Domestic Wells

A Buyer's & Seller's Guide

First American Title

Insurance Company of Oregon

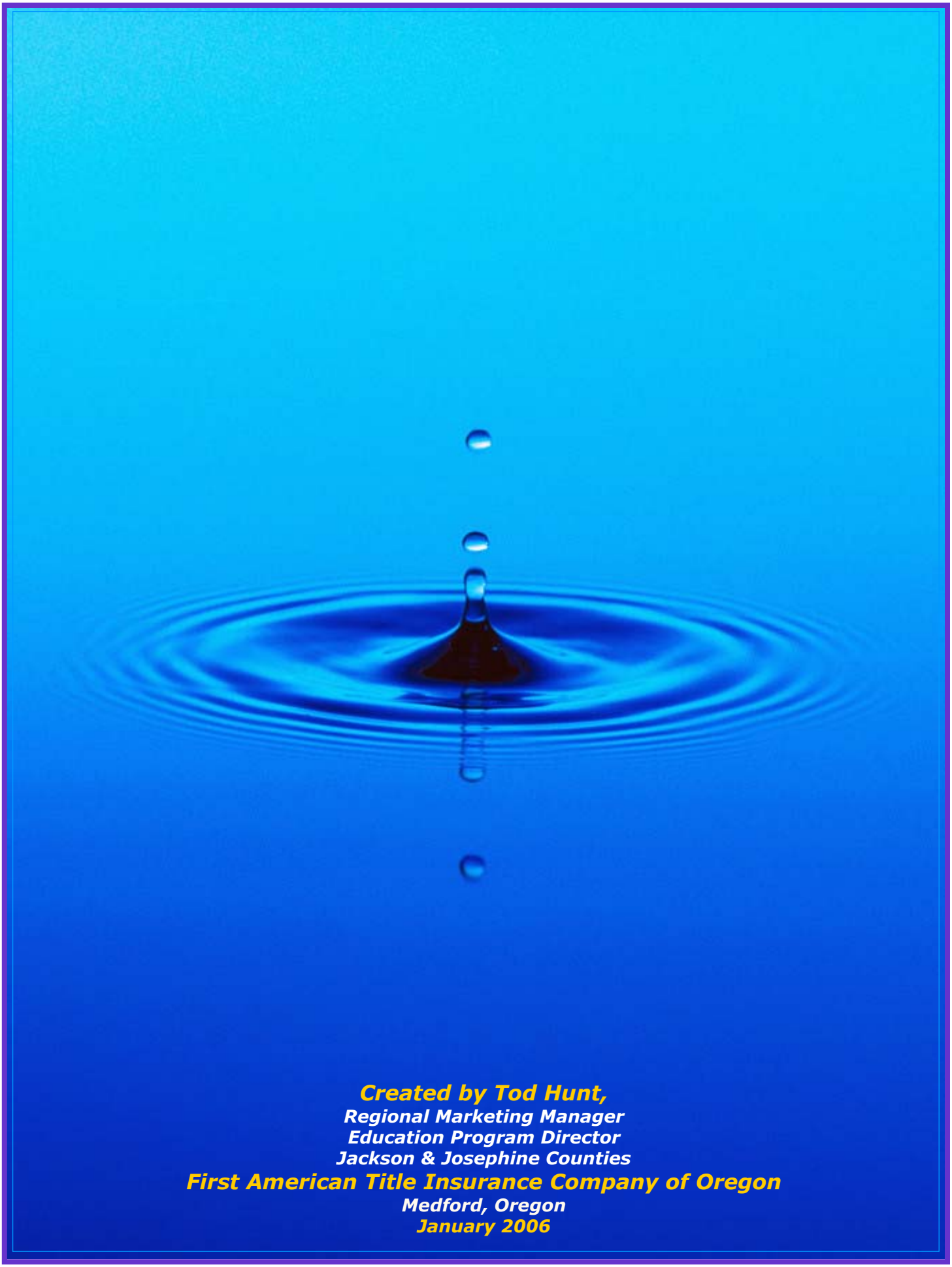

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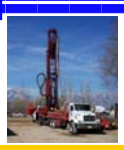
Table of Contents

Groundwater Sources	pp 1-3
Groundwater Statistics	pp 1-2
Groundwater Hydrology	pp 4-6
The Water Code—Exempt Uses	p 7
Locating Groundwater	pp 8-9
Water Well Logs	p 8
Water Witching	p 9
Installing a New Well	pp 9-18
Well Construction Standards	pp 11– 13
Well Types & Components	p 14-17
Water Pressure	p 18
Water Quantity	pp 19-20
Water Quality	pp 21-58
Testing For Minerals & Impurities	pp 28-34
Water Hardness	pp 35-38
Water Chemistry Summary	pp 40-41
Filtration Systems	pp 42-58
Carbon Filters	pp 42-43
Sediment Filters	p 44
Reverse Osmosis	pp 45-47
UV Filters	pp 48
Hydrogen Sulfide Filtration	pp 49-51
Iron & Manganese Filters	pp 52-53
Iron Bacteria Treatment	pp 54-55
Acidic Water Treatment	pp 56-57
Nitrate Filtration	p 58
Declining Water Resources	pp 59-66
Well Rehabilitation	pp 60-62
Hydrofracturing	pp 61-62
Well Troubleshooting	pp 63-66
Well Abandonment	p 67
Well Sharing	p 68
Well ID Program	p 68
Jackson County Water & Well Contractors	p 69
Josephine County Water & Well Contractors	p 70
Well Flow Sample Report	p 71
Top 20 Analysis Sample Report	p 72
Index	P 73
Acknowledgments	p 74



DOMESTIC WELLS

Water Sources

Private Water Wells

According to a 2001 independent market survey sponsored by the National Ground Water Association (NGWA), 78 percent of private water well owners prefer receiving their drinking water from their own well. That's as strong a customer satisfaction statement as can be found in any industry and a true and reverent testament to Mother Nature. Eighty-eight percent of those surveyed said private wells were their least expensive drinking water option.

Private water wells also allow consumers to take more control of their water quality. Well owners can take steps to protect their ground water from contaminants and can hire trained professionals to conduct regular maintenance checks and water quality tests.

Ground water is a significant water supply source. The amount of ground water storage dwarfs our present surface water supply. At any given moment it is 20 to 30 times greater than the amount in all the lakes, streams, and rivers of the United States. Ground water is also an important source of surface water. It also adds about 492 billion gallons per day to U.S. surface water bodies. Its contribution to the overall flow of rivers and streams in the U.S. may be as large as 50 percent, and it is a major source of water for lakes and wetlands. The Great Lakes are the largest system of fresh surface water on earth, containing roughly 18% of the world's supply.

Ground Water Supply

Ground water is tapped through wells placed in water-bearing soils and rocks beneath the surface of the earth. Of the total 341 billion gallons of fresh water the United States withdraws each day, ground water is estimated to be 76.4 billion gallons, or 22 percent. There are nearly16 million water wells in the U.S. supplying ground water for public supply, private supply, irrigation, livestock, manufacturing, mining, thermoelectric power, and other purposes.

The National Ground Water Association has determined that 47 percent of the U.S. population depends on ground water for its drinking water supply from either a public source or private well. In the Asia-Pacific region, 32 percent of the population is ground water dependent; in Europe, 75 percent; in Latin America, 29 percent; and in Australia, 15 percent.

There are 282,828 public supply wells in the United States. These are wells for public distribution systems. In comparison, there are 15.1 million individual households served by private wells. Approximately 800,000 boreholes are drilled in the U.S. annually. The construction of these vitally needed water supply systems involves the use of more than 19,000 drilling rigs by an estimated 8,000 ground water contracting firms.

The U.S. is the largest water well market in the world:

- United States—15.9 million wells
- India—12.3 million
- China—3.4 million
- Germany and South Africa—500,000 each

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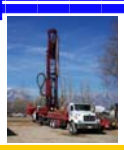


DOMESTIC WELLS

Groundwater Sources

Private household wells constitute the largest share of all water wells in the U.S. Other kinds of wells are used for municipal systems, industry, agriculture, and water quality monitoring. Michigan, with 1,121,075 households served by private water wells, is the largest state market, followed by:

- Pennsylvania—978,202 households
- North Carolina—912,113
- New York—824,342
- Florida—794,557

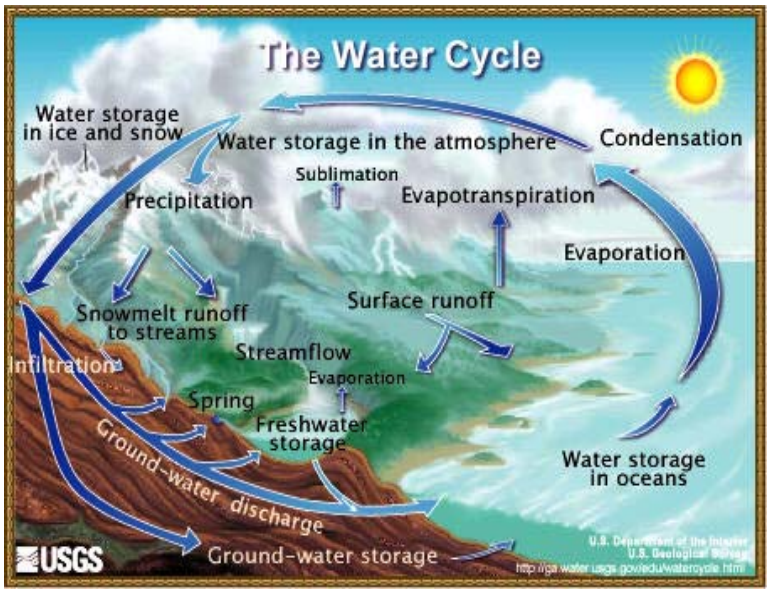
Irrigation accounts for the largest use of ground water in the U.S.—49 billion gallons. Texas leads the nation in the number of irrigation wells with 122,000. Other leading irrigation well states are:

- Nebraska—80,000 irrigation wells
- California—71,554
- Florida 59,150
- Arkansas—37,300
- Colorado—23,000
- Kansas—22,462

Water is an integral part of life on this planet. It is an odorless, tasteless, substance that covers more than three-fourths of the Earth's surface. Most of the water on Earth, 97% to be exact, is salt water found in the oceans. We can not drink salt water or use it for crops because of the salt content. We can remove salt from ocean water, but the process is very expensive.

Only about 3% of Earth's water is fresh. Two percent of the Earth's water (about 66% of all fresh water) is in solid form, found in ice caps and glaciers. Because it is frozen and so far away, the fresh water in ice caps is not available for use by people or plants. That leaves about 1% of all the Earth's water in a form useable to humans and land animals. This fresh water is found in lakes, rivers, streams, ponds, and in the ground. (A small amount of water is found as vapor in the atmosphere.)

The Water Cycle



Water is constantly being cycled between the atmosphere, the ocean and land. This cycling is a very important process that helps sustain life on Earth.

Precipitation, evaporation, and transpiration are all terms that sound familiar, yet may not mean much to you. They are all part of ***the water cycle***.

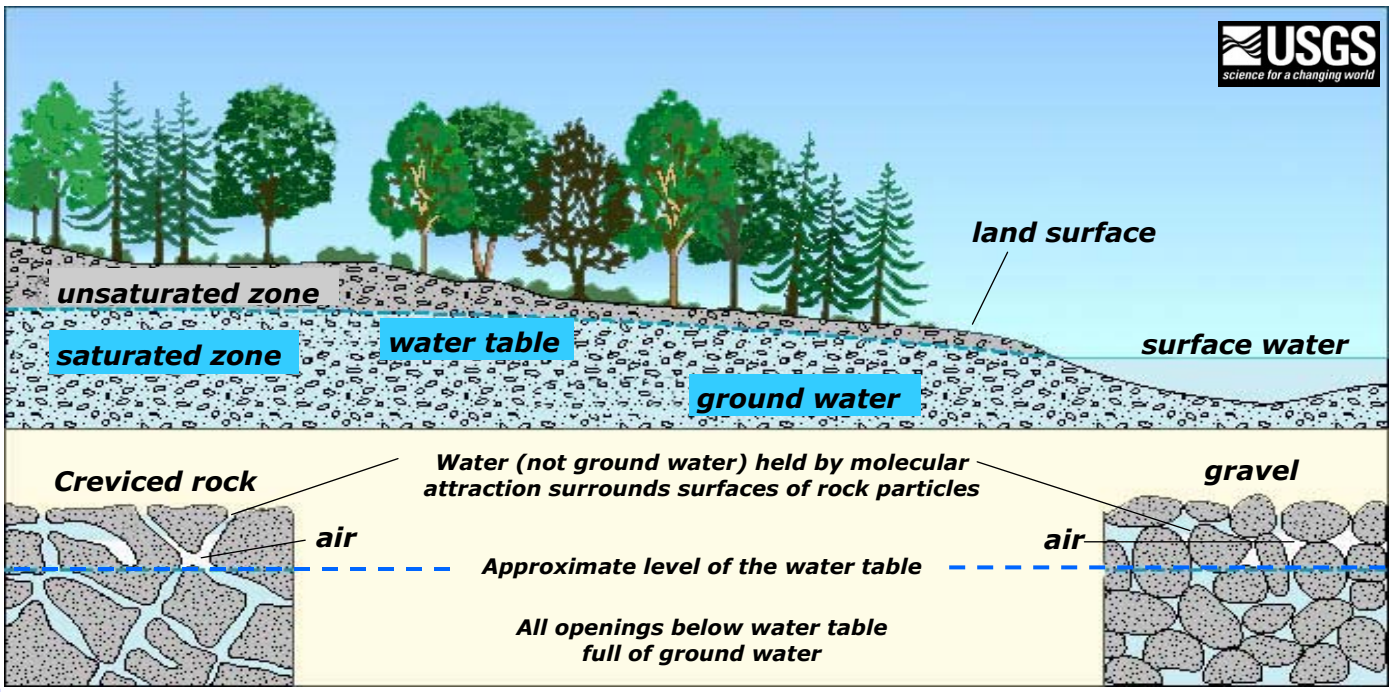
As the water evaporates, vapors rise and condense into clouds. The clouds move over the land, and precipitation falls in the form of rain, ice or snow. The water fills streams and rivers, and eventually flows back into the oceans where evaporation starts the process anew.

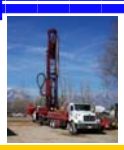
Origins of Groundwater

Groundwater originates as rainfall or melting snow that seeps or infiltrates into the ground. The amount of water that is absorbed into the ground varies widely depending on the quality of the land surface that is present. In surface material such as sand or gravel, as much as 40 to 50 percent of the rain and snow melt may seep into the ground. Seepage into material like clay, can range from 5 to 20 percent. The remainder of the precipitation moves into streams as runoff or returns to the atmosphere through evaporation. The volume of precipitation that soaks into the ground is also strongly affected by the season of the year. During warm months, water is more likely to be lost through evaporation, and transpiration—evaporation through plant leaves. During cold months, the ground may be saturated with rain or even frozen, resulting in increased run off.

Rain and snow melt that seeps into the ground continues downward under the force of gravity until it reaches a depth where water fills all of the openings (pores) in the soil or rock. This is called the ***saturated zone.***

The saturated zone typically includes numerous water-filled crevices in the upper layer of bedrock. Deeper bedrock layers may have few or no crevices where water can penetrate. The top of the saturated zone is called the ***water table.*** The water table rises and falls according to the amount of rain and snow melt that falls, the season of the year and the volume of groundwater removed through pumping. It is typically higher in early spring and lower in late summer. Heavy rainfall or drought conditions may significantly alter the typical pattern, however.





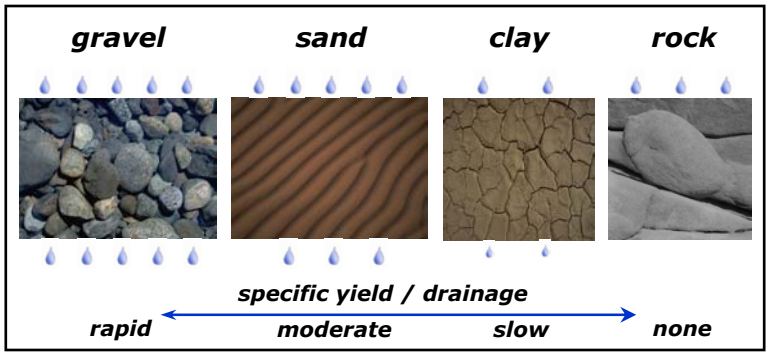
DOMESTIC WELLS

Groundwater Hydrology

A zone is usually present between the water table and the land surface where the openings, or pores, in the soil are only partially filled with water. This is the ***unsaturated zone.*** Water seeps downward through it to the water table below. Plant roots can capture the moisture passing through this zone, but it cannot provide water for wells.

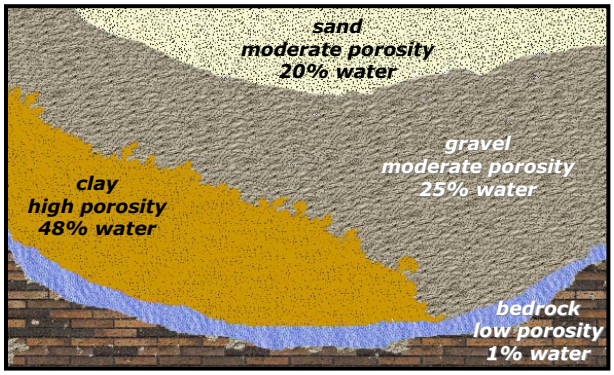
Groundwater Hydrology

The quality and quantity of a well's output depends a lot on the specific geologic formations in which the water lies.



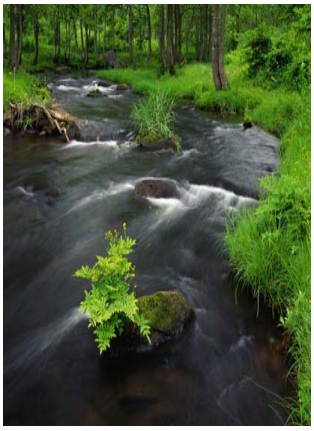
Permeability

Permeability is critical for water supply purposes. Permeability is the measure of a rock's capability to transmit liquid through it's pore spaces. How fast water will flow through openings or pores in soil or rock depends greatly on the qualities of the soil substrate. Low permeable soils that contain clay or rock restrict the flow of water. Highly permeable soils, consisting of sands and gravel, possess gaps between particles that enhance the flow of water. The specific yield is the actual amount of water that will drain out of saturated soil and rock by gravity flow.



Porosity

The capacity of soil or rock to hold water is called porosity. Saturated sand contains about 20% water; gravel, 25%; and clay, as much as 48%. Saturated bedrock with few crevices commonly contains less than 1% water. Despite its high water content, clay is not a good water source because the extremely small size of the openings between microscopic particles creates friction that effectively halts water movement altogether. Saturated clay is virtually impermeable.



Aquifers

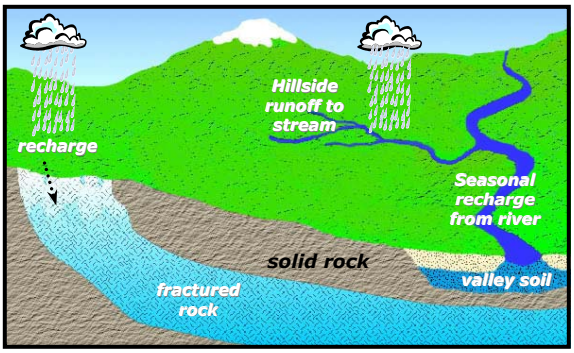
An aquifer is a formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs. In non-mountainous areas or near rivers in mountainous areas, the main aquifers are typically unconsolidated ***alluvium*** composed of mostly horizontal layers of alternating coarse and fine materials deposited by water processes via rivers and streams. Mixed soils made up mostly of clay, sand, and fine particles yield low amounts of water. Materials of coarse-grained sand and gravel sorted into distinct layers will yield high amounts of water. Bedrock aquifers will yield substantial amounts of water provided there are numerous large openings or cracks for connectivity.

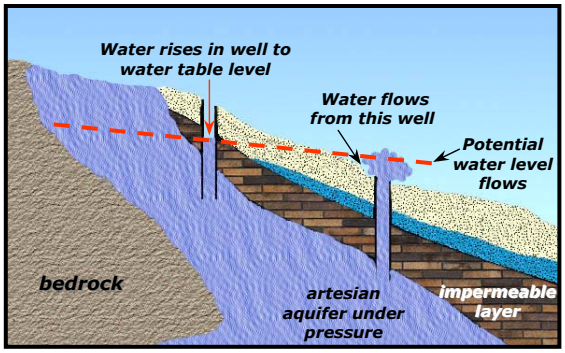
DOMESTIC WELLS

Groundwater Hydrology

Recharge

Water percolating into an aquifer is known as recharge. Percolation occurs intermittently during and immediately following periods of precipitation. Recharge occurs where permeable soil or rock allows water to readily soak into the ground. These areas are known as recharge areas. Permeable soil or rock formations where recharge occurs may occupy only a very small area or extend over many square miles. In addition to the rain and snow that falls directly onto the land surface above the aquifer, recharge from hillside runoff or streams may also collect and fill valley aquifers that filter water into the ground water reservoir.



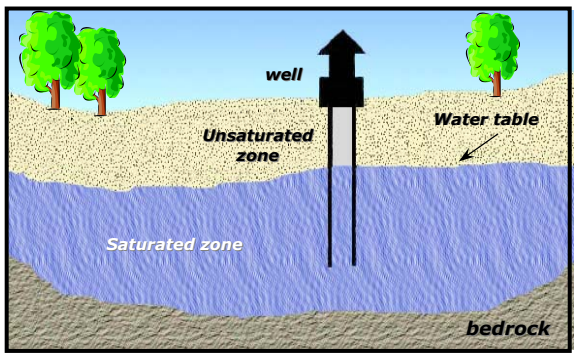


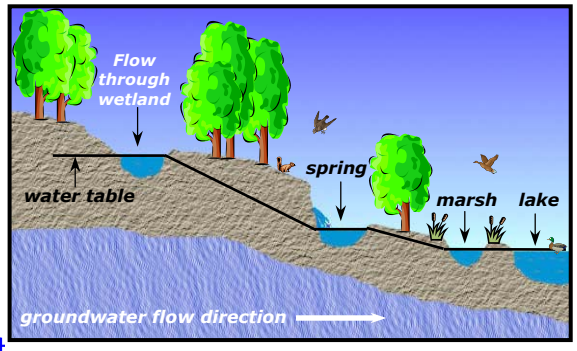
Confined or Artesian Aquifer

Groundwater that becomes trapped under impermeable soil or rock may be under pressure. This pressure is the result of the recharge area of the aquifer being at a higher level than the rest of the aquifer. The force of gravity pulls the higher water down which creates extra pressure inside the aquifer. This pressure in the aquifer will cause water in the well to rise above the aquifer level. The maximum level that the water in the well will rise to is known as the potentiometric surface, or potential water level. If this is higher than the top of the well, the well will overflow.

Unconfined/ Water Table Aquifer

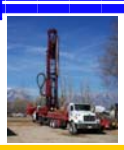
Aquifers that are not confined under pressure are called unconfined or water table aquifers. The water level inside a well is the same as the water table outside the well.





Groundwater Discharge Points

Groundwater enters the ground in ***recharge areas*** and leaves the ground at ***discharge points***. Discharge points are typically formed where soils are more permeable and create exit points such as springs, wet-lands, streams and lakes. As long as there is sufficient water present above the discharge point, discharge is continuous.

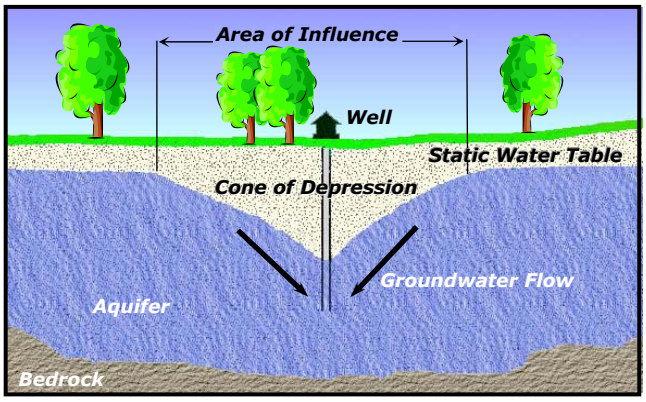


DOMESTIC WELLS

Groundwater Hydrology

Groundwater Flow Rates

Groundwater characteristically moves so slowly from recharge areas to discharge points, that flow rates in aquifers are typically measured in feet per day. Where large rock openings or crevices exist, often in limestone and in loose soil, such as coarse gravel, flow rates are much faster. Depending upon the quality of the soil substrate, groundwater may take just a few days or weeks or take years, decades or even centuries to move long distances through some aquifers. Due to the slow movement of ground water through soil, which typically moves in parallel paths (layers), turbulence to cause mixing rarely occurs. This proves to be an important factor in the location and movement of contaminants that enter the groundwater.



Cone of Depression

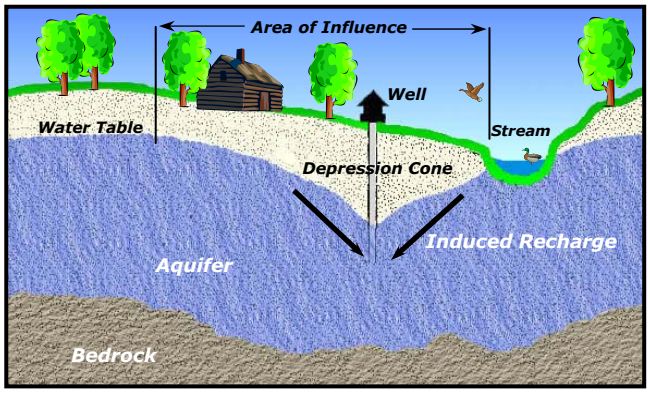
Pumping groundwater from a well lowers the water table near the well. This phenomenon, known as the ***cone of depression,*** diverts ground water flow away from the water table and towards the well's point of entry. The land surface overlying the cone of depression is referred to as the ***area of influence.***

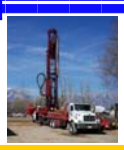
Well Contribution Zone

A groundwater recharge area that supplies water for a well is known as the ***catchment area*** or ***contribution zone***. This zone may affect an entire local aquifer or just a portion of a larger aquifer recharge area. The area of influence due to well pumping, that overlies the cone of depression, may extend beyond the contribution zone however. Induced recharge from well pumping causes groundwater to flow towards the well that would not normally contribute water to a well.

Induced Recharge

The cone of depression from a pumping well may extend to a nearby river or lake. When this occurs, water is drawn away from the adjacent water table supporting the river or lake level to recharge the well demand. This effect, known as ***induced recharge,*** can effectively empty entire stream and wetland areas to the point that they run completely dry.





DOMESTIC WELLS

The Water Code

The Water Code

Under Oregon law, all water is publicly owned. With some exceptions, cities, farmers, factory owners and other users must obtain a permit or water right from the Water Resources Department to use water from any source — whether it is underground, or from lakes or streams. Landowners with water flowing past, through, or under their property do not automatically have the right to use that water without a permit from the Department.

Exempt Uses of Surface Water

Some uses of water are exempt from the requirement to obtain a permit:

1. Natural springs: Use of a spring which, under natural conditions, does not form a natural channel and flow off the property where it originates at any time of the year.

2. Stock watering: Where stock drink directly from a surface water source and there is no diversion or other modification to the source. Also, use of water for stock watering from a permitted reservoir to a tank or trough, and, under certain conditions, use of water piped from a surface source to an off-stream livestock watering tank or trough.

3. Salmon: Egg incubation projects under the Salmon and Trout Enhancement Program (STEP) are exempt. Also, water used for fish screens, fishways and bypass structures.

4. Fire control: The withdrawal of water for use in, or training for, emergency fire fighting.

5. Forest Management: Certain activities such as slash burning and mixing pesticides. To be eligible, a user must notify the Oregon Water Resources Department and the Oregon Department of Fish and Wildlife and must comply with any restrictions imposed by the Department relating to the source of water that may be used.

6. Land management practices: Where water use is not the primary intended activity.

7. Rainwater: Collection and use of rainwater from an impervious surface (like a building's roof).

Exempt Uses for Ground Water

1. *Lawn or noncommercial garden:* ***Water not more than one-half acre in area.***

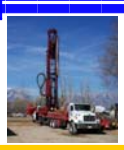
2. *Single or group domestic purposes not to exceed 3 households on one well:* ***No more than 15,000 gallons per day.***

3. *Stock watering*

4. *Down-hole heat exchange uses.*

5. *School grounds:* Ten acres or less, of schools located within a critical ground water area.

Note: While these water uses do not require a permit, the use is only allowed if the water is used for a ***"beneficial purpose without waste"*** and may be subject to regulation in times of water shortage.

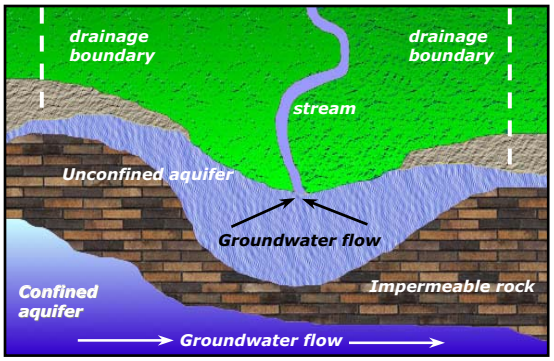


DOMESTIC WELLS

Locating Ground Water

Groundwater Drainage Area

Groundwater in unconfined aquifers, that do not have impermeable soil or rock layers between the aquifer and the land surface, usually flows into the same stream drainage basin where it is located. Confined or artesian aquifers, which exist at greater depth, may be part of a regional groundwater flow system that may not correspond with the surface drainage.



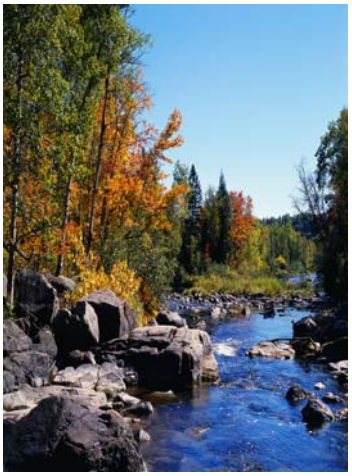
Finding Ground Water

The amount and quality of ground water in an area can depend on yearly rainfall, geologic conditions, topography, distance to nearby wells, and surface water supply. You can learn about the quantity and quality of well water in your area from local water well constructors and neighbors. A local well constructor can help you estimate well depth, yield and cost.

Ground water is a renewable resource. In most parts of the United States, water removed from the ground is constantly replaced, although in some parts of the country such as arid and semi-arid regions, a low rate of replenishment is far exceeded by the rate of ground water pumping, resulting in serious problems of ground water mining. Adequate time is needed to allow replenishment of underlying ground water reservoirs; also such areas must be properly managed in order to prevent water soluble waste products stored in these areas from infiltrating and polluting the underground supply.

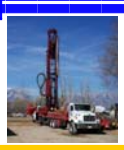
Water Well Reports

Another useful tool for learning about your local ground water is the water well report, often called a ***well log***. Well logs are prepared by the well constructor as required by Oregon water law. Well logs provide information on geologic formations encountered in a well and list details concerning well design, construction, and yields. They are a basic tool used in checking for ground water availability.



The Water Resources Department (WRD) has well logs for most of the water wells drilled in Oregon since 1955. However, the likelihood of finding records for wells constructed since 1970 is much higher than for older wells. Well logs are available on the Department's Internet website: ***www.wrd.state.or.us.*** From the home page, select "Find a Well Log" or "GRID-Web." There are numerous ways to query the information.

One of the most useful ways is to search using Township, Range, and Section. The data for all of the wells in the section(s) will be displayed on the screen. For effective searches, use a unique identifier, such as the original owner's name, tax lot information, street address, or age of well.



DOMESTIC WELLS

Installing a New Well

Water Witches

Enrico Ferorelli, copyright 1995

Water Witches or "dowsers" claim to predict the presence of water with hand-held tools such as forked twigs or metal rods. Since there is no scientific basis to dowsing, most geologists do not recommend the practice. Although most water witches charge only a modest fee, the U.S. Geological Survey and National Ground Water Association advise against employing a water witch to search for ground water.

Installing a New Well

The first step in installing a new well is proper planning. How much water is required to meet the needs of expected water usage in the home and garden? Where should the well be drilled? What well yield will we get? What water system equipment may be needed to provide a reliable supply? The builder or home-owner should get expert advice about the availability and reliability of local ground water and the safest place for drilling...before the first dirt is disturbed. This is the time most prospective well owners turn to well constructors, who have current information on state or local environmental restrictions, the permits required and mandatory construction standards expected.

Estimating Your Water Needs

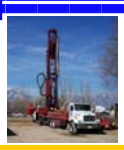
Once you know ground water is available, you must estimate how much water you need. To estimate your daily peak water demand, add the appropriate quantities of water for all uses which would likely occur on the day of the year in which water needs would be highest. Peak demand in the home normally occurs at the beginning of the day, at bedtime, or during laundry or irrigation uses. The following guide will help you determine peak demand.

Type of Use/ Dwellings	Gallons per day	Livestock	Gallons per animal per day
Single family	50-75/person	Cattle/horse	12
Multi-family	40/person	Dairy cow	35
Estate units	65-150/person	Hog	4
Lawn and garden	50-1,000/day	Goat or sheep	2
		Chickens	5-10 per 100

Placing Your New Well

The well constructor can recommend the best place for a well based on their knowledge of the local groundwater system, experience in similar areas, and records of previous wells. They can also rely on a diverse array of information about land surface topography, local vegetation, rock fracturing (where applicable), local geology, groundwater chemistry, data on thickness, depth, and permeability of local aquifers from existing wells, groundwater levels, satellite or aerial photographs, and geophysical measurements.

Sedimentary rock formations are typically the best producers of groundwater. Because of its porous makeup, sandstone can store large volumes of water. In low yielding rock formations (igneous and metamorphic), a well likely will need to be several hundred feet deep in order to provide adequate supply.



DOMESTIC WELLS

Determining the Location of Your Well

Locating The Well

Water well constructors have local knowledge and experience with state regulations; they can help you site your well. The following standards apply to the placement of wells:

- Locate the well away from septic tanks, sewage disposal areas (such as a drain field), and other sources of contamination such as stock yards, storm sewers, privies, or refuse dumps. WRD requires a *minimum* distance of 50 feet from septic tanks and 100 feet from sewage disposal areas. Soil type and topography in your area may require greater distances.
- Increase the distances in areas of highly permeable formations (i.e. sand and gravel).
- Run drainage away from the well on all sides; divert up-slope drainage away from hillside wells.
- Locate the well above (higher in grade) disposal areas if possible.
- Locate the well far enough away from buildings to allow easy access during maintenance, repair, testing, or re-drilling. Remember to plan future well construction or repairs before building a shelter around the well.
- Locate the well in an area free from flooding or plan extra precautions to protect it.
- Site your well as far as possible from neighboring wells. When wells are close together, they can interfere with each other and produce less water.
- Site your well a safe distance from your property line. This will prevent difficulties with neighboring septic systems and boundary line inaccuracies.
- State law requires two business days notice if you dig deeper than 12 inches. Call the Oregon Utility Notification Center at (800) 332-2344.
- Be aware of transmission lines and of overhead power lines where the drill rig will set up.

After legal, health and safety requirements, the main consideration in locating your well is convenience. If conditions allow, locate the well near where you will use the water and near a power source. Contact your county health and planning departments for additional well location and permit requirements before you drill.

Well Design's Form and Function

A water well is essentially a hole, shaft or excavation in the ground used for the purpose of extracting water from the subsurface. The overall objective of the design of the well system is to create a structurally stable, long-lasting, efficient well that has enough space to house pumps or other extraction devices, allows ground water to move effortlessly and sediment-free from the aquifer into the well at the desired volume and quality, and prevents bacterial growth and material decay in the well.

Most wells are vertical shafts, but they can also be horizontal or at an inclined angle. Horizontal wells are commonly used in bank filtration, where surface water is extracted via recharge through river bed sediments into horizontal wells located underneath or next to a stream.

Well Construction Standards

The following are some items you should track as your well is constructed.

WELL DEPTH can be measured by using a weighted line. The depth should be close to the depth recorded on the required well log.

CASING is steel or plastic pipe installed to prevent the borehole from caving in and to seal the upper portion of the well. The total length of casing used should be the same as that recorded on the well log.

SEALING the space between the borehole wall and the casing helps prevent commingling or contamination of the aquifer. The seal should be placed in one continuous operation from the bottom upward. A proper seal consists of neat cement (cement and water) or bentonite (a dry clay) which extends from the ground surface to the depth required by the construction standards that apply to the particular well. Standards require a minimum 18-foot seal.

COMMINGLING occurs when a well draws water from more than one water-bearing formation. In no case shall a well be constructed to tap into multiple water-bearing formations.

DEVELOPMENT involves vigorously pumping the well to help clean out drill cuttings and to maximize production of the well. Development should result in a well which produces sand-free or mud-free water when operated properly.

OPENINGS—All wells must have an access port for measuring artesian pressure. The access port must be unobstructed. If an airline is installed for measuring the water level, it must not block the access port. Make sure the access port is capped and that all other openings are plugged, sealed, or designed to prevent surface water from entering the well casing.

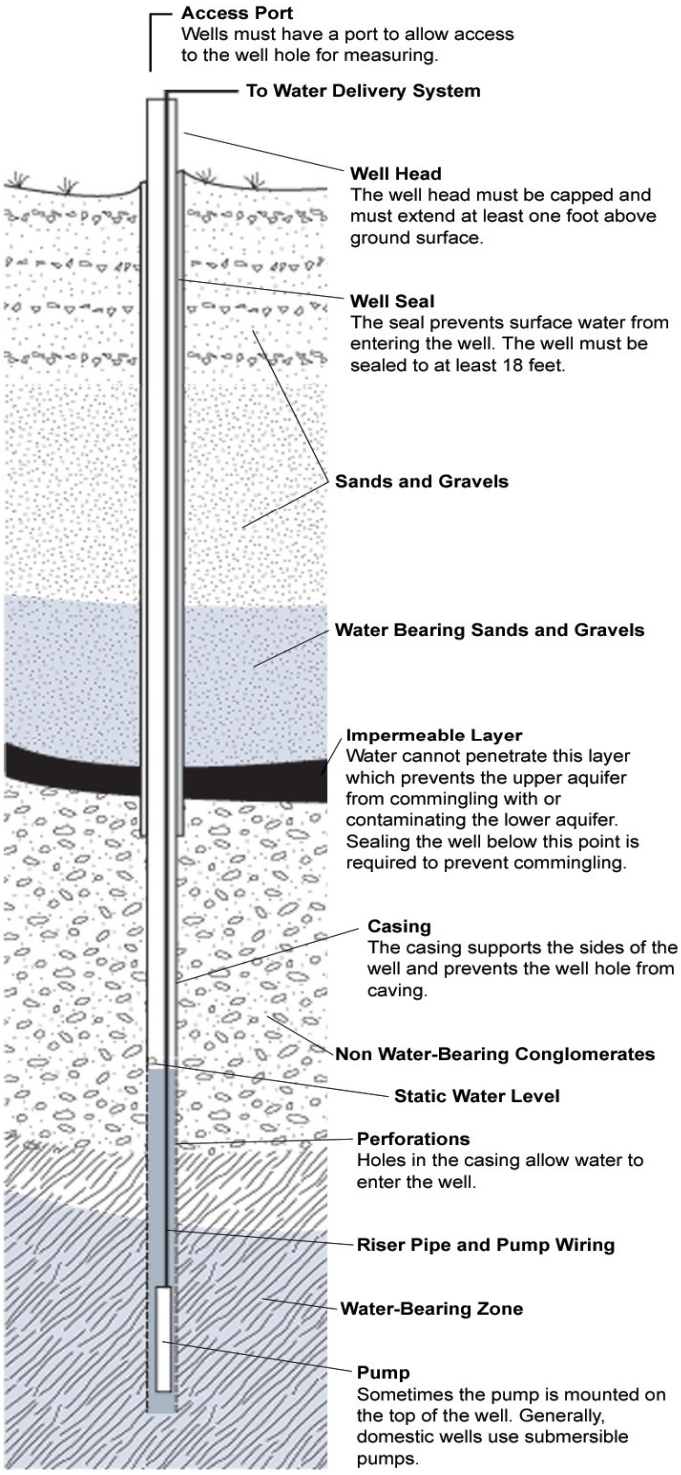
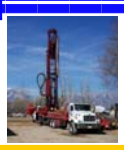


Illustration courtesy of Oregon Water Resources Department



DOMESTIC WELLS

Selecting a Water Well Constructor

Well Construction Standards

TOP TERMINAL HEIGHT—The casing head or pitless unit of any well must extend at least 12" above the finished ground surface or pump house floor, and 12" above the local surface runoff level.

YIELD TEST—The constructor will conduct a ***one-hour yield test*** to see how much water the well produces. One of these methods is used: pump, air, or bailer. The static water level, the date, the drawdown at the end of the test period, the pumping rate, and the length of the test period are recorded on the well log. Note whether the water level stabilized during the test. A one-hour minimum yield test is required upon completion of every well. Oregon law requires owners of wells with a water right (usually large industrial or irrigation wells) to conduct a well pump test once every ten years and report the results to the OWRD.

WELL IDENTIFICATION NUMBER—A stainless steel label, preprinted with an assigned number, should be attached to the well casing within 30 days of well construction. This unique number identifies your well and will be used to track any future modifications to the well. Please do not remove or cover this label.

WELL LOG—You should receive a copy of your water well report (well log) from the well constructor. The well log is one of the most important records of your property as it provides information on geologic formations encountered in a well and lists details concerning well design, construction and yields. You may obtain a copy on the Water Resources Department's website www.wrd.state.or.us. WRD has drilling records of most water wells drilled in Oregon since about 1955. It is a good idea to make a copy of the well log and post it near the well.

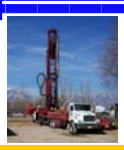
Selecting a Water Well Constructor

Be sure to choose a water well constructor who is licensed and bonded to construct water wells in Oregon. Names of local water well constructors are available from the following sources:

- Through the Department's website *www.wrd.state.or.us*
- The Oregon Ground Water Association
- Your local telephone directory
- Your neighbors
- The Water Resources Department's central office or your district watermaster.

Lending Institutions

If you need help financing your new well, check with lending institutions in your area before you look for a well constructor. Some lenders have specific requirements for well production, water quality, and well depth, and may have standards for sharing wells with one or more neighbors. Several types of loans for well construction are available. The cost of a well may be included in a loan for construction of a home. Sometimes interim loans are needed to cover the cost of the well until you receive financing for home construction. These are available from a variety of lending institutions.



DOMESTIC WELLS

Selecting a Water Well Constructor

Selecting a Water Well Constructor

Questions to ask before selecting a constructor:

- Do you have references?
- Do you provide a written agreement or contract?
- Do you have a valid Oregon water well constructor's license and bond?
- How long have you been in business and constructing wells?
- Does it cover the work to be performed?
- Does it include details and costs of well construction?
- Are the following items in the checklist mutually agreed upon?

CHECKLIST

This checklist will help ensure there is agreement between you and the well constructor about what is to be done. All of the items below should be addressed.

__hole diameter, changes in diameter with depth;

__casing material and diameter, cost per foot;

__who will identify location of drain fields, septic tanks, and other sources of contamination;

__drive shoe, if necessary

__approximate depth of well (set limits based on geology and individual needs) and cost per foot;

__liner pipe, if necessary

__sealing method; interval and costs;

__well development—duration, rate per hour or per day, completion criteria (for example, sand-free or mud-free water);

__intake diameter, perforated casing material, or screens

__yield test—length of test, method of test, water level drawdown;

__well disinfection;

__additional costs if the well is a flowing artesian well;

__abandonment procedures if the well is unusable;

__pump and installation costs (if the constructor provides this service);

__itemized costs;

__guarantee of materials and quality;

__projected completion date;

__well identification number;

__additional specific items.

DOMESTIC WELLS

Constructing A Well

Types of Wells

Drilled wells. Drilled wells are constructed by either cable tool (percussion) or rotary-drilling machines. Drilled wells that penetrate unconsolidated material require installation of casing and a screen to prevent inflow of sediment and collapse. They can be drilled more than 1,000 feet deep. The space around the casing must be sealed with grouting material of either neat cement or bentonite clay to prevent contamination by water draining from the surface downward around the outside of the casing. The most common well drilling methods are: ***air rotary, bucket auger, cable tool, down-the-hole,*** *and* ***reverse circulation.*** To see a video of these methods, go to ***http://www.wellowner.org/awaterwellbasics/typesofwells.shtml*** on the web.

Driven wells. Driven wells are constructed by driving a small-diameter pipe into shallow water-bearing sand or gravel. Usually a screened well point is attached to the bottom of the casing before driving. These wells are relatively simple and economical to construct, but they can tap only shallow water and are easily contaminated from nearby surface sources because they are not sealed with grouting material.

Dug wells. Historically, dug wells were excavated by hand shovel to below the water table until incoming water exceeded the digger's bailing rate. The well was lined with stones, bricks, tile, or other material to prevent collapse, and was covered with a cap of wood, stone, or concrete tile. Because of the type of construction, bored wells can go deeper beneath the water table than can hand-dug wells. Dug and bored wells have a large diameter and expose a large area to the aquifer. These wells are able to obtain water from less-permeable materials such as very fine sand, silt, or clay. Disadvantages of this type of well are that they are shallow and lack continuous casing and grouting, making them subject to contamination from nearby surface sources, and they go dry during periods of drought if the water table drops below the well bottom.

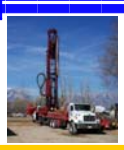
Drilling Your Own Well

A water well is much more than just a hole in the ground. To prevent ground water contamination, a well must be constructed using proper methods and equipment. Licensed and bonded water well constructors have the equipment, knowledge, and experience required for proper well construction. For this reason, the OWRD discourages landowners from drilling a well by themselves.

If you decide to construct, alter, or abandon a water well by yourself on your own property, you will have two responsibilities:

1. Obtain a Landowners Water Well Permit from the Department. You must submit an application, file a $5,000 landowner's bond, and a $25 application fee.
2. Construct, alter, or abandon the well according to ground water law and the general standards for construction and maintenance of water supply wells in Oregon.

You may obtain an application for a Landowner's Water Well Permit, a bond form, and a copy of current state well construction standards and regulations from WRD's website at *www.wrd.state.or.us*

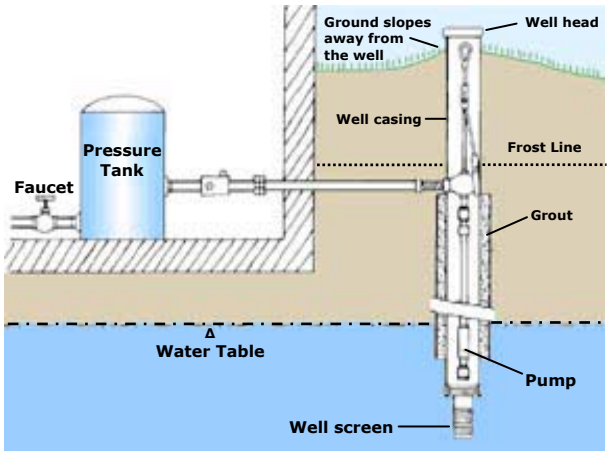


DOMESTIC WELLS

Installing A Well

Well Components

Once the well bore is drilled, the constructor installs a number of component parts to stabilize and secure the well hole. The diameter of the drilled hole is usually an inch or two wider than the diameter of the ***casing***.



The space between the drilled hole and the casing, called the ***annulus***, has to be filled to prevent surface water from migrating downward along the outside of the casing and contaminating the aquifer. The annular space between the well screen, well casing and borehole wall is filled with gravel or coarse sand called a ***gravel pack***. The gravel pack prevents sand and fine sand particles from moving from the aquifer formation into the well.

The uppermost section of the annulus is normally sealed with ***grout*** and it may be either cement or a special clay called ***bentonite***. Sometimes most of the space is filled with the fine rock pieces from drilling and then the top 20 feet is grouted with cement or bentonite.

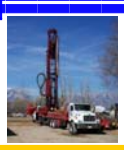
If the well is drilled into rocks that are crumbly, or into sands and gravels, a ***well screen*** probably will be needed. The well screen is a sieve or strainer-like cylinder attached to the bottom of the casing. It allows water to flow into the well while preventing fine rock particles or sand from entering.

The purpose of the well casings between and above the well screens are to prevent fine and very fine formation particles from entering the well, to provide an open pathway from the aquifer to the surface, to provide a proper housing for the pump, and to protect the pumped ground water from interaction with shallower ground water that may be of lower quality.

At the surface of the well, a ***surface casing*** is commonly installed to facilitate the installation of the well seal. The surface casing and well seal protect the well against contamination of the gravel pack and keep shallow materials from caving into the well. Surface casing and well seals are particularly important in hardrock wells to protect the otherwise open, uncased borehole serving as a well.

Well Development

After the well screen, well casing and gravel pack have been installed, the well is developed to clean the borehole and casing of drilling fluid and to properly settle the gravel pack around the screen well. A typical method for well development is to surge or jet water or air in and out of the well screen openings. This procedure may take several days or perhaps longer, depending on the size and depth of the well. A properly developed gravel pack keeps fine sediments out of the well and provides a clean and unrestricted flow path for ground water. Proper well design and good development will result in lower pumping costs, a longer pump life, and fewer biological problems such as iron-bacteria and slime build-up. Poorly designed and underdeveloped wells are subject to more frequent pump failures because sand and grit enter the well and cause significantly more wear and tear on pump turbines.



DOMESTIC WELLS

Installing A Well

Well Efficiency

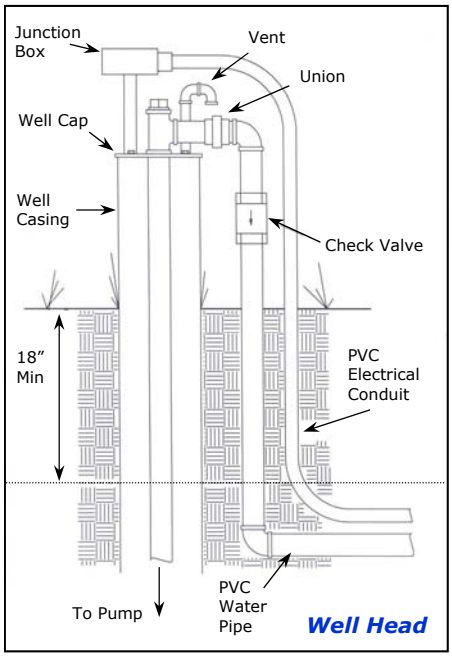
Poorly designed and underdeveloped wells also exhibit greater water level ***draw-down*** than do properly constructed wells, an effect referred to as ***poor well efficiency***. Poor well efficiency occurs when ground water cannot easily enter the well screen because of a lack of open area in the screen, a clogged gravel pack, bacterial slime build-up, or a borehole wall that is clogged from incomplete removal of drilling mud deposits. The result is a significant increase in pumping costs. Note that well efficiency should not be confused with pump efficiency. The latter is related to selection of a properly sized pump, given the site-specific pump lift requirements and the desired pumping rate.

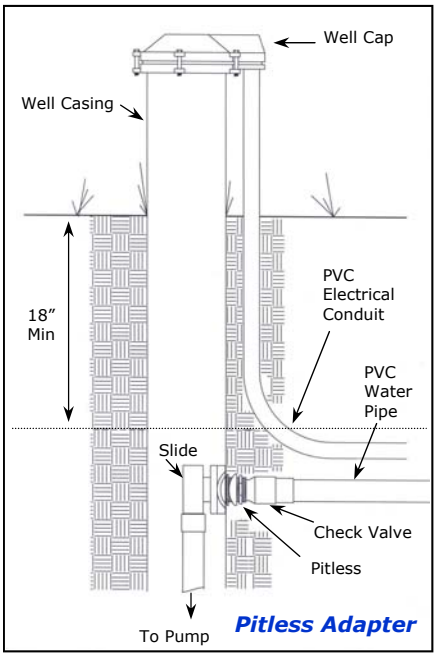
Well Head Seals

The construction of the final well seal is intended to provide protection from leakage and to keep runoff from entering the wellhead. The two basic types of well head installations are shown below.

Identification of the well to be tested is important so arrangements can be made for equipment necessary to perform testing. In the case of the ***Pitless adapter***, a pump hoist may be necessary.

The installation of a Pitless adapter can help reduce the possibility of freeze damage to the pump and water lines. The diagram shows a typical installation where all water plumbing remains below grade. This may also eliminate the need for a pump house or insulated cover required for standard well heads.



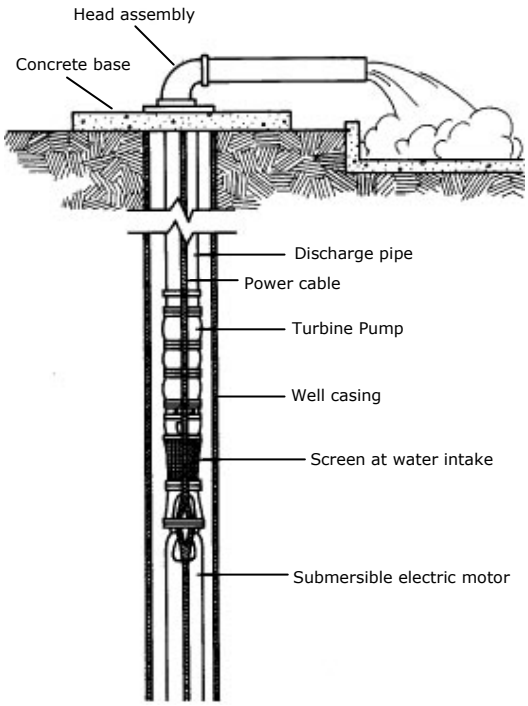


Bare properties are sometimes sold with an existing well on site that may require testing. Look at the well head and identify the type. If a Pitless adapter is installed, there is most likely a pump in the well.

If it is a standard well head with wires stubbed through a hole in the seal and there is a galvanized tee with plugs installed, there is most likely a pump installed.

Diagram courtesy of Hydro-Flow, Inc.

Purchasing and Installing a Pump

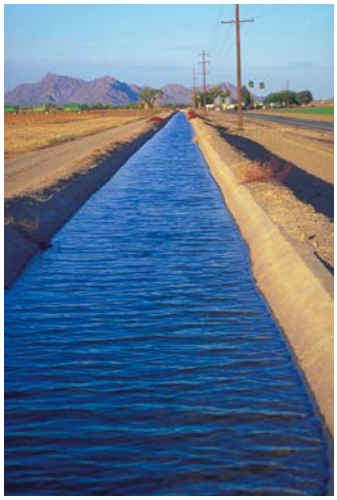


Water is pushed from the well to the surface by a pump. About 60% of home wells in the United States use an electric ***submersible pump.*** Submersible pumps are long cylinders usually 3 to 5 inches in diameter and 2 to 4 feet in length.

A submersible pump is a turbine pump close-coupled to a submersible electric motor. Both pump and motor are suspended in the water, thereby eliminating the long drive shaft and bearing retainers required for a deep well turbine pump. Because the pump is located above the motor, water enters the pump through a screen located between the pump and motor. A water delivery pipe comes up the well from the pump either into a holding tank or into the home directly. The pipe is usually made of PVC plastic, but steel pipe may also be used.

Submersible motors are smaller in diameter and much longer than ordinary motors. Because of their smaller diameter, they are lower efficiency motors than those used for centrifugal or deep well turbine pumps. Submersible motors are generally referred to as dry or wet motors. Dry motors are hermetically sealed with a high dielectric oil to exclude water from the motor. Wet motors are open to the well water with the rotor and bearings actually operating in the water.

In some wells, especially in narrow diameter holes where the depth to water is less than 25 feet, a shallow-well ***jet-pump*** may be used. Approximately 32% of U.S. homes have jet pumps. With a jet pump, the motor and pump are not in the well, but are usually close to the well in a basement or utility room. Jet pumps work by pumping water under pressure through an ejector into a discharge pipe coming up from the well. As the jet of high-pressure water is forced into the discharge pipe, it creates a vacuum and causes water to be drawn from the well. Shallow well jet pumps are not effective at depths below 25 feet but have the advantage of having no working parts down the well and so can be used in narrow diameter wells. Deep well jet pumps, used to pull water up from depths down to 75 feet, are used in 8% of American homes.



Well pumps are sold by pump dealers, some water well constructors, plumbing supply dealers, and various retail outlets. The water well constructor can tell you the well production and drawdown of the yield test. Using this information and the well diameter, you can select a pump to meet your water needs. The delivery system should produce enough water while using as little energy as possible. Selecting a pump with a capacity greater than the well yield can cause problems, such as muddy or sandy water, pump failure, or even well failure.

DOMESTIC WELLS

Water Pressure

Water Pressure

Water flows out of taps because of pressure in the water system. For most well systems it is a well pump that provides the pressure that makes the water flow. Different pumps have different flow capacities, as the overall rate of flow is directly related to the pump capacity. If your household has a 10-gallon per minute demand, there will be trickling water if the pump will only supply five gallons per minute.

A pressure tank in a water system is designed to have extra gallons of water on reserve so small demands don't require the pump to switch on. An example is turning on a faucet for a few seconds to get a glass of water. As the pump pushes water in, the air in the tank is compressed. At some point, called the cut-out pressure, a pressure switch interrupts the power to the pump and no more water enters the tank. Since there is compressed air above the water, there is enough force acting on the liquid to push it out of the tank, through the pipes, and all the way upstairs (possibly several flights of stairs) to the faucet.

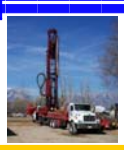
However, the tank cannot compensate for flow greater than the pump capacity.

Inadequate Water Pressure

If your well does not produce adequate pressure to facilitate your household water needs, you need to check that the pump is working properly. If there is adequate pressure in the tank, hard water could be causing the decline in pressure. A buildup of scale can cause increased friction in the pipes and hamper water pressure.

If installation of a device is required, there are **three solutions**.

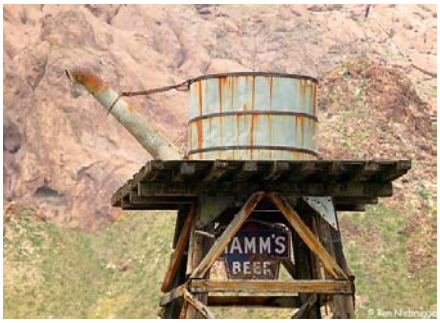
1. A constant pressure valve can be installed between the pump and the pressure tank. It will automatically adjust flow from the well pump to a preset pressure. It is relatively easy to install and a good, economic solution. It will solve many problems. However, it does not increase the flow rate greater than that of the pump.
2. Additional pressure tank capacity can be added to meet high demands for water that are in excess of the pump's capacity. Ensuring that two tanks and the existing pump will work compatibly will require a professional, but this will aid in the short-term demands. However, it will not permanently solve the problem of the shower, dishwasher, washing machine, and other heavy appliances all running at the same time.
3. The pump can be replaced with a variable speed pump. The motors of variable speed pumps can run up to two times faster than those with constant speeds. The speed of it is regulated by the demand for water. A device measures the demand for pressure, and adjusts the pump's flow rate. Some variable speed pumps have a slow startup, which eliminates power surges and reduces torque on the pump and well piping.



DOMESTIC WELLS

Water Usage Demand

Water Usage Demands



If your well cannot keep pace with the peak water usage demands in your house, then you should consider the installation of a ***holding tank***. A holding tank will provide a sizable reservoir of water to meet high volume demands from household laundry, dishwashing and bathing needs and possibly, part or all of your garden watering needs. Holding tanks typically range in size between 1,000 and 2,500 gallons, though can be purchased in as little as a 500 gallon tank or as large as a 10,000 gallon tank or greater.

A holding tank has the advantage of storing water during times of low demand (during the night). If the tank's elevation is above the house, you'll benefit from gravity by having a higher and more constant water pressure than if you rely solely on your well pump output.

A low water and high water float in your holding tank will switch the well pump on and off to meet demands and protect the tank from running dry or overfilling. A ***pressure switch*** attached to the well pump control box should be installed to shut the well pump off if and when the well "runs dry" to prevent the pump from burning out. A pressure switch is a load sensing device that monitors the electrical load on submersible pump/motors. If the load drops below a preset level for a minimum of 4 seconds, the switch will shut off the motor.

An experienced pump installer or plumbing contractor can plan a water system based on your needs and water source. In contrast to a domestic well, an irrigation well must be able to produce water at steady high rates for extended periods of time. Irrigation systems must be carefully designed to minimize pumping costs and to prevent excessive drawdown of the well.

Maintaining Your Well

Some simple well maintenance and record-keeping will help protect the quality of your water and your well. The landowner has the ultimate responsibility for maintenance of their well(s).

WATER QUALITY—Have a water sample analyzed for bacteriological quality at least once a year. Have a sample checked for chemical quality (such as hardness or specific conductance) every five years. Changes in water quality provide early warning of defective surface casing, seals, or contaminated aquifers. Many local water treatment or conditioning businesses, and some local Health Department offices or independent laboratories will perform these tests for a fee.

WATER LEVEL—Keep a permanent record of the depth of the water in your well by taking a measurement from the top of the water to a reference point such as the top of the well casing. These measurements will provide an early warning of water supply problems. Measure the water level at least twice a year and record the time and date. Measurements should be made on approximately the same dates each year, usually in the spring and fall. Let the well sit without pumping for at least one to two hours before measuring. If you have any questions about how to do this, ask your constructor.

SHELTER—Do not store poisons, pesticides, petroleum products, or other hazardous materials in your pump house or near your well. Do not use the pump house to shelter animals.

COVER—Periodically check the sanitary seal / well cap on top of the casing (well) to ensure it is in good repair.

DOMESTIC WELLS

Water Quantity - Well Flow Testing

Well Flow Test

A well flow test tells you the yield or production of the well and if it pumps water continuously for hours on end or not. When you hire a pump service to conduct a well flow test, they should check two different measures of the water level….static and pumping level.

In any well, under non-pumping conditions, the level at which the water resides in the well is known as the ***static water level***. When the pump is started, the water level will drop to a new level known as the ***pumping level*** and this level is a function of the pumping rate.

The difference between the static water level and the pumping level is referred to as the ***drawdown***. Dividing the pumping rate by the drawdown yields a value known as the ***specific capacity*** or well ***yield*** with units of gallons per minute or ***gpm***. This value provides a rough indication of the aquifer/well capacity to produce water.

Even though a well produced 20 gallons per minute when it was drilled 15 years ago, that may not be the case today. The yield of some wells can actually increase, stay the same or diminish over a period of time. If you have a ***holding tank*** you will need a qualified pump service to complete the well flow test due to the complexity of the plumbing and electrical system.

After the operator sets his equipment up at the well head, the pump will be activated and the operator will log flow meter and level probe readings every 15 minutes. Motor amperage, back pressure, grit discharged, clarity and odor are also monitored. To most accurately assess the well's productivity a Flow Test should be conducted over a ***4-hour*** period.

4-Hour Flow Test Report

TIME	WATER LEVEL	METER READING	GAL/15 MIN.	GPM
8.48 am	17' 3"	01069961		
9.03	64' 3"	01071156	119.5	8.0
9.18	79' 6"	01072300	114.4	7.6
9.33	98' 3"	01073415	111.3	7.4
9.48	111' 3"	01074470	106.7	7.0
10.03	" "	01075337	86.7	5.8
10.18		01076199	86.2	5.7
10.33		01077062	86.3	5.8
10.48		01077910	84.8	5.7
11.03		01078762	85.2	5.7
11.18		01079609	84.7	5.6
11.33		01080444	83.5	5.6
11.48		01081294	85.0	5.7
12.03		01082130	83.6	5.6
12.18		01082972	84.2	5.6
12.33	" "	01083812	84.0	5.6
12.48	111' 3"	01084652	84.0	5.6
1.03	2' 10"			

I certify that the above report is a true and accurate statement of the results of the flow test of the well at _____

conducted on 26 OCTOBER, 1993.

HYDRO-FLOW WELL TESTING

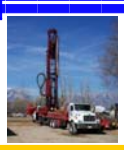
Authorized Signature

After the 4-hour test is complete, the pump is shut off and the static level is again measured. If the well produces water efficiently, i.e., the pump does not produce water in excess of the well's ***recovery*** or ***recharge rate***, the static level should be where it was at the beginning of the test.

If the new static level is lower at the end of the test than it was at the beginning of the test, the time required to re-establish the initial static level should be noted.

For a full well flow report, see appendix.

Report courtesy of Hydro-Flow, Inc.



DOMESTIC WELLS

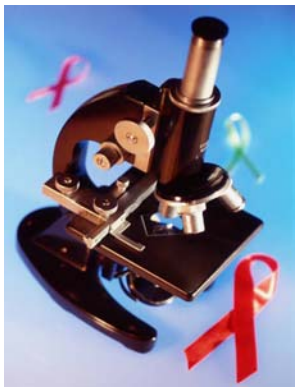
Water Quality - Sample Testing

Water Quality

"Pure" water does not exist – all natural water contains some gases and minerals. All natural waters, regardless of their source (surface or ground water), are likely to contain some microbial organisms. A few cause disease; some impart taste, odor, or turbidity (cloudiness) to the water; others are beneficial.

The acceptability or desirability for the presence of these materials in water is usually a matter of individual preference. Many people develop a tolerance for drinking water of poor taste, odor, or appearance, and they believe their water supplies do not need treatment. They should still have their water supply tested every year or after well and/or pump service. If a water quality problem is present, it can usually be remedied with the appropriate water treatment equipment. Changes in taste, odor, or turbidity of the water may be the first signals of a water problem.

Most water bacteria are harmless and many are actually beneficial. They consume organic debris, thereby reducing the water's chemical oxygen demand; prolong the useful life of filters; and destroy some foul tastes, odors, and colors. In addition, some produce by-products that kill or inhibit growth of some pathogens. Since pathogens are usually less numerous and less hardy in water than are other bacteria, their survival can be decreased by ordinary competition for food with more vigorous organisms.

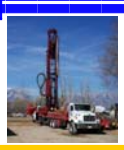


Disease may be transmitted by the consumption of contaminated water and shellfish or close-contact recreation. The human pathogens of major concern in drinking water and shellfish consumption follow the anal-oral route of transmission. The pathogen must enter the host through an appropriate portal, overcome the host's defenses, and proliferate to a sufficient degree to cause symptoms of disease. This contamination results from human and animal fecal matter migrating from surface deposition or from septic systems or leaking sewer lines.

You cannot directly smell unsafe bacteria or protozoa. They can only be detected using tests designed for that purpose. You should check your water quality regularly. Some sources of odors are caused by bacteria, a septic system leak, or the presence of chemicals. It is a good idea to take your nose seriously. Have the water tested.

The Centers for Disease Control and Prevention issues an annual survey of foodborne and waterborne disease outbreaks. For the two-year period 1999-2000, 25 states reported 9 outbreaks associated with water intended for drinking. The outbreaks caused an estimated 2,068 persons to become ill.

During the same period, 59 outbreaks from 23 states were attributed to recreational water exposure, affecting an estimated 2,093 people.



DOMESTIC WELLS

Well Water Sampling

General Procedures For Sampling

For most water tests, follow these steps when collecting a sample:

- Take the sample close to the pump, before the water goes through a treatment system.
- Do not take the sample from a swing-type faucet. Inspect the faucet for leaks. Select another faucet if there is leaking.
- Remove the aerator.
- Disinfect the faucet with bleach or a flame.
- Run the water several minutes to clear the line.
- Take the sample midstream. Do not touch the sides of the collection bottle, the opening or inside of the cap.
- If needed, store the sample in the refrigerator before taking to the lab.
- Submit the sample within 48 hours of collection.
- Transport the sample in a cooler or ship in an insulated container.

Some tests, such as lead, require the water stand in the pipes overnight before taking a sample. Again, follow the instructions provided by the lab or your Health Department.

Sample Collection in Oregon

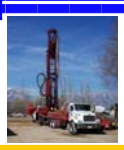
Per **OAR 333-061-0335** (1) Only persons who have knowledge of the appropriate procedures for the collection and handling of the water samples for nitrates and total coliform bacteria and who have experience in this area shall collect the samples. These persons include Registered Sanitarians, certified water system operators, well drillers, pump installers, and lab technicians.

Specific instructions for the collection, preservation, handling and transport of the samples may be obtained from certified laboratories, county health departments or the Oregon Health Division and must be strictly adhered to.

(2) The samples must be drawn from the source prior to any form of water treatment. Samples may be collected after treatment injection points where water treatment has been bypassed or temporarily disabled.

(3) In the event that the well has been shock chlorinated, no follow-up samples shall be taken until five days have elapsed.

Please Note: Neilson Research Corporation recommends that no follow-up samples should be taken until all traces of chlorine are gone and then wait 5 to 7 days before re-sampling.



DOMESTIC WELLS

Water Quality Testing

Testing Your Well

More than 500,000 Oregonians get their drinking water from private wells. If you are considering a home with an existing well, here are some things to ask:

Recent Well Test: When a home is sold or transferred, Oregon regulations require homeowners to test domestic well water for nitrate and coliform bacteria. If the test results are satisfactory, taste the water. The water will likely taste different because wells are not chlorinated and have different mineral contents. If you notice an "off" taste, stained fixtures, or lead or copper pipes in the home, you may want to request additional tests.

Water may appear clear and pure, but water from wells or other sources may contain dissolved minerals and other substances. Generally, ground water provides a good supply of safe water, that does not require treatment. If you are a private well owner, you need to test your water supply to insure the well provides safe, high quality water.

With the advice of your county Health Department or Cooperative Extension office, decide what tests are needed for your water supply. After selecting the tests, choose a lab to test the samples. Steps required for taking a water sample will vary for different tests. Timeliness and cleanliness are important when collecting any water sample. Use the sterile collection bottles the lab sends you and not your own bottles to take a sample. Labs often will only accept samples taken in their collection bottles.

Water Testing

Most testing laboratories or services supply their own sample containers. Use the containers provided and carefully follow the instructions given for collecting, preserving, and handling water samples. Samples for coliform bacteria testing must be collected using sterile containers and under sterile conditions. Some procedures require that water runs from an inside tap for several minutes before filling the sample containers. Other instructions ask you to collect samples in the morning after water has been confined in the pipes overnight. Laboratories may sometimes send a trained technician to collect the sample or to analyze the sample directly in your home.

A water sample needs to be submitted to the lab within 48 hours of collection. In some cases it must be kept cold prior to testing. Care must be taken to prevent anything but the water from contacting the inside of the bottle or the cap. Contaminants are often present in small amounts. Careless sampling prevents accurate test results.

You may wish to test during the following circumstances:

- If family members or houseguests have recurrent incidents of gastrointestinal illness
- If an infant is living in the home
- If you are buying a home and wish to assess the safety and quality of the existing water supply

Coliform Bacteria

Coliform bacteria originate as organisms in soil or vegetation and in the intestinal tract of warm-blooded animals (fecal coli). This group of bacteria has long been an indicator of the contamination of water and possible presence of intestinal parasites and pathogens.

The many sources of bacterial pollution include runoff from woodlands, pastures and feedlots; septic tanks and sewage plants; and animals and wild fowl. Domestic animals contribute heavily to the bacterial population. Many coliform bacteria enter natural streams by direct deposition of waste in the water and the runoff from areas with high concentrations of animals or humans.

Surprisingly, the most common source of contamination comes from improper well design and construction, incomplete well development and borehole stability problems. Other likely sources come from where the water is used, the spigot, sink, or unclean containers, backflow from a contaminated source, a sink-top carbon filter, bucket of water, or puddle at the end of a hose. Also, reduced pressure or suction in long water lines, or drawing in soil water at the joints are sources as well.

Most coliforms are harmless residents of soil and will not make people sick. Some strains of E. coli, the most common fecal coliform bacterium (usually living in animal fecal material), may be pathogens. Some found in food have been lethal. Their presence should be taken very seriously.

Your immune system also determines whether or not you will become ill. People become accustomed to the natural bacteria in their water while guests used to other water may have some discomfort or diarrhea. Immuno-compromised individuals may become ill under circumstances where people with normal immune systems would not and such individuals should be cautious of the water they drink.

Pathogenic (disease-producing) organisms occurring in water range from ultra-small viruses to microscopic bacteria to relatively large protozoa (cysts). Basically, three types of pathogenic organisms can affect the safety of water: bacteria, viruses, and protozoa.

Bacteriologic and protozoic pathogens are known to cause typhoid, dysentery, cholera, and some types of gastroenteritis. Conventional wisdom is that contamination of ground water with protozoa indicates surface water influence. Viruses account for more than 100 human maladies including polio, infectious hepatitis, and some forms of gastroenteritis. In general, viruses are more poisonous and more resistant to disinfection than bacteria.

A total coliform (TC) test is usually mandated as a standard of a "safe" water supply. The TC test will not detect the large majority of biofouling organisms or even most bacteria in a well. Once each year, test for coliform bacteria, nitrate, and anything else of concern. It is best to do this during the spring or summer following a rainy period. These tests should also be conducted after repairing or replacing an old well, pump, or pipes, and after installing a new well or pump.

Well Treatment of Bacteria

If treatment is necessary, there are a number of ways of addressing bacteriological concerns. Disinfection is the removal of infectious agents. Disinfection should not be confused with sterilization, which is the complete inactivation of living material. Water and wastewater disinfectants are potent biocides.

The disinfectant concentration and contact time are the prime factors in the inactivation of a microorganism. The product of the concentration and contact time for a specified level of kill (99%) provides a useful term to compare disinfectants and factors affecting microbial inactivation. The contact times for each disinfectant are variable.

Biological contaminants are most effectively eliminated through chlorine disinfection, filtration, ultraviolet irradiation, and ozonation. All methods must be properly designed for the intended use and properly maintained. Additionally, bacterial analysis of the treated water must be made with sufficient frequency to ensure adequate treatment.

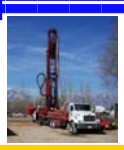
A disinfectant should be effective on many types of pathogens regardless of their quantity and it should be able to kill all pathogens within a reasonable retention time. The chemical should also be safe and easy to handle and it should not make the water toxic or unpalatable. In addition, the concentration of disinfectant in the water should be easy to monitor and the disinfection should provide residual protection against possible recontamination. Lastly, the disinfectant should be readily available at a reasonable cost.

Disinfectant dispersing equipment should also fill several requirements. The equipment should be automatic, require minimal maintenance, and treat all water entering the home. It should also be fail-safe so that no one can unknowingly use or consume untreated water.

Treatment methods include:

- Filtration
- Chlorination
- Ultraviolet irradiation
- Ozonation
- Silver treatment
- Iodination
- Pasteurization

All of these methods require proper maintenance, just as the well and the rest of the water system require regular and proper maintenance and service by a qualified professional.



DOMESTIC WELLS

Treating Your Well For Bacteria

Well Treatment of Bacteria

Many violations of the total coliform bacteria standards have resulted from inadequate disinfection after construction or maintenance work. After replacing or repairing a pump in an existing well, for example, the well water will often be temporarily contaminated with coliform bacteria, which are present in soil, vegetation, and the tools and hands of the maintenance crew.

Since dirt and accompanying bacteria almost always enter the well during maintenance activities, the entire system should be flushed out, disinfected, and sampled for coliforms prior to being put back into service. This is referred to as shock chlorination of the well. Laboratory personnel or a qualified technician from a water testing service can perform this procedure.

All wells recently constructed, repaired or not conforming to the accepted standard of bacteriological purity, should be thoroughly disinfected and sealed before being put into use. The well should be first pumped to remove or lower turbidity to make the disinfecting treatment more effective. Disinfect the well as follows:

1. Chlorinating Agent: Use any of the common household liquid bleaches containing 5% chlorine. For wells producing 10 or more gallons per minute, use 1 cup of granular chlorine (i.e. Swimming pool chlorine).

2. Preparation of Solution: Dilute 1/2 gallon of bleach into 3-5 gallons of water for every 50 feet of well depth. Remove the Vent from the Well Seal and pour the mixture into the well. Make sure the walls of the casing are washed down with the chlorine solution.

3. Solution Circulation: To insure that the chlorine mixture reaches the entire length of the casing, attach a hose to a tap nearest to the well, preferably at the pressure tank, and insert the other end of the hose down into the casing. Turn on the tap and allow the water to circulate for 1/2 hour. Before circulation, ensure the chlorine solution has filled the hose by running until chlorine odor is noted.

Circulate the chlorine mixture through the water lines making certain that every outlet (bathroom sink, tub, kitchen sink, outside taps, etc.) has been opened and chlorinated water allowed to flow through. The system must set at least 8-12 hours without any usage. Then open outlets and allow chlorinated water to be pumped out of the well. Be careful where you pump the chlorinated water. It can kill grass and plants!

After normal usage of the water for at least 5 days, the well should be re-sampled. To protect a well supply from surface contamination, a sanitary ***well Seal*** should be placed on the top of the well. If the sample following the chlorination still shows contamination, please contact the water testing lab to determine what other types of treatment might be necessary.

Nitrates

Nitrates are nitrogen-oxygen chemical units that combine with various organic and inorganic compounds. They are essential nutrients for plants, which absorb them from soil. The excess nitrates not used by the plants are carried through the soil to ground water in a process called "leaching." Once in water, they remain there until used by plants or another organism, or removed by water treatment techniques.

The greatest source of nitrates is fertilizers that are used to provide nitrates to crops. Animal and human waste also contains nitrogen in the form of ammonia. Decomposing plant and animal materials also generate nitrates.

Nitrates are very soluble, and do not bind with soil so the potential is high for them to migrate to ground water. This is especially true if your water well system is near agricultural land or animal feed lots. Incidents such as heavy rains, flooding, chemical spills, or failed sewage systems can cause nitrates to enter soil near your private water well, too.

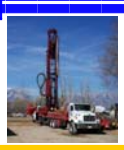
The U.S. Environmental Protection Agency has a maximum contaminant level for nitrates at 10 parts per million. High levels of nitrates can cause health problems, including ***methemoglobinemia,*** commonly known as ***"blue baby syndrome."***

In blue baby syndrome, ***nitrates*** are reduced to ***nitrites*** in an infant's stomach. When the nitrites enter the bloodstream, they interfere with the blood's ability to carry oxygen to body tissues. This can be an acute condition in which the baby's health deteriorates rapidly in a span of a few days. It can cause shortness of breath, increased susceptibility to illness, heart attacks, and even death by asphyxiation. Older children and adults are able to withstand higher levels of nitrates than babies because of stronger stomach acids that kill the bacteria.

However, there have been reports that nitrates could potentially be linked to gastrointestinal cancer. The EPA also says that long-term exposure to water over the maximum contaminant level can cause diuresis (excessive discharge of urine), increased starchy deposits, and hemorrhaging of the spleen.

Nitrates are very soluble, and do not bind with soil so the potential is high for them to migrate to ground water. This is especially true if your water well system is near agricultural land or animal feed lots. Incidents such as heavy rains, flooding, chemical spills, or failed sewage systems can cause nitrates to enter soil near your private water well, too. The one way to know for sure is to have your water tested because nitrates are tasteless and odorless.

Water containing nitrates can be treated by a variety of methods. The EPA has approved certain methods for removing nitrates and nitrites. Methods such as reverse osmosis or a disposable mixed-bed deionizer work best on point-of-use systems (installed in places such as the kitchen sink where water is mostly used for drinking or cooking). Ion exchange, used along with a water softening system, can provide a whole-house solution for nitrate contamination.



DOMESTIC WELLS

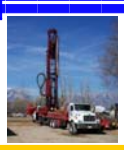
Testing Your Water For Minerals

Common Water Quality Problems

Problem	Cause	Solutions
Hard water (scales/deposits in kettles and water heaters)	Excess calcium	Water softeners* Reverse osmosis Distillation
Rusty (red to brown) staining of fixtures and laundry and/or metallic taste	Excess iron	Chlorination-filtration Greensand filtration Aeration-filtration Distillation Water Softener up to 4 ppm
Black staining of fixtures and laundry and/or metallic taste	Excess manganese	Chlorination-filtration Greensand filtration Aeration-filtration Distillation Water Softener Reverse Osmosis
Rotten egg smell	Hydrogen sulfide	Chlorination-filtration Greensand filtration Aeration-filtration
Water has laxative effect	Excess sulfates	Reverse osmosis Distillation
Turbidity/grittiness	Mud/silt/clay/sediment in water	Sediment filters (change filter) Depth Automatic filters (backwashes in cycles)
Organic (tea) color	Tannins	Chlorination-filtration Ozonation-filtration

Dissolved Minerals

As many as 50 minerals may naturally occur in water but these generally do not cause health problems, since they usually occur in such small amounts. More often they impart undesirable properties such as unpleasant taste, odor or hardness to the water. Some contaminants are living organisms, mainly soil bacteria. The ones which cause the most common odor, taste, smell and discoloration problems are the sulfur, iron and manganese bacteria. Occasionally other types of bacteria, which indicate unsanitary conditions, are present. These may not affect the characteristics of water, but are indicators of the possible presence of disease-causing microorganisms.



DOMESTIC WELLS

Impurities In Your Well Water

Top 20 Water Test®

Though the homeowner is responsible for testing their well for coliform bacteria and nitrates when they sell their home, many homebuyers also want to know what minerals are dissolved in the water. Neilson Research Labs in Medford Oregon, performs a test, called the Top 20, to detail the various concentrations of 20 different dissolved minerals in your well water. Some are hazardous, even in small concentrations. The 20 items tested include 14 trace metals—Aluminum, Arsenic, Barium, Boron, Cadmium, Calcium, Copper, Iron, Lead, Lithium, Manganese, Magnesium, Sodium, Zinc; 4 nutrients—Chloride, Fluoride, Nitrate, Sulfate; and 3 Physical Parameters—Specific Conductivity, Hardness and pH. ***The Top 20 is a registered trademark of Neilson Research Labs, Inc.***

Aluminum

Aluminum, the most abundant metal on Earth, is found in soil, in water and in air. Its chemical and physical properties make it ideal for a wide variety of uses. For example, aluminum and its compounds are often used in food as additives, in drugs (e.g., antacids), in consumer products (e.g., cooking utensils, anti-perspirant and aluminum foil) and in the treatment of drinking water (e.g., coagulants).

Because aluminum is so pervasive in the environment, to the point of being unavoidable, researchers have long been studying its effects on humans. This research has revealed a link between aluminum intake and neurological dementia in kidney dialysis patients (dialysis encephalopathy). In recent years, the public and the media have become concerned about other possible adverse effects of aluminum on human health, including its role in Alzheimer's disease, Parkinson's disease and amyotrophic lateral sclerosis (Lou Gehrig's disease). In addition, questions have been raised about the potential risks to infants who drink baby formula containing aluminum.

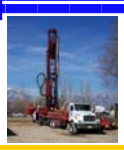
Arsenic

Most arsenic enters water supplies either from natural deposits in the earth or from industrial and agricultural pollution. Arsenic is a natural element of the earth's crust. It is used in industry and agriculture, and for other purposes. It also is a byproduct of copper smelting, mining and coal burning. U.S. industries release thousands of pounds of arsenic into the environment every year.

According to a 1999 study by the National Academy of Sciences, arsenic in drinking water causes bladder, lung and skin cancer, and may cause kidney and liver cancer. The study also found that arsenic harms the central and peripheral nervous systems, as well as heart and blood vessels, and causes serious skin problems. It also may cause birth defects and reproductive problems.

Barium

Barium is a lustrous, machinable metal which exists in nature only in ores containing mixtures of elements. It is used in making a wide variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In particular, it is used in well drilling operations where it is directly released into the ground. Short-term: EPA has found barium to potentially cause the following health effects when people are exposed to it at levels above 2 ppm for relatively short periods of time: gastro-intestinal disturbances and muscular weakness. Long-term: Barium has the potential to cause high blood pressure from a lifetime exposure at levels above the MCL.



DOMESTIC WELLS

Impurities In Your Well Water

Boron

Boron is a naturally occurring element. In the environment, boron is combined with oxygen and other elements in compounds called borates. Borates are widely found in nature, and are present in oceans, sedimentary rocks, coal, shale and some soils. There are several commercially important borates, including borax, and boric acid, and have many industrial uses in glass making, leather preservation, in welding and fertilizers.

Everyone is exposed regularly to small amounts of boron in food. Generally the amounts pose no harm because boron is regularly excreted in feces and urine over a period of several days. Children and infants on which boron compounds are used for medication can become acutely ill with nausea, vomiting, diarrhea, circulatory collapse, skin rash and confusion. Fatal poisonings often involve kidney failure.

It is beneficial to plants only within narrow limits, and excesses are injurious and even lethal to plants. Regular use of irrigation water with more than 1 ppm boron is harmful to most kinds of plants.

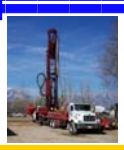
Cadmium

Cadmium is released into the environment from mining and metal processing operations, burning fuels, making and using phosphate fertilizers, and disposing of metal products**.** Cadmium is not mined, but it is a by-product of the smelting of other metals such as zinc, lead, and copper. Cadmium is used in nickel-cadmium rechargeable batteries and for metal plating. It also is used in some paints, plastics, and metal solders.

Cadmium is found naturally in small quantities in air, water, and soil. Since cadmium is a metal, it does not break down and can accumulate over time. Burning household or industrial waste and burning coal or oil may release cadmium into the air. Cadmium can enter the body from smoking tobacco, eating food and drinking water containing cadmium, and inhaling it from the air.

Cadmium has no beneficial effect on human health. Health effects caused by cadmium depend on how much has entered the body, how long you have been exposed to cadmium, and how the body responds. Some workers who breathe air with high levels of cadmium over a short time experience lung damage and even death. Breathing cadmium in air does not usually cause immediate breathing problems or any warning signs. Therefore, exposure may continue until serious lung damage has occurred.

Most cadmium levels found in the environment are not high enough to cause lung damage. Breathing lower levels of cadmium over several years can result in a buildup of cadmium in the kidneys and lead to kidney disease. It also can cause bones to become weaker. If you eat food or drink water that contains large amounts of cadmium, stomach irritation, vomiting, and diarrhea may result. Small amounts of cadmium taken in over many years may cause kidney damage and fragile bones.



DOMESTIC WELLS

Impurities In Your Well Water

Chlorine

The experimental use of chlorine began in the 1890's to combat water-borne diseases such as cholera and typhoid. It quickly gained wide acceptance because of low cost and high efficiency in killing just about everything hazardous in the water. Chlorine allowed population centers to spring up and thrive without any epidemic outbreaks.

The problem with chlorine is that it is a known poison and the safety of drinking this poison over the long term (i.e. your lifetime) is highly uncertain. Also, chlorine reacts with water-borne decaying organic matter like leaves, bark, sediment, etc. to create a family of chemicals called trihalomethanes and other highly toxic substances. Trihalomethanes, or THM's, include chemicals such as chloroform, bromoform and dichlorobromethane, all of which are extremely carcinogenic even in minute amounts.

If you are on a municipal system with chlorination, theoretically you are protected against bacteria. However, if the level of chlorination isn't high enough from the municipal source to your tap, bacteria can re-infect the water anywhere along the distribution system. The piping system -- whether it's the public water mains or your house plumbing -- has bacterial growth in it happening all the time.

If you are on a spring or a well, with no chlorine, then you are very vulnerable to bacterial contamination. Even the most pure sources cannot prevent occasional contamination from animals either dying or defecating in the source, or from neighboring pollution (i.e. septic tanks) traveling from an adjoining watershed to contaminate the source. Also, the pipes are again a source of bacteria. Many people do periodic testing on their well or spring source and rely on this method to assure themselves that they have good water.

Copper

Copper rarely occurs naturally in water. Most copper contamination in drinking water happens in the water delivery system, as a result of corrosion of the copper pipes or fittings. Copper piping and fittings are widely used in household plumbing. Generally, naturally soft water is more corrosive than hard water because it is more acidic and has low TDS.

At very high levels, copper can cause a bitter metallic taste in water and result in blue-green stains on plumbing fixtures. At low levels, copper in drinking water may cause no health symptoms. At high levels, copper in drinking water may cause symptoms easily mistaken as flu or other illnesses. Thus health symptoms are not a reliable indication of copper in drinking water.

Although copper is an essential micronutrient and is required by the body in very small amounts, excess copper in the human body can cause stomach and intestinal distress such as nausea, vomiting, diarrhea and stomach cramps. The lowest level at which these adverse effects occur has not been well defined. People with Wilson's disease, a rare genetic disorder, are more sensitive to the effects of copper.

DOMESTIC WELLS

Impurities In Your Well Water

Fluoride

Waters with high fluoride content are found mostly in calcium-deficient waters in many basement aquifers, such as *granite and gneiss*, in geothermal waters and in some sedimentary basins. Fluorides in water can be detrimental or beneficial. It all depends on the concentration. Surface water supplies are normally low in fluorides (less than 0.5 ppm). Some have no fluoride at all. Well waters may contain excessive amounts of fluoride. There are some wells which contain the recommended amount (1 mg/L) for drinking water.

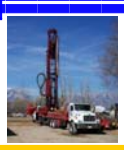
Fluorides are important because they have a definite relation to dental health. Research has shown that a concentration of 1 mg/L of fluoride in drinking water reduces tooth decay. On the other hand, some children under nine years of age exposed to levels of fluoride greater than about 2 mg/L may develop a condition known as "endemic dental fluorosis." Sometimes called "Colorado Brown Stain," this condition appears as a dark brown mottling or spotting of the permanent teeth. In certain cases, the teeth become chalky white in appearance. Further, federal regulations require that fluoride not exceed a concentration of 4 mg/L in drinking water. This is an enforceable maximum contaminant level standard, and it has been established to protect public health. Exposure to drinking water levels above 4 mg/L for many years may result in cases of crippling skeletal fluorosis, which is a serious bone disorder.

Lead

Lead rarely occurs naturally in water. Most lead contamination takes place at some point in the water delivery system. Lead pipes and lead solder in the distribution system are the main sources of lead pollution. Boston Globe estimates that 98% of all households have lead in their plumbing. Houses older than 20 years and less than five years are most at risk. Also, houses in areas of soft (low mineral levels) water tend to corrode the lead from the pipes more easily.

Lead is a cumulative toxin that stays in the tissue permanently, especially in brain tissue. It also affects a person in relation to their body weight. Therefore, an exposed adult can fend off the toxic effects for some time but in children, brain and developmental damage occur quickly and permanently.

Exposure to low levels of lead over an extended period of time can have severe health effects. Too much lead can damage your brain, kidneys, nervous system, and red blood cells. Those at the greatest risk, even with short-term exposure, are young children and pregnant women. According to the U.S. Environmental Protection Agency (EPA), lead dosage that would have little effect on an adult can harm a small child. Lead in drinking water can be a problem for infants whose diet consists of liquids--such as baby formula made with water. Since they are growing, children absorb lead more rapidly than adults. That lead can then impair a child's development, resulting in learning disabilities or stunted growth.



DOMESTIC WELLS

Impurities In Your Well Water

Magnesium

Magnesium is present in all natural waters and enters the groundwater the same way as calcium by contact with rock formations. Magnesium is associated with calcium and is also a major contributor to hardness. As well, magnesium may contribute to undesirable tastes in your water if the concentration is high. When present in water with sulfates, magnesium may have a laxative effect or cause gastrointestinal irritation.

Manganese

Manganese is a mineral that naturally occurs in rocks and soil and is a normal constituent of the human diet. It exists in well water as a groundwater mineral, but may also be present due to underground pollution sources. You may suspect that manganese is in your water if the water is discolored (brownish-red), causes staining of plumbing fixtures or clothing or has an off-taste or odor. Exposure to high concentrations of manganese over the course of years has been associated with toxicity to the nervous system, producing a syndrome that resembles Parkinson Disease.

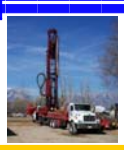
Sodium

Sodium is a naturally occurring mineral which is found in water sources. While sodium is not regulated as a contaminant in drinking water, it may have an effect on the consumer's health. In general, the sodium contributed to an individual's diet from drinking water is a small part of overall dietary intake. The American Heart Association's recommended standard for daily sodium intake is 3,000 milligrams. Persons on severely restricted sodium diets may want to consult their health professional regarding sodium levels in water. Water softeners can add sodium to your household water supply as well.

Zinc

Although zinc occurs naturally, most zinc finds its way into the environment because of human activities. Mining, smelting metals (like zinc, lead and cadmium) and steel production, as well as burning coal and certain wastes can release zinc into the environment. Zinc is frequently used as a protection to “galvanize” steel. When high levels of zinc are present in soils, such as at a hazardous waste site, the metal can seep into the groundwater. Zinc can enter the body if you eat foods or drink water or other beverages containing zinc, or if you breathe zinc dust or fumes from the air. Very small amounts of zinc enter the body through skin contact. Foods naturally contain zinc but vary greatly in their zinc content. Very small amounts of the zinc in food are absorbed by the body. Drinking beverages stored in metal cans or drinking water that flows through metal pipes coated with zinc also are sources of zinc exposure.

Zinc is an essential nutrient needed by the body for growth, development of bones, metabolism and wound-healing. Too little zinc in the diet also can cause adverse health effects such as loss of appetite, decreased sense of taste and smell, lowered ability to fight off infections, slow growth, slow wound-healing and skin sores.



DOMESTIC WELLS

Impurities In Your Well Water

Health Concerns on Dissolved Minerals

Eating or drinking too much zinc in a short period of time can lead to adverse health effects, such as stomach cramps, nausea and vomiting. Eating large amounts of zinc for longer periods may cause anemia, nervous system disorders, damage to the pancreas and lowered levels of "good" cholesterol. There is no evidence that zinc causes cancer in humans.

Asbestos

Asbestos is another potential carcinogen that can come either from water with naturally occurring asbestos (such as in areas that have a lot of serpentine rock) or from asbestos-lined water pipes. Thousands of miles of these pipes were laid throughout the U.S. in the 1950's and have yet to be replaced. Asbestos is so small that it is infeasible to remove it at the water treatment plant. To build such a removal facility is prohibitively expensive and would clog up the plant within five years of being in operation.

Chemicals

Chemicals are, for the most part, odorless, colorless and tasteless, therefore undetectable. Chlorine is the most predominant chemical in our water. Some of the most dangerous chemicals are present only in trace amounts (parts per billion) but highly toxic even at these minute levels. Sources are usually industrial or commercial, like leaking underground storage tanks for gasoline or industrial solvents such as TCE (trichloroethane). These leaking toxins end up in the ground water or in the municipal supply through breaks or cracks in the main water pipes. The biggest family of these toxics are VOC's or volatile organic contaminants, including various plastics, gasolines and petroleum products.

Next is the herbicidal group such as dioxin (2-4D) and lindane, used as a defoliant in modern logging operations and found in many wild and rural areas. Along with the herbicides come the pesticidal group such as DDT, malathione and other toxics used in insect eradication and control.

Parasites

This last group includes microscopic worms, parasites and protozoa. The biggest offenders are ***giardia*** and ***cryptosporidia*** which cause major diarrhea, dehydration, intestinal disorders and even death in people with compromised immune systems. Water experts estimate that over 63% of water problems in the Unites States today are directly caused by giardia and cryptosporidia.

Giardia is seven to fourteen microns in size and cryptosporidium is from three to 5 microns in size. When the environment becomes inhospitable (like the presence of chlorine or the absence of water), both parasites can go into the cystic form (like a hard, round impermeable microscopic egg). The cyst form is chlorine resistant and very hard to kill.

Municipal utilities are unable to completely remove these cysts. Cysts have been found in most major municipal water systems in the U.S. San Francisco, California has repeatedly tested positive for giardia in its chlorinated water that has traveled hundreds of miles from the Sierras.

Water Hardness

Water described as "hard" is high in dissolved minerals, specifically calcium and magnesium. Hard water is not a health risk, but a nuisance because of mineral buildup on plumbing fixtures and poor soap and/or detergent performance.

Water is a good solvent and picks up impurities easily. Pure water - tasteless, colorless, and odorless - is often called the universal solvent. When water is combined with carbon dioxide to form very weak carbonic acid, an even better solvent results. As water moves through soil and rock, it dissolves very small amounts of minerals and holds them in solution. Calcium and magnesium dissolved in water are the two most common minerals that make water "hard." The degree of hardness becomes greater as the calcium and magnesium content increases.

Living With Hard Water

Hard water interferes with almost every cleaning task, from laundering and dishwashing to bathing and personal grooming. Clothes laundered in hard water may look dingy and feel harsh and scratchy. Dishes and glasses may be spotted when dry. Hard water may cause a film on glass shower doors, shower walls, bathtubs, sinks, faucets, etc. Hair washed in hard water may feel sticky and look dull. Water flow may be reduced by hard water deposits in pipes.

Dealing with hard water problems in the home can be a nuisance. The amount of hardness minerals in water affects the amount of soap and detergent necessary for cleaning. Soap used in hard water combines with the minerals to form a sticky soap curd. Some synthetic detergents are less effective in hard water because the active ingredient is partially inactivated by hardness, even though it stays dissolved.

Bathing with soap in hard water leaves a film of sticky soap curd on the skin. The film may prevent removal of soil and bacteria. Soap curd interferes with the return of skin to its normal, slightly acid condition, and may lead to irritation. Soap curd on hair may make it dull, lifeless and difficult to manage.

When doing laundry in hard water, soap curds lodge in fabric during washing to make fabric stiff and rough. Incomplete soil removal from laundry causes graying of white fabric and the loss of brightness in colors. A sour odor can develop in clothes. Continuous laundering in hard water can shorten the life of clothes. In addition, soap curds can deposit on dishes, bathtubs and showers, and all water and plumbing fixtures.

Hard water also contributes to inefficient and costly operation of water-using appliances. Heated hard water forms a scale of calcium and magnesium minerals that can contribute to the inefficient operation or failure of water-using appliances. Pipes can become clogged with scale that reduces water flow and ultimately requires pipe replacement.

Water Hardness

Potential Health Effects of Water Hardness

Hard water is not a health hazard. In fact, the National Research Council (National Academy of Sciences) states that hard drinking water generally contributes a small amount toward total calcium and magnesium human dietary needs. They further state that in some instances, where dissolved calcium and magnesium are very high, water could be a major contributor of calcium and magnesium to the diet. Much research has been done on the relationship between water hardness and cardiovascular disease mortality. Numerous studies suggest a correlation between hard water and lower cardiovascular disease mortality. The National Research Council has recommended further studies on this relationship.

Hard water treated with an ion exchange water softener has sodium added. According to the Water Quality Association (WQA) the ion exchange softening process adds sodium at the rate of about 8 mg/liter for each grain of hardness removed per gallon of water. For example, if water has a hardness of 10 grains per gallon, it will contain about 80 mg/liter of sodium after being softened with an ion exchange softener if all hardness minerals are removed. Because of the sodium content of softened water and potential benefits of drinking hard water, some individuals may be advised by their physician not to install water softeners, to soften only hot water, or to bypass the water softener with a cold water line (usually to a separate faucet at the kitchen sink) or to install a reverse osmosis system to provide water for drinking and cooking.

Testing For Hardness

Many companies that sell water treatment equipment offer hardness tests. When using these water tests, be certain you understand the nature of the test, the water condition being measured, and the significance of the test results.

An approximate estimate of water hardness can be obtained without the aid of outside testing facilities. Water hardness testing kits are available for purchase. If more accurate measurements are needed, obtain a laboratory test.

Classification of water hardness (hardness as calcium carbonate).

Classification	mg/l or ppm	grains/gal
Soft	0 - 17.1	0 - 1
Slightly hard	17.1 - 60	1 - 3.5
Moderate hard	60 - 120	3.5 - 7.0
Hard	120 - 180	7.0 - 10.5
Very Hard	180 & over	10.5 & over

The severity of hardness is measured by grains (of mineral) per gallon (GPG) or, in some cases, by parts per million (PPM). These two measurements are related: 17.1 PPM equals 1 GPG. Technically, any water that contains more than 1 GPG of dissolved hardness minerals is considered hard, but realistically, water with from 0 to 3.5 GPG is relatively soft. Water with more than 10.5 GPG is very hard. Between those extremes is typical, moderately hard water.

The Table above, adapted from the Water Quality Association (WQA), shows hardness classifications. Hardness ions are typically combined with sulfate, chloride, carbonate, or bicarbonate ions. For consistency, concentrations are generally converted to the equivalent concentration as calcium carbonate and expressed in terms of hardness as calcium carbonate.

Water Hardness

The Environmental Protection Agency (EPA) establishes standards for drinking water which fall into two categories - Primary Standards and Secondary Standards. Primary Standards are based on health considerations and Secondary Standards are based on taste, odor, color, corrosivity, foaming, and staining properties of water. There is no Primary or Secondary standard for water hardness.

Controlling Water Hardness

There are two ways to help control water hardness; add a packaged or liquid softener to a batch of water (washing machine or tub), or use an ion exchange water softening unit. Powdered or liquid water softeners are chemicals that help control water hardness. They fall into two categories: precipitating and non-precipitating.

Precipitating water softeners include washing soda and borax. These products form an insoluble precipitate with calcium and magnesium ions. The mineral ions then cannot interfere with cleaning efficiency, but the precipitate makes water cloudy and can build up on surfaces. Precipitating water softeners increase alkalinity of the cleaning solution and this may damage skin and other materials being cleaned.

Non-precipitating water softeners use complex phosphates to sequester calcium and magnesium ions. There is no precipitate to form deposits and alkalinity is not increased. If used in enough quantity, non-precipitating water softeners will help dissolve soap curd for a period of time. Ion exchange water softening units can be permanently installed into the plumbing system to continuously remove calcium and magnesium.

Installing a Water Softener

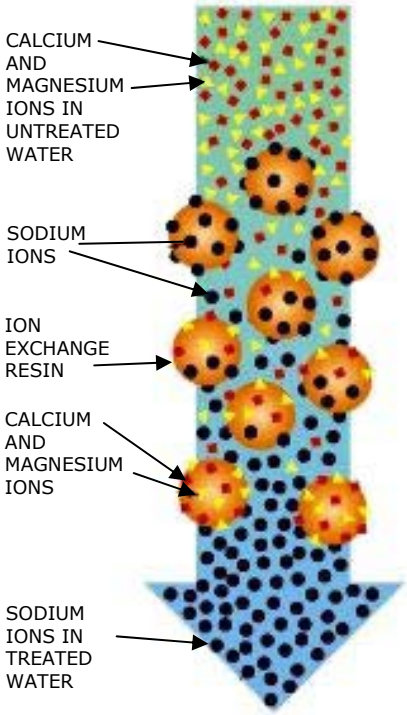
Water softeners operate on the ion exchange process. In this process, water passes through a media bed, usually sulfonated polystyrene beads. The beads are supersaturated with sodium.

The ion exchange process takes place as hard water passes through the softening material. The hardness minerals attach themselves to the resin beads while sodium on the resin beads is released simultaneously into the water.

When the resin becomes saturated with calcium and magnesium, it must be recharged. The recharging is done by passing a salt (brine) solution through the resin. The sodium replaces the calcium and magnesium which are discharged in the waste water.

Softened water is not recommended for watering plants, lawns, and gardens due to its sodium content. Although not commonly used, potassium chloride can be used to create the salt brine. In that case potassium rather than sodium is exchanged with calcium and magnesium.

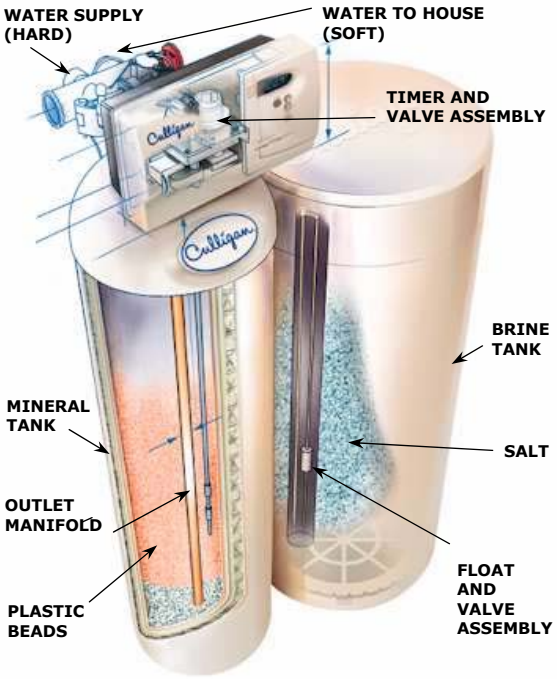
Culligan Water Conditioning



Installing a Water Softener

Softening Water

Before selecting an ion exchange water softener, test water for hardness and iron content. When selecting a water softener, the regeneration control system, the hardness removal capacity, and the iron limitations are three important elements to consider.



There are three common regeneration control systems. These include a ***time-clock control*** (you program the clock to regenerate on a fixed schedule); ***hardness sensor control*** (sensor detects hardness of the water leaving the unit, and signals softener when regeneration is needed), and ***water meter control*** (regenerates after a fixed amount of water has passed through the softener). This is the most efficient and least wasteful use of water in regeneration.

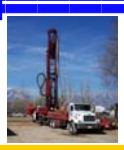
Hardness removal capacity, between regenerations, will vary with units. Softeners with small capacities must regenerate more often. Your daily softening need depends on the amount of water used daily in your household and the hardness of your water. To determine your daily hardness removal need, multiply daily household water use (measured in gallons) by the hardness of the water (measured in grains per gallon). ***Example:*** 400 gallons used per day X 15 grains per gallon hardness = 6,000 grains of hardness must be removed daily.

Iron removal limitations will vary with water softener units. If the iron level in your water exceeds the maximum iron removal capacity recommended by the manufacturer of the unit you are considering, iron may foul the softener, eventually causing it to become plugged. If the manufacturer does not identify an iron removal capacity, assume the capacity to be zero.

Slippery Soft Skin

Many customers who have water softeners installed in their houses notice that their skin feels "slippery" after a bath. Some customers say, "My water is too soft! I can't rinse the soap off!" This reaction is normal for new soft water customers. What causes that slippery feeling? Clean skin!

Hard water leaves an insoluble soap-curd film on you, causing your hair and skin to "squeak". You "squeaked" with hard water because there was an invisible hard water soap scum film on your hair and skin, causing your skin, scalp and hair to really be overly dry. This is bad for skin and hair. Soap scum film builds up on hair, weighting it down and making it brittle and lifeless. Soap scum film on skin makes our skin dry and itchy. Here is one way you can prove this to yourself. Notice that hard water leaves a bathtub ring and soft water does not. That hard water bath tub ring is made of scummy, "gooky stuff" that sticks to the tub.



DOMESTIC WELLS

Effects of pH in Your Water

Effects of pH on Water

The pH level of your drinking water reflects how acidic it is. pH stands for "potential hydrogen", referring to the amount of hydrogen mixed with the water. pH is measured on a scale that runs from 0-14. A measurement below 7 indicates acid is present and a measurement above 7 indicates alkalinity. Seven is neutral.

The normal range for pH in ground water lies between 6 and 8.5. By comparison, vinegar measures 3 pH, beer measures between 4 and 5, while milk measures around 6.4.

Water with a low pH can be acidic, soft or corrosive. This water can leach metals from pipes and fixtures, such as copper, iron, lead, manganese and zinc. It can also cause damage to metal pipes and aesthetic problems, such as a metallic or sour taste, laundry staining or blue-green stains in sinks and drains. Water that contains elevated levels of toxic metals could also show a low pH level.

Alkaline in Your Water

Drinking water with a pH level above 8.5 could indicate that the water is hard. Hardness does not pose a health risk, but can cause aesthetic problems, such as an alkali taste to the water that makes coffee taste bitter; build-up of scale on pipes and fixtures that can lead to lower water pressure; build up deposits on dishes, utensils and laundry basins; difficulty in getting soap and detergent to foam; and lowered efficiency of electric water heaters.

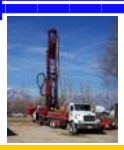
Health Effects of pH

The U.S. Environmental Protection Agency (EPA) does not regulate the pH level in drinking water. It is classified as a secondary drinking water contaminant whose impact is considered aesthetic. However, the EPA recommends that public water systems maintain pH levels of between 6.5 and 8.5, a good guide for individual well owners.

To test your well water's pH, contact your local health department for a list of state-certified laboratories that can test the pH level. If it is acidic, you may have problems with leaching of copper and lead from your plumbing. Consider testing for lead if pH test shows your water is highly acidic.

Treat the problem of acidic, low pH drinking water with a neutralizer. The neutralizer feeds a solution, typically using soda ash, into the water to prevent the water from reacting with the house plumbing or contributing to corrosion, which can leach metals into the water. Note however that neutralizing with soda ash increases sodium content of the water, which may pose additional health concerns for your household.

Treat hard water yielding a high pH with an ion-exchange system (softener) or the addition of a lime-soda ash mixture. These processes also can increase the sodium content of the water.



DOMESTIC WELLS

Water Chemistry Summary

Water Chemistry Analysis Summary

Aluminum: ***Federal Limit: 0.05 - 0.2 mg/L. Highest Value Found: 16.3 mg/L.*** EPA recommends that the concentration of aluminum in drinking water not exceed 0.2 mg/L because of aesthetic effects, such as taste and odor problems.

Arsenic: ***Federal Limit: 0.010 - 0.050 mg/L – Highest Value Found: 3.88 mg/L.*** The current EPA limit for Arsenic is 0.010 mg/L. Symptoms of arsenic poisoning include weight loss, nausea, diarrhea, hair loss, depression, tiredness, and intestinal upsets. Long term effects are circulatory diseases, skin and other cancers.

Barium: ***Federal Limit: 2 mg/L. EPA has established a limit of 2 mg/L in drinking water.***

Boron: ***Federal Limit: No maximum drinking water limit, EPA is considering 0.6 mg/L. Highest Value Found: 179 mg/L.*** The recommend limits for agriculture is 1 - 4 mg/L. Boron is included in this package because it is exceptionally toxic to plants and is commonly requested by homeowners. Plants can tolerate from 1.0 to 4.0 mg/L. If you have problems with growing plants, it could be the water and not your green thumb!

Cadmium: ***Federal Limit: 0.005 mg/L.*** Symptoms of cadmium poisoning include cramps, nausea, vomiting and diarrhea. Long term exposure to lower levels of cadmium leads to kidney disease, lung damage and fragile bones. Cadmium can get into the water by corrosion of some types of galvanized piping, or by improper disposal of wastes from households, industries, and automotive repairs.

Calcium and Magnesium: ***No Federal Limits.*** They are essential nutritional elements. Calcium and Magnesium is commonly requested by homeowners. It is used to calculate Hardness.

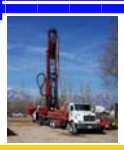
Chloride: ***Federal Limit: 250 mg/L – Highest Value Found: 6,700 mg/L.*** Homeowners with a chloride level of 100 mg/L or more may complain of a salty taste after the installation of a softener.

Conductivity: ***No Federal Limits - Highest Found: 24,500.*** The information from this test is used to give an approximate determination of an amount of dissolved minerals in the water supply.

Copper: ***Federal Limit: 1.0 mg/L with an Action Level at 1.3 mg/L for Public Water Systems. Highest Value Found: 5.27 mg/L.*** Can cause staining of fixtures, hair and fabrics. Also imparts a bitter taste to water. At high levels can cause stomach irritation and vomiting.

Fluoride: ***Federal Limit: 4 mg/L. Oregon limit 2.0 mg/L: - Highest Value Found: 15.56 mg/L.*** Long term effects are a permanent brown staining of the teeth, destruction of tooth enamel, brittle and easily broken bones, painful and stiff joints.

Hardness: ***Federal Limit: 250 mg/L – Highest Value Found: 5,000 mg/L.*** The term "hardness" is applied to the soap-neutralizing power of water. Hardness is usually attributed to the calcium and magnesium ions. These ions combine with soap to form an insoluble precipitate often seen as scum on the water and a ring around the bathtub. Iron and manganese can also contribute to the hardness.



DOMESTIC WELLS

Water Chemistry Summary

Water Chemistry Analysis Summary

***Iron:* Federal Limit: 0.3 mg/L – Highest Value Found: 88.07 mg/L.** This is a common problem. In the aquifer (water bearing stratum) iron is usually present in the reduced form because of the absence of oxygen. In this form, iron is soluble in water and is not visible. However, when the iron comes in contact with oxygen, it oxidizes to the visible reddish compound that settles out as rust-like material which stains clothing and fixtures.

***Lead:* Federal Limit: 0.015 mg/L (Action Level) – Highest Value Found: 3.1 mg/L.** This is a very protective standard and is aimed at protecting pregnant women and small children. Public water systems found to have levels of lead above this standard are required to install corrosion control treatment to reduce the aggressiveness of the water, preventing or reducing the leaching of lead into the water

***Lithium:* No Federal Limit.** Occurs naturally in Southern Oregon and is currently being monitored by Neilson Research Corporation.

***Manganese:* Federal Limit: 0.05 mg/L – Highest Value Found: 11.4 mg/L.** The chemistry of manganese in water is identical to that of iron, with the exception that manganese produces a brownish, rather than a red discoloration. In addition, a high level of manganese produces a very unpleasant odor/taste in water. High levels of manganese are toxic to expectant mothers and children

***Nitrate:* Federal Limit: 10.0 mg/L – Highest Value Found: 48.74 mg/L.** This chemical effects infants under the age of 6-9 months. In this age group nitrates reduce the blood's ability to carry oxygen and may cause death or permanent brain damage to the child. High nitrate levels also cause gastric and stomach cancers.

***pH:* Federal Limit: 6.5-8.5 pH Units – Range Found: 4.78 -11.4 pH Units.** The ideal pH for drinking water is 7.5. When pH is below 7.0, the water is acidic and can cause corrosion of pipes and fixtures. When the pH is higher than 8.0, the water is alkaline. This can create mineral deposits on the interior surfaces of pipes and the water will have a slippery feeling.

***Sodium:* No Federal Limit: Advisory limit of 20 mg/L for those individuals on a 500 mg/day medical restriction.** Highest Natural Value Found: 2,841 mg/L. There is not an enforceable limit on sodium. If the sodium level approaches 100 mg/L and the chloride level is near 100 mg/L, individuals may notice a salty taste to the water. These levels also effect plant growth.

***Sulfate:* Federal Limit: 250 mg/L - Highest Value Found: 1630 mg/L.** Sulfate is a substance that occurs naturally. Diarrhea may be associated with the ingestion of high levels of sulfate.

***Zinc:* Federal Limit: 5.0 mg/L – Highest Value Found: 32.3 mg/L.** Gives the water a metallic taste. Can cause a greasy film on boiling. High levels give water a milky appearance. Zinc bearing water should not be used in acid drinks like lemonade because zinc citrate and other organic zinc compounds that will result may be poisonous.

Neilson Research Corporation

Water Filtration Systems

The process of filtration involves the flow of water through a granular bed of sand or another suitable media, at a low speed. The media retains most solid matter while permitting the water to pass. The process of filtration is usually repeated to ensure adequate removal of unwanted particles in the water. On a very simple basis, Filter Systems are classified by the amount and type of media or resin they hold, measured in cubic feet, and the flow rate of water. The amount of resin/media determines the capacity or size of the system while the type determines the water characteristic being eliminated.

Activated Carbon Filters

Activated carbon filtration is very common in a number of home water treatment systems to reduce or eliminate bad tastes and odors, chlorine, and many organic contaminants.

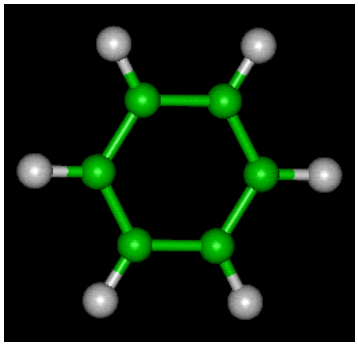
Carbon is a substance that has a long history of being used to absorb impurities and is perhaps the most powerful absorbent known to man. One pound of carbon contains a surface area of roughly 125 acres and can absorb literally thousands of different chemicals. Activated carbon is carbon which has a slight electro-positive charge added to it, making it even more attractive to chemicals and impurities. As the water passes over the positively charged carbon surface, the negative ions of the contaminants are drawn to the surface of the carbon granules.

Activated carbon filters used for home water treatment typically contain either granular activated carbon (GAC) or powdered block carbon. Although both are effective, carbon block filters generally have a higher contaminant removal ratio. The two most important factors affecting the efficiency of activated carbon filtration are the amount of carbon in the unit and the amount of time the contaminant spends in contact with it. The more carbon the better. Similarly, the lower the flow rate of the water, the more time that contaminants will be in contact with the carbon, and the more absorption that will take place. Particle size also affects removal rates.

Activated carbon filters are usually rated by the size of the particles they are able to remove, measured in microns, and generally range from 50 microns (least effective) down to 0.5 microns (most effective). Very fine 0.5 micron carbon block filters are commonly used to remove cysts such as ***giardia*** and ***cryptosporidium.***

A typical counter-top or under-the-counter filter system has from 12 to 24 ounces of activated carbon. The most common carbon types used in water filtration are bituminous, wood, and coconut shell carbons. While coconut shell carbon typically costs 20% more than the others, it is generally regarded as the most effective of the three.

Activated Carbon Filters



There are two principal mechanisms by which activated carbon removes contaminants from water; ***absorption***, and ***catalytic reduction***. Organic compounds are removed by absorption. Catalytic reduction involves the attraction of negatively-charged contaminant ions to the positively-charged activated carbon. Residual disinfectants such as chlorine and chloramines are removed by catalytic reduction.

Activated carbon filters remove/reduce many ***volatile organic chemicals (VOC),*** pesticides and herbicides, as well as chlorine, benzene, radon trihalomethane (THM) compounds, solvents and hundreds of other man-made chemicals found in tap water. Some activated carbon filters are moderately effective at removing some, but not all, heavy metals.

Although some iron, manganese, and hydrogen sulfide will be removed by these higher quality activated carbon filters, a manganese greensand iron reduction filter is generally preferred to remove these contaminants as the effectiveness of carbon filter against iron and manganese is generally short-lived if the contaminant concentration is high.

Carbon filters are NOT generally successful at removing dissolved inorganic contaminants or metals such as minerals/salts (hardness or scale-causing contaminants), antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, copper, fluoride, mercury, nickel, nitrates/nitrites, selenium, sulfate, thallium, and certain radio nuclides. Removing these contaminants requires either a reverse osmosis water filter system or a distiller.

Granulated Activated Charcoal (GAC) does not remove sediment / particulate material very well, so they are often preceded by a sediment filter. Sediment pre-filters also prolong the activated carbon cartridge life by eliminating gross contaminants that would otherwise clog the activated carbon thereby reducing the surface area available for absorption. Carbon block filters are generally better then GAC filters at removing sediment. The use of a carbon filter is also very commonly used as a pre-treatment as part of a reverse osmosis system to reduce the many organic contaminants that could foul the reverse osmosis membrane.

Sediment Removal Filters

A cartridge sediment filter removes suspended material such as sand grains, silt, loose scale, rust flakes, clay particles or organic material from the water. These materials can be the cause of turbidity or cloudiness in the water. When water contains sediment, it races through pipes like liquid sandpaper, grinding away at pumps, glassware, appliances, fixtures, valves and sprinklers systems.

Sediment filters often are used in combination with another drinking water treatment method for removal of contaminants such as dissolved iron, manganese or hydrogen sulfide through such processes as aeration, ozonation or chlorination. These treatments oxidize dissolved iron, manganese or hydrogen sulfide into solid particles that the filter then traps. Sediment filters are also used as pre-treatment for other processes such as activated carbon (AC) filtration and reverse osmosis (RO) in order to increase their effectiveness.

Sediment Removal Filters

No one piece of treatment equipment manages all contaminants.
All treatment methods have limitations and often situations require a combination of treatment processes to effectively treat the water. Sediment filters alone do not effectively remove dissolved organic or inorganic material that may be harmful. They do not effectively remove nitrate, heavy metals, pesticides or trihalomethanes (by-products sometimes formed during drinking water chlorination). Cartridge sediment filters are not generally recommended for removing microbial contaminants. However, sediment filters can remove insoluble (not dissolvable) or suspended iron and manganese.

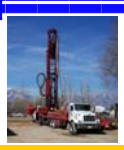
Cartridge sediment filters are generally Point-of-Use (POU) devices that can be installed under the sink, attached to a tap, or used as a pre-filter for other water treatment processes to increase their effectiveness and longevity. Where sediment may be an issue with water-using appliances such as washing machines, dishwashers or hot water heaters, sediment filters may be Point-of-Entry (POE) devices that treat all water at its entry point into the home. In this situation POE media filters or multimedia filters are often used.

Sediment filters work like the oil filter in your car. The filters consist of a housing, usually plastic, surrounding the filter medium. Filter material may be paper, ceramic, polypropylene, string, spun cellulose, rayon, or granular media. It is wound or corrugated around a tubular opening to form a cylinder. Wrapping or corrugating the material creates a larger filter surface area for contact with untreated water. These filters must be periodically replaced. Others, called Depth Automatic Filters regularly backwash and clean themselves, reducing maintenance and long-term cost.

In the sediment filtration process, pressure from the water line forces the water through the media or fiber wraps of the medium into the inner cylinder, which leads out of the filter to the water line. Contaminants strained from the water are retained on the surface of the medium or are trapped within it. The size of particles retained depends on the pore size or the space between media fibers or granules.

Most filters list an average pore size and are rated by the manufacturer according to the smallest particle they can trap. In general, sediment filters are rated by a "micron" number. This refers to the particle size that will be trapped by the filter. They are further classified as "nominal" or "absolute." For instance, a nominal 5 micron filter can trap 85 % of particles of five microns and larger; an absolute 5 micron filter can trap 99.9 % of particles of 5 microns and larger. For most purposes, nominal filtration is fine; when very high grade water is required, an absolute-rated filter may be needed.

Ultraviolet water treatment systems need sediment pre-filtration for the unit to perform to specification. The additional cost of installing a sediment filter upstream of more expensive water treatment systems will more than pay for itself over the long-term. They can also minimize service calls for prematurely plugged filter systems.



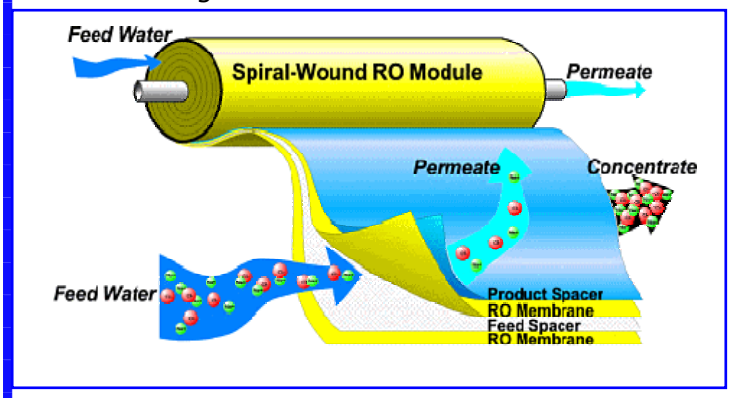
DOMESTIC WELLS

Reverse Osmosis Water Filtration Systems

Reverse Osmosis

Reverse osmosis, also known as ***hyperfiltration***, is the finest filtration known. This process will allow the removal of particles as small as ions from a solution. Reverse osmosis is used to purify water and remove salts and other impurities in order to improve the color, taste or properties of the fluid.

Reverse osmosis uses a very fine ***semi-permeable*** plastic membrane that has extremely tiny pores, that allows the fluid that is being purified to pass through it, while rejecting the contaminants that remain. Most reverse osmosis technology uses a process known as ***crossflow*** to allow the membrane to continually clean itself. The fluid that passes through the membrane is collected as purified water while the rest continues downstream, sweeping the rejected species away from the membrane. The process of reverse osmosis requires a driving force to push the fluid through the membrane, and the most common force is pressure from a pump. The higher the pressure, the larger the driving force. As the concentration of the fluid being rejected increases, the driving force required to continue concentrating the fluid increases.



Reverse osmosis is capable of rejecting bacteria, salts, sugars, proteins, particles, dyes, and other constituents. The separation of ions with reverse osmosis is aided by charged particles. This means that dissolved ions that carry a charge, such as salts, are more likely to be rejected by the membrane than those that are not charged, such as organics. The larger the charge and the larger the particle, the more likely it will be rejected.

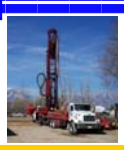
Reverse Osmosis System

The average RO system is a unit consisting of a sediment/chlorine pre filter, the reverse-osmosis membrane, a water storage tank, and an activated-carbon ***post*** filter.

If the raw water being treated comes from a well or another private source, disinfection and ***pre***-filters (to remove chlorine and/or particulates/sediment) may be needed in advance of the R/O unit to remove contaminants that can foul or damage the membrane.

Reverse osmosis can remove dissolved solids, salts, minerals that cause hardness, organic chemicals and other impurities. R/O units may also remove contaminants such as chromium, mercury and nitrates. It can improve the taste of water for people who do not like the taste of dissolved mineral solids.

REVERSE OSMOSIS SYSTEM



DOMESTIC WELLS

Reverse Osmosis Water Filtration Systems

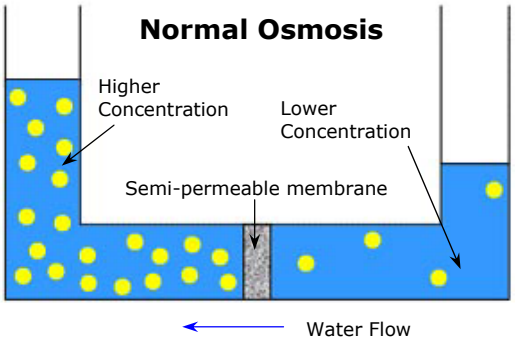
Reverse Osmosis

Treated water will not produce scale in kettles and coffee makers. Because sodium and potassium are removed, people on a medically prescribed sodium or potassium-restricted diet may benefit. Before purchasing a R/O unit, check the certification and literature for the particular model to verify exactly what it can and cannot remove. Prices for R/O systems typically range from $150 for point of use to over $1,500 for point of entry units.

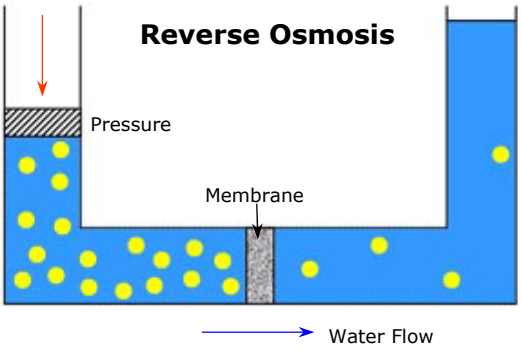
A reverse osmosis unit should be used only with drinking water that is known to be safe to drink. Although reverse osmosis can remove microbiological contaminants, R/O does not disinfect the water to drinking standards. A flaw or tear to the membrane could allow untreated water to flow through the unit without removing disease-causing organisms. Remember if you are unsure of the quality of your water, get it tested. If you have any doubts about the safety of your water, then it should be disinfected before using a R/O unit.

Operating a reverse osmosis unit is not water-efficient—and the amount of water used depends on the quality of the incoming water and the system water pressure: the higher the pressure, the more efficient the process. R/O units will not operate efficiently at water pressures below 40-45 psi. If the pressure is too low, a booster pump should be installed to increase pressure.

Osmosis vs Reverse Osmosis



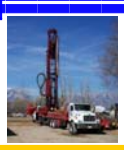
Osmosis is the movement of water molecules across a semi-permeable membrane from an area of high concentration to an area of low concentration. This drive to find equilibrium is defined as the osmotic pressure. Once an equilibrium is attained between both sides of the membrane, the net flow of water ceases. This is basically how fluids transfer in our body's own cells.



Reverse Osmosis is the process of ***forcing*** a solvent, such as salt, from a region of high concentration through a membrane to a region of low concentration by applying a pressure in excess of the ***osmotic pressure***. This process has been used in treating sea water to get fresh water since the early 1970s.

Water Quality Association

Diagrams courtesy of the Water Quality Association



DOMESTIC WELLS

Reverse Osmosis Water Filtration Systems

Buying a Reverse Osmosis System

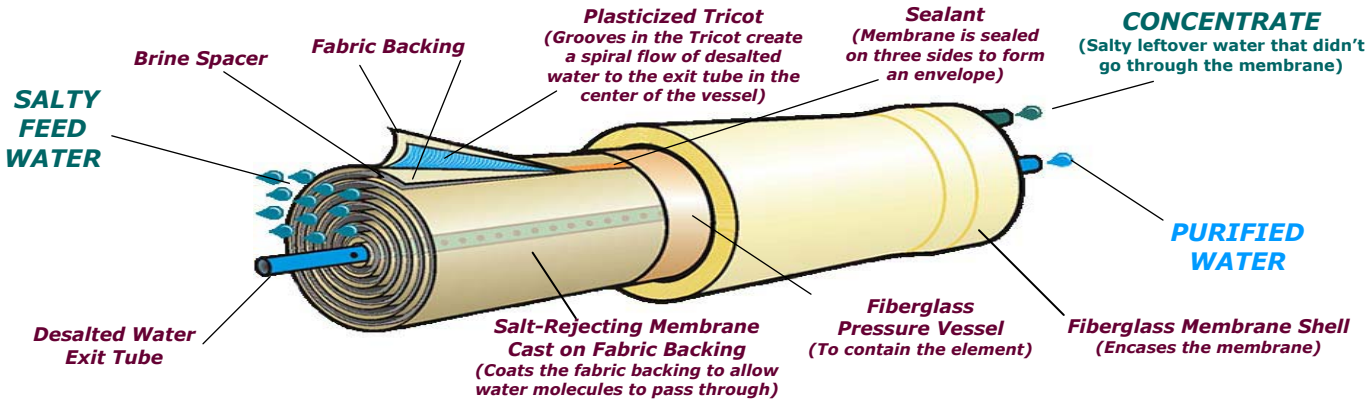
With many of the less expensive units available (about $150-250), an R/O unit may have to process anywhere from 3 to 5 gallons of water to produce just 1 gallon of purified water. This unusable water, called ***brine***, contains contaminants that the R/O unit has removed. This will create a higher demand on your well and septic system. Some of the best, and more expensive units (about $500-700) will process water at a 2 to 1 or even a 1 to 1 ratio. Some R/O units can produce 1 gallon per minute while others will produce just 8 to 25 gallons per day. Though slower than a carbon or sediment water filter, RO systems can typically purify more water per day than distillers and are less expensive to operate and maintain.

When deciding on a water treatment system be sure to investigate all options and all costs. To compare purchase to lease or rent options consider the following:

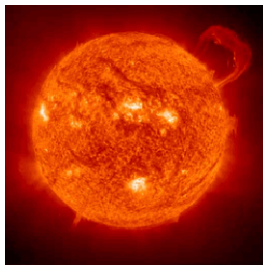
1. **Initial Costs of the System:** Be sure that all parts are included, especially when comparisons are being made. RO units range in cost from $300 to $3000 and vary in quality and effectiveness. Replacement membranes cost $50 to $200 and filter cartridges around $50.
2. **Installation Costs:** These costs are generally the responsibility of the purchaser, but who pays installation fees when renting or leasing? Is there enough space to accommodate the system being considered or will some modifications of space be needed?
3. **Operating and Maintenance Costs:** Electricity to pump the water is the only significant operating cost. The pre and post filters and the reverse osmosis membranes must be changed according to the manufacturer's recommendation, and the storage tank must be cleaned periodically. Whether routine maintenance can be done by the owner or requires special service is important information when purchasing a system. When renting or leasing, how and when servicing is to be done and who pays for the supplies and service needs to be clearly stated. For example, is the service done on a schedule or an "as needed" basis?

Look at overall costs of the system. The low price models may end up costing you more; e.g., a $150 unit requires that the membrane be replaced annually at a cost of $200, whereas the membrane of a $500-700 unit need only be replaced every 4-5 years and at a nominal cost of just $50!

Reverse Osmosis Membrane Element Inside a Pressure Vessel



UV Filters



Ultra-violet (UV) treatment is the disinfection process of passing water by a special light source. When properly sized and installed on a visually clear water source, UV can effectively protect from microorganisms in the water. This method of treatment is growing in popularity because it does not add chemicals or change the chemical composition of the water.

Immersed in the water in a protective transparent sleeve, the special light source emits UV waves, similar to the sun's UV but stronger, that alter the nucleic acid (DNA) of viruses, bacteria, molds or parasites, effectively sterilizing them. It should be noted that these "inactivated" microorganisms are not removed from the water and prolonged storage of water after UV treatment is not recommended. Since UV treatment does not remove dirt and particles, metals such as lead or iron, or hard minerals such as calcium, other filtration devices are required.

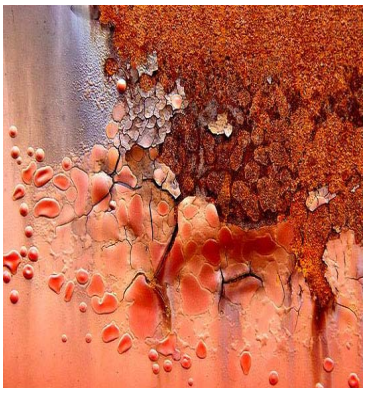
Water should be free of soil or sand particles (it should look clear and not cloudy). Such particles can block the UV rays and allow harmful particles to survive. Accordingly, a UV system normally has a five-micron sediment filter installed upstream from the UV unit. For surface water usage (as opposed to well water), a one-micron absolute filter should then be installed after the five-micron filter to remove cysts like ***giardia*** and ***cryptosporidium.***

The UV unit is installed after these sediment filters. There are characteristics that can affect UV effectiveness such as water hardness, alkalinity, pH, and iron concentrations etc. Accordingly, water should be tested before installation to see if it will need additional treatment. This will assure proper UV disinfection. Contact a UV manufacturer or a water-testing laboratory to arrange a test.

UV units operate at a low cost. The bulb gradually loses its disinfecting capabilities over time. It should be changed at least once a year — even if it is still operating. The quartz sleeve surrounding the bulb must be kept clean in order for the unit to function safely. It should be examined once a month; and if it becomes cloudy, it should be cleaned. ***Note:*** *no one system can treat water 100 percent, and without proper maintenance it should not be considered 100 percent reliable.* In cases where you suspect the water is unsafe due to a malfunction of the unit, you should boil water for one minute before using the water for drinking and brushing teeth. Should your plumbing becoming contaminated, it is recommended that you contact your local public health unit for the proper clean-up procedures.

Costs vary from $300 for a basic self-installed unit to $700-$900 for a plumber-installed system — which includes a basic UV unit and labor. Costs can go up to $1,200 for a unit with more features. These include a flow-restrictor to make sure that the treatment capacity of the unit is not exceeded, a solenoid — a device that shuts off the water when the power is off — and an intensity meter to close down the system if the bulb is not producing strong enough UV rays. If the system is combined with filters, there are additional costs for regular filter replacement. An annual filter/lamp replacement can be approximately $150. A lamp/bulb alone may cost from $40 to $100 depending on the wattage of the bulb. The electrical costs of the system is similar to running a 60-watt bulb.

Other Water Filtration Systems



In addition to the typical water quality concerns regarding sediments, bacteria, and the taste of your drinking water, some wells have more serious quality issues that require more intensive solutions to eliminating contaminated water.

Dealing with Iron and Manganese

Next to hardness, the presence of iron is probably the most common water problem faced by consumers and water treatment professionals. The ***secondary*** or ***aesthetic maximum contaminant levels*** (MCL) for iron and manganese are 0.3 milligrams per liter (mg/l) and 0.05 mg/l, respectively. Iron and manganese in excess of the suggested maximum contaminant levels (MCL) usually results in discolored water, laundry, and plumbing fixtures.

Small amounts of iron are often found in water because of the large amount of iron present in the soil and because corrosive water will pick up iron from pipes. Clothing washed in water containing excessive iron may become stained a brownish color. Manganese produces a brownish color in laundered clothing, leaves black particles on fixtures and as with iron, affects the taste of beverages, including coffee and tea.

Well water from the faucet or tap is usually clear and colorless. However, when water containing colorless, dissolved iron is allowed to stand in a cooking container or comes in contact with a sink or bathtub, the iron combines with oxygen from the air to form reddish-brown particles (commonly called rust). Manganese forms brownish-black particles. These impurities can give a metallic taste to water or to food.

The rusty or brown stains on plumbing fixtures, fabrics, dishes, and utensils cannot be removed by soaps or detergents. Bleaches and alkaline builders (often sodium phosphate) can make the stains worse. Over time, iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the quantity and pressure of the water supply.

Unfortunately, iron and manganese can often be quite difficult to treat. This is due primarily to the fact that iron can be present in several forms, and each form can potentially require a different method of removal. Adding insult to injury, ***Hydrogen Sulfide*** is also commonly found in water containing iron causing the water to have a ***"rotten egg"*** odor.

Hydrogen sulfide in drinking water is a common nuisance contaminant. Although it is not hazardous to health, the offensive odor and corrosivity of household water containing hydrogen sulfide make treatment desirable. Although there are various treatment alternatives, chlorination is the most commonly used and effective. Often, the treatment for hydrogen sulfide is the same as for iron and manganese, allowing removal of all three contaminants in one process.

Hydrogen Sulfide

Water containing hydrogen sulfide, commonly called sulfur water, has a distinctive "rotten egg" odor, which may be especially noticeable when running hot water. Such water can discolor coffee, tea and other beverages, and alter the appearance and taste of cooked foods. A concentration as low as 0.1 milligrams hydrogen sulfide per liter of water (mg/1) is detectable by smell by most people. However, characteristic hydrogen sulfide taste can be detected in water with a concentration as low as 0.05 mg/1.

Hydrogen sulfide dissolved in water can also corrode plumbing metals, such as iron, steel, copper and brass and exposed metal parts in washing machines and other water-using appliances. The corrosion of iron and steel from hydrogen sulfide forms ferrous sulfide or "black water" which can darken silverware and discolor copper and brass utensils. Hydrogen sulfide can also interfere with the effectiveness of water softeners.

Origin of Hydrogen Sulfide

Hydrogen sulfide gas is formed from decomposing underground deposits of organic matter, such as decaying plant material. Hydrogen sulfide from sewage pollution can occur in some surface water, in poorly constructed wells, or in shallow wells close to sewer lines or septic systems. Wells drilled in shale or sandstone, or near coal or oil fields often have hydrogen sulfide present in the water. The presence of hydrogen sulfide may be seasonal and frequently occurs in well water which also contains appreciable levels of iron and/or manganese, or that has a low pH.

Hydrogen Sulfide Treatment

To determine an appropriate treatment method, it is necessary to find out how much hydrogen sulfide is present in the water supply. Since hydrogen sulfide is a gas that is dissolved in water and can readily escape from it, determining the concentration of hydrogen sulfide requires that the water sample be tested at the site or be immediately stabilized for laboratory analysis. Sample bottles with stabilizing chemicals should be obtained from the laboratory that does the analysis. These stabilized water samples cannot be analyzed for other contaminants. When sewage pollution is a suspected source of hydrogen sulfide, the water should also be tested for bacteria.

The recommended treatment for reducing hydrogen sulfide varies with its concentration in household water. Select the treatment appropriate for the amount of hydrogen sulfide present in the water supply from the following treatment options: (Where ranges for hydrogen sulfide concentrations given below overlap one another, more than one treatment method may be suitable.)

- ***Trace amounts of hydrogen sulfide (up to a few tenths mg/L)***

At this level, activated carbon filtration will reduce the unpleasant taste associated with hydrogen sulfide but has a very limited capacity for odor absorption. Hydrogen sulfide gas is adsorbed onto the carbon surface. In this method, the filter, when exhausted, **must** be replaced, and cannot be recharged.

DOMESTIC WELLS

Hydrogen Sulfide Filtration Systems

Hydrogen Sulfide Treatment

- ***Less than 2 mg/L hydrogen sulfide***

Aeration (adding air to the water) is an appropriate treatment method. In any aeration system, the water must be protected from bacterial contamination and freezing, and there are large space requirements. Another limitation of this method is that the aeration process produces a strong hydrogen sulfide odor near the aerator which may be unpleasant if near the household living area. Furthermore, this process, by itself, may not always reduce the hydrogen sulfide to unnoticable levels. However, the addition of a carbon filter may remove some of the remaining trace amounts of hydrogen sulfide. Culligan Water's system can remove up to 5 ppm

- ***1-10 mg/L hydrogen sulfide***

The use of an iron-removal filter containing ***manganese greensand*** is suggested. Manganese dioxide oxidizes hydrogen sulfide and the oxidized particles are then filtered out in the lower part of the bed. Manganese greensand filters must be recharged with a solution of potassium permanganate when the manganese greensand is depleted. This process is similar to regenerating a water softener and usually must be implemented at intervals from one to four weeks depending on the condition of the water, size of the unit, and amount of water consumption. Water with a pH below 6.7 may need to be treated with an acid water neutralizer before this process will be effective.

- ***More than 6 mg/L hydrogen sulfide***

Constant chlorination using an automatic chemical feed pump is the most common treatment method. The recommended dosage is 2 mg/L chlorine for each mg/L hydrogen sulfide. The chlorine should be added ahead of the mixing tank and sufficient storage must be provided to maintain 20 minutes of contact time between the water and the chemical. This process may produce objectionable taste in the water. Depending upon the amount of chlorine added, an activated carbon filter may be used to obtain chlorine-free water for cooking and drinking. The same carbon filter can also reduce any remaining hydrogen sulfide. Maintenance and replacement of filter systems should be considered since sulfur, iron, manganese and other suspended materials in the water can quickly clog the filter.

Sulfur Bacteria

Sometimes the characteristic "rotten egg" odor is caused by sulfur bacteria. This type of bacteria is not harmful. It lives in hot water plumbing. Sulfur bacteria chemically changes hydrogen sulfide to sulfate, which produces the unpleasant odor. Sometimes gelatinous slime is present, similar to iron bacteria.

Shock chlorination of the entire water system, including storage, hot water tanks, and distribution lines, kills the bacteria. This process introduces very high concentrations of chlorine into the water system. Chlorine should remain in the system for several hours, preferably overnight. If the situation persists, continuous chlorination may be required to prevent bacterial growth.

DOMESTIC WELLS

Iron Filtration Systems

Types of Iron in Well Water

There are basically four types of iron found in water, they are:

- ***Soluble or Ferrous Iron*** - Soluble iron is often called ***"clear water iron"*** since it is not visible in poured water. It is found in oxygen-free water from deep wells or groundwater. When exposed to oxygen however, iron particles precipitate out of solution and form as rust particles.
- ***Oxidized or Ferric Iron*** - Ferric iron, also known as "red iron" contains red particles easily visible in the water as the result of exposure to oxygen (oxidation) from the air.

- ***Colloidal Iron*** - Consists of extremely small particles of oxidized iron particles suspended in water. This type of iron looks more like cloudy, colored water instead of actually seeing small red particles of iron.
- ***Bacterial Iron*** - Green or black slime deposits in toilet tanks or fouling water filters and softeners is a good indication of the presence of bacterial iron. Better described as ***iron biofouling***, the iron bacteria problem is both complex and widespread.

Filter Systems for Iron Removal

Soluble Iron—Pyrolox Filter System

To remove Soluble or "Clear Water" Iron, it is best to install a ***Pyrolox Filter System***. These units work very well not only at removing this type of Iron and Manganese, but also remove any hydrogen sulfide (rotten egg) odor, from water supplies with a pH of 6.5 or more. Used in water treatment for more than 75 years, it is a durable material with a long service life and a low annual attrition of the bed. Pyrolox has a high capacity for low contaminant concentrations.

A Naturally mined ore, Pyrolox is a mineral form of manganese dioxide that consists of very heavy, steel-grey pyrolusite (MnO_2) granules. Pyrolox functions as a catalyst, but itself remains relatively unchanged. Pyrolox works on a principle whereby the hydrogen sulfide, iron and manganese are oxidized and trapped on the media. Nothing is imparted into the drinking water. It does not require regeneration but does require periodic, vigorous back-flushing to remove trapped material.

Pyrolox is normally positioned after aeration or other means of oxidation such as chlorine or ozone (Chlorine or other oxidants accelerate the catalytic reaction). This is more suitable for Pyrolox filters as they are at their most efficient when dealing with oxidized contaminants.

Iron Filtration Systems

Filter Systems for Iron Removal

Oxidized Iron—Birm Filter System

Birm Iron Backwash Filters efficiently removes iron for applications where hydrogen sulfide (rotten egg odor) is NOT present, organic matters do not exceed 4 ppm and Ph level is greater than 6.8. The Birm Iron filter will also remove Manganese in applications where the Ph level is between 8 and 9.

Birm is a black granular filter material used for removal of iron and/or manganese from water in pressure or gravity systems. It contains an active insoluble catalyst to precipitate iron and/or manganese. Because the presence of iron is most common, iron removal is the usual application for Birm. Under suitable conditions, the iron and dissolved oxygen in water react on contact with the Birm filter bed and, as a result, the iron is precipitated in the form of hydroxide. This is a coagulated material which is filtered out in the bed of Birm. Periodic backwashing flushes out the accumulated iron and the Birm is again ready to perform its function. Birm is not consumed in the iron removal operation.

If the Iron presence in your water is 3 ppm or greater, you will need an air injector filter to increase the amount of oxygen in the water. With this configuration, the unit will be able to handle up to 20 ppm of iron. For stand alone iron filter—up to 15 ppm.

Iron with Hydrogen Sulfide—Manganese Greensand Filter System

To remove ***Oxidized OR Soluble Iron*** as well as Hydrogen Sulfide from your well water, a ***Manganese Greensand Filter System*** is indispensable. These Iron Filter systems use a high quality gluconite greensand filter media which is coated with a layer of Manganese Dioxide.

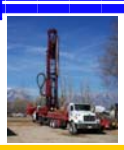
Manganese Dioxide removes iron and other inerts by three processes.

First, the media is fine in size and the greensand works as a simple sand filter to remove inorganics above 30 micron in size.

Secondly, soluble iron and manganese are oxidized and precipitated by contact with higher oxides of manganese on the greensand granules. The hydrogen sulfide is reduced by oxidation to an insoluble sulfur precipitate.

Thirdly, precipitates are then filtered and removed by backwashing. When the oxidizing capacity power of the Manganese Greensand bed is exhausted, the bed has to be regenerated with a weak potassium permanganate ($KMnO_4$) solution thus restoring the oxidizing capacity of the bed. ***Note:*** These systems are designed for water supplies with pH between 6.2 and 8.8. If your water supply has a pH of 6.1 or less, you need to neutralize pH before passing the water through this system.

For removal of ***Colloidal and Bacterial Iron***, the raw water must first be treated with ***chlorine*** before entering either the Birm, Pyrolox, or Manganese Greensand Filter Systems.



DOMESTIC WELLS

Bacterial Iron Filtration Systems

Iron Bacteria

Iron bacteria, a natural part of the environment, are generally more common than sulfur bacteria, simply because iron is abundant in ground water. These microorganisms combine dissolved iron or manganese with oxygen and use it to form rust-colored deposits. In the process, known as ***iron biofouling,*** the bacteria produce a foul smelling brown slime that can coat, clog and corrode well screens, pipes, and plumbing fixtures. This slime isn't a health hazard, but if left unchecked, increases the chance of a sulfur bacteria infestation. If conditions are right, the bacteria can grow at amazing rates and render an entire well system virtually useless in just a few months.

Detecting Iron Bacteria

There are certain sight indications that your well may have an iron bacteria problem. These are:

- Red, yellow, or orange color to the water
- Slime on the inner walls of the toilet tank
- A smell that may resemble fuel oil, cucumber, or sewage. (This smell may be noticeable only in the morning or after other periods of non-use. If a disinfectant is used in the toilet tank, this sign of iron bacteria might not be apparent.)
- If you have reason to suspect an iron bacteria problem, you may wish to try shock (or "batch") chlorinating the well, as described later, before having a water sample tested by a laboratory. Culligan Water has a specific iron bacteria test kit that can determine the level of contamination.

Preventing Iron Bacteria

Because it is difficult to get rid of iron bacteria once they exist in well systems, prevention is the best safeguard against accompanying problems.

For well drillers, prevention means disinfecting everything that goes into the ground with a strong (250 ppm) chlorine solution. Iron bacteria are nourished by carbon and other organics, and it is essential that these are not introduced into any part of the well system during the drilling process. Tools, pumps, pipe, gravel pack material, and even the water used in drilling should be disinfected. Use of a tank that circulates chlorinated water instead of digging a mud pit will help avoid contamination from soil. When the well is completed, it should be purged, shock chlorinated (using 1000 ppm solution), and then pumped.

For owners of new wells in places where iron bacteria have been a problem, the best prevention is to be especially alert for signs of their occurrence. If the well driller and pump installer are scrupulous in keeping the new well "clean," iron bacteria even in such areas can be avoided.

For owners of wells with previous iron bacteria infestation, chlorination is the best way to prevent it from reoccurring. Owners can periodically clean wells by shock chlorination (described in the next section), except that they should use a weaker solution—2 quarts of 5.25% chlorine bleach in 100 gallons of water (or 1.25 qts. of 10% chlorine bleach). Another possibility is to install a chlorination unit, a method generally not adopted unless other problems also exist.

Chemical Treatment of Bacterial Iron

Since bacteria tend to build up again a few months after treatment, well owners should try to control rather than completely "cure" the problem. For several reasons, routine chemical disinfectants that effectively wipe out other bacteria are only modestly successful against iron bacteria.

Iron bacteria build up in thick layers forming a slime that keeps disinfectants from penetrating beyond the surface cells. In addition, mineral iron dissolved in water can absorb much of the disinfectants before they reach the bacterial cells. Also, because chemical reactions are slowed at the cool temperatures common in wells, bacterial cells need a long exposure to the chemical for treatment to be effective. Even if chlorine kills all the bacterial cells in the water, those in the groundwater can be drawn in by pumping or drift back into the well.

Because of these factors, thoroughly treating an iron bacteria infestation requires more than simply dumping chlorine into the well. The following steps are recommended:

1. Prepare the chlorine solution. Approximately 8 quarts of 5.25% (or 5 qts. of 10%) chlorine bleach such as Hylex, Chlorox, etc., should be mixed with 100 gals. of water. It is best to prepare an amount more than the amount of water standing in the well, and the 100-gallon measure is a safe estimate if this is not known. Most garbage cans hold 30 gals. or more, so that filling three (clean, of course) cans with the solution is sufficient.
2. Pour or pump the solution into the well in one continuous flow. Attach a hose to a faucet and, making certain the hose itself is clean, place the other end of the hose into the well. Open the faucet and recirculate for one hour the now-chlorinated water, washing down the inside of the casing and the pump piping. Faucets in your house should be opened until you detect a chlorine smell, then close them.
3. Allow the chlorine solution to remain in the well and piping for at least 24 hours, preferably longer. The system should then be purged free of chlorine. Since it can disrupt a septic system, the chlorinated water should run outdoors, perhaps into a ditch. It may also kill grass and shrubs, and should not flow into a lake or stream. Well owners may need to repeat this process more than once.

If indications of iron bacteria persist, you can at least protect your household plumbing and appliances by installing an automatic chlorinating system with an iron removal unit. This process will not stop the iron bacteria from slowly corroding your well pump over time, but it will stop the infestation from entering your home and corroding and clogging your pipes.

Mechanical Treatment

In addition to chemical treatment, other methods are available to control iron bacteria in community water systems. Stagnant water conditions can be avoided by looping dead-end plumbing lines and periodically flushing low-flow lines to reduce bacteria. Forcing hot water or steam into a well to disperse the slime and kill the bacteria has also worked well. In addition, flushing large quantities of heated water into the aquifer has been found successful in field tests.

DOMESTIC WELLS

Neutralizing Acidic Water

Corrosivity of Acidic Water

On private water systems, one of the most common causes of corrosion is from low pH, which can be defined as acidic water with a pH of less than 7.0 pH. Signs of acid water are corrosion of fixtures, blue staining (from copper pipes) or rust staining (from iron pipes). pH neutral water should be within a 7.0 to 7.8 range.

Corrosion is a natural process involving chemical or electrical degradation of metals in contact with water. The rate of corrosion will vary depending on the acidity of the water, its electrical conductivity, oxygen concentration, and temperature. Acidic water with pH values in the range of 6 to 7 is more corrosive to the metals used in plumbing systems than alkaline water. Both ground waters (wells) and surface waters (such as spring water or creeks) can be acidic.

Common causes for acidic water are acid rainfall due to atmospheric carbon dioxide and other airborne pollutants, runoff from mining spoils, and decomposition of plant materials. Acidic waters can be high quality and are typically low in buffering calcium minerals, but are high in dissolved carbon dioxide gas, which can cause the low pH or acidity.

Treatment Options—Calcite Neutralizers

One of the most convenient methods to raise pH, hardness and alkalinity is to use an ***Automatic Backwashing Calcite Neutralizer Filter.*** These filters will typically raise the pH of the water to 7.0 or 8.0 and add 30 to 100 ppm of hardness depending on the alkalinity and water hardness.

Calcite, a naturally occurring, crushed and screened white marble, calcium carbonate media, is typically used for most applications as a mild neutralizing agent. One of the advantages of Calcite, is its self-adjusting property in that it corrects pH only enough to reach a non-corrosive equilibrium. It does not over correct under normal conditions. Calcite is often supplemented with ***Corosex*** (magnesium oxide). Corosex is a stronger neutralizing media, and used as a blend with calcite for applications with a very low pH or high ***TDS (total dissolved solids).***

In neutralizer filters, acidic waters slowly dissolve the calcium and magnesium media on contact as the water flows through the filter, raising the pH of the water and increasing the alkalinity. This eliminates the effects of corrosive water chemistries and can help to prevent corrosion of piping and fixtures. The size of the system is directly proportional to the flow rate of the water, in gallons per minute. The higher the flow rate, the larger the system required.

Periodic automatic backwashing will prevent packing of the media inside the tank while reclassifying the Calcite bed to help maintain high service flow rates. Depending on the level of pH, water chemistry and service flow, the Calcite bed will have to be periodically replenished about every 2-3 years, as the Calcite is depleted. As the Calcite slowly dissolves in your water, neutralizing the low pH level, it will also increase the hardness of your water to the point where you may need to add a water softener. There are no chemicals or brine tanks needed for these units to operate, only a drain for back-washing and an electrical outlet to operate the automatic backwashing valve.

Treatment Options—Chemical Injection System

In some cases, instead of dissolved carbon dioxide causing the low pH or acidity, the acidity is caused by mineral acids, either natural or from mining or other industrial wastes. Often the pH is very low, less than 5.0. Treating this type of water requires a ***Chemical Injection System.*** (Also known as a ***Soda Ash Feeder***).

Metering pumps are used to inject a small amount of soda ash (sodium carbonate) or sodium hydroxide into the water, usually in conjunction with a contact tank. Soda ash is bought dry, usually in 25 or 50 lb bags and mixed with soft or pure water in the solution tank. When a saturated solution is achieved (approximately 1 pound per 5 gallons of water), a solution of between 50 and 500 ppm are injected, depending on the pH, alkalinity and flow rate of the water.

For home wells, the metering pumps are wired to turn on and start pumping soda ash solution, when the well pump is energized or running. For best results, the incoming water should remain in contact with the additive mixture for at least 10 minutes for the proper pH adjustment to occur.

You may also want to consider a Chemical Injection System if your water contains a very high ***TDS*** level. This is because with an already large amount of dissolved solids contained in your water, it may not be possible for standard calcite or Corosex media to have sufficient contact time to neutralize your pH. ***Soda ash feeders raise pH and increase alkalinity but not hardness.***

Follow-up Testing for Quality Assurance

The pH should be checked on-site and the metering pump adjusted after the system is installed and running. Routine weekly or monthly testing of the pH is recommended to make sure the treated water has the desired pH level. If the piping in the home is copper it is also important to test for copper residuals to verify that the corrosion is slowing down or has stopped. A simple copper test, done on the water that is first drawn out of the tap will show if there is a copper residual still in the water, indicating corrosion. Over a period of six to twelve months the copper residual levels will slowly decrease in most cases, after the water has been treated.

In some cases the corrosion will continue even when the pH is neutralized. This can occur if the existing piping is severely corroded, or if there are other reasons or causes for the corrosion, in addition to the acidic water. If there are dissimilar metals connecting together, such as copper pipe and iron pipe joined together, corrosion can continue to occur. Other causes include high levels of dissolved oxygen, sulfate bacteria, high levels of dissolved solids and/or stray electrical currents coming into contact with the water stream.

The cause must first be isolated before a solution can be found, but if the water is acidic, the first step is to use an acid neutralizer to raise the pH, and track the copper residuals in the water, before using other solutions in combination with the neutralizer.

Nitrate Filters

Nitrates can be found in water supplies that are in areas where there are heavy use of fertilizers. Nitrate is a very soluble substance, easily dissolved in water and extremely hard to remove. Treatment for nitrate is, therefore, very complicated and expensive. The three methods of reducing or removing nitrate are:

- demineralization by distillation or reverse osmosis
- ion exchange
- Blending

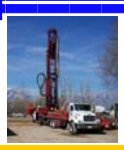
Demineralization removes nitrate and all other minerals from the water. ***Distillation*** is one of the oldest, most effective types of demineralization. The distilling process has only three steps: 1. the water is boiled; 2. the resulting steam is caught; and 3. the steam is condensed on a cold surface, turning back into water. The nitrate and other minerals remain concentrated in the boiling tank.

Reverse Osmosis is another way to demineralize water. It reduces but does not remove all nitrates. Both of these demineralization systems require a lot of energy to operate efficiently and are high-maintenance systems. They are also low-yield systems that may provide enough water for a family, but cannot produce the large quantities needed for livestock.

The second type of water treatment for nitrate contamination is ***ion exchange***. Ion exchange introduces another substance that trades places with the nitrate. Most often chloride is exchanged for nitrate. The ion exchange unit is a tank filled with special resin beads that are charged with chloride. As water containing nitrate flows through the tank, the resin takes up nitrate in exchange for chloride. In time, all the chloride will be exchanged for nitrate. The resin can then be recharged by back washing with a brine solution (sodium chloride) and reused.

Because ion exchange systems can treat large volumes of water, they are more appropriate than demineralization for treatment of livestock water supplies. There are, however, some drawbacks to ion exchange systems. First, in addition to exchanging nitrate, the resin beads will also take up sulfate in exchange for chloride. Therefore, if sulfates are present in the water supply, the capacity of the resin to take up nitrate is reduced. Second, the resin may also make the water corrosive. For this reason, the water must go through a neutralizing system after going through the ion exchange unit. Finally, backwash brines, which are high in nitrate, must be disposed of properly so they do not re-contaminate the groundwater supply.

The third and most common way to reduce nitrates is to dilute the nitrate-polluted water by ***blending*** it with water from another source that has low nitrate concentrations. Blending the two waters produces water that is low in nitrate concentration. Blended water is not safe for infants but is frequently used for livestock. There is no simple way to remove all nitrate from your water. Although it is common to think of boiling, softening or filtration as a means of purifying water, none of these methods reduce nitrate contamination.



DOMESTIC WELLS

Limited Water Resources

Drought

Wells that are placed near the water table are the ones that you hear about ***"running dry"*** during droughts or when there is an increase in ground water pumping. The reason for this is that the water table falls further below the surface when it is not replenished by rainfall or if more water is pumped out than is coming in. It's like putting a straw into the top of a glass of water. If you drink and don't lower the straw toward the glass bottom, you will end up sucking air. There is still water in the glass; your straw is just sitting above it.

Typically, water levels fluctuate on a seasonal basis, rising in the "wet" months and falling in the "dry" months. So, a well will not recover after just one rainfall event. It takes several slow, soaking rains for the water to filter through the ground. Shallower wells may see their water levels rise more quickly with a return of rain. Deeper wells are likely to ride out a drought with no problems; but if they are affected, it will take more rainfall-maybe several months-to filter down to their depth.

What should you do if your well is affected? The answer depends on your well. Is the drought worse than usual? Has this happened during previous droughts? Have your neighbors' wells also been affected? Have you observed other changes in your well: taste or smells in the water? Answers to these questions will determine if the problem is with a ***falling water table*** **or** ***failing well***. ***Deepening*** a well so that it is well below the water table may help to insure a more drought-resistant water supply, although deepening a well is never a guarantee that you will get more water. ***Redeveloping*** an existing well may also make it more efficient. ***Hydrofracturing***, a technique that uses high-pressure water to open fractures in surrounding rock and thereby increase water flow, may also improve your water supply. Talk with a qualified water well contractor to determine which strategy may work best in your situation.

If you need to deepen your well, contact a local, reputable well constructor who is familiar with local ground water conditions and is familiar with the state-of-the-art drinking water construction methods. States and local governments may have contractor licensing and well construction laws. For additional information, you may wish to contact a local National Ground Water Association member in your area or the state ground water or water well association.

Declining Well Production

The increased pumping of larger capacity well systems during a drought may cause the ground water level to be drawn down. The declining ground water level may then be below your pump's intake. The answer again is to ***drill deeper, rehabilitation, or hydrofracturing.***

In general, there is no adverse impact on overall ground water quality from a drought. If a homeowner drills a deeper well in response to a drought, the homeowner may end up with more mineralized water. This is because the water has been in the ground longer and may have taken on some of the characteristics of the surrounding rock formations. The homeowner may also gain water quality benefits from a deeper, properly constructed well. These deeper wells are better protected from surface man-induced contamination sources, such as lawn fertilizer applications or accidental spills.

Well Rehabilitation

Rehabilitating a Well

The situation is not always bleak when a household water well fails to produce the amount of water that it did when it was first installed. Instead of the expense of abandoning the well and installing a new one, a professional contractor can often ***"rehabilitate"*** the well and restore flows that provide enough water for all of a family's daily needs.

What does a contractor base the decision to rehabilitate a well on? Several factors are involved, including the ground formation that the well is drilled in, the construction of the well, and the problem that has caused the decreased flow. Sometimes, the water table in the area has dropped and simply drilling the well deeper is the answer. A professional contractor can do tests to see if rehabilitating measures will be successful. The well will often be shut off for 24 to 48 hours to see if the static level (the level of the water table in a well when the pump is not operating) returns to or gets near the original level. If so, rehabilitation will usually work. Before starting the project, contractors may lower a down-hole video camera into the well to make sure no other problems will be encountered.

Along with the water table dropping, which has happened in several parts of the country because of droughts, there can be other reasons for reduced productivity. The most common is the plugging of holes along the well's casing and incrustations forming on the well screens. The amount of water going through the well system will drop significantly if several holes or portions of the screens are clogged. Calcium carbonate, iron bacteria, silt, clay, and "slime," a combination of sediment and deposits, are all common well "cloggers".

Well Rehabilitation Methods

Two typical methods are (1) using chemicals to dissolve the incrusting materials so they can be pumped from the well and (2) cleaning the well with a brush that can be attached to a drilling rig and then used in the well. ***High pressure jetting, well surging hydrofracturing*** are procedures in which water is injected into the well at extreme pressures. Contractors will often use a combination of these methods.

High-pressure jetting features a tool with an adjustable, multi-head, water-powered jet that lowers into the well and injects water at a high pressure, dislodging debris from the well.

Well surging is the repeated injecting and flushing out of water in a well system. With repeated flushing, the debris is washed away.

With ***hydrofracturing***, water is sent into the entire well at an extreme pressure. The water removes debris from the clogged perforations in the casing and can crack the formations underground to create new sources of water.

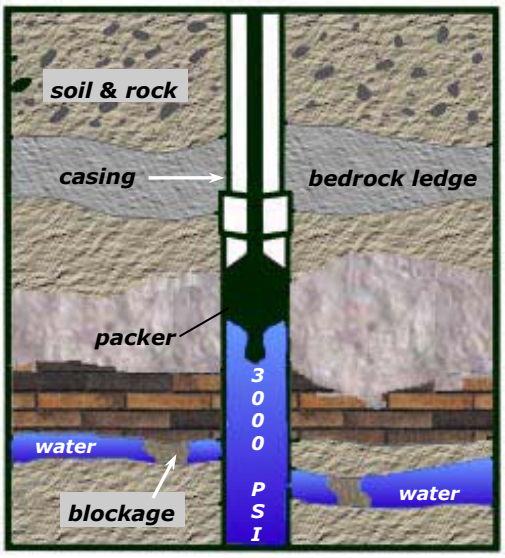
For more information on rehabilitating a water well system, contact a professional contractor in your area.

Hydro-Fracturing

Hydro-fracturing is a well development process that involves injecting water under high pressure into a bedrock formation via the well. This is intended to increase the size and extent of existing bedrock fractures, thereby enlarging the network of water bearing fractures and size of the area supplying water to the well.

Hydro-fracturing, originally developed in the oil fields to increase production volumes, is a relative newcomer to the drinking water well industry. It is now the method preferred by most contractors for developing bedrock wells because it is a controlled process.

The procedure is often used to increase well yields of new deep drilled wells with marginal or inadequate production rates. It may also be applied to older existing wells that have progressively diminished recovery rates over time, usually caused by mineralization and incrustation of rock fractures.



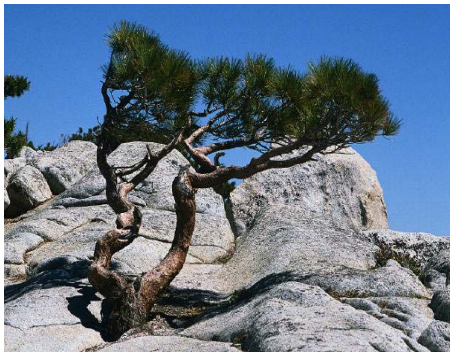
The procedure involves the installation of an inflatable or mechanical borehole packer into a water well and expanding it ("setting") below the casing depth/static level and above the fracture/joint system. This isolates the potential production zone from the rest of the well.

Generally, upwards of 1500 to 2000 gallons of water are pumped down through the water injection pipe into the bedrock formation at high-pressure ranging from 500 to 2,000 psi. In some cases, 3000 psi pressure may be needed in tight rock formations. It is extremely important that only clean, disinfected water is used for injection water because of the extreme pressure involved and the potential for forcing contaminants deep into the bedrock aquifer.

The pressure and flow created in the production zone usually causes small, tight fractures/joints in the rock to open up and spread radially. The newly opened and flushed out fractures provide connections between nearby water-bearing fractures and the borehole. Water is pumped into the formation for 5 to 30 minutes at delivery rates from 50 to 75 gallons per minute (gpm).

If successful, pressure will steadily rise to a maximum level as the rock formation resists flow, then will suddenly drop off and stabilize at a lower pressure. The drop in pressure indicates that the formation is accepting water and the resistance to flow is diminished.

Hydro-Fracturing



Next a mixture of sand and water is pumped into the newly formed fractures, and the old expanded and rejuvenated fractures. This helps scour the fractures and props them open while continuing to allow a porous surface for the water to pass through.

One or two packers may be used for hydro-fracturing. In a ***single packer*** operation, the placement of the packer starts at the top of the bore hole because rock fractures first at the shallowest depths. Additional packer settings are then made at 100 to 200 foot intervals down the well bore, depending on the well depth.

Several thousand gallons of water are used in this process to insure that every possible fracture has been rejuvenated and created. A well test always follows the hydraulic fracturing process. However, in order to determine the true amount of improvement that has been made, several days need to pass to allow the well to achieve an equilibrium before the test can be properly administered.

Zone fracturing utilizes a two packer system where the packers are placed in series and water is pumped into the zone between the packers. This system can be more effective because it concentrates pressures within a small area, typically 30 to 60 foot intervals, and individual fractures can be isolated and hydraulically fractured. With this method, the procedure starts within a specified section of the well targeted by the water well contractor.

Each successive sequence stresses one interval higher than the last. In this way, all potential water bearing fractures or fracture zones are worked independently within the section being "hydro-fracted." This differs from the single packer, or one or two frac sequence method which probably only affects the weakest, least resistant point(s) in the well but still may produce adequate results for private wells serving individual households.

Zone fracturing is a more expensive and time consuming procedure and is generally used only on difficult wells or public supply wells or if a larger flow of water is desired. Well yield increases, if successful, are generally modest but may constitute a significant increase if the original well yield was very low. Occasionally, large increases in well recovery are realized.

A typical well yield gain after hydro-fracturing is 1/2 to 5 gallons per minute. Water well contractors report a high success rate, however, in some instances due to geologic conditions, hydro-fracturing will not increase well yield. If initial pressure continues to build and reaches the operator's maximum equipment capacity, the formation will not accept water and the procedure may not be successful.

Troubleshooting Well Problems

There are four common symptoms associated with most water well problems:

- Reduced well yield
- Sediment in the water
- Change in water quality
- Dissolved gas in the water.

Water well problems result from many causes including equipment failure, depletion of the aquifer, corrosive qualities of the water and improper well design and construction. Correctly identifying the cause enables you to select appropriate treatment or maintenance to fix the problem rather than abandon the well. This troubleshooting module is designed to help you recognize the symptoms of the problem, identify the cause and select the appropriate course of action. Technical assistance from drilling contractors or groundwater consultants may be valuable.

Causes of Well Problems

There are several basic causes of well problems.

- Improper well design and construction
- Incomplete well development
- Borehole stability problems
- Incrustation buildup
- Biofouling
- Corrosion
- Aquifer problems
- Overpumping

The first two causes relate to the expertise and performance of the drilling contractor. Borehole stability problems, incrustation, corrosion and aquifer problems are related to characteristics of the aquifer. The last cause, overpumping, is caused by well users.

Improper Well Design and Construction

When designing a well, the drilling contractor must match the type of well construction with the characteristics of the producing aquifer. A well screen is a slotted column beneath the well casing that blocks fine sand particles from traveling with the water through the pump. Decisions affect the:

- Choice between a perforated well casing/liner vs. well screen
- Placement of well screen or perforated liner
- Size and amount of sand pack around the well screen (if required)
- Location of the pump in the well.

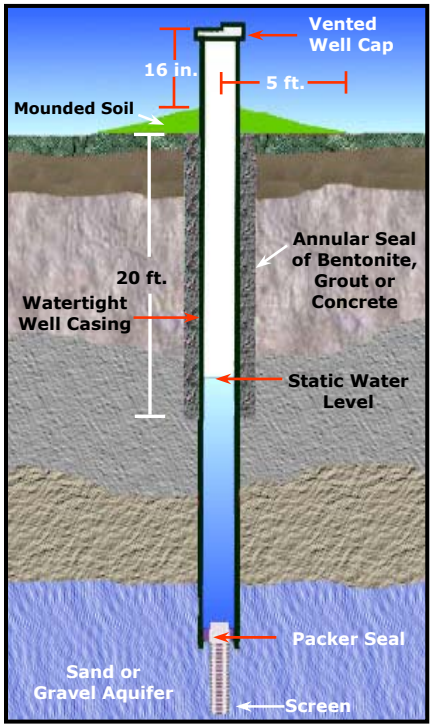
Improper Well Design and Construction

If poor choices are made, you may experience problems with sediment in your water or reduced well yield. Regulations require that a well must be completed to ensure no damage will be incurred to the pumping system, plumbing or fixtures due to sediment in the water.

Incomplete Well Development

During drilling, mud and bore hole cuttings can partially plug the aquifer. This material must be fully removed by the drilling contractor to allow water to freely enter the well. This procedure is part of well development. If the well has not been fully developed, you may experience problems with sediment in your water or low well yield.

Borehole Stability Problems



Borehole stability problems can result from damaged casing and screens, borehole wall collapse, corrosion or excessive water velocities into the well. High water velocity can cause formation particles, like sand, to flow into the well, causing eventual collapse of the borehole wall.

It is essential that the proper materials be selected and installed to avoid such problems. A combination of poor materials, improperly placed screens and a poor well seal make it uneconomical to maintain and restore such a well. Often the most cost effective solution is to drill a new well that is properly designed and constructed.

Mineral Incrustation

Mineral incrustation is a common problem in some shallow water table type aquifers where there is an abundance of dissolved minerals including calcium, magnesium and iron, as well as iron bacteria. When water is pumped from the well, changes in pressure and temperature occur. This creates ideal conditions for minerals to precipitate or settle out, causing scale formation on the casing, liner and screens. Although incrustation or scale formation occurs mostly in the screen or slotted casing, it can also affect the formation around the well.

A combination of good preventive maintenance and good management practices can minimize the effect of incrustation. Management practices that reduce water pumping rates can reduce the effects of mineral incrustation. A strategy of reduced pumping rate with longer pumping intervals helps prevent incrustation of screens and perforated liners. For clogs with carbonate scale, sulfamic acids are used with inhibitors and modifiers.

Troubleshooting

Biofouling

Installing and pumping a well increases the level of oxygen and nutrients in the well and in the surrounding aquifer. Bacteria, such as iron bacteria, may thrive under these conditions. They can form a gel-like slime or biofilm that captures chemicals, minerals and other particles such as sand, clays and silts. Minerals, such as iron, oxidize and get trapped in the biofilm. "Biofouling" occurs where biofilm accumulations are sufficient to reduce water flow. This can mean reduced well yield and water quality.

Regular shock chlorination can reduce the buildup of biofilms. For iron bacteria and slime, a liquid bacteria acid is effective. If the bacteria problem is persistent some of the more aggressive chemicals are muriatic acid and hydroxyacetic acid. The chemicals are placed in the well and agitated frequently for 24 to 72 hours. The well is then pumped with water before a water test is given to see if the well system is ready to be put back in service.

Corrosion

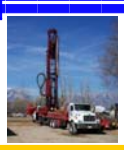
Chemical substances found in water can eat away or corrode metal well casings. To avoid corrosion, the drilling contractor must choose a casing material that is suitable for the water supply. For example, drilling contractors usually select plastic casing liners and stainless steel well screens for corrosive water. Sulfate-reducing bacteria can also cause corrosion. Shock chlorination can keep these bacteria in check.

Aquifer Problems

While most well problems are related to the construction, development or operation of the well, the formation can also be a source of problems. Reduced aquifer yield can be caused by lack of recharge. For example, the amount of water withdrawn can exceed the recharge from rain and snow melt. This is referred to as ***"mining the aquifer."*** Sometimes the decline in water level is seasonal. Typically water levels are higher in spring and lower in the fall. Extended dry periods can also impact water levels, especially in shallow water table type aquifers. Checking the water level in your well is an important maintenance procedure. You will be able to identify water level trends and identify well problems or aquifer depletion before it becomes serious.

Overpumping

A well is overpumped if water is withdrawn at a faster rate than the well was designed for or the aquifer is able to produce. Overpumping is the most common well problem that leads to premature well failure. Overpumping not only depletes the groundwater aquifer (or source), but it rapidly increases the rate of corrosion, incrustation and biofouling related problems. Overpumping also increases the rate of sediment particles moving toward the well, causing plugging of the perforated area where water flows into the well. It can also cause the aquifer to settle and compact which further restricts water flow to the well. If you are pumping water at a rate close to the well's capacity, excessive pump cycling can increase the problem of biofouling.



DOMESTIC WELLS

Troubleshooting

Dealing With a Dry Well

Wells in aquifers may be compared with drinking straws in a glass of water. The question may be asked: how many straws can be used before the glass runs dry? The answer depends on the size of the glass, how often it is refilled, how deep into the glass the straws are, and how much water is withdrawn by each straw.

Too many wells, too much consumptive use, and extended dry conditions may impact aquifers. However, most domestic wells use a very small amount of water in relation to the amount of ground water stored in the surrounding area. Depending on local geology and residential lot sizes, many home wells are hydrologically independent of neighboring wells. It is possible that a home well may be affected by nearby pumping, especially if it shares an aquifer used for irrigation. Deepening the home owner's well can often solve the problem.

A possible reason for a decline in a well's yield may be chemical or biological incrustation in the well, or a worn and inefficient pump. An apparently failing well does not necessarily mean there is a failing aquifer. Clogged wells can be rehabilitated, and pumps can be replaced. Before you panic, consider the following actions:

- Consult a qualified driller or hydrogeologist to establish possible cause for your dry well.
- Assess well geology to determine the risk of potential sources of contamination on ground water quality degradation (If the well is completed below a significant clay or impermeable layer, the risk of ground water contamination from land use activities may be negligible).
- Approach neighboring property owners to make them aware of your drinking ground water supply and request that they curtail any land use activities that may affect your ground water quality, especially within the capture zone.
- There may be the possibility of finding additional water supplies by drilling your existing well deeper or drilling at a different location on your property.
- If you are still getting some water, installing a holding tank to store water and filling it up as water in the well is more readily available (times when a neighbor is not pumping or it is a time of greater natural recharge, that is, during the rainy season or when the snow is melting).
- There could be a co-operative solution in sharing the water from your neighbor’s well.

There is no legislation in force, right now, that restricts the use of water from domestic wells beyond the established household water exemptions. People whose wells may be adversely affected by others may consider seeking damages through the courts. Consult a professional hydrogeologist to ascertain the possibility that the drilling of a well on your neighbor’s property actually was the cause of your well going dry. Consult your lawyer regarding possible legal actions to take.

DOMESTIC WELLS

Well Abandonment

Abandoning Your Well

Unused wells that are not properly abandoned can cause ground water contamination, waste, or loss of artesian pressure. Ultimately, landowners can be held responsible for harm to the ground water resource resulting from old or unused wells. Oregon's well abandonment standards are designed to prevent contamination of the well or aquifer by surface and subsurface leakage which may carry harmful chemicals or bacteria. The standards also seek to prevent physical injury. *The State Water Resources Department (WRD)* has minimum standards that describe the acceptable methods for two types of well abandonment.

Temporary Abandonment

A well is considered temporarily abandoned when it is taken out of service. Owners of such wells intend to bring the well back into service at a future date. Temporarily abandoned wells must be covered by a watertight cap or seal which prevents any materials from entering the well.

Permanent Abandonment

A well is considered permanently abandoned when it is completely filled so that movement of water within the well is permanently stopped. With the exception of hand-dug wells, a permanent abandonment must be performed by a licensed water well constructor, or the landowner under a Landowner's Water Well Permit.

The appropriate permanent abandonment method will depend on information obtained from an examination of the well log and an onsite investigation of the well. Generally, a drilled well with steel or plastic casing will be abandoned by either removing or ripping the casing and filling the borehole with cement from the bottom up. Any pump, wiring, or debris in the well must be removed before the cement is placed.

If a review of the well log indicates that the well is a filter or gravel-packed well (where pea gravel is used to screen out loose geologic material in the well), WRD must pre-approve any abandonment method. A greater potential exists for harm to the ground water resource from incorrect abandonment of this type of well due to the artificial gravel-pack material.

If a hand-dug well is to be abandoned, you must notify WRD and obtain approval for the abandonment method before beginning the abandonment.

Typically, a hand-dug well free of debris may be abandoned by filling the well with cement or concrete to above the water-bearing zone and then clean fill (not gravel) to land surface. Hand-dug wells containing debris may be subject to other abandonment methods. Consult your WRD well inspector before initiating any filling activity.

DOMESTIC WELLS

Sharing Water

Sharing Water

If you plan to construct a well to serve more than one household, a carefully drawn agreement should be negotiated. Generally, legal advice is sought for such an important document between water users and well owners. Bear in mind that a shared well can serve no more than 3 households. The agreement should address these questions:

- Who will maintain the well?
- Who may access the well for maintenance?
- How will power costs and water availability be shared?
- Under what conditions can the property on which the well is located be bought and sold?
- What is each party's interest or right to use the water?
- What type of organization will manage operation of the well now and in the future?
- How will costs of well reconstruction or pump replacement be shared?
- How will the 1/2 acre of irrigation exempt from a water right be divided among the parties?

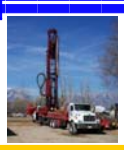
Consult with your lending institution about their restrictions on lending for shared wells. If the well serves more than three households, it is considered a ***public water system*** and is regulated by the Oregon Health Division (OHD), Department of Human Resources. OHD must regularly monitor surface and ground water sources for all regulated contaminants and provide testing records to customers upon request. Oregon law requires that water meet or exceed standards before it is released into the distribution system.

Well Identification Program

In 1996, the Oregon's Water Resources Department began the *Well Identification Program* requiring that all wells, no matter what their current use, be physically tagged upon the sale of the property.

1. The owner must first contact the Water Resources Department by filling out a well identification application to obtain a package containing a metal well identification label or tag, a letter titled *Attaching Well Identification Labels*, and a form titled *State of Oregon Well Identification Form*.
2. The metal tag is then attached to the well by the owner, well driller, or licensed pump installation specialist.
3. The Well Identification Form must be filled out, and returned to the OWRD in Salem upon transfer of property ownership. However, as of January 1, 2006, Well ID forms will no longer be required to be recorded at the local County Clerk's Office.

If you have any questions about this program or need the Well Identification package contact the Water Resources Department at (503) 378-8455 (x700) or for more information see: ***http://www.wrd.state.or.us***



DOMESTIC WELLS

Water and Well Contractors

JACKSON COUNTY

Water—Bulk Delivery

AAA Marie's Water Delivery	890-2754, 830-0808
A-1 Water Express	944-7806
Acme Waterboy Delivery	821-0277
Andrews Water Delivery	951-8748
Plum Valley Water Company	488-5082, 826-6250

Water Treatment Contractors

Ashland Drilling, Inc	535-1907
Ecowater Solutions	772-1081
Desert Pump Company, Inc	826-3136
Green Valley Pump, Inc	535-4275
Hydro-Flow, Inc	772-4453

Well Drilling & Construction

A-1 Well Cleaning & Testing	772-2815
Artesian Drilling, Inc	772-1177
Ashland Drilling Company	488-2827
Gribble Well Drilling, Inc., Gold Hill	855-1328
BG Hicks Consulting Geology	482-8638
Lawrence Linebaugh, Water Witching	846-6453
Medina Well Drilling, Inc	664-6339
Pioneer Drilling, Inc	482-5393
Rogue Valley Drilling	776-7944

Water Testing Laboratories

Ecowater Solutions	772-1081
Neilson Research Corporation	770-5678

Well Testing

A-Accurate Well Flow Testing	772-9878
A-1 Well Cleaning & Testing	772-2815
Affordable Pump Service	535-4090
All American Pumps	773-4640
Ashland Drilling, Inc	488-2827
Ecowater Solutions	772-1081
Flowtek	830-3569
Green Valley Pump, Inc	535-4275
Hydro-Flow, Inc	772-4453
Jacksonville Pump Service	770-9055
Quality Water Systems	245-7470
Siskiyou Pump Service	664-4660

DOMESTIC WELLS

Water and Well Contractors

JOSEPHINE COUNTY

Water—Bulk Delivery

AAA Marie's Water Delivery	582-0780, 830-0808
H2O To Go Water Service	476-1756
Liberty Water	474-6560

Water Treatment Contractors

Coleman's Well Drilling & Pump	476-7129
Ecowater Solutions	772-1081
Hydro-Flow, Inc	772-4453
The Water Works	476-0154
The Waterfixer	955-5221

Well Drilling

A-Accurate Well Flow Testing & Repair	479-7272
Applegate Water Well Drilling, Grants Pass	479-2758
Artesian Drilling, Inc	772-1177
Capp's Pump Service	476-7324
Clear Water Well Drilling	955-9654
Clouser Drilling, Cave Junction	592-6777
Coleman's Well Drilling & Pump	476-7129
Ed's	476-3700
Gribble Well Drilling, Inc., Gold Hill	855-1328
Lawrence Linebaugh, Water Witching, Williams	846-6453
Medina Well Drilling, Inc	664-6339
Pioneer Drilling, Inc	479-6300
Quinn's Well Drilling & Pump Service	862-9355
Rogue Valley Drilling	776-7944

Water Testing Laboratories

Ecowater Solutions	772-1081
Grants Pass Water Laboratory	476-0733
Neilson Research Corporation, Medford	770-5678

Well Testing

A-Accurate Well Flow Testing	479-7272
A-1 Well Cleaning & Testing	474-1777
Coleman's Well Drilling & Pump	476-7129
Flowtek	866-356-9835
Gary Biggs—Cave Junction	592-2574
Hydro-Flow, Inc, Medford	772-4453
Oregon Pump Service	479-4455

DOMESTIC WELLS

Well Flow Report

Hydro-Flow Inc.
P.O. Box 3849, Central Point, OR 97502
(541)772-4453 Fax (541)773-3481
CCB #110565

FLOW TEST REPORT **Job No:** 1480

Prepared for: Your Client
Address: Billing Address
Site Address: Site Address
Technician:
Pump Type: Submersible **HP:** 3/4
Well Diameter: 6"
Draw Down Level: 111 ft 3 in
Recovery Level: 52 ft 10 in
Total Gallons Flowed: 1469.1
Test Type: Flow Test
Comments: *1. Pump Depth of 111 feet 3 inches per level probe in pump column.
**2. Well depth is 126 feet per well log.

Time: 8:48 AM
Date: 10/26/93
Pump Depth: *111 ft
Well Depth: **126 ft
Static Level: 17 ft 3 in
Total Draw Down: 94 ft 0 in
Total Recovery: 58 ft 5 in **within:** 15 min
Average GPM: 6.1
Meter No: 64199340

TIME	WATER LEVEL	METER READING	GAL/15 min	GPM
8:48 AM	17 ft 3 in	106996.1		
9:03 AM	64 ft 3 in	107115.6	119.5	7.97
9:18 AM	79 ft 6 in	107230.0	114.4	7.63
9:33 AM	98 ft 3 in	107341.3	111.3	7.42
9:48 AM	111 ft 3 in	107447.0	105.7	7.05
10:03 AM	111 ft 3 in	107533.7	86.7	5.78
10:18 AM	111 ft 3 in	107619.9	86.2	5.75
10:33 AM	111 ft 3 in	107706.2	86.3	5.75
10:48 AM	111 ft 3 in	107791.0	84.8	5.65
11:03 AM	111 ft 3 in	107876.2	85.2	5.68
11:18 AM	111 ft 3 in	107960.9	84.7	5.65
11:33 AM	111 ft 3 in	108044.4	83.5	5.57
11:48 AM	111 ft 3 in	108129.4	85.0	5.67
12:03 PM	111 ft 3 in	108213.0	83.6	5.57
12:18 PM	111 ft 3 in	108297.2	84.2	5.61
12:33 PM	111 ft 3 in	108381.2	84.0	5.60
12:48 PM	111 ft 3 in	108465.2	84.0	5.60
1:03 PM	52 ft 10 in			

I certify that the above report is true and accurate statement of the results of the flow test of the well at Site Address

Conducted on 10/26/93 _____
Authorized Signature

FIRST AMERICAN TITLE

Neilson Research Corporation

245 South Grape Street, Medford, Oregon 97501 541-770-5678 Fax 541-770-2901

Analysis Report

ORELAP 100016
EPA OR00028

Your Client
Billing Address
Site, Address 97000

Lab Order: **0312273**
NRC Sample ID: **0312273-01B**
Collection Date: **12/11/2003 9:05:00 AM**
Received Date: **12/11/2003 11:00:00 AM**
Reported Date: **8/24/2005 4:53:17 PM**

Sample Information:

Your Client
Rogue River Drive
Shady Cove, OR 97539

Client Sample ID: Rogue River Dr
Collectors Name: Sampler's Name
Sample Location: Outside faucet
Source: Well

TOP 20 ANALYSIS TM

Analyses	Method	NELAC Accredited	Result	Qual	MRL	Units	EPA Limit	Date Analyzed
Aluminum	EPA 200.7	A	**0.0133**		0.005	mg/L	0.05 - 0.2	12/16/2003
Arsenic	EPA 200.9	A	**ND**		0.001	mg/L	0.01- 0.05	12/12/2003
Barium	EPA 200.7	A	**0.156**		0.05	mg/L	2.0	12/16/2003
Boron	EPA 200.7	A	**0.122**		0.05	mg/L	N.L.	12/16/2003
Cadmium	EPA 200.7	A	**ND**		0.001	mg/L	0.005	12/16/2003
Calcium	EPA 200.7	A	**53.7**		1	mg/L	N.L.	12/16/2003
Chloride	EPA 300.0	A	**4.52**		1	mg/L	250	12/12/2003
Copper	EPA 200.7	A	**ND**		0.01	mg/L	1.3 AL	12/16/2003
Fluoride	EPA 300.0	A	**ND**		0.2	mg/L	2 - 4	12/12/2003
Hardness	EPA 200.7	A	**178**		3.8	mg/L	250	12/16/2003
Iron	EPA 200.7	A	**0.0166**		0.015	mg/L	0.3	12/16/2003
Lead	EPA 200.9	A	**0.00230**		0.001	mg/L	0.015-AL	12/12/2003
Lithium	EPA 200.7		**ND**		0.1	mg/L	N.L.	12/16/2003
Magnesium	EPA 200.7	A	**10.7**		1	mg/L	N.L.	12/16/2003
Manganese	EPA 200.7	A	**ND**		0.02	mg/L	0.05	12/16/2003
Nitrate Nitrogen	EPA 300.0	A	**0.711**		0.2	mg/L	10	12/12/2003
pH	SM 4500 H-B	A	**7.28**		0.1	pH Units	6.5 - 8.5	12/11/2003
Sodium	EPA 200.7	A	**35.9**		1	mg/L	N.L.	12/16/2003
Specific Conductance	SM 2510B	A	**462**		1	µmhos/cm	N.L.	12/11/2003
Sulfate	EPA 300.0	A	**5.30**		0.5	mg/L	250	12/12/2003
Zinc	EPA 200.7	A	**0.0512**		0.05	mg/L	5.0	12/16/2003

Neilson Research Corporation

Notes: MRL -Minimum Reporting Limit ND - Not Detected at the MRL N.L. - No Limit
TM - Top 20 is a registered trade mark of Neilson Research Corporation, Oregon Accredited Laboratory: ORELAP 100016, OR-028

The current Arsenic limit for public water systems is 0.05 mg/L. All public water systems must comply by Jan 2006 to the new Arsenic limit of 0.010 mg/L.

Please Note: If the test results indicate a need for water treatment or conditioning, additional testing may be required.

1

DOMESTIC WELLS

Content Index

Abandonment of Your Well 67
Acidic Water 56-57
Activated Carbon Filters 42-43
Aluminum 29
Aquifers 4-5, 65
Arsenic 29
Asbestos 34
Barium 29
Biofouling 65
Birm Filters 53
Boron 30
Cadmium 30
Calcite Neutralizing System 56
Carbon Filters 42-43
Chemical Injection System 57
Chemical Contamination 34
Chlorine, Chloride Contamination 31
Chlorine Treatment 25-26, 49-51, 54-55
Coliform Bacteria 24-26
Components of a Well 15
Cone of Depression 6
Construction Standards 11-12
Contaminant Testing in Water 28-33
Contribution Zone 6
Copper, Contaminant 31
Corrosion 65
Decling Well Production 59
Design, Well 10
Development, Well 15
Drilling Constructors, Jackson County 69
Drilling Constructors, Josephine County 70
Drought 59
Dry Well 66
Efficiency, Well 16
Estimating Water Needs 9
Exempt Uses of Water 7
Flow Test 20, 71
Fluoride 32
Ground Water 1-6
Hardness of Water 35-38
Hydrofracturing 61-2
Hydrogen Sulfide 49-51
Hydrology 4-6
Induced Recharge 6
Installing a new well 9-19
Iron Bacteria 54-55
Iron Filtration 49, 52-53
Lead 32
Locating Groundwater 8
Locating Your Well 10
Magnesium 33
Maintaining a Well 19
Manganese 33
Manganese Filtration 49
Manganese Greensand Filters 53
Mineral Incrustation 64
Mineral Testing in Water 28-33
Nitrates 27, 58
Nitrate Filtration 58
Organic Chemical Contamination 34
Overpumping 65
Oxidized Iron 53
Parasites 34
Permeability 4
pH in Water 39
Porosity 4
Pressure, Water 18
Problems, Cause of 63-66
Pump Installation 17
Pyrolux Filters 52
Recharge 5
Rehabilitation of Your Well 60, 62
Reverse Osmosis 45-47
Quality of Water 21-58
Sampling Your Well Water 21-23
Sediment Filters 43-44
Selecting a Well Constructor 12-13
Siting Your Well 9
Sodium 33
Softener 35-37
Soluble Iron 52
Sources of Water 1
Sulfur Bacteria 51
Testing for Organic Contaminants 34
Testing Your Well Water Process 22-23
Top 20 ™ 29, 72
Troubleshooting 63-66
Types of Wells 14
Usage Demand, Water 19
UV Filtration 48
Water Chemistry Analysis Summary 40-41
Water Code 7
Water Cycle 2
Water Filtration Systems 42-52
Water Pressure 18
Water Quality 21-58
Well Head Seals 16
Well Logs / Reports 8
Witching 9
Zinc 33

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"What Is Groundwater?" Dr. Lyle S. Raymond, Jr., and published by New York State Water Resources Institute, Cornell University.

Reverse Osmosis, Canada Mortgage and Housing Corporation

Groundwater Stewardship Program, Oregon State University

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