. Water quality in the creeks and groundwater providing baseflow to the creeks is largely controlled by land-use practices beyond the boundary of the park. Regional groundwater flow paths also originate with recharge in upland areas outside the park. Groundwater in these longer flow paths flows toward, and discharges to, the Delaware River.

Currently, the park does not conduct groundwater monitoring as part of their natural resources program. Some testing and monitoring occurs as a requirement for operating public water supply systems using wells as their source of water. Various monitoring programs are operated by federal, state, and county agencies. The Delaware River Basin Commission monitors surface-water quality, but not groundwater. The purpose of this report is to compile information regarding



Figure 1. Map of the Delaware Water Gap National Recreation Area

monitoring programs operated by these entities and determine whether additional groundwater monitoring should be conducted by the National Park Service.

Previous Investigations

There have been many investigations and publications of the geology and groundwater resources of the area surrounding Delaware Water Gap. Many of them have been at the county scale.

Miller et al. (1939) wrote a report describing the geology of Northampton County, PA. The report includes a geologic map and a 20-page section describing the groundwater resources of the various geologic formations. Only a small part of the extreme southeast part of the park (east of Kittatinny Mountain and south of the Delaware River) is within Northampton County. At that time (1939) there were no wells in the part of the county that is now included in the park, approximately the Slateford Creek area. This area of the park is underlain by Martinsburg Shale. The shale generally supplies small amounts of good-quality groundwater to shallow wells. However, in some areas there is enough pyrite in the shale to cause the water to have an objectionable amount of sulphur.

Poth and Lloyd (1970) prepared a report describing the geology and occurrence of groundwater in the Pennsylvania part of the park. Their report was largely focused on recommendations for siting wells at various planned developments (picnic areas, campgrounds, boat launch areas, etc.) for the recreation area.

Crowl (1971) mapped the surficial geology of the Delaware River valley from Matamoras, PA south to Shawnee-On-Delaware (near East Stroudsburg), PA. The mapping was conducted to document the resources that would potentially have been covered by the proposed Tocks Island dam and reservoir.

Nemickas (1973) prepared a report describing the geology and occurrence of groundwater in the New Jersey part of the park. His report included recommendations for siting wells at various planned developments (picnic areas, campgrounds, boat launch areas, etc.) for the recreation area. The report includes an inventory of wells in the area, most of which are low-yield, private, domestic wells. Results of test drilling and testing for seven wells at various locations in the New Jersey part of the park are included in the report.

Miller (1974) prepared a report describing the geology and groundwater resources of Sussex County and part of Warren County in New Jersey. The investigation included compilation of records and logs for 3161 wells and other hydrologic information. Miller provided interpretation and summarized the available data.

Carswell and Lloyd (1979) completed a report describing the geology and groundwater resources of Monroe County, PA. Monroe County is on the northwest side of the Delaware River from approximately park headquarters downstream to the water gap. Wells completed in the fractured bedrock aquifers in the area will generally yield several tens of gallons per minute of good quality water. Bedrock formations outcropping in the park in this area are a sequence of Devonian and Silurian carbonates, shales, siltstones, and calcareous sandstone and

conglomerate that dip toward the northwest. The concentration of total dissolved solids in water from wells in these bedrock formations ranges from about 100-400 mg/l and averages about 250 mg/l. Stratigraphically, these formations are above the Bloomsburg Redbeds and below the Marcellus Shale. Unconsolidated sediments comprising the valley-fill aquifer along the Delaware River will yield more water, several hundred gallons per minute, to wells. Dissolved solids concentration in water from wells in the unconsolidated valley-fill aquifer averages less than 100 mg/l.

Davis (1989) prepared a report describing the groundwater resources of Pike County, PA. Pike County includes the northern part of the park, approximately the area upstream of the park visitor center. Hydrogeology and groundwater quality are similar to that of Monroe County. The Delaware River valley is filled with several hundred feet of unconsolidated sand and gravel from glacial deposits and river alluvium. Upland areas to the northwest of the Delaware River valley are blanketed by a few tens of feet of glacial deposits overlying fractured bedrock formations that dip toward the northwest. The Mahantango Formation underlies most of the park area in Pike County. The Mahantango is comprised of fractured siltstone, claystone, and shale rock material. Some of the more northwesterly parts of the park are underlain by Trimmers Rock Formation, which is comprised of siltstone, shale, and sandstone. Throughout the county, water quality is good and suitable for most uses.

Senior (1994) investigated the presence of nitrogen and chloride in the valley-fill aquifer in the area between Milford and Matamoras, PA. The study was conducted to determine the effect of sewage disposal via individual on-site septic systems and road runoff on groundwater quality in the highly developed 7-mile corridor between Milford and Matamoras. She showed that the valley-fill aquifer is very vulnerable to contamination from surface infiltration. Chloride concentrations (presumably from road salting and septic system effluent) were greater adjacent to highways and in areas with large concentrations of septic systems.

Cinotto et al. (2003) conducted a study of the park area and provided a report that described the physical geography of the area and potential threats to groundwater quality, described the geohydrologic framework of the region, and identified wells that might potentially be used to obtain samples for analyses of groundwater chemistry. Their investigation included an inventory of wells in the park.

Fischer et al. (2004) reported the results of water quality monitoring for the USGS NAWQA program for the Delaware River Basin. Groundwater samples frequently had detectable concentrations of nutrients, pesticides, and VOCs. The number of contaminants detected and their concentration increased with the degree of development of the surrounding area. Arsenic and radon, two naturally occurring chemicals, frequently exceeded USEPA drinking-water standards. Pesticides, VOCs, and nutrients were frequently detected, but concentrations were low and never exceeded USEPA drinking-water standards.

Hickman and Fischer (2008) collected water samples at stations on 14 streams within or entering the park during 2002-04 in order to define water quality and provide a baseline from which to detect changes in water quality over time. Results of the water-quality analyses, along with land-use data for the drainage basins associated with the samples, were used to define

water-quality characteristics; to identify relations among water quality, streamflow, and season; and to establish a baseline and develop methods to detect future changes in water quality.

Sloto (2008) investigated the effects of land use change and groundwater pumping (associated with development) in the Pocono Creek watershed in Monroe County, PA. Although the Pocono Creek watershed is outside the park, the geology and hydrology are similar to that of most of the streams that flow into the park from the Pocono Plateau, e.g., Raymondskill Creek, Dingmans Creek, Bush Kill, etc. Reduced groundwater recharge from changes in land use and additional groundwater pumping are predicted to cause reductions of baseflow of streams in the watershed. Conclusions from this study are likely indicative of expected potential impacts of upstream development on streams flowing through the park.

The USGS is currently monitoring groundwater levels and conducting a reconnaissance of groundwater quality in Pike County, PA. The study is being conducted to provide a baseline for future comparison of changes to groundwater quality and baseflow to streams, identify areas with (or without) existing water-quality impairments, and to assist county planning efforts to preserve or mitigate current hydrologic conditions. The study is scheduled to run through 2009 with a report to summarize the findings.

Geology and Hydrogeology

The Geologic Resources Division of the National Park Service (GRD) compiled a geologic map for the entire park and surrounding area from the various geologic maps of smaller areas within the park. The USGS has published geologic maps for most of the 7.5' quadrangles in the area. In addition, there are geologic maps of various scales and coverage areas available from state agencies in Pennsylvania and New Jersey. GRD used maps from these various sources to compile a map of the entire area with common stratigraphic nomenclature and map units. A complete listing of geologic maps and references is available with the GRD map. Digital files of the completed compilation are available on the internet at;
http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

The park occupies the Minisink Valley, a southwest-northeast trending valley that was formed by erosion of weaker bedrock formations. The valley is bounded on the southeast by Wallpack Ridge, Shawangunk Ridge, and Kittatinny Mountain. These ridges are underlain by conglomeratic bedrock formations that are more resistant to erosion, and thus form ridges. To the west, the park transitions into the upland areas of the Pocono Plateau.

The hydrogeologic framework of the park and surrounding area includes;

1. Devonian and Silurian fractured bedrock formations, primarily shale and siltstone with some limestone and sandstone beds (deposited 350-450 million years ago).
2. Glacial till deposits blanketing the bedrock in the upland areas outside the valley of the Delaware River.
3. A river valley that was scoured by glaciers and subsequently filled by sand, gravel, and other sediments from the melting glaciers.

A simple representation of the hydrogeologic framework is shown in Figure 2.

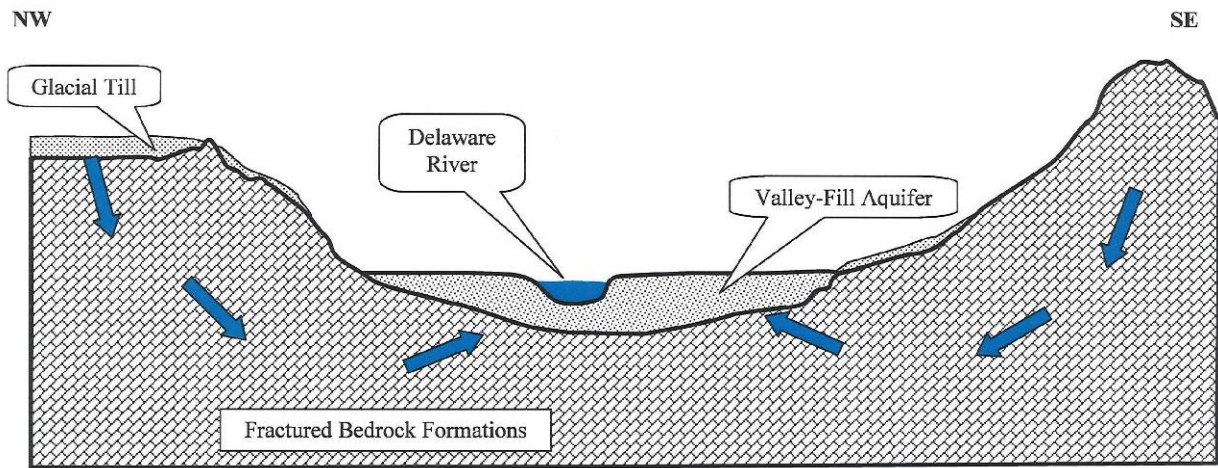


Figure 2. NW-SE schematic cross-section across the Delaware River valley. Arrows show general direction of groundwater flow.

Aquifers at Delaware Water Gap are either unconsolidated sand and gravel filling the stream valleys or fractured bedrock. The sand and gravel in the stream valleys are either of glacial origin, having been deposited during the last ice age, or alluvial sediments deposited by streams. Bedrock formations in the area are sandstones, shales, siltstones, and limestone.

The bedrock geologic formations underlying the park and surrounding areas are well fractured, allowing groundwater to flow between formations. At a regional scale, the fracturing of the bedrock facilitates analyses of the groundwater system as a single, interconnected flow system. The productivity of the bedrock aquifers is dependent on the degree of fracturing of each formation. In general, the bedrock formations have been sufficiently fractured to allow successful construction of water-supply wells. Estimates of the potential yield of wells completed in each geologic formation were provided in the Tocks Island Region Environmental Study (Roy E. Weston, 1970). Most geologic formations will yield 100 gpm or more to properly designed and constructed wells.

Glacial till blankets the bedrock formations in upland areas to a thickness of several tens of feet. Glacial till is generally a poor aquifer because it is the unsorted, unstratified deposits of glaciers. Till is a mixture of sediments of all sizes; clay, silt, sand, gravel, and boulders. The fine-grained sediments (clay and silt) fill the pore spaces between larger sediments, eliminating or reducing the channels for groundwater flow. Most wells in upland areas are probably drilled through the glacial till to tap groundwater in the underlying bedrock formations.

The alluvial valley-fill aquifer of the Delaware River valley is the receptor of groundwater from all sources on its way to eventual discharge to the Delaware River. Groundwater from bedrock aquifers underlying adjacent upland areas passes through the alluvium on its way toward the river. Infiltration from the land surface in the river valley is a pathway for contaminants and nutrients (e.g., highway runoff or chemicals and fertilizers from agricultural fields) to enter the local groundwater system. These local groundwater systems also discharge to the river. Many tributary streams will lose water to infiltration into the alluvium after the stream flows from the

bedrock uplands onto the alluvium filling the valley. The alluvial groundwater also flows toward and eventually discharges to the river.

The valley-fill aquifer along the Delaware River is the primary aquifer within the park. Adjacent areas underlain by bedrock aquifers are often outside the park boundary. However, land-use practices on areas underlain by bedrock aquifers may result in degrading groundwater quality in the bedrock aquifer, which will eventually flow to and discharge into the valley-fill aquifer. The valley-fill aquifer is especially susceptible to contamination because it is very permeable and the water table is shallow. Contamination can enter the valley-fill aquifer by infiltration of surface water from streams crossing from bedrock upland areas into the park, groundwater discharge from adjacent bedrock aquifers, and infiltration from the overlying land surface (e.g. highway runoff and chemicals from agricultural fields).

Previous and Ongoing Water Quality Investigations and Data

USGS-NAWQA – The USGS conducted an assessment of water quality (groundwater and surface water) throughout the Delaware River basin in 1998-2001 as part of the National Water-Quality Assessment Program (NAWQA) (Fischer et al., 2004). Their sampling included 30 wells in the Piedmont clastic rocks, 30 wells in the clastic rocks in the Valley and Ridge province, and 16 wells constructed in glaciofluvial deposits. NAWQA studies are regional in nature, rather than focusing on specific geographic areas or water-resource issues. Analyses of groundwater samples showed that groundwater in the basin has been affected by human influences and natural geologic processes. Nutrients, pesticides, and VOCs were frequently detected in groundwater samples, but less frequently and at lower concentrations than in surface waters. The number and concentrations of anthropogenic contaminants was related to the degree of development and type of land use. Concentrations of naturally occurring radon and arsenic frequently exceeded drinking-water standards. Most other chemical compounds were detected at low concentrations and rarely exceeded drinking-water standards. Results of chemical analyses are archived in the USGS NWIS database.

NJDEP-AGWQMN – New Jersey operates an ambient groundwater quality monitoring network (AGWQMN). Originally, the monitoring program used existing wells to determine the effect of geology on groundwater quality. After that initial assessment of the anticipated water quality for wells constructed into various aquifers/rock types, the program was redesigned to allow assessment of the status and trends of shallow groundwater quality as a function of land use related to non-point source pollution. The network contains 150 wells statewide, with 30 of the wells sampled every year on a rotating 5-year cycle. Monitoring wells are located to allow assessment of shallow groundwater in areas that fall into three general land-use classifications; undeveloped, agricultural, and urban. Goals of the AGWQMN are to; 1) assess groundwater quality, 2) assess groundwater quality trends, 3) identify and evaluate contaminant sources, and 4) identify emerging water-quality issues.

Samples are collected by staff from the USGS and NJDEP Bureau of Fresh Water and Biological Monitoring. Samples are analyzed at the USGS national water quality laboratory in Denver, CO. Chemical and physical parameters analyzed at each well include; field parameters (such as pH, specific conductance, dissolved oxygen, temperature, and alkalinity), major ions, trace elements, gross-alpha activity, volatile organic compounds, and pesticides.

The groundwater quality data are currently available from an interactive GIS site for the NJDEP I-MAP at <http://www.state.nj.us/dep/gis/depsplash.htm>. Data are also available in the USGS annual Water Resources Reports for New Jersey and online at the USGS database, <http://waterdata.usgs.gov/nwis/>.

The ambient groundwater monitoring network is nearing completion of the second 5-year cycle. Groundwater quality from wells in undeveloped areas provides a baseline for evaluating the effects of agricultural and urban land uses on shallow groundwater. Wells located in areas with predominantly urban and agricultural land use generally have higher concentrations of total dissolved solids. Wells in agricultural and urban areas also generally have more frequent occurrences and higher concentrations of trace elements, nutrients, volatile organic compounds, and pesticides. Shallow groundwater in agricultural areas has the highest frequency of pesticide detection and the highest median nitrate concentration. Groundwater in urban areas generally has higher dissolved solids, dissolved iron, chloride, and VOC (e.g., MTBE) concentrations.

There is only one monitoring well in the current shallow groundwater quality monitoring network that is in or near the park. That well is at the campground in Worthington State Forest, approximately across the river from the Hialeah picnic area (41°00'49"N, 75°04'58"W). There are other wells in or near the park that were sampled as part of the initial assessment of ambient groundwater quality in New Jersey (the pre-1999 era of the program). These wells were generally only sampled one or two times.

Adjacent Public Water Supply Wells – There are many small communities and residential developments adjacent to the park. Many of these have community water systems supplied from wells that have regular water quality testing. There might also be water quality data available for the many public-supply wells providing water for schools, resorts, restaurants and other types of public or semi-public use. EPA maintains a database of public water supply systems that could be searched to identify which systems are in close proximity to the park and might have water quality data and/or monitoring programs in place that could provide information representative of groundwater quality adjacent to (or flowing toward) the park. http://www.epa.gov/enviro/html/sdwis/sdwis_query.html

DEWA Public Water Supply Wells – The Headquarters water system at the park is classified as a non-transient, non-community water system. It is tested for basic water chemistry, contaminants, and VOCs every three years. Other wells and water systems in the park are classified as transient, non-community systems and testing is limited to bacteriological and nitrate testing.

Groundwater Quality Data in the USGS NWIS Database – There are a number of wells in or near the park that were sampled by the USGS as part of previous investigations. That data is available to provide a baseline for comparison to future analyses of groundwater quality from the same wells, or other wells completed in the same aquifers. A search of the USGS NWIS database for wells with water quality data located within the legislated park boundary found 33 wells (Table 1). There are many more wells with water quality data that are located within a short distance outside the park boundary, particularly in Pennsylvania (Figure 3).

Wells that have been sampled in the past would likely be good candidates for future water-quality sampling, particularly those wells that were sampled more than once. Comparison of future water-quality analyses with past data may provide an indication of trends or changes in water quality, regardless of whether a well was located inside or outside the park boundary.

Groundwater level monitoring in and near the park. – There are a number of wells in or near the park where the water level is measured on a regular basis. The USGS NWIS database was searched to find records for wells that are, or have been, regularly measured by the USGS. The database was searched for all wells in the five counties bordering the park (Pike, Monroe, and Northampton Counties in Pennsylvania and Sussex and Warren Counties in New Jersey) that have three or more water level records. By specifying three or more measurements, we eliminate all of those wells that have only one or two water level measurements that were associated with collection of a water-quality sample. There are 21 wells in or near the park that have some period of water level monitoring (Table 2). Only three of those wells have long-term periods of records; one well in Pike County, PA and two wells in Sussex County, NJ. Most of the other records are for wells that are being measured monthly as part of a current USGS project to assess groundwater conditions in Pike County PA. Several other wells that have some period of water level record (Figure 4), but these wells are too far distant from the park to be of much use in assessing the status or trends of groundwater levels in the park.

Current data for water levels in monitoring wells are available from the USGS Groundwater Watch website <http://groundwaterwatch.usgs.gov/>.

There are two active water-level monitoring wells in Sussex County, NJ that are within the park boundary. Both wells are near the Walpack Environmental Education Center. The Taylor Observation Well (370202) is 95 feet deep and is completed in the Bossardville Limestone. Water levels in the well are recorded hourly, with real-time data available on the internet. The Walpack Twp 4 Well (370207) is 55 feet deep and is completed in glacial till. Water levels in the well are recorded hourly. The minimum, maximum, and mean daily values are available on the internet, but with a delay of several weeks from the date of the measurements.

The Pike County Observation Well (PI-200) is 799 feet deep and is completed in the Trimmers Rock Formation. Water level in the well has been measured monthly since October 1996. Data are available on the internet.

The USGS is conducting a two-year assessment of groundwater in Pike County, PA. The assessment includes monthly measurement of water levels in 48 wells. Ten of these wells are located within or near (within 2500 meters) of the park boundary. Water level data are available on the internet. The final report for this project will probably be available in 2010-11 and should provide additional information regarding local hydrogeologic conditions.

Currently active water level monitoring at wells in Monroe and Northampton Counties, PA and Warren County, NJ are too far from the park to be of much use in evaluating park resources.

Marcellus Shale natural gas development

There is currently much interest in drilling horizontal wells into the Marcellus Shale to extract natural gas trapped in the shale. Development of the horizontal wells includes hydrofracking to fracture the rock and allow release of greater quantity of gas from the formation. Well drilling and development may have adverse environmental impacts (Moss, 2008).

The Marcellus Shale outcrops in Pennsylvania along the west side of the Delaware River Valley. Within the park, the shale is too thin and too close to its outcrop area to be a viable target for natural gas development. Currently well drilling for natural gas development occurs further west in Pennsylvania, beyond the watersheds of tributary streams flowing into the park from the Pocono Plateau. However, well drilling could occur closer to the park in the future. Park staff should remain vigilant regarding leasing and permit applications to be aware of the potential for natural gas development in the watersheds that are tributary to the park.

Drilling and development is already occurring in tributaries to the Delaware River upstream of Delaware Water Gap NRA. Thus, there is a potential for adverse impacts to the main stem of the Delaware River in the park, but those impacts would emanate from tributary watersheds upstream of Delaware Water Gap NRA.

Is there a need for groundwater monitoring in the park? Probably not.

Previous groundwater quality monitoring by various federal, state, and local agencies have thoroughly documented the ambient groundwater quality of the various aquifers underlying and adjacent to the park. These data are archived in databases maintained by federal agencies, primarily the USGS NWIS database and provide a baseline for comparison with future groundwater analyses.

Site-specific monitoring plans could be developed if there are specific contaminant sources that threaten groundwater quality. Dedicated monitoring wells would probably be required to provide control over the location, depth, and aquifer being sampled to provide credible data to address the issue of concern. It is extremely unlikely that an existing well would be located in the desired location or screened at the desired depth to provide the data needed to assess potential contaminant threats. Site-specific monitoring would probably be of limited duration to document the existence and remediation of a problem.

Water level monitoring might be warranted to monitor potential impacts of large-volume groundwater pumping at municipalities or industrial sites adjacent to the park. If there are no water users pumping large volumes of groundwater, then groundwater level monitoring would only show the effects of normal seasonal and climatic cycles, similar to currently existing monitoring.

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County Location	Station Name	Latitude DMS	Longitude DMS	Aquifer	Depth feet	Sampling Dates	
Monroe County, PA	MO 189	405831	750845	Shawangunk Fm.	300	Jan-74	
Monroe County, PA	MO 191	410247	750311	Esopus Formation	308	Dec-68	
Monroe County, PA	MO 199	405728	750757	Shawangunk Fm.	300	Sep-70	
Monroe County, PA	MO 202	410448	750032	Buttermilk Falls Fm.	147	May-71	
Monroe County, PA	MO 540	410300	750206	Poxono Island Fm.	40	Sep-72	
Northampton County, PA	NP 584	405703	750745	Martinsburg Shale	300	Sep-70	Sep-70
Pike County, PA	PI 142	411712	744950	Outwash	40	Mar-82	
Pike County, PA	PI 191	410732	745734	Mahantango Fm.	40	Sep-72	
Pike County, PA	PI 192	410648	745902	Mahantango Fm.	40	Sep-72	
Pike County, PA	PI 232	412003	744605	Outwash	130	Oct-91	
Pike County, PA	PI 233	412009	744554	Ice-contact deposits	145	Oct-91	
Pike County, PA	PI 234	411313	745142	Outwash	42	Jul-82	
Pike County, PA	PI 308	410612	745915	Outwash	108	Jul-01	Aug-07
Pike County, PA	PI 481	412003	744604	Outwash		Oct-91	
Pike County, PA	PI 482	411956	744605	Outwash	142	Oct-91	
Pike County, PA	PI 486	412004	744609	Outwash	119	Oct-91	
Pike County, PA	PI 520	411252	745220	Outwash	200	Jul-01	
Pike County, PA	PI 556	411738	745050	Mahantango Fm.	400	Aug-07	
Pike County, PA	PI 558	410525	750217	Mahantango Fm.	300	Sep-07	
Sussex County, NJ	370004--Peters Valley	411151	745107	Esopus Formation	300	May-72	Sep-91
Sussex County, NJ	370006--White Russian	410542	745733	High Falls Fm.	249	May-72	Sep-73
Sussex County, NJ	370007--Hemlock Pond	410623	745406	Shawangunk Fm.	180	May-72	Sep-73
Sussex County, NJ	370008--Dddn 4-1	411102	745130	Stratified Drift	30	Sep-72	
Sussex County, NJ	370202--Taylor Obs	410914	745304	Bossardville Limestone	95	Sep-91	
Sussex County, NJ	370207--Walpack Twp 4 Obs	410928	745228	Stratified Drift	55	Sep-92	
Sussex County, NJ	370453--Dom	411930	744314	Stratified Drift	65	Jul-00	
Warren County, NJ	410006--Worthington 4	410045	750507	High Falls Fm.	165	Apr-68	
Warren County, NJ	410007--Millbrook 1	410430	745746	High Falls Fm.	300	Jun-72	
Warren County, NJ	410008--Lake Coventry	410437	745727	High Falls Fm.	300	Jul-72	
Warren County, NJ	410014--Dddn 2-1	410354	745947	High Falls Fm.	41	Sep-72	
Warren County, NJ	410254--Worthington St Forest 1	410017	750615	High Falls Fm.	100	Mar-91	
Warren County, NJ	410266--Van Campen Farm House	410422	745751	High Falls Fm.	172	Sep-92	Jun-00
Warren County, NJ	410386--MW92	410049	750458	Stratified Drift	36	Sep-01	Jun-06

Table 1. Wells at Delaware Water Gap NRA having groundwater quality data in the USGS NWIS database.

County	Site Name	In or Near Park?	Altitude	Depth, feet	Number of measurements	Most recent data	Aquifer
Pike County, PA	PI 200	near	1180	799	107	3/4/08	Trimmers Rock Fm.
Pike County, PA	PI 308	in park	350	108	3	8/30/07	Outwash
Pike County, PA	PI 402	near	850	825	13	4/10/08	Mahantango Fm.
Pike County, PA	PI 448	near	690	72	13	4/10/08	Till
Pike County, PA	PI 449	near	700	500	13	4/10/08	Trimmers Rock Fm.
Pike County, PA	PI 515	near	401	214	13	4/10/08	Outwash
Pike County, PA	PI 550	near	1207	250	12	4/10/08	Towamensing Mbr. of Catskill Fm.
Pike County, PA	PI 552	near	975		8	4/10/08	Trimmers Rock Fm.
Pike County, PA	PI 556	in park	719	400	9	4/10/08	Mahantango Fm.
Pike County, PA	PI 565	near	822	154½	11	4/10/08	Ice Contact Deposits
Pike County, PA	PI 566	near	822	155½	12	4/10/08	Ice Contact Deposits
Pike County, PA	PI 567	near	822	155½	6	11/7/07	Ice Contact Deposits
Pike County, PA	PI 568	near	792	400	12	4/10/08	Mahantango Fm.
Pike County, PA	PI 569	near	1169	220	12	4/10/08	Trimmers Rock Fm.
Pike County, PA	PI 578	near	1102	225	12	4/10/08	Trimmers Rock Fm.
Pike County, PA	PI 582	near	1140	725	12	4/10/08	Towamensing Mbr. of Catskill Fm.
Pike County, PA	PI 588	in park	955	76	10	4/10/08	Trimmers Rock Fm.
Pike County, PA	PI 589	in park	486	101	10	4/10/08	Kame Terrace
Pike County, PA	PI 590	in park	377	350	10	4/10/08	Marcellus Shale
Sussex County, NJ	370202	in park	480	95	136	3/12/08	Bossardville Fm.
Sussex County, NJ	370207	in park	425	55	111	3/12/08	Stratified Drift

Table 2. Wells in the USGS NWIS database that are located in or near (within 2500 meters) Delaware Water Gap NRA and having data for more than two water level measurements. Accessed April 2008.

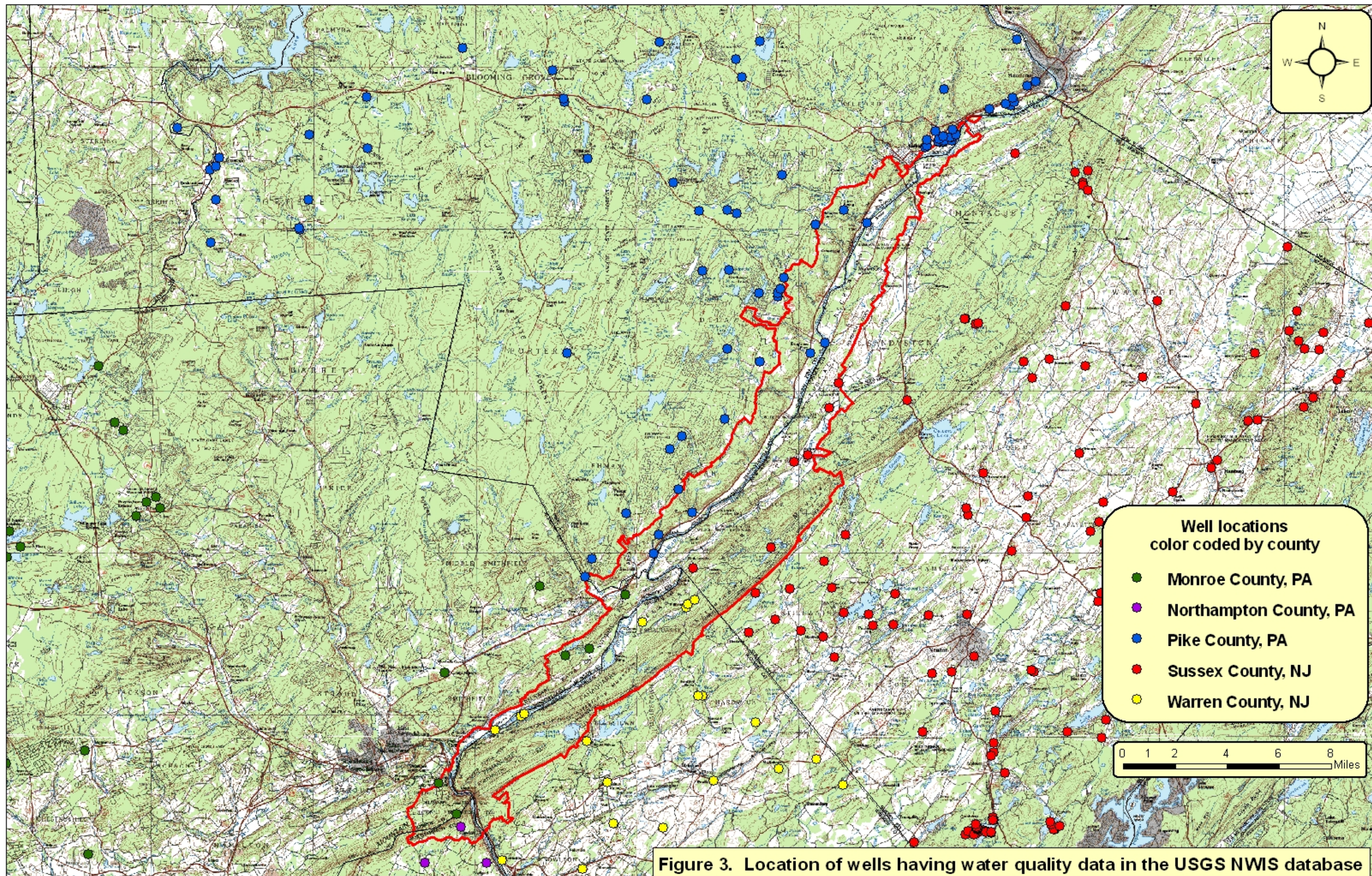


Figure 3. Location of wells having water quality data in the USGS NWIS database

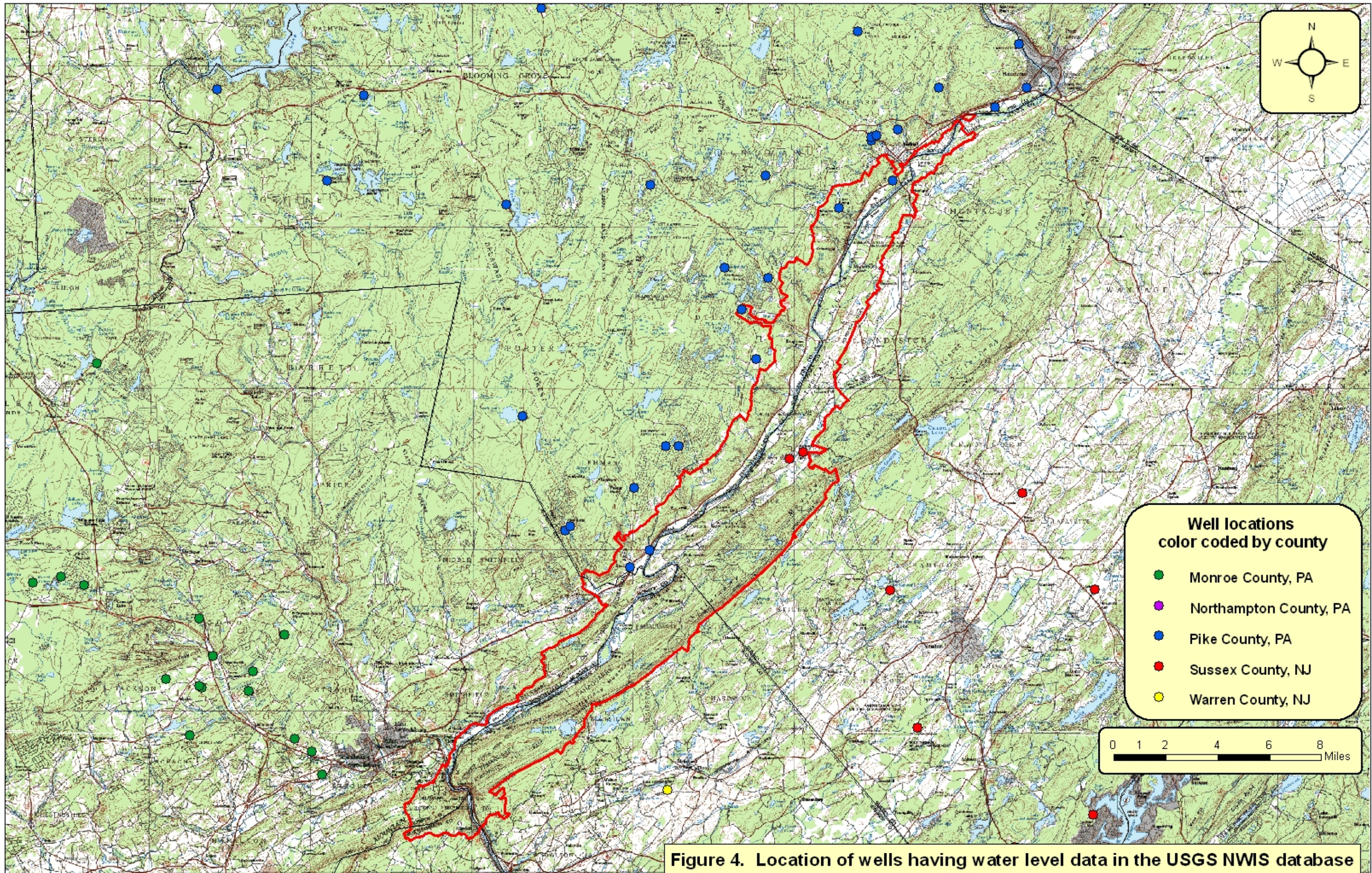


Figure 4. Location of wells having water level data in the USGS NWIS database