

# 6. Groundwater

## *Protecting Pike County's Water Supply*

by John Jose, Watershed Specialist, Pike County Conservation District

*“High quality water is more than the dream of conservationists, more than a political slogan; high quality water... is essential to health, recreation, and economic growth.”*

~ Edmund S. Muskie

Former Secretary of State & U.S. Senator

While “surface waters” such as lakes, ponds, streams, rivers and wetlands are visible and familiar to us, groundwater often remains an out-of-sight and out-of-mind issue. As a result, a great deal of misunderstanding and misinformation about this vital resource exists. This chapter will cover basic yet essential concepts in understanding groundwater, challenges to protecting this resource in Pike County and measures that can be taken by individuals, communities and municipalities to conserve local groundwater supplies.

**Pike County is entirely dependent on groundwater to meet its water needs.**

### **Who Needs It? We all do!**

Pike County is entirely dependent on groundwater to meet its water needs. With the exception of bottled water originating from sources outside of the County, all water that is consumed at home, in school, and in the work place originates as groundwater from private, community and municipal wells, and springs.

**The challenge now faced lies in maintaining regional groundwater reserves for both present and future needs.**

The challenge now faced lies in maintaining both the quantity and quality of regional groundwater reserves for both present and future needs. This challenge is made all the more clear and urgent with the realization that, for the last three and a half decades, Pike County has experienced a level of development distinguishing it as the fastest growing county in Pennsylvania and among the most rapidly developing in the nation.

### **Groundwater for Human Health**

Clean water is required not only for basic human survival, but is also necessary for maintaining good health. With some exceptions, groundwater supplies underlying Pike County generally meet these needs for resi-

dents. However, it is a resource that is vulnerable to pollution from a variety of sources.

As residential and commercial development continues, more homes, buildings, roads and highways are built and more underground storage tanks and on-lot sewage treatment systems are installed. The catch is, *all of this development activity is literally taking place on top of the water supply that Pike County depends on.* In addition, residents, through activities around the home, may unknowingly be contributing to the pollution of the groundwater they consume.



*A clean and adequate supply of water is essential to maintaining good health*

Although overall, Pike County’s groundwater resources are generally of good quality, contaminants, both naturally occurring and of human origin, have been detected in private and community water wells. For more discussion on causes and prevention of groundwater contamination refer to “Maintaining Groundwater Quality: Let’s Keep it Clean Folks!” later in this chapter and Chapter 2 on non-point source pollution. Information on water testing can be found in Appendix E.

### **The Dollars and Cents of Groundwater**

Clean and adequate groundwater supplies are also essential to a healthy economy. Tourism is a significant component of Pike County’s economy and the County’s high quality natural resources are one of the primary draws for people visiting the region. Polluted groundwater could negatively impact tourism by making the area a less desirable vacation destination.

In addition, any small or large-scale industry considering Pike County as a potential location to establish a facility, will be looking for clean groundwater supplies in order to avoid costly treatment measures needed to make water suitable for its manufacturing processes; contaminated groundwater could be a disincentive to such industry.

**Groundwater is, in a sense, the life-blood of Pike County. Not only does it provide residents with a generally clean and abundant water supply, it is also vital to the regional economy and to sustaining a healthy environment.**

Last, but not least, are the catastrophic financial impacts that indi-

vidual homeowners and communities experience when contamination renders groundwater supplies unpotable. Costs to locate and develop new water supplies and carry out cleanup efforts can run into the millions of dollars and very seldom is polluted groundwater restored to its original contaminant-free state.

## Clean Groundwater for Clean Streams

Good groundwater stewardship practices are essential to maintaining the health of the County's state designated High Quality and Exceptional Value streams. Why? Because groundwater and surface water resources are interconnected through the hydrological cycle. As groundwater migrates up to the earth's surface, "discharging" to lakes, streams and wetlands, contaminants in groundwater can enter these surface waters and impact the aquatic life they support. Additionally, conservation initiatives should focus not only on ensuring that adequate groundwater supplies are maintained for human needs but should also focus on ensuring that adequate amounts remain to provide "base flow" to streams during dry periods, particularly under drought conditions.

*Groundwater is, in a sense, the lifeblood of Pike County. Not only does it provide residents with a generally clean and abundant water supply, it is also vital to the regional economy and to sustaining a healthy environment.*

## The Water Cycle

The amount of water present on Earth today has remained constant for millions of years. In fact, the water in this morning's coffee may have been the same water a dinosaur sipped from a pond millions of years ago. This water continually circulates and is recycled through the **hydrological (water) cycle** (Figure 1).

In the hydrological cycle, **evaporation** from the earth's surface and **transpiration** from the surface of plant leaves releases water vapor into the atmosphere. Eventually, water in the atmosphere condenses and falls back to the earth as some form of precipitation (rain, snow, sleet, etc.). A portion of the precipitation falling on Pike County's watersheds will travel across the land's surface as stormwater runoff (Chapter 4), entering nearby surface waters.

Rain and snowmelt that does not run off as stormwater or return to the atmosphere through transpiration and evaporation can percolate down through soil layers and into the open spaces of underlying sand, gravel and bedrock providing **recharge** of groundwater supplies.

## A Story of Rocks, Sand and Water

The idea that groundwater is found beneath the earth's surface in underground rivers or lakes is largely a myth. In Pike County, local groundwater supplies are found in either of two basic types of earth materials: **consolidated bedrock** such as sandstone or shale or **unconsolidated glacial debris** consisting of silt, sand, gravel and rocks.

**Bedrock:** The majority of Pike County residents obtain their groundwater from wells drilled into bedrock. "Solid" bedrock acts as a sponge storing and moving groundwater through minute, interconnected pore spaces. Significant quantities of groundwater also move through the cracks and fractures running throughout bedrock. This interconnected system of cracks and fractures acts as a subterranean plumbing system that residents tap into when a well is drilled into bedrock.

**Glacial deposits:** The last glacial period that impacted Pike County ended approximately 20,000 years ago. A sheet of ice, upwards of three thousand feet thick and covering much of Northeast Pennsylvania, began to melt as climatic changes brought increasing temperatures. As a result, large quantities of sand, gravel and rock that were embedded in this ice sheet were deposited over much of the County.

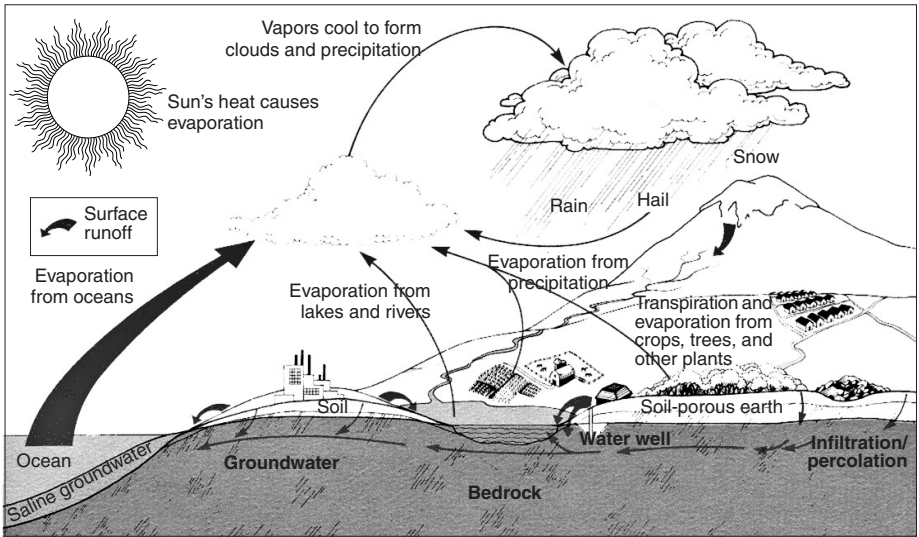
While some of this material simply dropped out directly onto the surface of the land, much was transported in vast quantities of melt waters, flowing downward across the landscape, eventually reaching the Delaware River Valley where these materials settled out, leaving behind deposits up to 500 feet deep. Groundwater supplies in these glacial deposits occupy the open spaces in sand, rocks, and gravel.

The most significant deposits of glacial material in Pike County occur along the County's eastern edge, particularly in the Milford-Matamoras corridor area. Water wells in this area draw their water from groundwater stored in this glacial material.

## Groundwater, Aquifers, Water Tables and Streams

The **water table** marks the top of the **zone of saturation**. *All water found below the water table within the zone of saturation, occupying the open pore spaces in sand, gravel and bedrock, is **groundwater**.*

The water table is not static but falls as groundwater continuously migrates to the earth's surface into springs, streams, wetlands and lakes. Water tables, or groundwater levels, fall more quickly during dry periods



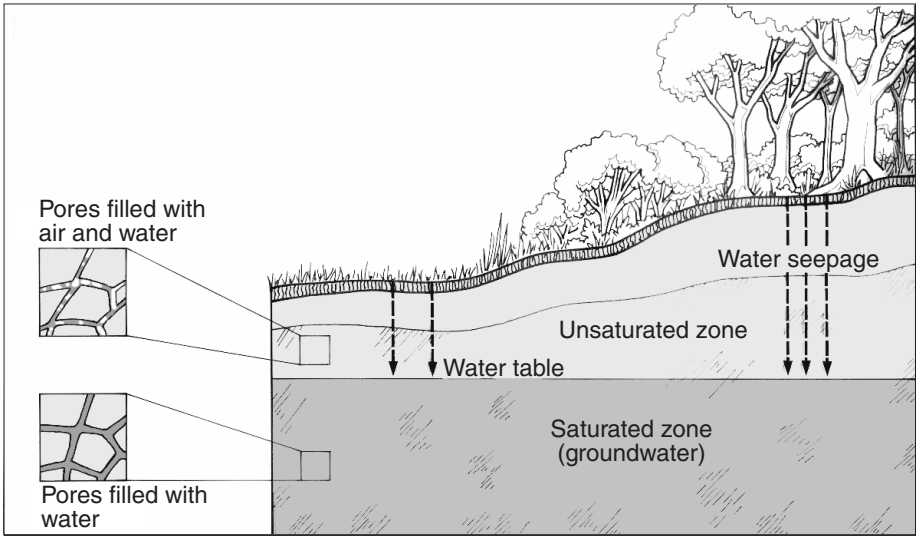
*Figure 1: Water cycle illustration. Courtesy of the League of Women Voters of PA, Citizen Education Fund*

when precipitation is not available to provide recharge. Conversely, precipitation and snowmelt will raise the water table, bringing it closer to the earth's surface as the zone of saturation rises. When a well stops providing water during a drought, it is often because the water table has dropped below the depth of the water pump in that well.

Areas beneath the earth's surface where sufficient quantities of groundwater are found that can be extracted to meet human demand are referred to as **aquifers**. An aquifer may be as small as a few acres or may underlie an entire watershed.

**Gravity** and **pressure** are the primary forces causing groundwater to flow underground and eventually return to the surface. Groundwater generally flows along a natural gradient from upland recharge areas, in the higher elevations of watersheds, to lowland discharge areas where groundwater returns to the surface forming springs and entering lakes, streams and wetlands. How quickly groundwater travels beneath the surface depends on several factors and varies from only a few inches per year up to several feet per day.

It is significant that 70-80% of the water that flows through Pike County streams is supplied by groundwater. In fact, during dry periods, 100% of the water moving through many streams originates as groundwater discharging up from below. At a temperature of approximately 50 de-



*Figure 2: Groundwater illustration. Courtesy of the League of Women Voters of PA, Citizen Education Fund*

grees, groundwater flowing into streams helps to maintain colder water temperatures, which in turn enables streams to hold more dissolved oxygen. This becomes critical during drier, warmer summer months when colder, oxygen-rich water is needed to keep fish, including Pike County’s native brook trout, and other aquatic stream life, alive.

**Groundwater Quantity: When is Enough, Enough?**

Pike County’s undeveloped, forested landscapes allow for relatively high rates of infiltration or groundwater recharge by rain and snow melt. This recharge replenishes and sustains the supply of groundwater that residents and businesses depend on.

However, as residential and commercial development proceeds, forests are cleared and replaced by **impervious surfaces** in the form of parking lots, highways, secondary roads, driveways and rooftops, disrupting the groundwater recharge process. Simultaneously, increasing numbers of wells are drilled, putting increasing pressure on underlying aquifers. Droughts, occurring with increasing frequency and intensity in recent years, are a third major factor.

These factors all affect groundwater supplies, impacting both people and streams and pointing to the need for conservation measures practiced by residents (see Appendix C) and businesses as well as proactive planning for long-term management of groundwater resources.

## Summer = Groundwater Drought

During the summer growing season, rainfall from showers and thunderstorms may cause stream, river and lake levels to rise quickly and reach capacity or even spill their banks causing flooding. The appearance of this abundance of water may lead residents to believe that a drought has been broken and water conservation measures can be relaxed. But what is going on beneath the surface with groundwater supplies may be an entirely different story.

Why? Because during the growing season the process of groundwater recharge is “short-circuited” by growing vegetation. When leafed out, plants (including Pike County’s forests) act as living pumps drawing water from soil, transporting it up through vascular tissue in trunks and branches and releasing it through the surface of leaves into the atmosphere.

As a result, during the summer season, a considerable amount of rain must fall before any significant recharge or replenishment of groundwater supplies occurs. Only when plants have absorbed as much water as they need and soil layers have become saturated is water from rainfall able to move past the root zone of plants and down through soil layers and bedrock into the zone of saturation providing groundwater recharge and raising the water table.

However, droughts affecting Pike County have been broken during the growing season when the remnants of tropical storms or hurricanes have moved through the region and dropped significant amounts of rain that has fallen steadily over a period of days. Under these conditions soils become saturated, thirsty plants have their water needs met and water from rainfall is able to reach the water table, replenishing groundwater supplies for Pike County’s private, community, and commercial wells.

### Groundwater Quality: Let’s Keep it Clean Folks!

Leaking underground storage tanks, hazardous wastes released from transport trucks involved in highway accidents and improperly or illegally disposed of toxic wastes all present a threat to groundwater supplies. While these potential sources of contamination must be addressed there is another less obvious, but potentially widespread source of groundwater pollution known as **non-point source pollution** (Chapter 2).

In Pike County’s watersheds, non-point source pollution originates from many diverse, scattered sources including on-lot sewage treatment systems, road de-icing agents, small-scale livestock operations, household haz-

ardous wastes including lawn and garden chemicals, leaking automobile fluids and improperly disposed of motor oil.

These types of pollutants can potentially enter the water cycle, following the same route as rain or snowmelt, moving down through soil layers and bedrock into groundwater supplies and eventually flowing into wells or up into a nearby stream. In addition, household hazardous wastes (Chapter 2) dumped down household drains can move through a septic system, eventually reaching groundwater and potentially contaminating drinking water wells. As a general rule of thumb, “If you wouldn’t want to drink it, think twice before pouring it on the ground or dumping it down a drain!”

**70-80% of the water that flows though Pike County streams is supplied by groundwater.**

The impacts of contaminated groundwater are felt on many levels in affected communities including:

- Social impacts and psychological stress as normal day-to-day lives of individuals, families and communities are disrupted
- Sub-acute and acute illness among residents
- Short and long-term financial liability incurred by residents, businesses and community associations

While the groundwater supplies underlying Pike County’s watersheds are generally considered to be of good quality, contaminants, either naturally occurring or introduced by human activities, have been detected in residential water samples. These include lead and copper (released from household plumbing by corrosive groundwater), bacteria, radon and in some cases MTBE, a chemical component of gasoline. Information on water testing can be found in Appendix E.

Even with state of the art technology and even when sufficient monetary resources – possibly in the millions of dollars – can be obtained, cleanup of contaminated groundwater is a lengthy process and very often groundwater is not completely restored to its original contaminant-free state. To protect community drinking water supplies, and to avoid these consequences, the ultimate solution is preventative measures taken by residents, the business sector, community associations and municipalities that focus on maintaining groundwater supplies in a state as free of contamination as possible.

## **Summary**

Pike County residents, visitors and businesses depend entirely on



## Underground Storage Tanks for Home Heating Oil and Groundwater Contamination

Underground storage tanks (USTs) are often used to store home heating oil. Usually constructed of metal, USTs are subject to the corrosive forces of their subsurface environment. As a result, over time, these tanks have the potential to rust through and develop leaks releasing heating oil to surrounding soil and to groundwater. Even tanks that are coated to resist corrosion are prone to failure.

USTs have been known to begin leaking as quickly as twenty years after installation and a leaking tank may go undetected, allowing for the release of its contents. Signs of a leaking UST include a strong petroleum odor around a tank or in a basement, the need to refill a tank more often than would be expected, a dark staining of soil around the area where a tank is located, water accumulating in a tank or sudden erratic behavior of a furnace caused by water that has become mixed with heating oil.

Contamination of the homeowner's and neighboring wells can occur and as a result, the owner of a failed UST can incur significant financial liability not only for cleanup and removal of a tank and contaminated soil, but also for costs associated with groundwater cleanup and damage to neighboring homes and property. To help ensure against an undetected failure one option for a property owner is to remove and replace a UST with an above ground tank.

The cost of removing a UST and replacing it with an above ground tank before it fails can provide significant cost savings down the road. Financial assistance for the removal and cleanup of failed USTs is available through the PA DEP's Underground Storage Tank Heating Oil Clean-up Program (See Resources for More Information at the end of this chapter). When having a new home built the homeowner can request installation of an aboveground tank outside a home or in a basement.

groundwater to meet their water needs. The groundwater found beneath Pike County watersheds is generally of good quality and adequate in supply to meet current, local demand.

However, groundwater is a resource that is vulnerable to over-withdrawal and contamination. Rising rates of residential and commercial de-

velopment in Pike County will continue to present significant challenges to maintaining adequate and clean groundwater supplies. Because groundwater contamination is often difficult to detect, expensive to cleanup and a threat to both human and environmental health, the best approach is to prevent contamination from occurring in the first place.

Groundwater protection requires a multi-faceted approach including educational efforts from school students to community leaders, implementation of Source Water Protection (SWP) plans (Appendix F), and participation by all residents doing their part as “groundwater guardians.” Refer to the suggestions listed below for measures that residents, community associations and municipal officials can take to protect Pike County’s groundwater resources.

### **Action Steps for Groundwater Protection**

- ☞ Attend meetings or write letters to local municipal officials supporting their efforts to create municipal ordinances designed to protect groundwater including ordinances for private well construction, on-lot sewage treatment system maintenance, Conservation Design principles for land development and the start of a household hazardous waste collection program.
- ☞ Support your community association in the adoption of restrictions, covenants and codes designed to protect groundwater and in any efforts undertaken to establish and improve Wellhead Protection plans for community wells.
- ☞ Have your septic tank inspected and pumped on a regular basis to minimize groundwater contamination from your on-lot system.
- ☞ Join or form an environmental committee for your community association and start a groundwater protection program.
- ☞ Properly dispose of household hazardous wastes including not pouring down household drains or onto the ground.
- ☞ Support efforts to conserve wetlands. Wetlands act as filters, removing many water pollutants and providing recharge to underlying aquifers.
- ☞ Replace underground storage tanks for heating oil with above ground tanks to prevent a potential undetected leak.

☞ Have your water tested. While water testing does not protect groundwater, it can provide valuable information on the quality of well water and treatment measures that may be needed to remove pollutants that are present. Refer to Appendix E for more information on water testing.

### **Resources for More Information**

PA DEP, Groundwater Protection: [www.depweb.state.pa.us/dep/site/default.asp](http://www.depweb.state.pa.us/dep/site/default.asp). Select “Search” and “Groundwater Protection.”

PA DEP, Home Heating Oil Underground Storage Tank Clean-up: [www.depweb.state.pa.us/dep/site/default.asp](http://www.depweb.state.pa.us/dep/site/default.asp). Select “Storage Tank Cleanup Program.” Includes information on procedures and financial assistance available for cleanup of failed underground, residential heating oil tanks.

PA League of Women Voters Water Resource Education Network: [pa.lwv.org/wren/library.html#groundwater](http://pa.lwv.org/wren/library.html#groundwater). Downloadable groundwater educational materials.

Penn State Water Resources Extension: [www.sfr.cas.psu.edu/water](http://www.sfr.cas.psu.edu/water)

Pennsylvania Groundwater Association: [www.pgwa.org](http://www.pgwa.org)

Pike County Conservation District: [www.pikeconservation.org](http://www.pikeconservation.org)

US EPA, Citizen’s Guide to Groundwater Protection: [www.epa.gov/safewater/protect/citguid.pdf](http://www.epa.gov/safewater/protect/citguid.pdf)

US EPA, Groundwater and Drinking Water: [www.epa.gov/ogwdw](http://www.epa.gov/ogwdw)

U.S. Geological Survey, Water Resources of the U.S.: [water.usgs.gov](http://water.usgs.gov)