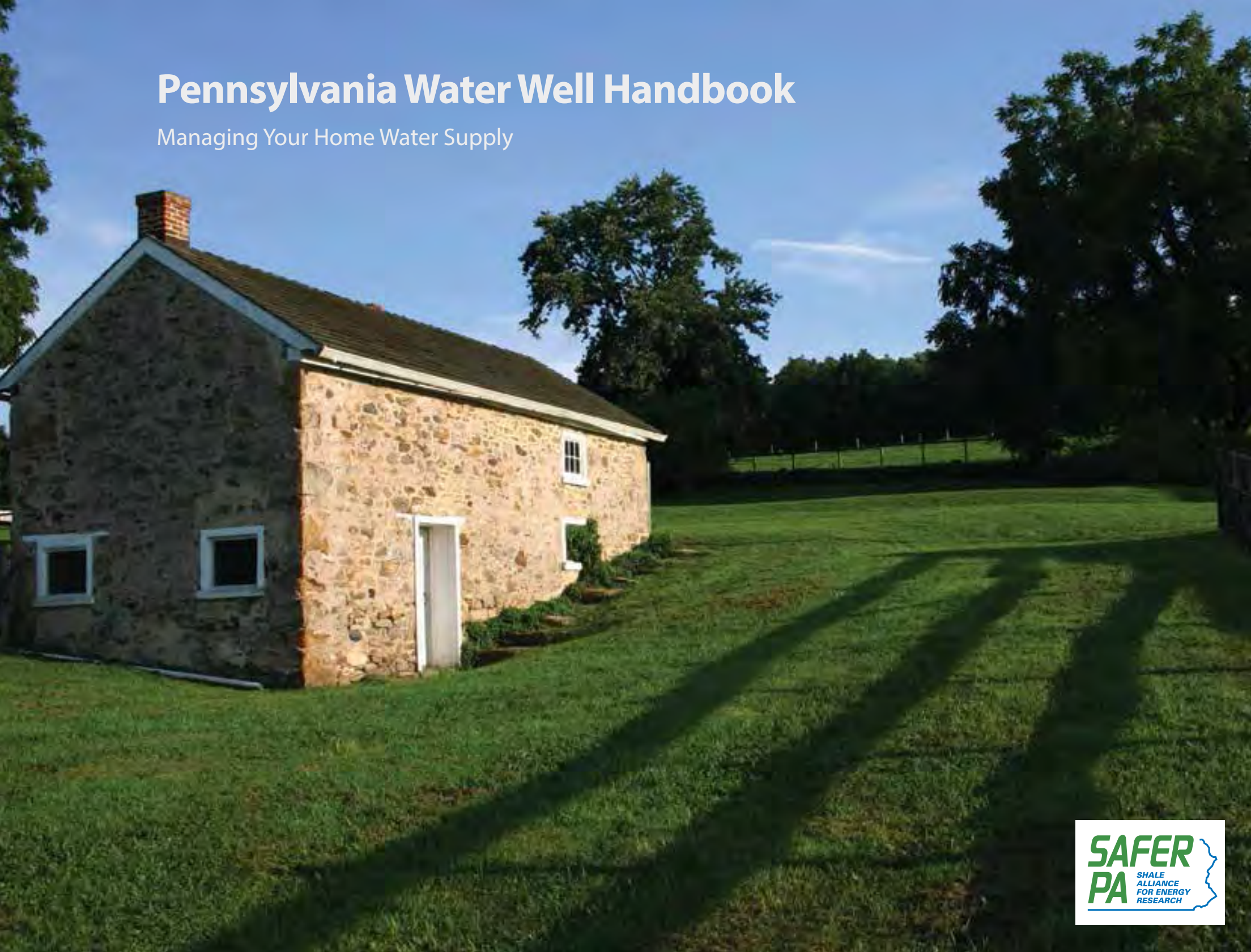
Pennsylvania Water Well Handbook

Managing Your Home Water Supply



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Our mission is to work collaboratively with government, environmental, academia, industry, and other stakeholders to advance technology, analysis and education that supports safe and sustainable development of the Commonwealth's shale resources.

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Section 1

Introduction

Objective of this Handbook

This handbook is intended to be a valuable resource for owners of private water supplies in Pennsylvania. The objective of this handbook is to provide an overview of Pennsylvania private water supplies, including details on the natural water cycle in Pennsylvania, how water occurs in aquifers, typical water quality issues, best management practices for water well siting and construction, water quality protection, how to interpret laboratory reports, and improving your water quality through treatment, if required. At the end of the document are useful references with more information on specific topics addressed in each section. Information provided in this handbook is freely adapted from publications provided by various federal, state and local agencies. The back pocket of this handbook can be used to keep your water system records and notes together. This handbook and your records should be stored in a safe place with your other important documents.

If you live in rural Pennsylvania, chances are the water in your home comes from a well or spring that produces water from a natural underground geologic feature called an "aquifer." In Pennsylvania, over a half billion gallons of water per day are produced from private water supplies and Pennsylvania is second only to Michigan in the number of households that rely on private water wells. It is estimated that over one million private water wells are utilized in the Commonwealth and approximately 12,000 to 15,000 new water supply wells are drilled each year.

Where Groundwater Comes From

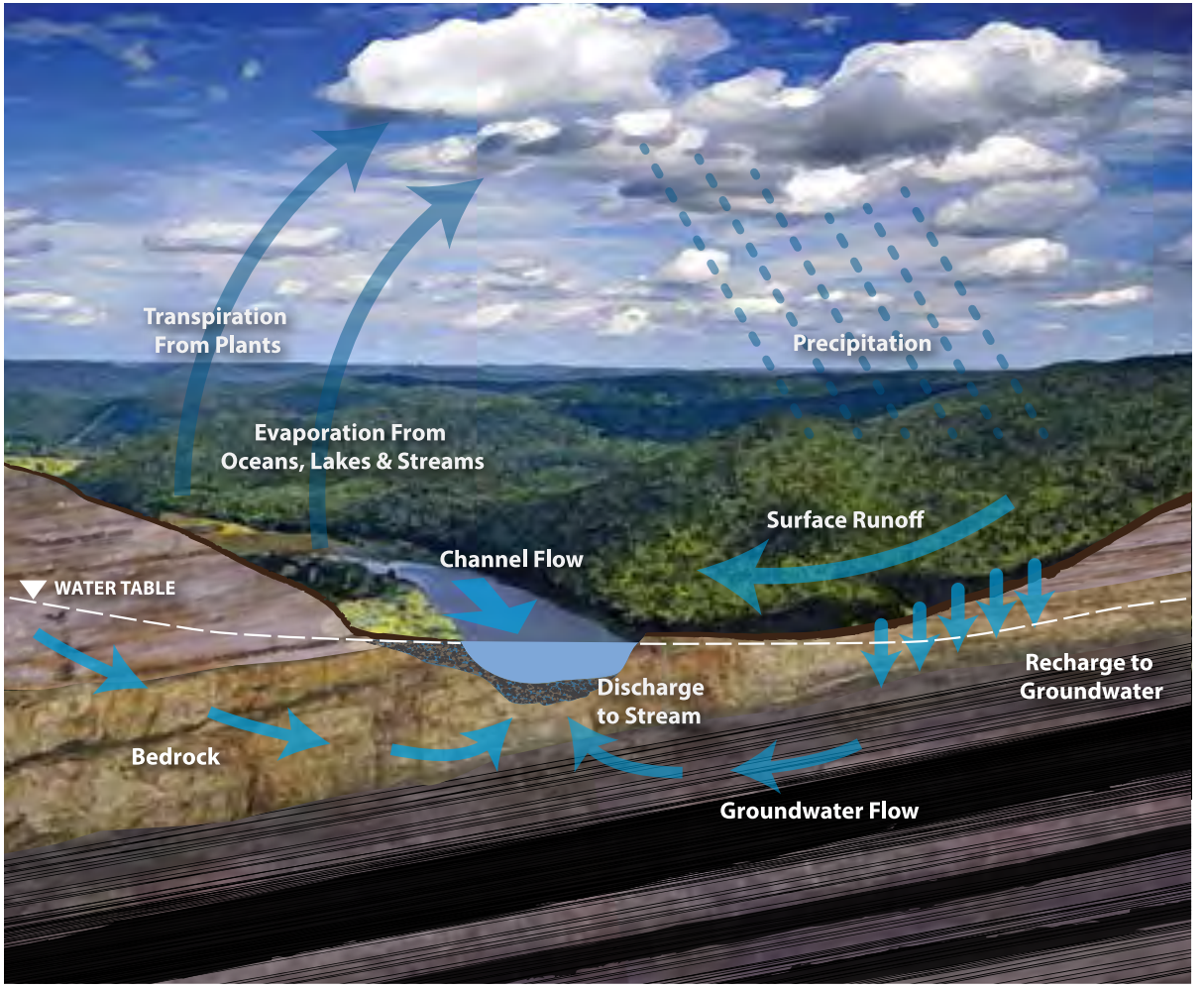


Figure 1: Water Cycle

The Water Cycle

The natural water cycle that supplies water to aquifers is illustrated in Figure 1. Water that evaporates from oceans, lakes, and streams, or is emitted by plants, condenses in the atmosphere to form precipitation (rain, sleet or snow) that falls to the Earth's surface. This precipitation flows overland to streams or seeps down into the ground. Some of the downward seepage is retained in soil to support plant growth. The rest of the water recharges our aquifers. Groundwater can be one of the cleanest sources of water on Earth because of the natural filtration, chemical reactions, and biological activity that occur as water seeps downward to recharge aquifers.

In Pennsylvania, approximately 75 percent of precipitation occurs as rainfall and the rest is from snowfall. In general, most aquifer recharge occurs during early spring and late fall when the soil is not frozen and plants are not actively growing.

Pennsylvania Aquifers

An aquifer is an underground layer of water-bearing geologic material from which groundwater can be extracted at a rate suitable for our needs. Any discussion of Pennsylvania aquifers starts with our geology. One only needs to look at the various landforms within the beautiful vistas in Pennsylvania to appreciate the complexity of the soil and rock formations that lie below.

Our soil and rock formations are the result of many processes that have occurred over billions of years, including:

- ancient continental separations and collisions;
- intrusions of molten rock;
- the deposition of sediments on land, near shorelines and in marine environments;
- the hardening of buried materials by pressure and temperature;
- rock folding, faulting and fracturing; and,
- the advance and retreat of glaciers.

All of these processes have created the various materials that form aquifers in Pennsylvania.

The basic types of aquifers in Pennsylvania are depicted on Figure 2 and their common characteristics are listed on Table 1.

Porosity and Permeability

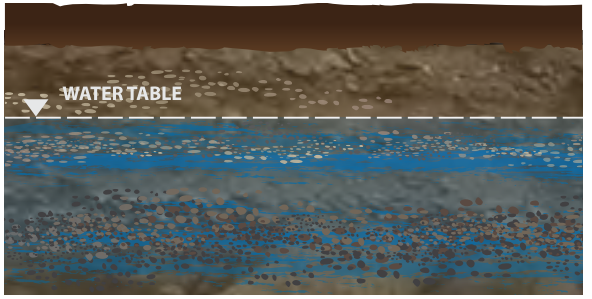
The ability of an aquifer to produce water is largely dependent upon aquifer porosity and permeability. Groundwater collects and moves within an interconnected network of openings or pores. The porosity of an aquifer is the size and amount of these openings. The permeability of an aquifer is defined as the relative ease with which water can move through interconnected pore spaces.

Fractured Bedrock Aquifers

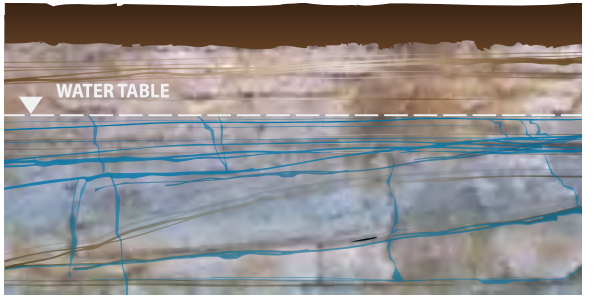
The general distribution of various types of aquifers across Pennsylvania is shown on Figure 3. Most private water wells in Pennsylvania are drilled in fractured bedrock aquifers which include sandstones, shales, carbonate rock, and crystalline rocks. In fractured bedrock aquifers, porosity is created by interconnected fractures, openings between rock layers, and solution openings. Examples of these interconnected features can be seen along road cuts throughout the Commonwealth. Solution openings occur in bedrock comprised of carbonate minerals (limestones and dolomites). These carbonate rocks are prone to chemical weathering that enlarges certain pore spaces in the rock. Fractured bedrock aquifers have a wide range of permeability, and in many areas, fractured bedrock is highly permeable and produces ample water for household use. In a few areas, fractured bedrock can have very low permeability, where the elements of pore space are not well connected. In this situation, water wells may be drilled deeper to intersect enough low yielding features to create a sufficient water supply or to create storage in the well.

Sand and Gravel Aquifers

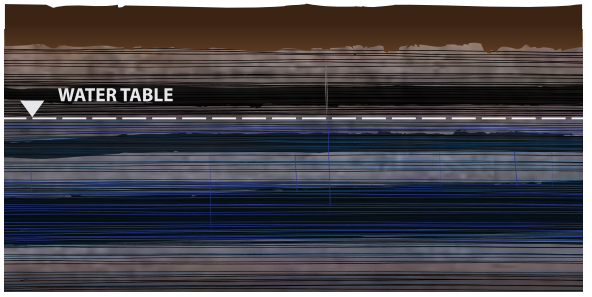
A small percentage of the water wells drilled in Pennsylvania are drilled in sand and gravel aquifers.



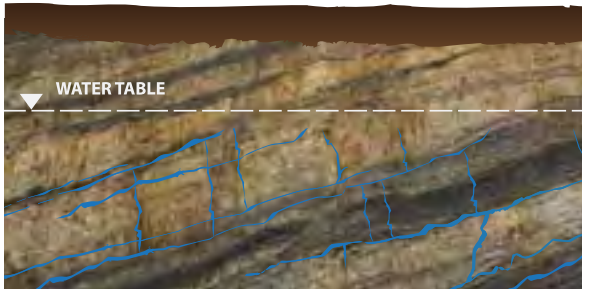
Sand and Gravel



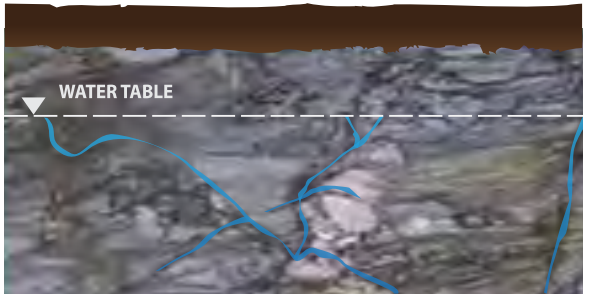
Sandstone



Shale



Carbonate



Crystalline Rock

Figure 2: Basic Aquifer Types in Pennsylvania

Our sand and gravel aquifers are found in river valleys where historic glacial activity and/or modern day stream processes have deposited thick layers of sand, gravel, cobbles, and boulders. These aquifers mostly occur north of the limits of glaciation in Pennsylvania as shown on Figure 3. The large porosity and permeability present within sand and gravel aquifers accounts for some of the largest producing water supply wells in the Commonwealth.

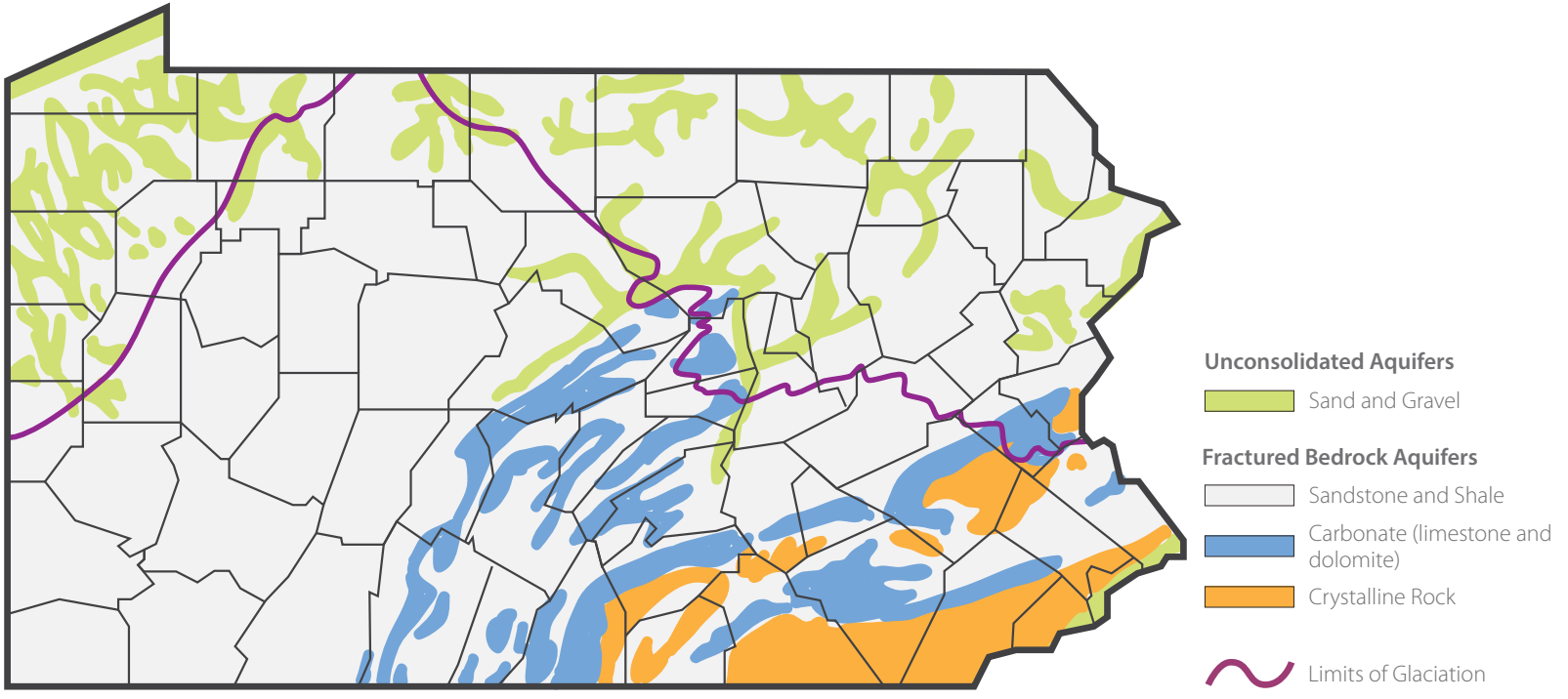


Figure 3: Distribution of Aquifers Across Pennsylvania
Modified from: *The Geology of Pennsylvania's Groundwater*, PGS Ed. Ser. 3, 1999.

What Kind of Aquifer Do You Have?

Water well contractors with experience drilling in your area will be able to tell what to expect in terms of the type and permeability of local aquifers. To determine the type of aquifer your water well is drilled into, review your well drilling record, ask your water well contractor, ask a geologist, visit your local library for geologic reference material, or go online and visit the Pennsylvania Geological Survey (PGS) website listed in Section 11.

Table 1: Common Characteristics of Pennsylvania's Aquifers

Aquifer Type and Description	Map Code	Common Depth Range (in Feet)	Common Yield Range (in GPM)	Typical Water Quality
Unconsolidated sand and gravel aquifers: sand, gravel, clay, silt, cobbles, boulders		20 - 200	100 - 1,000	Soft water with less than 200 mg/L dissolved solids; some high iron concentrations.
Fractured sandstone and shale aquifers		80 - 200	5 - 60	Sandstone layers have soft water with less than 200 mg/L dissolved solids; shale layers have hard water and 200–250 mg/L dissolved solids.
Fractured and solution-prone carbonate aquifers		100 - 250	5 - 500	Very hard water with more than 250 mg/L dissolved solids.
Fractured crystalline aquifers: quartzite, granite, gneiss and schist		75 - 150	5 - 25	Soft water containing less than 200 mg/L dissolved solids; some moderately hard water with high iron concentrations.

Modified from: *A Quick Guide to Groundwater in Pennsylvania*, Penn State College of Agriculture, 2007.

How Your Water Well Should Be Located, Constructed And Tested

General Overview of Well Location and Construction

Considerations for appropriate water well location and construction are important for landowners planning to drill a new water well or replace an existing water well. However, these considerations are also of interest to landowners who want to properly maintain an existing water well. Unlike most states, there are currently no regulations in Pennsylvania that specify how a private water well should be constructed or mandate water quality testing of private supplies by a laboratory. Pennsylvania water well contractors are obligated to maintain a Water Well Drillers License that requires them to keep and submit detailed records regarding the construction of each water well to PGS. A few local governments, like Chester, Montgomery, and Bucks Counties, PA, have developed water supply well construction standards under local regulations. You should investigate whether local standards exist in your area. Pennsylvania may adopt private water well regulations in the future.

If you are considering installing a private water well, it is assumed that public water is not available or it is cost prohibitive to have public water piped to your house, or you may simply prefer the quality of well water over public water. Be aware that some towns and cities with available public water systems have ordinances against the use of private water supply wells.

The location of your household private water supply well will be determined by you and your water well contractor. If your land holding is large and you need a lot of water for purposes other than household use (for example, to support a farming operation) or, if groundwater is scarce, you should consider hiring a professional hydrogeologist to locate your water well and design its construction. You can identify local professional hydrogeologists in the Yellow Pages of your phone book or on the internet.

Water Well Location Best Management Practices

In general, your water well should be located upslope and away from potential sources of pollution (see Section 7). Water tables (the upper surfaces of the uppermost aquifers) tend to slope in the same direction as the land surface and groundwater generally moves in the down slope direction. Water wells should be located as far away as possible from any potential sources that could affect water quality.

Water Well Construction

The PGS has developed a set of recommendations regarding the proper construction of private water wells in bedrock that can be viewed at their website listed in Section 11. Figures 4a (for bedrock wells) and 4b (for sand and gravel wells) are representations of important components included in properly constructed water wells. One of the most important features of a properly constructed water well is the seal that is formed when concrete grout is placed to completely fill the space between the outside of the surface casing and drill hole. The surface casing is made of steel or polyvinyl chloride pipe. For bedrock water wells, the surface casing is set from within bedrock to a couple feet above the surface. The surface casing should be long enough to case off the upper zone of soil and weathered bedrock. The grout seal protects your water well water from shallow subsurface sources of water quality impacts (like faulty septic systems) and from surface runoff water. Installation of the grout seal is not currently required by regulation in Pennsylvania and you will need to specify this element to your water well installation contractor in the scope of work.

Another important element of a properly installed water well is a vented sanitary cap fitted on

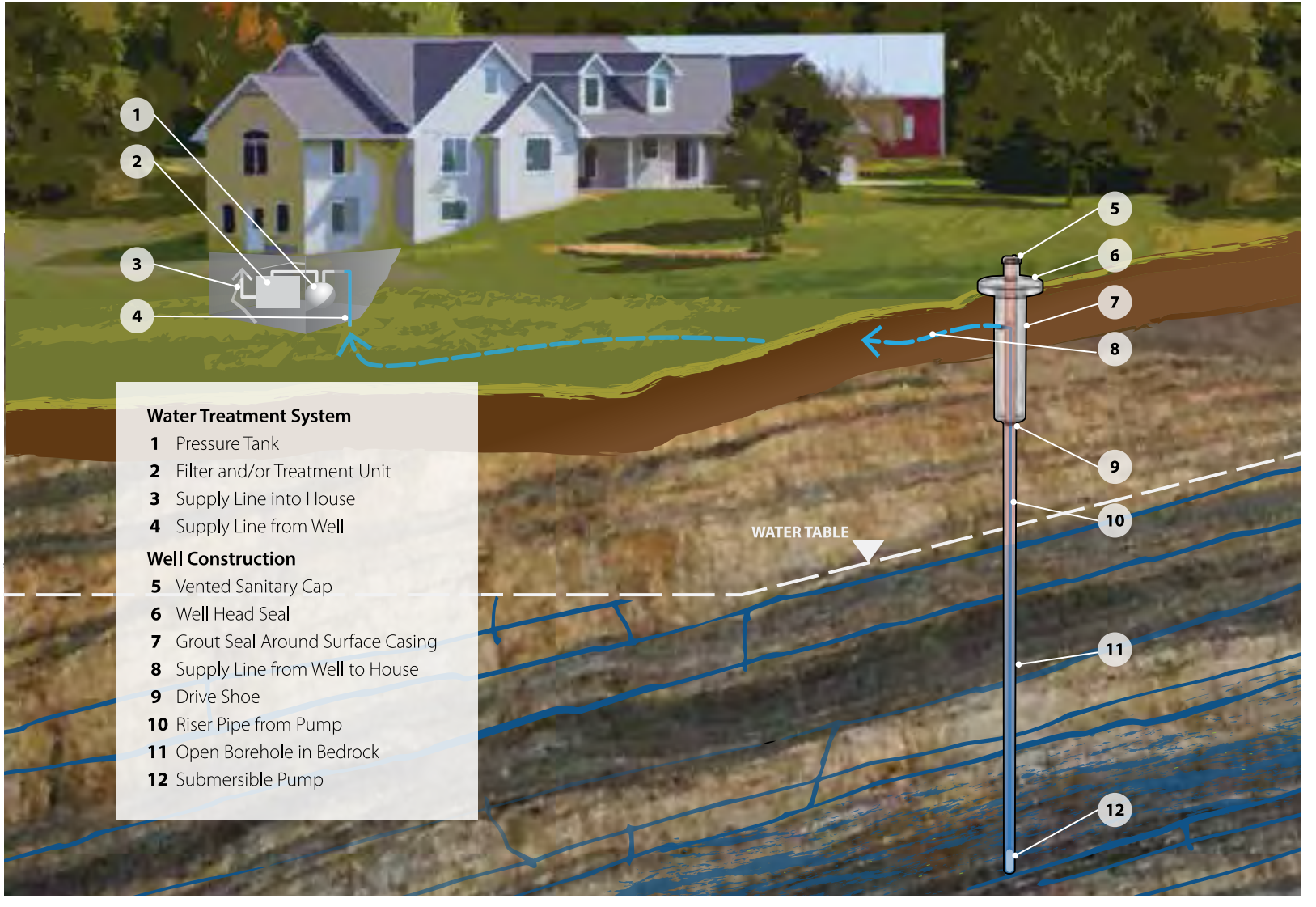


Figure 4a: Well Construction in a Fractured Bedrock Aquifer

top of the surface casing which prevents unwanted access to the well by man, vermin or insects. The vent allows any gas that might accumulate in the water well casing to escape (see Section 7).

The final depth of your water well will be determined by you and your water well contractor and will depend on the depth to water producing zones below the bottom of the surface casing. For some low yielding aquifers, the contractor may add storage capacity to the well by drilling tens of feet deeper than the lowest water producing zone.

The final step in well installation, prior to installing the pump and running the water line to the house, is to "develop" the well to remove sediment in the water created during drilling or being produced from fractures in the aquifer. Contractors develop wells by surging and removing sediment in water over a period of time. The contractor may develop the well by blowing compressed air through the drill bit and raising the drill bit up and down or by raising and lowering a submersible pump. This process removes sediment from the well until the water becomes clear. Some water wells require very little development time, while others can require more than 24 hours to develop, depending on the characteristics of the aquifer. Over time, sediment may accumulate in your water well and your contractor may need to redevelop your well to improve water quality and yield as part of routine maintenance. Excessive sediment buildup can result in elevated metals in your water.

Safe Yield Testing

After your water well is constructed and developed, it is advisable to have the contractor determine the average rate of flow that can be maintained over time without dropping the water level in the well to the pump intake. If the water level falls below the pump intake it will cease to deliver water. Details for performing a safe groundwater yield test can be found in the references in Section 11. An internet link to useful forms, including one that can be used to record data during a safe yield test, is provided inside the back cover of this handbook. The safe yield test can be repeated by a contractor at any time to determine if there has been a decrease in well performance.

System Disinfection

After a new water well is connected to a home water supply system, or any time work has been performed on the system, the well and piping should be disinfected. Your water well contractor can disinfect your system by a process referred to as "shock chlorination." Procedures for shock chlorination are described in references listed in Section 11. If shock chlorination is performed you should plan to be without water for a period of 14 to 18 hours.

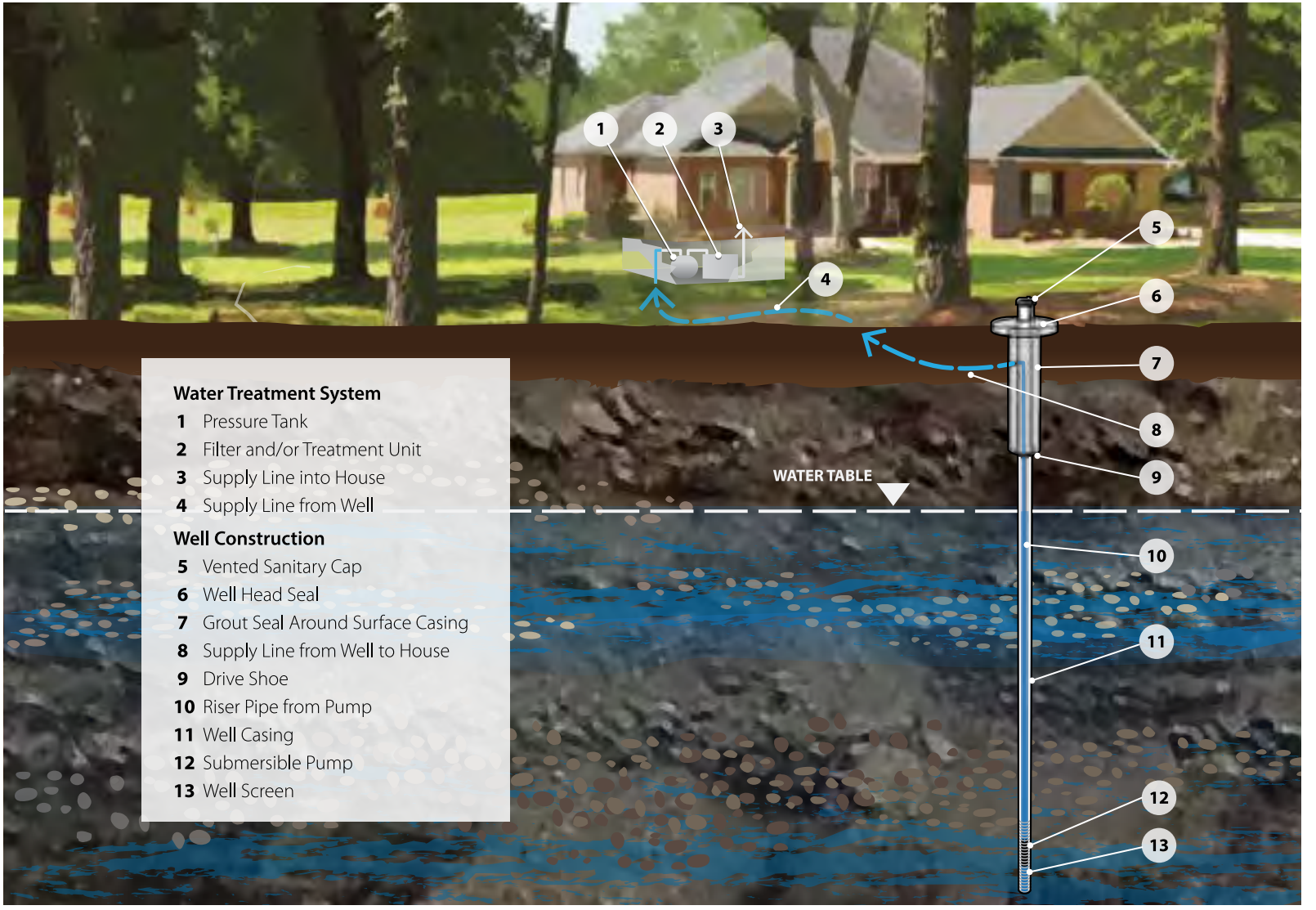


Figure 4b: Well Construction in a Sand and Gravel Aquifer

How Your Private Water System Functions

Here's How it Works

As shown on Figures 4a and 4b, the pathway of water flow from your well to your faucet starts with upward flow in the riser pipe. Water flowing upward in the riser pipe takes a 90 degree turn through the surface casing a few feet below ground surface and enters a buried horizontal pipe that leads to your home. The riser pipe and horizontal pipe connect through the surface casing at a fixture called a pitless adaptor. The pitless adaptor allows easy detachment of the riser pipe from the inside of the surface casing such that the riser pipe and pump can be removed for maintenance, repairs or replacements.

Once water enters your home (typically through a basement wall), it is commonly connected to a pressure tank designed to maintain sufficient pressure in your water lines. The pressure tank is usually located right after the water pipe enters your home and can be placed either before or after a water treatment system. A switch signals the well pump to turn on when pressure in the tank is getting low and signals the pump to turn off when pressure in the system has achieved a pre-determined maximum, usually near 40 pounds per square inch. This saves wear and tear on your pump by preventing continuous operation.

In some cases, when a water well has a low yield, a storage tank is added to the system or the driller creates storage by deepening the well.

How To Protect And Maintain Your Water Well

Routine Maintenance

Properly constructed private water supply systems require routine maintenance. An internet link to a routine maintenance checklist is provided inside the back cover of this handbook. One essential step in protecting and maintaining your water supply is the hiring of a qualified contractor for new well installations and maintenance. As stated earlier, at this time in Pennsylvania, water well drillers and installers are not regulated in terms of their ability to perform a proper installation; therefore, the Pennsylvania private water well owner is left to do their own due diligence regarding the qualifications of contractors. Since your water supply is essential to your home and health, it is important to identify reputable firms in your area to perform any work on your water well.

Another important step is to have your contractor perform the safe yield test discussed in Section 3 upon installation of a new water well and once every five years, or any time you detect a significant reduction in well performance. If a reduction in safe yield occurs, the contractor can improve the yield by removing sediment, biological growth, or scale from your supply system, or by deepening the well. Note, your water system should be disinfected by shock chlorination after these types of major maintenance activities. Keep a record of each safe yield test in the pocket of this handbook.

Other Types Of Water Supplies (Springs And Cisterns)

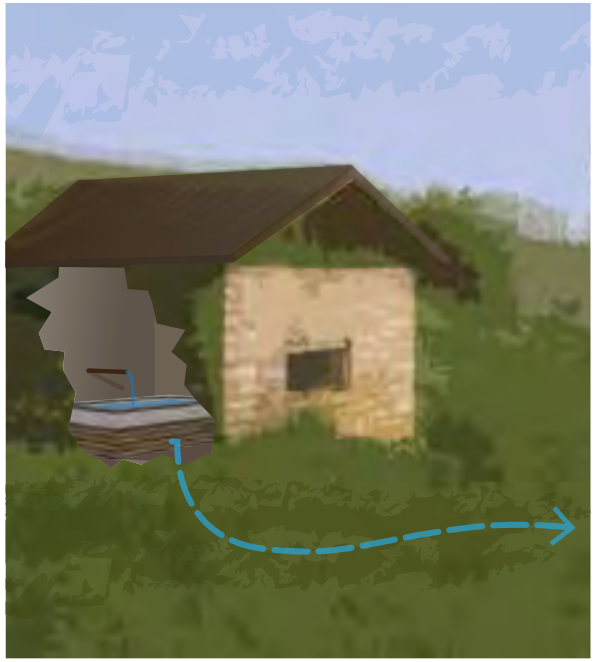


Figure 5a: Spring House

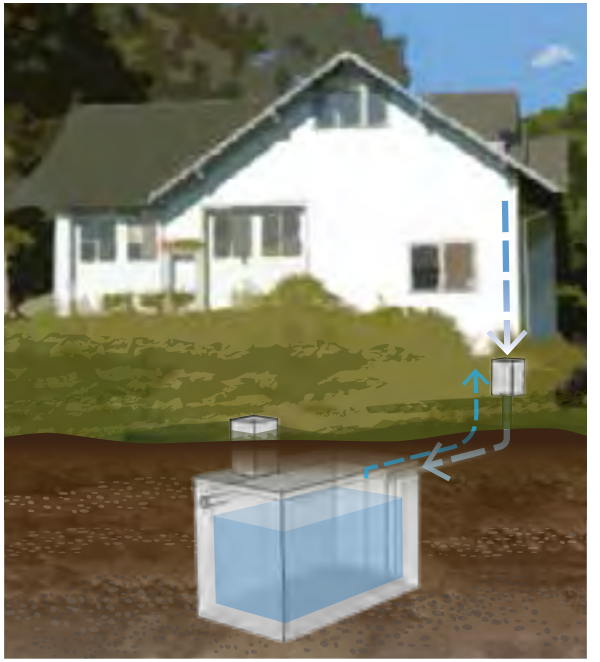


Figure 5b: Cistern

Springs

A spring occurs where groundwater naturally discharges to the land surface. In some cases, a great deal of natural filtration has occurred over a long underground flow path prior to the discharge and this water may be usable as a water source without treatment. However, in many cases, spring water is more representative of groundwater that is moving over a short flow path, close to the surface, and beneficial natural filtration is limited. If developed properly and treated, springs can provide a safe and reliable source of water for an individual homeowner. The amount of flow a spring produces throughout the entire year should be evaluated before the spring is considered as the sole source of water for a home because spring flow is often highly variable and may not provide a consistent, reliable source. Most useable springs have a man-made or natural pool with enough depth to accommodate a pump for delivering water to the home water supply system.

Landowners that use a spring for a safe water supply should place a totally enclosed structure (spring house) on top of the spring with a locked access door. To the extent possible the spring house should be sealed to the surrounding land surface to inhibit access by small animals. The spring house door should be locked at all times except for inspections and maintenance. Springs are very susceptible to coliform bacteria and water borne parasites such as giardia and cryptosporidium. For this reason, it is highly advisable to treat spring water by disinfection and filtration (see Section 9).

Cisterns

A cistern is a tank, usually installed underground, that stores water for drinking and other household uses. Although rare in Pennsylvania, cisterns are sometimes used in areas where aquifers are not present or aquifers are polluted and there is no alternative source of water. Cisterns can store water that is trucked to the home or they can store rainwater collected from your roof. For a household to use rain as a water source, a roof catchment area and appropriate treatment need to be installed with the cistern (see Section 9). Like springs, it is highly advisable to disinfect cistern water prior to drinking.

Potential Sources Of Water Quality Impacts

Overview of Potential Impacts

Within this section we will discuss both man-derived and naturally-occurring sources of adverse impacts to groundwater quality in private water systems. Some of the most common sources of adverse impacts for private water supplies in Pennsylvania are depicted on Figure 6. In most cases, adverse impacts can be easily eliminated but you cannot know what is present in your water supply unless you have your water tested (see Section 8).

Proper water well siting and well construction may be the easiest way to prevent adverse impacts to your water quality. Installation of a surface casing of sufficient length and with a properly installed grout seal may be the most important action you can take to prevent adverse impacts. If adverse impacts occur, they can often be addressed by removing sources, correcting well siting and well construction issues and/or by installing the appropriate water treatment system.

Homestead Sources of Water Quality Impacts

The most likely sources of adverse impacts to private water systems are related to failing on-lot septic systems and agricultural sources. On-lot septic systems are designed to trap solid waste in a tank and distribute liquids over a large area underground using a tile field. Within the tile field, the liquids leach through soil where natural processes neutralize pollutants found in human waste. One of the most important elements of a properly designed on-lot septic system is the presence of soil of a certain thickness and with sufficient drainage characteristics. Adverse impacts from on-lot sewage treatment systems may occur when treatment systems are:

- located too close to water wells;
- located upslope from water wells;
- located in areas with high water table conditions;
- are not properly designed with sufficient soil thickness and soil drainage characteristics;
- receive waste loads that exceed the original design limits;
- used for disposal of household chemicals;
- are not properly maintained, especially if solids tanks are not periodically emptied; or,
- have been in operation for a long period of time.

For more information about on-lot septic systems see the references in Section 11.

Other common sources of adverse impacts to private water supplies include household chemicals, agricultural chemicals, and manure that has been improperly stored or applied. Typical forms of household and agricultural chemicals include fertilizers, herbicides, pesticides, paint, solvents, other cleaners, and waste oil. Always use chemicals as instructed on the label. Do not store or use chemicals near your water well. Promptly clean up any leaks or spills discovered during routine inspections of storage areas. Used or dated chemicals should never be poured down a drain or on the ground. Try to only buy the amount of chemical needed for immediate use and take your dated and used chemicals to household hazardous waste cleanup days organized by your local government or local waste management service.

Heating oil and automotive fuels stored in tanks can also be sources of adverse impacts. Historically many of these tanks were buried underground. If possible, fuel tanks and lines should be located above ground where leaks can be easily detected and repaired. Care should be taken to prevent spills on the ground when transferring fuel from a tank to a piece of equipment or fuel can.

Historically, some landowners used a remote area of their property for household waste disposal. This practice is illegal and can contaminate an aquifer. Disposal of homestead wastes into sinkholes in carbonate rock has been an issue in Pennsylvania. Abandoned mines and quarries have also been targets for historic illegal waste disposal in the Commonwealth. Both sinkholes and abandoned mines allow for rapid infiltration of wastes into aquifers and pose serious threats to groundwater quality.

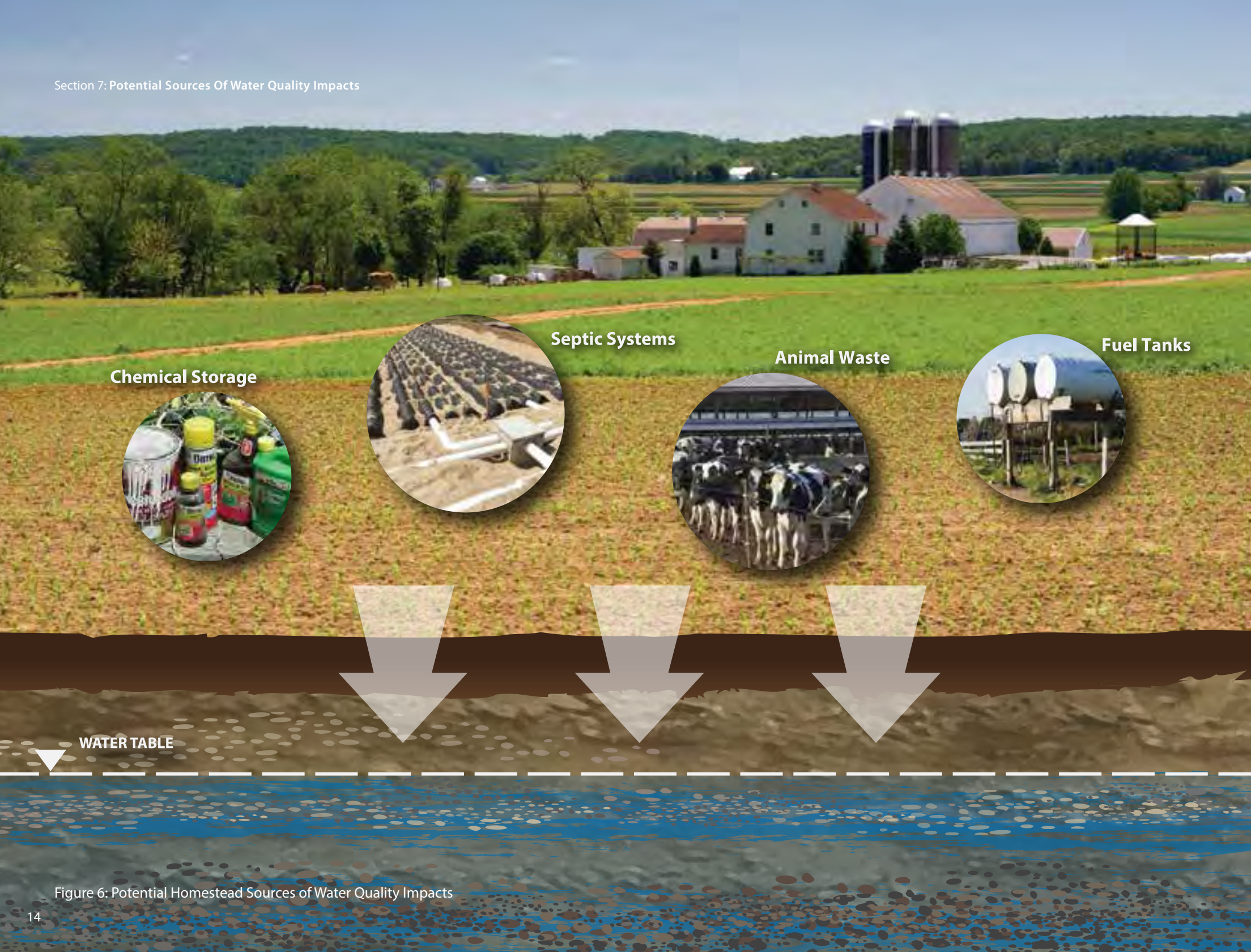


Figure 6: Potential Homestead Sources of Water Quality Impacts

Gas Migration Pathways

1 Methane venting from well cap

2 Methane moving in water line to home

3 Methane moving outside of surface casing and in water-line bedding

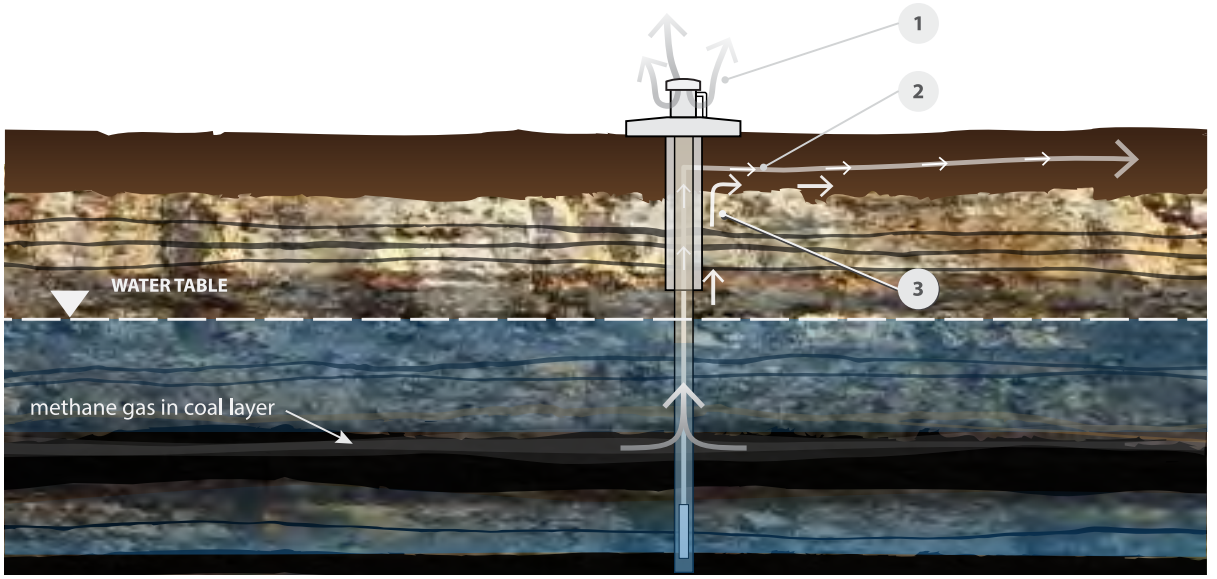


Figure 7: Gas Migration in Private Water Supplies

Naturally Occurring Sources of Water Quality Impacts

Natural conditions in an aquifer can cause adverse impacts to water quality, as well.

Inorganic Constituents

Hard water deposits from calcium and magnesium are common in groundwater from carbonate aquifers. Iron and manganese often occur in supplies sourced from some shale aquifers. Certain metals like arsenic, barium and lead can naturally occur in Pennsylvania aquifers at levels toxic to humans; however, each can be removed with the appropriate water treatment system. The concentrations of these metals in your water can only be determined by a water sample that is analyzed by a laboratory (see Section 8).

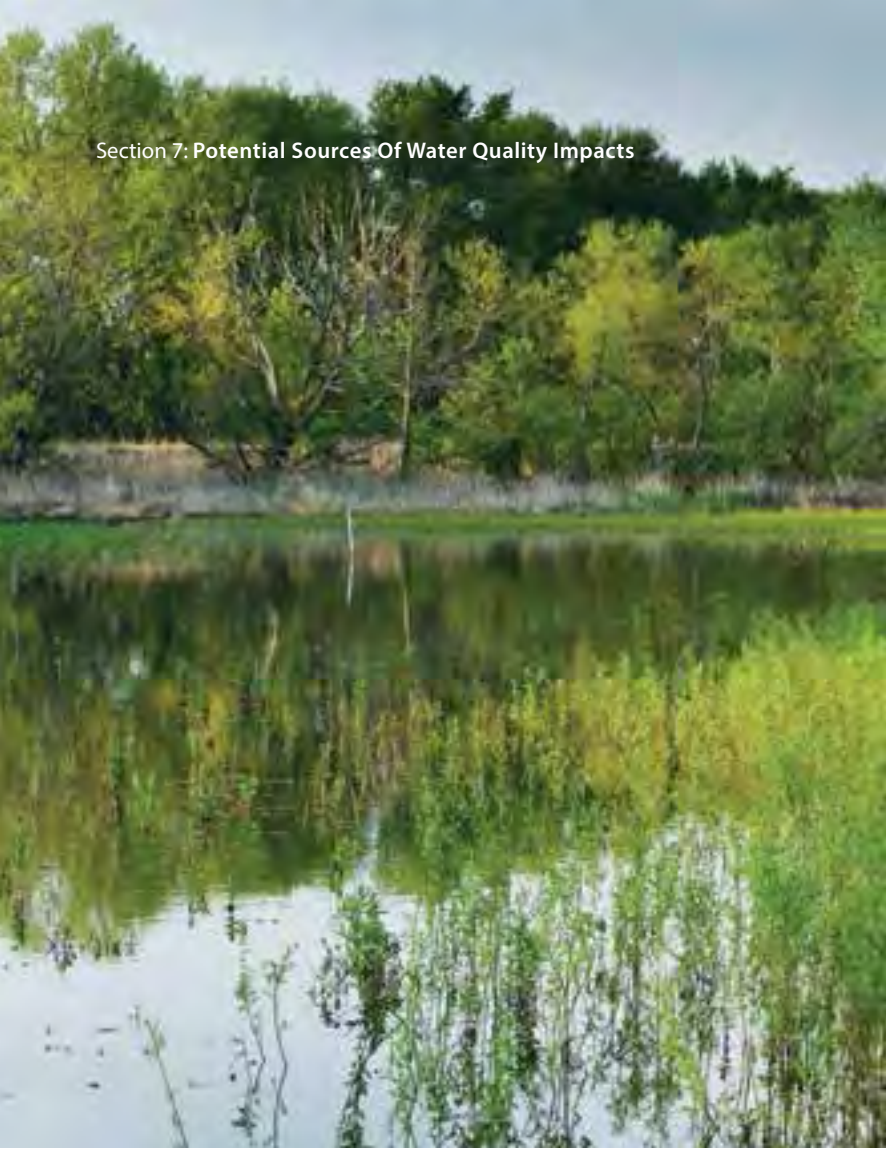
Gases

In Pennsylvania, it is not uncommon for naturally occurring gases to be present in private wells. The most common gases are methane, hydrogen sulfide, and radon. Depending on the gas concentration and pressure conditions, dissolved gas will release to the atmosphere and fill the space within the well surface casing, above the water level. Where there are significant levels of gas in a well, the water may appear to be fizzing or even boiling. It is important for your well to be properly constructed with a vented sanitary cap and located in a well-ventilated area where gas can escape to the atmosphere without consequence. If the well casing is not properly vented or sealed with grout, gas may preferentially migrate in the subsurface to low pressure areas such as basements (see Figure 7). This may cause a dangerous situation, including the possibility of explosion and should be addressed immediately. Gaseous compounds can also be transferred from water to air in pressure tanks or as water is delivered from faucets or showerheads.

Hydrogen sulfide often results from the bacterial breakdown of organic matter in the absence of oxygen, such as in swamps, sewers, or near septic systems. Hydrogen sulfide is a colorless gas that is typically very easy to detect at low concentration because it smells like rotten-eggs. At higher concentrations hydrogen sulfide gas becomes toxic, corrosive, flammable, and explosive but is less detectable by odor because the toxic effect of the gas limits your ability to smell. As such, you should immediately remove yourself and others from any space having a rotten-egg odor. Recommended treatment systems for hydrogen sulfide in water include aeration, chlorination, and ozonation.

Naturally occurring methane is odorless, colorless, and tasteless and represents a potential explosion and asphyxiation risk under certain conditions. Care should always be taken to ventilate confined spaces where well water is used. The United States Geological Survey (USGS) and others have conducted extensive water quality studies that indicate some areas of Pennsylvania have detectable levels of naturally-occurring methane in 25 to 30 percent of the water wells sampled. These water wells typically occur in areas underlain by geologic materials that contain organic matter. Extensive testing has led experts to believe that concentrations of dissolved methane in well water below 1 mg/L are harmless, in the range of 7 to 10 mg/L are not usually cause for concern, and above 10 mg/L indicate treatment would be prudent. Methane in well water can be corrected using an aeration system. Methane concentrations in well water and air can be highly variable over time; therefore, periodic testing is recommended whenever the presence of methane is suspected or confirmed through testing.

Radon is a naturally occurring, odorless, radioactive gas primarily formed from the decay of uranium and thorium present in soil and bedrock, and therefore can be found



dissolved in groundwater. It can be harmful to your health if present in breathing space or if water contains a high enough concentration. Studies have shown that exposure from breathing radon in air represents a much greater health risk than exposure from ingesting radon in water. The United States Environmental Protection Agency (EPA) uses a concentration of 4 pCi/L (picocuries per liter) in air and a concentration of 300 pCi/L in drinking water as recommended action levels. Radon can enter your breathing space directly from bedrock or soil against the foundation of your home or can be dissolved in groundwater and can be released when water leaves your faucet or showerhead. The concentration of radon in air can be measured by calling a reputable contractor or by purchasing a radon test kit at your local hardware store. Radon in water can be tested in a water sample sent to a certified laboratory. Recommended treatment systems for radon in water include granulated activated carbon and aeration.

Industrial and Commercial Sources of Water Quality Impacts

Man-derived sources of water quality impacts to private water systems in Pennsylvania have been caused by historic and sometimes current industrial and commercial activity. These include potential sources related to mining, manufacturing, oil and gas exploration and development, waste management, and commercial businesses such as gasoline stations and dry cleaners. If you suspect a possible water quality impact from industrial or commercial activity near your property, consult Section 11 at the end of this handbook for additional information or contact your local Pennsylvania Department of Environmental Protection (DEP) office.

Historically, coal mining activity resulted in pollution of both surface and groundwater resources throughout a large portion of Pennsylvania. In areas where coal mining has occurred, private water supplies may be impacted. It is not uncommon for coal mines to produce acidic water that contains high levels of iron, manganese, aluminum, and sulfate. Orange colored stream bottoms are indicators of acid mine drainage. If you live in a mining region, you may notice poor-tasting water that causes various staining and odor problems as a result of a nearby active or abandoned mine. Also, coal seams and coal mines are potential sources of methane in groundwater.

Pennsylvania's manufacturing history broadly includes textiles, steel making, foundries, pharmaceuticals, bulk chemicals, microelectronics, wood processing, petrochemicals and other industries. Historic waste disposal practices at manufacturing facilities impacted aquifers at certain locations throughout the Commonwealth. Most of the historic manufacturing-based waste disposal areas have been investigated and cleaned up under federal and Pennsylvania environmental regulatory programs. Information concerning historic industrial sites that are under investigation, or that have already been cleaned up, including the constituents related to these sites, is available using the references listed in Section 11.

Pennsylvania has a long history of oil and gas exploration and development, dating back over 150 years. Similar to other industries in Pennsylvania, as oil and gas development evolved, environmental regulations became more robust. Regulations under Chapter 78 (*http://www.pacode.com/secure/data/025/chapter78/chap78toc.html*)

have been recently revised and continue to be modified through new statutes such as the Oil and Gas Act of 2012 (Act 13; *http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/2012/act13.pdf*). Possible indicator constituents associated with oil and gas development include total dissolved solids (TDS), chloride, methane, or any of the BTEX compounds (benzene, toluene, ethylbenzene and xylene). However, as documented by the USGS, elevated levels of TDS, chloride and methane can also naturally occur in some groundwater in Pennsylvania. If you suspect an adverse water quality impact from local oil and gas activity, contact the DEP and the oil and gas operator, and Gas Well Drilling and Your Private Water Supply, Pennsylvania State University Extension Service (see Section 11).

Proper Decommissioning of Water, Oil and Gas Wells

There are several good reasons why you may choose to terminate use of an existing water supply well or an unused water well may have been left behind on your property by a previous landowner. Unused water wells are potential open conduits through which pollutants can directly enter the aquifer and your water supply.

Pollutants traveling in surface water or from shallow subsurface sources (e.g. failing septic systems) can enter an unused well and go directly into the aquifer. Also, any waste poured into an unused well goes directly to the aquifer. For these reasons, it is very important to properly decommission (fill in, plug, and seal) unused wells to protect your water supply.

Proper sealing of an unused water well is achieved by hiring a reputable water well contractor to perform the work. Proper well-sealing procedures can be found in the references in Section 11. The proper steps for sealing usually include:

- removal of all piping, electrical wires, pumps and other materials;
- shock chlorination;
- either removing the surface casing completely or cutting the surface casing off below the ground;
- completely filling highly conductive zones with conductive materials (like sand and gravel);
- completely filling less conductive zones and the upper section of the well with a sealant (cement grout or other non-conductive material); and,
- restoring the land surface consistent with its existing use (lawn, pavement, etc.).

Because of the long history of oil and gas well drilling in Pennsylvania, a number of older, unplugged oil and gas wells exist. The discovery and proper sealing of these wells is an important objective for DEP and active oil and gas operators working in Pennsylvania. If you discover, or are concerned about older, unplugged oil and gas wells located on or near your property, notify the DEP and local oil and gas operator.

Your Water Quality And How It Compares To Drinking Water Standards

Water Quality Testing

This section will provide information as to why periodic laboratory testing of your water supply is important and will assist you in understanding the water analysis report provided by the laboratory.

The natural chemical character of your water, or "water quality," is the product of chemical reactions between water and the minerals in your aquifer. These reactions determine the types and concentrations of naturally occurring minerals in your water supply. All natural water contains some concentration of dissolved minerals, trace metals, and bacteria. In most cases, the concentrations of these naturally occurring constituents are low and actually beneficial to human, animal, or plant health; or at the very least, are of no consequence. However, when concentrations of certain constituents exceed water quality standards, they may be detrimental to human, animal or plant health. In some cases, naturally occurring minerals and trace metals are present in water at high concentrations due to man's activities. Also, certain forms of bacteria and organic chemicals can be present in water from man's activities.

The only way homeowners can determine the quality of their water supply is to have the water sampled and sent to a laboratory for analysis. This should be done when the system is first installed and periodically thereafter, or whenever you notice a change in your water. You can collect water quality samples yourself using approved, laboratory-cleaned sample bottles, and following guidance provided by the laboratory, or the laboratory will send a trained sampler to your home to collect the sample. Always have your water analyzed by a DEP-certified water testing laboratory. Be sure to ask if the lab is certified for the tests you are electing to run, because laboratories are reevaluated periodically, and their certification status may change. See Section 11 for information on how to obtain a list of DEP-certified laboratories for more information.

Units of Concentration

Once the laboratory has completed analysis of your water sample, you will receive a report. The report will contain a concentration value for each constituent you specified for analysis. The concentration is the amount of the constituent in a specific amount of water. The most common units of measure for the concentrations of substances in drinking water are "milligrams per liter" (mg/L) and "micrograms per liter" (µg/L). Sometimes you will also see the unit "parts per million" (ppm) which is the same as mg/L. In addition, you can always consult the laboratory that conducts the testing for additional information.

How Much of a Constituent is Too Much?

Evaluating the quality of your water is accomplished by comparing the results from your laboratory report to published water quality standards. Many of these standards are based on health implications, while some are based on nuisance criteria (taste, odor, staining, etc.). EPA and DEP regulate public drinking water quality using a set of health-based standards referred to as Maximum Contaminant Levels (MCLs) and a set of nuisance-based standards referred to as Secondary MCLs (SMCLs). For purposes of comparison, Pennsylvania MCLs and SMCLs are listed on Tables 2, 3 and 5. Although these standards were developed for regulation of public water supplies, and are not used to regulate private water supplies, they are useful for assessing private water quality. They are divided into three categories: general water quality indicators, nuisance constituents, and additional common regulated constituents.

Table 2: General Water Quality Indicators

Indicator	Public Water Quality Standard (Type)	Potential Sources and Effects
Total Coliform Bacteria	0 counts per one hundred milliliters (MCL)	Coliform bacteria are a large group of bacteria that occur throughout the environment in fecal matter and in other sources. They are used as an indicator organism to show the potential for disease causing bacteria to be present in water. A positive result of any value warrants additional testing for E. coli and/or fecal coliform to determine if human or animal waste is the source.
E. Coli	0 counts per one hundred milliliters (MCL)	A type of coliform bacteria found in the intestines of animals and humans. An indicator that water has been polluted by human sewage or animal waste.
Fecal coliform	0 counts per one hundred milliliters (MCL)	A type of coliform bacteria found in the intestines of animals and humans. An indicator that water has been polluted by human sewage or animal waste.
Nitrate-Nitrogen	10 mg/L (MCL)	Nitrate in drinking water usually originates from fertilizers, septic systems, and human or animal wastes.
Nitrite-Nitrogen	1 mg/L (MCL)	Nitrite in drinking water usually originates from fertilizers, septic systems, and human or animal wastes.
pH	6.5 to 8.5 standard pH units (SMCL)	An important overall measure of water quality. Low pH will cause pitting of pipes and fixtures and/or metallic taste. This may indicate that metals are being dissolved. High pH may cause a soda taste in water and water may feel slippery.
Total Dissolved Solids (TDS)	500 mg/L (SMCL)	The TDS concentration is a measure of the combined effect of all major dissolved ions in water. Dissolved minerals, like sodium, calcium, magnesium, iron, manganese, potassium, chloride, carbonate and sulfate comprise the TDS of a water sample. High TDS indicates excessive hardness and is associated with mineral staining of laundry, or a salty, bitter taste.

Sources:
a) *A Guide to Private Water Systems in Pennsylvania*, Pennsylvania State University Extension Service, 2009 : *http://pubs.cas.psu.edu/FreePubs/pdfs/agrs111.pdf*
b) Centers for Disease Control – Drinking Water website – Private Wells: *http://www.cdc.gov/healthywater/drinking/private/*
c) U.S. EPA Groundwater and Drinking Water website: *http://water.epa.gov/drink/contaminants/*

General Water Quality Indicators

The current list of federally regulated water quality criteria for public water supplies is very long and it would be expensive to have your water tested for the full list. Fortunately, you can assess your water quality using a much shorter list of general water quality indicators. These include constituents with published MCLs and SMCLs and constituents without published standards. The following is one list of general water quality indicators that can be used for routine analysis (as often as once per year):

- total coliform bacteria
- E. coli bacteria
- fecal coliform
- Nitrates and nitrites
- pH
- total dissolved solids (TDS)
- odor/color
- gas bubbles

Table 2 lists those indicators that will require laboratory analysis of a water sample. You should add to your annual indicator list any suspected constituents associated with industrial or commercial activities on or adjacent to your property that could impact your water supply (see Section 7). The E. coli bacteria, fecal coliform, and nitrates/nitrites analyses can be omitted from this list if total coliform is not present (0 colonies/100 milliliters).

Industry Baseline Sampling Programs

Some industries in Pennsylvania (like mining) are required to sample water supplies within a certain distance of the operations as a requirement of their permit to operate. Other industries will ask to sample and analyze your water for a long list of constituents that could potentially be related to their operations, if you are within a certain distance of their operations. There is no requirement for oil or gas well operators to have a record of the water quality of nearby water supplies prior to commencing operations; however, baseline sampling is protective of the interests of both the water supply owner and the oil or gas well operator, and provides a comprehensive snapshot of the water well quality that can be very useful to the well owner. Whenever you are approached to participate in a baseline sampling program you should receive a copy of the laboratory report and an explanation of the results in a timely manner. In many cases, baseline sampling programs reveal water quality impacts that were present prior to industrial activity that can be addressed by the landowner.

Nuisance Constituents

Nuisance constituents represent no adverse effects on humans, animals or plants at low levels, but they may make water unsuitable for many household purposes. Nuisance constituents include chloride, iron, manganese, iron bacteria, hydrogen sulfide (at low concentrations), and hardness. You should sample for specific nuisance constituents whenever their presence in your supply is suspected. The laboratory results will help you determine the best course of action needed to eliminate the nuisance. Table 3 lists water quality standards potential sources and, effects of these nuisance constituents.

Water Hardness

Water hardness is a particular type of nuisance constituent that causes white, scaly deposits on plumbing fixtures and cooking appliances, and decreased cleaning action of soaps and detergents. Hardness is determined by the amount of the minerals (chiefly calcium and magnesium carbonate) in your water. Hard water can also cause scale to buildup in plumbing, hot water heaters and other appliances that use water and reduce their effective longevity. Hard water will reduce how soapy your bath and laundry water can become. The list of laboratory analyses

Table 3: Common Nuisance Constituents

Constituent	Public Water Quality Standard (Type)	Potential Sources and Effects
Chloride	250 mg/L (SMCL)	Chloride is common in Pennsylvania water supplies but it rarely reaches levels of concern. It occurs naturally in most groundwater but may become elevated due to leaching from salt storage areas around highways or from brines produced during gas well drilling. Other possible sources of chloride are sewage effluent, animal manure, and industrial waste. Sodium often occurs at similar concentrations as chloride and can be a concern for people with heart issues.
Iron	0.3 mg/L (SMCL)	Iron is a common natural problem in groundwater in Pennsylvania and may be worsened by mining activities. Iron does not occur in drinking water in concentrations of health concern to humans. The secondary drinking water standard for iron is 0.3 mg/L because it causes a metallic taste and orange-brown stains that make water unsuitable for drinking and clothes washing.
Manganese	0.05 mg/L (SMCL)	Manganese is a naturally occurring metal that may be worsened by mining activities. Manganese concentrations normally found in drinking water do not constitute a health hazard; however, even small amounts of manganese may impart objectionable tastes or blackish stains to water. Manganese has a health based standard for groundwater in Pennsylvania of 0.3 mg/L.
Iron Bacteria	No Standard	Iron bacteria feed on small amounts of iron in water. While they do not constitute a health threat, they are a nuisance in private water systems because they form gelatinous strands, masses, or thin films that plug pipes, toilets, and plumbing fixtures and reduce flow from wells. Their appearance can vary from orange or brown to clear. Water testing is rarely available to determine if iron bacteria are present. Confirmation is usually based on the visual symptoms in the water, or on microscopic analysis by someone familiar with these bacteria.
Hydrogen Sulfide	3 threshold odor number (SMCL)	Hydrogen sulfide (H_2S) is a noxious gas that imparts a disagreeable rotten egg odor when dissolved in water. It is a naturally occurring gas that is common in groundwater in parts of Pennsylvania. Very small concentrations of hydrogen sulfide in water are offensive to most individuals. If you have hydrogen sulfide, it must be removed by treatment. Even low levels over a long period of time may cause health problems.

Modified from: *A Guide to Private Water Systems in Pennsylvania*, Pennsylvania State University Extension Service, 2009: *http://pubs.cas.psu.edu/FreePubs/pdfs/agrs111.pdf*

Table 4: Hardness Classifications

Classification	Hardness (mg/L or ppm)	Hardness (gpg)	Indications
Soft	Less than 17	Less than 1.0	Soft and slightly hard water are considered fairly pure and drinkable. Because of the very low amount of dissolved minerals in it, it reacts well with cleaners such as household cleansers or laundry detergent and does not leave behind a residue. Usually, water softening equipment is not necessary.
Slightly hard	17 to 60	1.0 to 3.5	
Moderately hard	60 to 120	3.5 to 7.0	Moderately hard water may leave behind a slightly unpleasant taste after drinking. This water will clean with some efficiency, but may leave light yellow spots on laundry or a thin white or oily film on hard surfaces after using it with a cleaning solution. When water falls into the moderately hard range, some homeowners elect to install water softening equipment.
Hard	120 to 180	7.0 to 10.5	Hard water has a noticeably unpleasant flavor, but is still considered potable. Cleaning agents do not react well with hard water and often a distinct oily, white crust is left behind after cleaning. Hard water usually requires water softening equipment to make it usable for a home.
Very hard	More than 180	More than 10.5	Very hard water is generally safe to drink; however, it often tastes foul and may cause nausea in some people. Cleaning with very hard water is extremely difficult, as the cleaning agents do not dissolve well in it, therefore making rinsing inefficient or even impossible. Over time, very hard water leaves distinctly yellow or white crusts on surfaces and may require powerful cleaners to dissolve these mineral deposits. Very hard water necessitates water softening equipment.

Modified from: *A Guide to Private Water Systems in Pennsylvania*, Pennsylvania State University Extension Service, 2009: *http://pubs.cas.psu.edu/FreePubs/pdfs/agrs111.pdf*.

for the first water quality sample taken from a private water supply system should contain a hardness test to determine if treatment is appropriate. Hardness should not change over time but if you notice any indications of elevated hardness you should have your supply retested.

Table 4 will help you interpret your water hardness results. Hardness may be expressed in either mg/L or "grains per gallon" (gpg). A gpg is used exclusively as a hardness unit by water treatment personnel and equals approximately 17 mg/L. Those water supplies falling in the "hard-to-very hard" categories may need treatment by a commonly used technology referred to as softening (see Section 9).

Additional Common Regulated Constituents in Pennsylvania

The constituents listed on Table 5 represent additional common regulated constituents found in Pennsylvania groundwater that have known potential health effects. All can be derived from man's activities, but can also occur naturally given the right conditions. These include the metals arsenic, barium, lead, and copper, and the gas radon. Select parameters listed in Table 5 could be added to your annual sample parameter list if the associated industrial or commercial activities are occurring close to your water source or if the natural occurrence of a constituent has been found through previous water quality sampling.

Table 5. Additional Regulated Constituents in Pennsylvania.

Contaminant	Standard (Type)	Potential Health Effects and Sources
Arsenic	0.010 mg/L (MCL)	When consumed over a long time, arsenic may cause skin damage or problems with circulatory systems and increase risk of cancer. Potential sources include runoff from orchards, glass manufacturing wastes, coal ash and electronics production wastes. It can occur above the MCL naturally in aquifers given the right geochemical conditions.
Barium	2 mg/L (MCL)	When consumed over a long term barium may cause elevated blood pressure. It can be present in oil and gas industry and metal refinery waste. It can occur above the MCL naturally in aquifers given the right geochemical conditions.
Copper	1.0 mg/L (MCL)	Short term exposure to copper in water above the MCL can cause gastrointestinal distress. Long term exposure to copper in water above the MCL can cause liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the MCL. Copper can be present in drinking water from corrosion of household plumbing systems and can occur above the MCL naturally in aquifers given the right geochemical conditions.
Lead	0.005 mg/L (MCL)	When consumed over a long period, high lead in drinking water causes nervous disorders and mental impairment; especially in young children. It can also cause kidney damage, blood disorders and hypertension, or low birth weights. Potential sources include discarded acid batteries, brass faucets, lead caulking, lead pipes and lead soldered pipe joints. It can also leach from natural geologic materials under the right geochemical conditions.
Radon	300 - 4,000 pCi/L (PEPAS)	Radon has been shown to cause lung cancer upon inhalation, but ingestion of radon in water is not thought to be a major health concern. Radon is a naturally occurring radioactive gas formed underground by the decay of uranium, thorium, or radium deposits. Mostly commonly, radon gas enters breathing space in a home through openings in the foundation. The most serious threat from radon in water is the inhalation of escaping gas during showering or bathing.

Sources: a) U. S. EPA Drinking Water Contaminants website, *http://water.epa.gov/drink/contaminants/*
b) Centers for Disease Control – Drinking Water – Private Wells, *http://www.cdc.gov/healthywater/drinking/private/index.html*
c) DEP Division of Drinking Water Management MCLs and MRDLs
http://files.dep.state.pa.us/Water/BSDW/DrinkingWaterManagement/RegsStandardsResources/pa-mcls_06.pdf

How To Treat Your Water, If Treatment Is Required

Best Treatment for Your Water

If laboratory results indicate a constituent is a nuisance or could potentially affect your health, you should consider incorporating a water treatment technology within your water delivery system. You should be proactive in learning about each of the basic water treatment processes and the constituents they remove. Become an educated consumer and know which treatment devices will solve your specific problem before you approach treatment vendors. Table 6 provides information on the most common water treatment processes. The chart at the end of this section is a water treatment decision guide for the most common constituents that impact private water supplies.

Water Softening

Water softening is a very common treatment process to remove hardness from your water. The resulting soft water is more compatible with soap and extends the lifetime of plumbing and appliances.

However, as with all water treatment, you should carefully consider the disadvantages of softening before making a decision on how to proceed. The disadvantages of water softening include:

- increased levels of sodium or potassium in softened water (depending on which type of salt is used in your softener system);
- increased potential for pipe, tank, and faucet corrosion;
- potential negative impact on houseplants; and,
- difficulty removing soap residue from your skin when bathing.

Since the levels of sodium and potassium can affect your health, consult your health professional before installing a water softening system. Attention should be paid when selecting the type of salt to charge your system, especially if you have a heart condition or high blood pressure. Ask your water treatment professional to clearly describe any negatives that might result from use of their system.

Your Water Treatment Equipment Provider

Reliable water treatment system vendors can be found in most Yellow Pages or via the internet using search words like "Water Purification," "Water Filter," or "Water Treatment Equipment." Additional assistance can often be found by talking to the local Pennsylvania State University Extension Service, local health department and, in some cases, the laboratory that analyzed your water. Care should be taken when a treatment system provider offers to test your water or demonstrates in-home water quality tests. Many of these in-home tests are difficult to perform, can provide misleading information, and may not provide comprehensive testing of all constituents of interest. It is important to be an educated consumer and seek good advice from knowledgeable sources prior to investing in a water treatment system.

Table 6: Common Water Treatment Processes Used in Pennsylvania

Treatment Method	Primary Uses
Acid neutralization	Corrosive water, copper, lead, pinhole leaks in plumbing
Activated alumina	Arsenic, fluoride
Aeration	Hydrogen sulfide, methane, volatile organic compounds (VOCs), radon
Anion exchange	Sulfate, nitrate, arsenic
Granular activated carbon filters	Chlorine, pesticides, herbicides, radon, miscellaneous tastes and odors, VOCs, and limited removal of hydrogen sulfide odor
Chlorination	Bacterial disinfection, hydrogen sulfide odor, iron
Distillation	Removes everything except VOCs, pesticides, herbicides
Oxidizing filters	Iron, manganese, hydrogen sulfide
Ozonation	Bacteria, metals, hydrogen sulfide and other odors, tastes
Reverse osmosis	Removes dissolved pollutants from water
Sediment filters	Soil, sand, other particles. Certain types can also be used to remove water borne parasites
Softening	Removes hardness (scale) along with limited amounts of dissolved iron
Ultraviolet light	Bacterial disinfection

Modified from: *A Guide to Private Water Systems in Pennsylvania*, Pennsylvania State University Extension Service, 2009: *http://pubs.cas.psu.edu/FreePubs/pdfs/agrs111.pdf.*

Considerations For Water Treatment

Each column of decision making should include consultation with a qualified water treatment contractor and lists possible treatment types to resolve your water quality issue. If you have any immediate concerns about the quality of your drinking water, drink and cook with bottled water until the issue is resolved.

The total coliform bacteria in your water is above 0 CFUs/100ml or your water has a foul odor.

ACTION

Try to eliminate the source of contamination. Check the well head, well cap, septic system and potential sources of surface contamination near the well. Have your water well shock disinfected. Retest (see Section 3).

If bacteria keeps coming back after disinfection of your well.

THEN

Disinfect the well again and wait a full 24-hours before flushing the system. If your coliform test is still above 0 CFUs/100mL, have your contractor inspect for damage that may cause leaks and repair and clean the well. Other types of bacteria may be present such as slime forming bacteria, sulfate reducing bacteria, etc. which are difficult to remove with a single disinfection of your well. If the retest is still above 0 CFUs/100 mL have your contractor install a disinfection system such as chlorination, ozone, or the use of ultraviolet (UV) light.

ALSO

Your water may require testing more often. Your disinfection system requires additional maintenance and care. Request an annual inspection from the contractor that installed your system.

The pH of your water is lower than 6.5 or greater than 8.5.

ACTION

pH adjustment of your water will require the services of a private water system contractor.

A test for lead and copper is suggested if the pH is below 6.5 and these metals are present in the piping and fixtures of your water system.

A test for zinc is suggested if the pH is below 6.5 and you have galvanized piping.

The TDS (total dissolved solids) of your well water is above 500mg/L.

ACTION

May require the installation of a Reverse Osmosis unit if the taste of the water is unpleasant.

The hardness of your well water is above 180 mg/L or has a salty taste.

ACTION

May require softening of the hot water side of your system. Talk to your water treatment contractor about the benefits and disadvantages of treating hard water at various levels above 180 mg/L.

The Nitrate-N is above 10 mg/L or Nitrite-N is above 1 mg/L.

ACTION

Try to find and eliminate the source of contamination. Check the well head, well cap, septic system and potential sources of surface contamination near the well (e.g. fertilizers). Retest the water for nitrate and nitrite.

Is Nitrate-N still above 10 mg/L or Nitrite-N still above 1 mg/L?

Your water treatment contractor may recommend treatment by Reverse Osmosis, or Anion Exchange.

The iron in your water is above 0.3 mg/L or the manganese is above 0.05 mg/L or your water turns red or black after standing in a glass.

ACTION

May require any one of several types of filters. These systems include a simple water softener (for Iron below 1-3 mg/L), green sand type filters, back-washable filters, etc.

Your water has a rotten egg smell or is known to contain hydrogen sulfide.*

ACTION

Immediately contact the DEP and local authorities (fire or police department) and follow their instructions.

The solution to your issue may be proper ventilation or treatment by chlorination, granular activated carbon or aeration.

**You can smell rotten egg gas (hydrogen sulfide) at a lower concentration than a laboratory can analyze. If you have hydrogen sulfide it must be removed by treatment. Even low levels over a long period of time may cause health problems.*

Your water fizzes, your faucet sputters or your water is known to contain methane.

ACTION

Contact the DEP and local authorities (fire or police department) and follow their instructions; you should also contact the local oil and gas operator, and consult *Methane Gas and Its Removal from Wells in Pennsylvania* available from your local Pennsylvania State University Extension Service office or via the internet (see Section 11).

The solution to this issue may be proper ventilation or aeration.

Any trace metal** exceeds a public drinking water MCL.

ACTION

Your water treatment contractor will select the treatment type based on the trace metals of concern.

***The trace metals arsenic, barium, copper, and lead are common naturally occurring metals or may leach from piping in your water system. Antimony, beryllium, cadmium, mercury, selenium, and thallium are less common trace metals.*

Glossary of Terms

Acid mine drainage – Drainage of water from areas that have been mined for coal or other sulfur-bearing minerals; the water has a low pH, sometimes less than 2.0, and often contains elevated concentrations of certain metals.

Aquifer – Saturated geologic material that can store and transmit groundwater for use by man.

BTEX – The group of constituents benzene, toluene, ethylbenzene and xylene that can be an indicator of water quality impacts from an industrial source.

Cistern – A storage facility used for storing water for home or farm. Often used to store rain water from roofs where adequate groundwater in aquifers is not available.

Total coliform bacteria – An analytical test for a large group of bacteria that occur throughout the environment. Total coliform bacteria are used as an indicator to show the potential for disease causing bacteria to be present in water. A reported result of "present" or > 0 colonies per 100 milliliters warrants additional testing for E. coli and fecal coliform bacteria.

E. coli – An analytical test measuring the concentration of Escherichia coli, an anaerobic bacteria commonly found in the intestines of warm-blooded organisms. E. coli bacteria can be present in water supplies from manure, failed on-lot septic systems and buried animals. A positive E. coli result is a strong indication that human sewage or animal waste has contaminated the water.

Fecal coliform bacteria – An analytical test measuring the concentration of a specific class of coliform bacteria that live in the feces of warm blooded animals. Fecal coliform bacteria can enter groundwater from percolation from manure amended fields, failed on-lot septic systems and buried animals.

DEP – The Pennsylvania Department of Environmental Protection.

Disinfection – The destruction of all pathogenic organisms, with chlorine, ozone, ultraviolet "UV" light or heating.

Drive shoe – A tapered ring welded onto the bottom of the water well surface casing as reinforcement against stress as the casing is seated into bedrock. Once seated, the drive shoe creates a seal for grouting the annulus between the borehole wall and surface casing.

EPA – The United States Environmental Protection Agency.

gpg – Grains per gallon. A unit of measure for hardness equal to 17.1 mg/L.

gpm – Gallons per minute. A common unit used to express the flow of water over time.

Groundwater – Water found in saturated zones below the ground surface. The source of water in aquifers feeding water wells and springs.

Hardness – The presence of high concentrations of dissolved minerals, chiefly calcium and magnesium carbonate, in a water supply.

Hard water – Alkaline water containing dissolved salts that cause scale to form in pipes and appliances and prevents soap from lathering.

Hydrogen sulfide – A poisonous, flammable, gas that smells like rotten eggs at low concentrations but is not smelled at higher concentrations because the sense of smell is limited by the gas.

Iron bacteria – Non-toxic, microorganisms that feed on iron in water. They may appear as globs of gelatinous material or sand-like lumps of black sediment in your water supply.

MCL – Maximum Contaminant Level. The maximum allowable level of a constituent in a public water supply and a guideline for water quality in private supplies. MCLs are specified in the Primary Drinking Water Standards set by EPA and DEP.

Methane – A colorless, tasteless, odorless, flammable, lighter-than-air gas that can be found in water wells as a result of natural occurrence associated with coal seams, or other zones that contain trapped gases. Methane may also be present in water wells due to non-compliant conditions at nearby oil or gas wells or drilling activities.

Nitrate and nitrites – Salts of the element nitrogen. The presence of nitrates and/or nitrites in a water supply generally indicates pollution by human or animal waste, and/or commercial fertilizer.

NTU – Nephelometric turbidity unit. An analytical test measuring the "cloudiness" or turbidity of water.

Nuisance constituents – Constituents in a water supply that affect aesthetic or functional aspects of the water and have little or no impact on health. Some nuisance contaminants have SMCLs established by EPA and DEP.

On-lot septic system – An on-site system designed to treat and dispose of domestic sewage.

Organic chemicals – Those chemicals that contain carbon. If not properly handled, stored, transported, and disposed, organic chemicals can pollute water supplies. These can include trihalomethanes, pesticides, volatile organic compounds and chemical used to produce pharmaceuticals.

PGS – The Pennsylvania Geological Survey.

pH – A water quality parameter related to the hydrogen ion concentration of water. The range of pH values in natural waters is from 2 to 9 standard units, with 7 being the divide between acidic water (less than 7) and basic water (greater than 7). pH values outside the range from 6.5 to 8.0 standard units are indicative of a water quality impact.

Pitless adaptor – A fitting completing the ninety-degree turn in a water well from the vertical water supply line (riser pipe), through the surface casing to the horizontal water supply line that delivers water to the home. The fitting is located on the surface casing below the frost line and allows the vertical water supply line to be easily detached from the surface casing for pump and other types of water well maintenance.

Potable water – Water fit for drinking by humans.

Private water system – Any water supply system that does not meet the definition of public water system, for example, a private individual water source, such as a residential water well, spring, or cistern.

Radon – A tasteless, odorless, colorless radioactive gas formed from decay of uranium in rocks. High concentrations of radon are known to be carcinogenic.

Recharge – Rainwater and snow melt that seeps down through surface soils and geologic materials to replenish aquifers.

RO – Reverse Osmosis. A process whereby water is purified using pressure and semipermeable membranes that filter out unwanted salts and other constituents.

Safe yield – The maximum constant water pumping rate for a water supply well that can be maintained over an extended period of time without lowering the water level in the well to the pump intake.

SMCL – Secondary Maximum Contaminant Level. The maximum allowable level of a non-toxic contaminant in a public water supply and a guideline for water quality in private supplies. SMCLs are parameters associated with the aesthetic qualities of water (odor, color, etc.) and are set by EPA and DEP.

Spring – A discrete location where the water table intersects the land surface resulting in a water flow high enough to establish a water supply.

Surface water – All water naturally open to the atmosphere; and found in oceans, lakes, ponds, streams, and runoff.

TDS – Total dissolved solids. A measure of all of the dissolved inorganic ions in water.

Trace metals – Certain metals found in groundwater that can have adverse effects on human health at low concentrations and tend to accumulate in the food chain. Some trace metals are also referred to as heavy metals and have EPA and DEP MCLs.

Transpiration – The passing of rain and snow water through plants back to the atmosphere.

Turbidity – A cloudy condition in water due to suspended clay, silt or organic matter, measured in units of NTUs. Turbidity is removed from well water by well development or can be treated with filtration or flocculation.

USGS – The United States Geological Survey.

VOCs – Volatile organic compounds. Organic, sometimes toxic, chemical compounds that readily evaporate. VOCs are used in fuels, by some industries and by some commercial businesses.

Water quality – The relative state of a water supply for consumption, good or bad, as generally determined by the combined effects of taste, color, smell, corrosivity, staining, pH, hardness, the concentration of naturally occurring dissolved solids, and presence or absence and concentration of constituents that are hazardous to human, animal or plant health.

Watershed – An area of land that drains downslope to the lowest point such as a river, lake, stream, or aquifer.

Water table – The upper surface of the saturated zone of the uppermost aquifer in an area.

Water well – A cylindrical structure drilled and constructed below ground for the purpose of extracting groundwater from an aquifer.

Well decommissioning – The process of properly sealing a water well or oil and gas well that is no longer in use.

References

The references that were used to develop this handbook and other useful references are listed in this section. If you are interested in a particular reference and do not have access to the internet, take the website listing to your local public library to obtain a printed copy. The text and glossary of this handbook are freely adapted from publications provided by Penn State, EPA, USGS, DEP, and PGS and other organizations.

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http://pubs.usgs.gov/gip/gw_ruralhomeowner/pdf/gw_ruralhomeowner.pdf

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Water Facts #29, Testing Drinking Water Supplies Near Gas Drilling Activity, 2011.

http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/gas_well_water_testing1.pdf

Gas Well Drilling and Your Private Water Supply

http://extension.psu.edu/natural-resources/water/marcellus-shale/gas-well-drilling-and-your-private-water-supply

Methane Gas and Its Removal from Wells in Pennsylvania, 2013.

http://extension.psu.edu/natural-resources/water/drinking-water/water-testing/pollutants/methane-gas-and-its-removal-from-wells-in-pennsylvania

Other Useful Websites

EPA - Private Drinking Water Wells

http://water.epa.gov/drink/info/well/index.cfm

PGS groundwater education website

http://www.dcnr.state.pa.us/topogeo/groundwater/index.htm

Master Well Owner Network - puts local experience of other private well owners at the disposal of private well owners

http://extension.psu.edu/natural-resources/water/mwon

The Groundwater Foundation

http://www.groundwater.org/get-informed/basics/

National Groundwater Association Consumer Information Sheets

http://www.ngwa.org/Professional-Resources/Pages/Clip-and-Copy-Series.aspx

EPA Groundwater and Drinking Water

http://water.epa.gov/drink/index.cfm

Center for Disease Control and Prevention – Drinking Water Website – Private Wells

http://www.cdc.gov/healthywater/drinking/private/index.html

Well Drillers

PA Licensed Water Well Drillers, PGS

http://www.dcnr.state.pa.us/topogeo/groundwater/gw_privwells/drillers/index.htm

Well Construction

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http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_006800.pdf

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Well Decommissioning Procedures

Water-Well, Abandonment Guidelines, PA Dept. Conservation and Natural Resources

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_006802.pdf

Safe Yield Testing

Private well guidance for determining Safe Yield, Pub. #28, Private Drinking Water in Connecticut, June 2009

http://www.ct.gov/dph/lib/dph/environmental_health/private_wells/28_Private_Well_Guidance_for_Determining_Well_Safe_Yield.pdf

wellcare® information for you about Determining the Yield of a Well

http://www.watersystemscouncil.org/VAiWebDocs/WSCDocs/984763Insert_26.PDF

Well Maintenance

Annual Check-Up, Wellowner.org

http://wellowner.org/water-well-maintenance/annual-checkup/

Well Maintenance and Tips, Illinois EPA

http://www.epa.state.il.us/well-water/well-maintenance-tips.html

List of PA Certified Water Testing Laboratories by County

Find a Local Water Testing Lab - Pennsylvania State University Extension Service

http://extension.psu.edu/natural-resources/water/drinking-water/water-testing/testing/certifiedlabs.pdf/view

Interpretation of Laboratory Results

Drinking Water Contaminants – EPA

http://water.epa.gov/drink/contaminants/index.cfm

DWIT - Drinking Water Interpretation Tool, psiee and Pennsylvania State University Extension Service

http://www.psiee.psu.edu/water/dwit.asp

Tips for Understanding Your Water Test Results, Marcellus Shale Coalition, 2013

http://marcelluscoalition.org/wp-content/uploads/2013/05/Tips-on-Understanding-Your-Water-Test-Results.pdf

Baseline Sampling

Recommended Pre-Drill Water Supply Surveys: Marcellus Shale Coalition, 2013.

http://marcelluscoalition.org/wp-content/uploads/2013/03/RP_Pre_Drill_Water.pdf

Surface Coal Mining and Your Water Supply, What Every Property Owner Should Know, DEP, 2000.

http://www.dep.state.pa.us/dep/deputate/minres/FactSheets/WaterSupRep.htm

Gas in Water Wells

Stray Gas in Water Well Systems, National Groundwater Association

http://www.gwpc.org/sites/default/files/event-sessions/McCray_Kevin_0.pdf

Radon (Rn), EPA website

http://www.epa.gov/radon/

Methane Gas and Your Water Well, DEP Fact Sheet

http://www.dep.state.pa.us/dep/deputate/minres/districts/homepage/california/SSA/5600-FS-DEP2690.pdf

Health Based Information on Contaminants in Drinking Water

Centers for Disease Control and Prevention

http://www.cdc.gov/healthywater/drinking/private/index.html

Water Treatment

NSF Home Drinking Water – Quality and Treatment

http://www.nsf.org/consumer-resources/health-and-safety-tips/water-quality-treatment-tips

Iron and Manganese in Private Water Systems, Pennsylvania State University Extension Service, F 138

http://resources.cas.psu.edu/WaterResources/pdfs/iron.pdf

Industrial and Commercial Site Cleanups

Mid-Atlantic Corrective Action website, EPA

http://www.epa.gov/reg3wcmd/correctiveaction.htm

Hazardous Sites Cleanup Program, DEP

http://www.portal.state.pa.us/portal/server.pt/community/hazardous_sites_cleanup_program/20600

Land Recycling (Brownfields) Program, DEP

http://www.portal.state.pa.us/portal/server.pt/community/land_recycling_program/20541/program_results/1034918

Naturally Occurring Constituents in Well Water

Baseline Groundwater Quality from 20 Domestic Wells in Sullivan County, Pennsylvania, 2012

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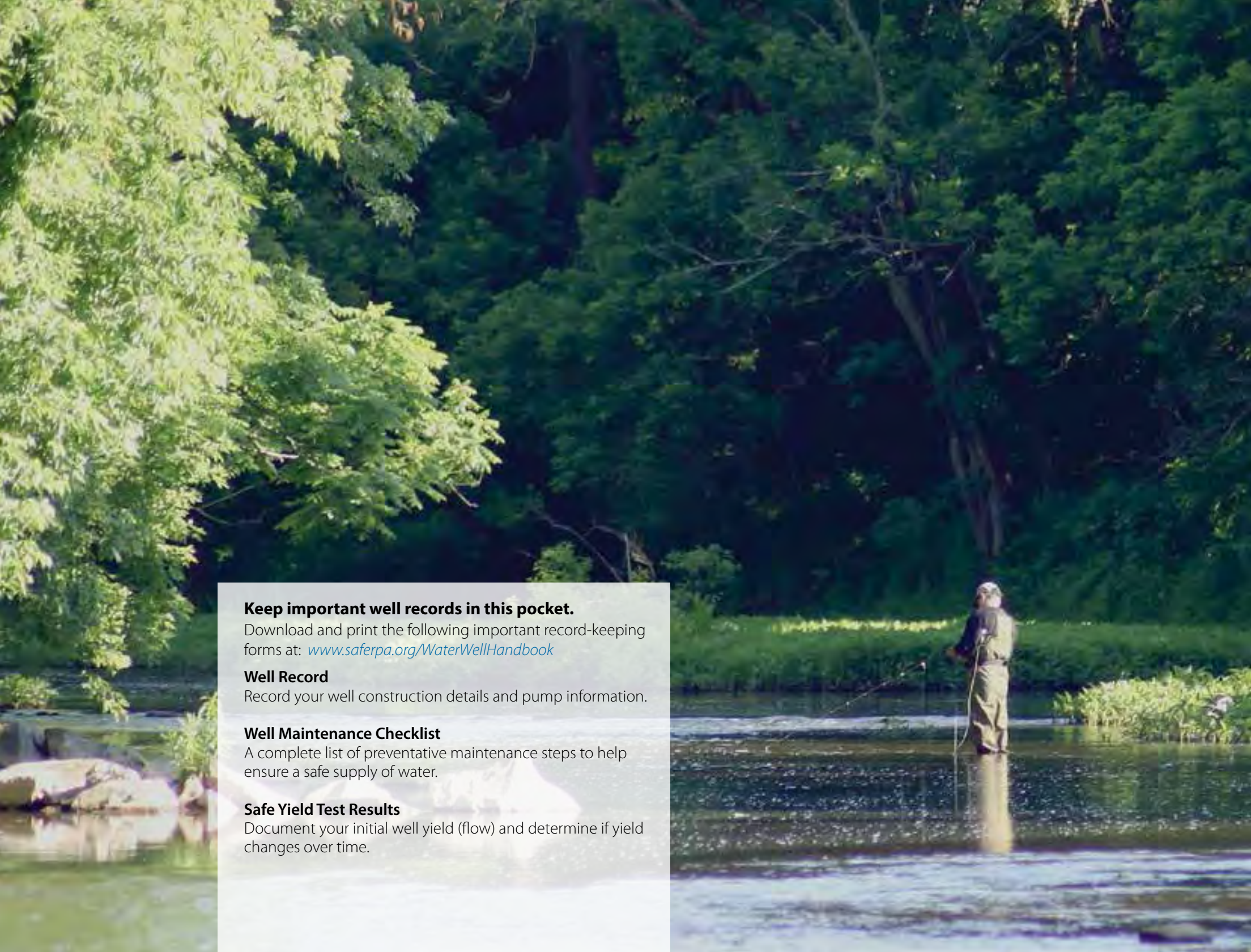

Keep important well records in this pocket.
Download and print the following important record-keeping forms at: *www.saferpa.org/WaterWellHandbook*

Well Record
Record your well construction details and pump information.

Well Maintenance Checklist
A complete list of preventative maintenance steps to help ensure a safe supply of water.

Safe Yield Test Results
Document your initial well yield (flow) and determine if yield changes over time.