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Private Drinking Water Wells: Planning for Water Use

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This publication is one of six in a series designed to help rural families understand and manage their private drinking water supplies.

When planning for a private drinking water supply, it is important to determine if the well capacity will meet water demands. The well capacity — the amount of water that can be produced — must be accurately determined. A Nebraska-licensed water well professional can help determine the appropriate well flow rate — a measure of the gallons of water that can be produced per minute. The flow rate must be capable of providing the total quantity of water needed every day — the total daily demand. In addition, the flow rate should be sufficient to meet temporary large demands that occur throughout the day — the peak use demand. If the amount of water produced by the well is greater than the total daily demand, but the flow rate is insufficient to meet the peak use demand, intermediate storage can be used to supplement the water supply during peak use periods.

In addition, it is important to determine if the well water quality is adequate for its intended use. Drinking water does not need to be pure to be safe for consumption, hygiene, and other domestic uses. Whether drinking water is safe will depend on which substances are present and in what amounts. Water quality can be determined by having a sample tested by a certified laboratory. If water quality does not meet the minimum standard desired, water treatment may be an option.

Determining Well Capacity

A Nebraska-licensed water well professional can determine the yield of a well. The professional will pump the well continuously for an extended period. During the pumping period, measurements will be taken to determine the water level drop in the well relative to the rate at which water is being pumped out. The balance point will occur when the water level stops dropping as a given amount is pumped, providing the well yield in gallons per minute. Quantities of water produced by marginal aquifers are difficult to estimate by the contractor and sometimes wells do not yield as desired. There are several variables that cannot be easily accounted for when dealing with marginal aquifers. It is important to have realistic expectations when dealing with marginal aquifers.

Determining Water Quantity Needs

The quantity of water supplied by a private water supply must meet the total daily demand and all peak use demands. Both demands can be minimized with wise water use.

Total Daily Demand

The average American uses from 60 to 100 gallons of water per day. You can estimate the total daily domestic water demand by multiplying use (100 gallons per day) by the number of people that might reasonably be expected to live in the rural home. This gives an estimate of the total gallons per day that will be needed for domestic use. A more specific total daily demand can be calculated by using the water use estimates in *Table I*. Amounts are based on long-term national averages; actual water use may vary significantly.

The well flow rate (gallons per minute, or gpm) multiplied by the number of minutes in a day that the well pump will operate provides an estimate of the total gallons of water that will be produced each day. This amount must be equal to or greater than the total daily demand. Minimizing water use will reduce the total daily demand. To reduce demand, start with the fixtures and activities that use the largest volumes of water. The toilet, shower/bath, and clothes washer account for two-thirds of the water used in an average household.

Toilets installed after 1993 are water efficient. Toilet dams or water-filled plastic containers can be installed in older toilet tanks but the reduced flow can affect the effectiveness of a flush; you may have to flush two or three times to remove the waste. In older toilets, about 3 gallons of water may be needed in the tank to flush properly. Avoid placing bricks that crumble in the tank; they may affect operation. Reduce the number of toilet flushes by not using the toilet as a waste paper basket.

Table I. Water use estimates for household appliances and fixtures

Appliance or Fixture	*Typical Water Use*
Clothes washer — standard	40 to 50 gallons per load
Clothes washer — high efficiency	18 to 28 gallons per load
Dishwasher — standard	7 to 14 gallons per load
Dishwasher — high efficiency	4.5 to 7 gallons per load
Sink faucet — standard	3 to 5 gallons per minute of use
Sink faucet — low flow	2 gallons per minute of use
Toilet — standard	3.5 to 5 gallons per flush
Toilet — low-flush (Required Jan. 1, 1994)	1.6 gallons per flush
Shower — standard	6 to 8 gallons per minute of use
Shower — low-flow (Required Jan. 1, 1994)	2.5 gallons per minute of use
Garbage disposal	4 gallons per minute of use
Water softener regeneration	50 to 100 gallons per cycle
Backwash filters	100 to 200 gallons per backwash
Reverse osmosis filter	3 to 5 gallons per 1 gallon of treated water

Leaks account for a great volume of water usage. About 20 percent of toilets leak. To test for a leak, put a few drops of food dye in the tank. If, after 15 minutes, color appears in the bowl, there is a leak that should be repaired. Typically, the toilet flapper needs replacing or the water level needs adjusting.

The rate that water flows through fixtures will affect the amount of water used. Showerheads manufactured after 1993 have flow rates of no more than 2.5 gpm. Faucet aerators at sinks restrict the water going through the faucet by about 50 percent, adding air to make the flow appear the same. Faucet aerators with flow rates of 1.5 gpm or lower (½ - 1 gpm) are available.

Water-saving clothes washers use about ⅓ as much water as traditional washers. When purchasing a new washer, check the label to determine water efficiency. Try to narrow your options to those that are most efficient. Features to look for include the option of reusing water from one wash cycle for another wash cycle, and the ability to adjust water levels to accommodate different size loads or different degree of washing needed. When laundering, adjust water levels to the laundry load size and degree of soil. Typically, fewer full loads use less total water than several small loads.

Peak Use Demand

Water use will not be the same over the course of a day; it will fluctuate. Water systems must meet the needs of many uses during short periods of time. These times, called peak use periods, usually occur near mealtimes, during laundry periods, and when occupants are showering or bathing. The water system should be able to produce enough water to meet the peak demand for a period of two hours. If it cannot, intermediate storage can be used to supplement the water supply during peak use periods.

The *Private Water Systems Handbook*, developed by Midwest Plan Services[1], recommends the following minimum flow rates for homes to meet peak demand.

A minimum of 10 gpm is recommended for a 2-bedroom, 2-bath home. The minimum flow rate increases with additional bedrooms and/or baths since larger homes will be likely to have more residents using more fixtures and appliances at the same time. Other recommended minimum flow rates include:

3 bedrooms, 2 baths — 12 gpm
4 bedrooms, 3 baths — 16 gpm
5 bedrooms, 3 baths — 17 gpm

In general, add 2 gpm for each additional bedroom and 2 gpm for each additional bath.

Ideally, the yield of the well should exceed the recommended minimum flow rate. This is because the recommended minimum flow rate may not support the operation of multiple water-using devices at the same time, and some devices may require greater flow rates to operate properly. The *Private Water Systems Handbook* lists flow rate requirements for typical devices (*Table II*).

Table II. Typical flow rate requirements for household water-using devices. MWPS (Midwest Plan Service), Iowa State University, Ames, IA, *www.mwps.org*. Used with permission: Jones, D. *Private Water Systems Handbook.*

Device	*Typical Flow Rate Required for Operation*
Automatic washer	5 gpm
Dishwasher	2 gpm
Garbage disposal	3 gpm
Kitchen sink	3 gpm
Shower or tub	5 gpm
Toilet flush	3 gpm
Bathroom sink	2 gpm
Water softener regeneration	5 gpm
Backwash filters	10 gpm
Outside hose faucet	5 gpm
Outdoor lawn sprinkler system	12 gpm
Fire protection	10 gpm — preferred 20 gpm

[1]©MWPS (MidWest Plan Service), Iowa State University, Ames, IA., *www.mwps.org*. Used with permission: Jones, D., *Private Water Systems Handbook*.

Lawn sprinkler systems place additional demands on the system. Typical lawn sprinkler irrigation systems may require a 12-gpm flow rate to operate properly. This is in addition to that required to meet normal household needs.

Peak use demand can be reduced by changing the timing of water-using activities and spreading out water use. Spread out laundry, doing only one or two loads per day. Have some family members shower at night while others shower in the morning. Install low-flow water fixtures, and encourage short showers. Run the dishwasher at night after family members have gone to bed. Compost food wastes and avoid using a garbage disposal.

Conserving water and distributing water use over an extended period has the additional benefit of extending the life of a septic system. Wastewater generated by a household should remain in the septic tank long enough — at least 24 hours — for heavy solids to settle out, forming sludge, and light solids to float to the top, forming scum. Except for the period immediately after pumping, a septic tank contains wastewater to its full capacity at all times. As a gallon of wastewater flows into the tank from the house, a gallon of effluent flows out of the tank into the drainfield. If wastewater moves in and out of the tank too rapidly, due to constant flow for extended periods, or heavy water flow at any time, solids remain suspended in the wastewater. This means they may move with the effluent out of the tank and into the drainfield. Solids can clog a drainfield, decreasing its ability to treat wastewater. This can lead to costly repairs or even the need for replacement.

Determining and Protecting Water Quality

Drinking water is never pure. Water naturally contains minerals and microorganisms from the rocks, soil, and air with which it comes in contact. Human activities can add many more substances to water. Drinking water does not need to be pure to be safe, however. In fact, some dissolved minerals in water can be beneficial to health. For example, the National Research Council states that drinking water containing dissolved calcium and magnesium generally contributes a small amount toward human dietary needs. Naturally occurring fluoride in groundwater can help protect against tooth decay. Whether or not drinking water is safe will depend on which substances are present and in what amounts.

An ounce of protection is worth a pound of cure when it comes to the drinking water source. If wells are poorly located, constructed, or maintained, they can allow bacteria, nitrate, or other pollutants to contaminate the groundwater serving as the drinking water source.

Most acreages, farms, and ranches with private wells use septic systems or other onsite wastewater treatment systems for treating wastewater and returning it to the environment. If systems are poorly designed, located, constructed, or maintained, they can contribute to groundwater contamination.

Runoff is the water from rain, melting snow, or excess irrigation that moves across property. As it flows, runoff can collect and transport soil, pet waste, livestock manure, salt, pesticides, fertilizer, oil and grease, leaves, litter, and many other potential pollutants. Polluted runoff can flow down a poorly sealed or an unplugged well where it can contaminate groundwater. In areas with porous, sandy soils, pollutants carried by runoff may percolate through the soil into groundwater.

Pesticides (herbicides, insecticides, fungicides, and rodenticides) and fertilizers (nitrate and phosphorus) play an important role in the management of rural property. If pesticides and fertilizers are not stored, handled, and applied correctly, they can seep through soil into groundwater.

Consider the variety of products used in households and on rural property — paints, solvents, oils, cleaners, wood preservatives, batteries, and adhesives. Also, consider the amount of these products that goes unused or is thrown away. Minimizing usage of these substances, along with practicing proper disposal procedures can protect groundwater, the source of drinking water.

For additional information on drinking water protection, see:

Protecting Private Drinking Water Supplies: An Introduction, *www.ianrpubs.unl.edu/sendIt/g2049.pdf*

Protecting Private Drinking Water Supplies: Water Well Location, Construction, Condition, and Management, *www.ianrpubs.unl.edu/sendIt/g2050.pdf*

Protecting Private Drinking Water Supplies: Household Wastewater (Sewage) Treatment System Management, *www.ianrpubs.unl.edu/sendIt/g2051.pdf*

Protecting Private Drinking Water Supplies: Hazardous Materials and Waste Management, *www.ianrpubs.unl.edu/sendIt/g2053.pdf*

Protecting Private Drinking Water Supplies: Pesticide and Fertilizer Storage and Handling, *www.ianrpubs.unl.edu/sendIt/g2054.pdf*

Protecting Private Drinking Water Supplies: Runoff Management. *www.ianrpubs.unl.edu/sendIt/g2052.pdf*

Testing Private Drinking Water

The quality of water provided by a private drinking water well can be determined through laboratory analysis. Several Nebraska laboratories offer testing services that include drinking water analysis. Some are operated by government agencies and others are private commercial laboratories.

Since there are many potential water contaminants, it would be very costly — and in most cases unnecessary — to test a private water supply for all of them. Tests for nitrate and bacteria often are used as general indicators of the safety of private well water. Generally, private water supplies should be checked annually for these contaminants. Tests for nitrate and bacteria do not guarantee the water is safe, however, as other contaminants could be present. Tests should be done for other substances when specific contamination is suspected. Contamination might be the result of a spill, backflow, use of product near the well, the presence of industrial or commercial activities in the vicinity of the well, the presence of a contaminant in neighboring wells, or other similar situations.

The safety and quality of private drinking water in Nebraska is not subject to any federal or state regulation. It is at the discretion of the water user except in cases where water quality is regulated at the local level or when state licensing may be required for a specific activity. Although not required by federal or state regulations, the quality of private well water can be evaluated by comparing test results to water quality standards enforced for public drinking water supplies.

The Federal Safe Drinking Water Act directs the U.S. Environmental Protection Agency (EPA) to establish minimum national drinking water standards for public water supplies. These standards set limits on the amounts of various substances allowed in public drinking water. EPA regulations currently cover about 100 potential contaminants. Drinking water regulations established by EPA reflect the best available scientific and technical judgment. The number of contaminants regulated is increasing, and standards are re-evaluated as new data and information become available.

The maximum concentration of nitrate-nitrogen allowed in public water supplies is 10 milligrams per liter, which also can be reported as 10 parts per million. Public water supplies must be free of bacteria. While not required, users of private water supplies might strive to meet these standards.

For additional information on water quality, see:

An Introduction to Drinking Water, *www.ianrpubs.unl.edu/sendIt/g1539.pdf*

Drinking Water: Arsenic, *www.ianrpubs.unl.edu/sendIt/g1552.pdf*

Drinking Water: Bacteria, *www.ianrpubs.unl.edu/sendIt/g1826.pdf*

Drinking Water: Copper, *www.ianrpubs.unl.edu/sendIt/g1360.pdf*

Drinking Water: Fluoride, *www.ianrpubs.unl.edu/sendIt/g1376.pdf*

Drinking Water: Hard Water (Calcium and Magnesium), *www.ianrpubs.unl.edu/sendIt/g1274.pdf*

Drinking Water: Iron and Manganese, *www.ianrpubs.unl.edu/sendIt/g1714.pdf*

Drinking Water: Lead, *www.ianrpubs.unl.edu/sendIt/g1333.pdf*

Drinking Water: Nitrate-Nitrogen, *www.ianrpubs.unl.edu/sendIt/g1784.pdf*

Drinking Water: Sulfur (Sulfates and Hydrogen Sulfide), *www.ianrpubs.unl.edu/sendIt/g1275.pdf*

Drinking Water: Uranium, *www.ianrpubs.unl.edu/sendIt/g1569.pdf*

If water quality does not meet the desired minimum standard, water treatment may be an option. No single piece of treatment equipment manages all contaminants. All treatment methods have limitations and a situation may require a combination of treatment processes to effectively achieve the desired water quality.

For additional information on water treatment, see:

Drinking Water Treatment: An Overview, *www.ianrpubs.unl.edu/sendIt/ec703.pdf*

Drinking Water Treatment: What You Need to Know When Selecting Water Treatment Equipment, *www.ianrpubs.unl.edu/sendIt/g1488.pdf*

Drinking Water Treatment: Sediment Filtration, *www.ianrpubs.unl.edu/sendIt/g1492.pdf*

Drinking Water Treatment: Carbon Filtration, *www.ianrpubs.unl.edu/sendIt/g1489.pdf*

Drinking Water Treatment: Water Softening (Ion Exchange), *www.ianrpubs.unl.edu/sendIt/g1491.pdf*

Drinking Water Treatment: Reverse Osmosis, *www.ianrpubs.unl.edu/sendIt/g1490.pdf*

Drinking Water Treatment: Distillation, *www.ianrpubs.unl.edu/sendIt/g1493.pdf*

Drinking Water Treatment: Continuous Chlorination, *www.ianrpubs.unl.edu/sendIt/g1496.pdf*

Drinking Water Treatment: Shock Chlorination, *www.ianrpubs.unl.edu/sendIt/g1761.pdf*

Summary

When planning for a private drinking water supply, consider the quantity and quality of water that will be needed. The quantity of water supplied by a private water supply must meet the total daily demand and all peak use demands. Both total daily demand and peak use demands can be reduced with wise water use. The quality of a private drinking water supply is at the discretion of the user, and drinking water does not need to be pure to be safe. The quality of water can be evaluated by testing the water and comparing laboratory results to guidelines established for public water supplies. If the water quality is less than desired, treatment may be an option.

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The Midwest Plan Service publication *Private Water Systems Handbook* provides additional information on private drinking water systems. The publication can be purchased from Midwest Plan Service, 122 Davidson Hall, Iowa State University, Ames, Iowa, 50011-3080; phone 800-562-3618; website *www.mwps.org*.

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