NATIONAL EDITION

practical plumbing

HANDBOOK

WITH IMPORTANT WATER-SAVINGS TIPS

Updated 2019

Practical Plumbing Handbook

This booklet will provide you with useful information on conserving water and fixing many common problems such as leaky faucets, running toilets and inefficient irrigation systems.

This handbook explains just a few of the ways that you can conserve water while keeping your home in tip-top condition. It is not intended to help you fix major plumbing problems. In these instances, please call a licensed plumber.

Alliance for Water Efficiency

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CALIFORNIA WATER EFFICIENCY PARTNERSHIP

A Chapter of the Alliance *for* Water Efficiency

WWW.CALWEP.ORG

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Water conservation is not something that should be considered only during a drought. Conservation and water efficiency should be a way of life.

TOP TEN WAYS TO SAVE WATER AT HOME

SECTION 1

The ABC's of Plumbing

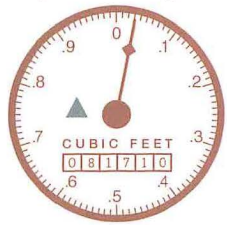
Funny, It Didn't Look Broken

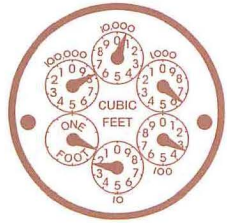
WATER METERS – HOW TO DETERMINE IF YOU HAVE A LEAK

The Two Common Meter Types

Your water meter keeps track of how much water your household uses. The meter is usually located on your property near the street inside a concrete box marked "WATER METER." It may be a bit dark inside the meter box, so bring a flashlight along! In some homes the water meter is located in the basement. Note that some water providers have been replacing older analog meters with digital models and most newly-constructed homes are equipped with digital meters.

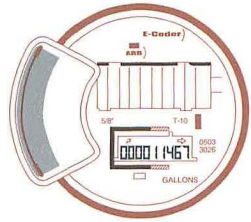
Example – Analog meters





Meters measure water in cubic feet, gallons, cubic meters, or other units. One cubic foot is equal to 7.48 gallons. For example, if your meter says you used 41 cubic feet in a day, you would multiply 41 by 7.48 to find that 306 gallons were used. In the U.S., units may be measured as 100 cubic feet or 1,000 gallons. In Canada, the measure is in cubic meters. Digital meters will often alternate between the unit read and the flow rate in gallons or litres per minute.

Example – Digital meter



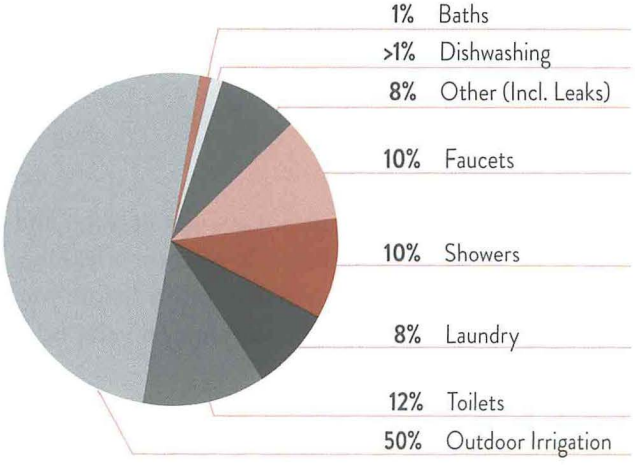
You can check for leaks on individually-metered residences by using your meter. Simply turn off all

water uses on the property. If the flow indicator (triangle or star) is turning, you've got a leak. If not, note the location of the pointer and the last two numbers on the far right windows. Do not run water for 30 minutes. If the pointer has moved and/or the numbers have rolled higher, there is a leak. Turn off your home's main shut-off valve. If the pointer is still moving, then the leak is somewhere in the supply line from the meter to the shut-off valve. If the pointer stops rotating, then the leak is inside the house.

It is important to note that very small leaks might not be detectable at the meter, depending upon the type and age of meter. Even if there is no movement, you still need to check individual fixtures, fittings and appliances for possible leaks.

Digital meters will indicate leaks in various ways depending upon what type of meter model you have. The easiest way to detect a leak is by observing the flow indicator value after all water to the property has been shut off. If the flow indicator displays positive flow, you have a leak. Some digital meters might also indicate leaks by displaying a leak indicator icon, the term "reverse" ("forward" indicates normal operations), or a left-pointing arrow. Read on to determine the possible cause.

Single Family Water Use



MASTER VALVES – HOW TO SHUT OFF THE HOUSE WATER SUPPLY

The master water supply shut-off valve controls the water supply coming onto your property and into your home. It is usually located inside the water meter box (generally installed in a front yard or basement). Once you have found the master valve, paint or label it so it is easy to locate. Show everyone in the home the location of the valve in case of an emergency, such as a burst pipe. Make sure the master valve is accessible—if a pipe is broken and water is gushing out, you don't want to have to climb over obstructions to close the valve! Turn the valve handle clockwise to shut off the water supply.

Shutoff Valves to Fixtures

Most modern homes also have shutoff valves for the water lines to individual fixtures and water-using appliances. Shutoff valves are located under sinks on both hot and cold supply lines, beneath a toilet tank, at water supply hoses leading to a washing machine, and at the pipe leading into a water heater. Check these valves annually to ensure they are not stuck in place, corroded or partially turned off. Stuck or corroded shutoff valves may spring a leak when suddenly turned. If a shutoff valve appears to be stuck or corroded, schedule it for replacement. If a particular fixture such as a faucet has little or no flow, the shutoff valve may be partially or fully turned off.

NOTE: Shutoff valves should **always be kept in the fully open position** (or fully off during repairs).

LEAKS

Left unfixed, leaks can waste a very significant amount of water and can develop into more serious plumbing problems. If a fixture is leaking, such as a faucet or toilet, turn off the shutoff valve to that fixture before you repair it. If there is no shutoff valve, turn off the master shut-off valve (at or near the water meter) to the house water supply.

Section 2 of this booklet provides specific instructions on how to fix many common leaks around the home:

WATER PRESSURE

Water pressure that is too high or too low can be the cause of many common plumbing problems.

Low water pressure results in low water flow.

Possible causes of low or no water flow are:

- Low incoming pressure to the house
- Partially closed shutoff valve to a fixture (as noted above, shutoff valves should **always** be fully open)
- Clogged screens and aerators in faucets
- Clogged strainers in hose connections (to washing machine, for example)
- Clogged or blocked water supply tubing
- Clogged showerheads
- Bad diverter valve to shower (for shower over tub combination)
- Frozen or freezing pipes
- Faulty pressure regulator
- Clogged water softeners
- Clogged water purifiers

Low pressure to a faucet or fixture can be caused by a partially closed shutoff valve. Check this first.

If you still have low pressure, you may have a clog or stoppage somewhere in the system. Section 2 of this booklet tells how to clean or repair clogged faucet aerators, water supply tubing, shutoff valves, showerheads, clothes washer and hose screens.

If only the hot-water faucet has low pressure and the washing machine shutoff valve is open, check the inlet valve to the water heater (see page 51).

If the flow to all your faucets and fixtures is abnormally low, the master shutoff valve coming into your house may be partially closed. If this isn't the problem, call a plumber or your water agency.

High water pressure can also be a problem.

Water pressure is a function of the water utility serving the home. You have no control over it. Pressure can vary slightly depending upon your home's relation to hills, reservoirs and pumps. Water pressure that is too high can waste water and stress your pipes, connection hoses, water-using appliances, and fixtures. Water should enter the house at about 45 to 60 pounds of pressure per square inch (psi)...plumbing codes usually set the maximum at 80 psi. You can check your water pressure with a simple water pressure gauge (available at most hardware stores for about $10). The gauge attaches to an outdoor faucet (hose bibb). Note: some hose bibbs may "T" off the main service line to the house, **before** the pressure regulator, so it may not be reading the indoor water pressure. Check your own plumbing configuration. For indoor water pressure, for example, attach the gauge to the shut-off valve serving your clothes washer in order to get the reading **after** the pressure regulator. Also, check the pressure at the front and back outdoor hose bibbs; minor differences in pressure may indicate the complete lack of a pressure regulator. As such, one should be installed if your municipal water provider is delivering water at high pressure to your home.

A damaged or worn out pressure regulator can result in destructively high water pressure in the building. Excess pressure can cause shortened water-heater life and failure of the dishwasher solenoid valve, and it is harder on the icemaker, faucets, fixtures, water-using appliances, and the whole plumbing system in general.

Furthermore, water pressure in excess of 80 psi may void warranties of some appliances or fixtures. And, if you have a home warranty, some warranty companies will void your warranty if you have excessive water pressure.

Water pressure regulators are mounted inline on the incoming water supply and can be exposed or buried. Regulators control both the water pressure and the flow rate of the incoming water supply. They are usually required by your local building department in order to comply with the prevailing plumbing code.

In the typical home, pressure regulators have a lifetime of 10 to 15 years, although earlier failure could occur in situations where extremely hard water exists. So, if you have an older home in which the regulator has never been replaced, it may be time to do so.

Water Hammer

Have you ever heard a slamming or banging noise in your plumbing system when someone shuts off a faucet? That sound is called water hammer, and it is caused by the sudden change of water flow, with resulting pressure surges, which makes pipes vibrate. Over time, recurring water hammers can loosen the mounting brackets that attach the pipes to the studs and joists in your home, leading to more movement and risk of leakage or a break in pipe joints and fittings.

Water hammer is most often caused by high water pressure in excess of 65 psi. Installing a pressure regulator (see above) to your home's water supply may be the simplest way to stop water hammer. If this doesn't work, you can try restoring the "water hammer arrestors" in your plumbing system (if you have them).

Many homes have short sections of pipe rising above each faucet (usually concealed inside the wall). These are filled with air and act as shock absorbers. Over time, they can become filled with water and lose their effectiveness.

Fortunately, hammer arrestors can be easily restored by draining your home's pipes, and slowly turning the water supply back on. To do this, first close the house master supply shutoff valve and all the shutoff valves to the toilets. Open the highest and lowest faucets in the house to drain all the

water from the pipes. Then close the faucets and reopen the house master valve and the toilet shutoff valve(s). Slowly turn on each faucet and the water arrestors should be refilled with air and restored. If your house doesn't have hammer arrestors, it may be time to install them by hiring a plumber or purchasing the arrestors at a hardware store and installing them yourself.

If none of these solves the problem, a plumber may have to install a pressure relief tank in your home plumbing system. This tank is partially filled with air and acts as a shock absorber to stop water hammer.

SECTION 2

Repairs & Preventative Maintenance

INDOORS

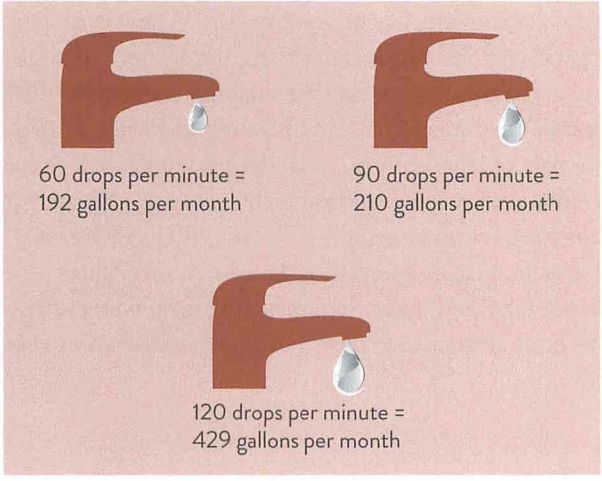
Leaks

Leaks Waste Water, Cost Money

Leaks: through an opening, pressure 60 lbs.

Leak size	1/4″	3/16″	1/8″	1/16″	1/32″
Gallons per month wasted	400,000	225,000	100,000	25,000	6,800

Leaks: drops



Faucets

Most faucets can be categorized as being either washerless- or compression-(washer) type faucets. Just because a faucet is washerless does not mean it will never leak. Rather, the parts will last longer since their design minimizes friction and wear.

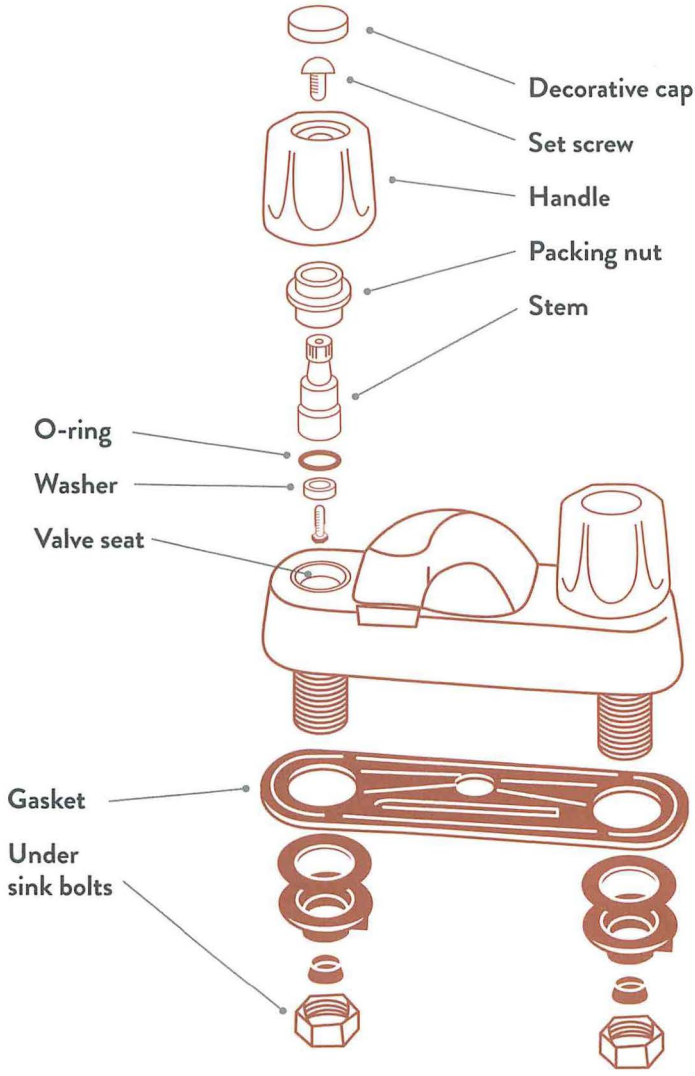
Before working on any type of faucet, turn off the shutoff valves beneath the sink. Cover the sink with a towel to protect it from tools that might drop, and to prevent small parts from falling into the drain. Wrap the jaws of wrenches with duct tape to protect the surface finish of the faucet.

When disassembling a faucet, pay close attention to the order of the parts; it's easy to forget the correct order in which a faucet is assembled. You might even sketch or photograph the parts lying in sequence. Keep the old parts to take to the hardware store for the proper replacements. Note the make and model of the faucet to make it easier to find and purchase parts or kits at the hardware store or online.

If you have less water flow when you turn the water back on after a plumbing repair, rust is probably clogging a valve. Old steel pipes (especially hot water lines) rust on the inside. When you turn the water back on, rust scales break loose and lodge in the valves. To clear them out, open the faucets to full flow and then clean the faucet aerators.

If you have to replace your faucet, look for the WaterSense label when purchasing products. All products bearing the WaterSense label complete a third-party certification process that includes independent laboratory testing to ensure they meet U.S. Environmental Protection Agency (EPA) criteria. As a part of that criteria, WaterSense faucets are characterized by steady flow even at very low building water pressures because they are what is termed "pressure compensating". Faucets and faucet accessories—products that can be attached easily to existing faucets to save water—that obtain the WaterSense label will have demonstrated both water efficiency and the ability to provide adequate flow. For more information visit **epa.gov/watersense/**.

Compression or Washer Type Faucet



Repairing Dual-Handle Compression Type Faucets

Compression faucets (also known as washer-type faucets) have separate cold and hot water handles that come to a "soft stop" when turned off. Compression faucets typically leak due to worn hardware including washers, gaskets, o-rings and/or corroded valve seats. Leaks occur at either the handle or the spout.

To fix a leak at the *spout*, determine whether the leak is coming from the hot or cold valve by turning off the water at each of the fixture shutoff valves (typically located under the sink). Whichever valve leaks after being turned off is the shutoff valve in need of repair.

Fixing a leak around one of the *handles* may require nothing more than removing the handle and tightening the packing nut. After turning off the water supply, remove the handle by popping off the decorative cap on top of the handle and remove the set screw (Note: there may be a small set screw on the side of the handle). Next, tighten the packing nut with a wrench. If this does not stop the leak, loosen the packing nut and remove the stem. Replace the stem if it is damaged or the threads are worn. The problem might also be a worn washer located at the end of the stem. To replace the washer, remove the screw that attaches the washer to the stem. Next, re-fit the stem with a new washer. The washer must be the correct size so that it fits snugly around the stem.

If the washer is not damaged, you may need to repair or replace the valve seat. There are two types of valve seats: built-in and removable. If the valve seat is built into the faucet, you'll have to smooth it with a tool called a valve-seat dresser. Insert the dresser into the valve seat and turn it clockwise one or two times. Clean out metal shards with a clean damp cloth. If the valve seat is removable use a valve wrench to remove the old seat. Before installing a new valve seat, be sure to coat the threads with pipe joint compound.

Repairing Single-Handle Washerless Faucets

These popular washerless faucets use one lever or handle to control both hot and cold water flow. There are two basic types of single-lever faucets: cartridge valves (Moen and American Standard are common brands) and ball-valves (Delta and Peerless are common brands). Both require

replacement parts that are often specific to the manufacturer of the faucet, although some generic replacement parts are available at most home improvement stores or can be purchased online.

A ball valve can be identified by the faucet handle moving in all directions, similar to a joystick for a computer game. Cartridge faucets allow the faucet handle to move straight up and down to control water flow; the handle turns clockwise and counterclockwise to adjust the mix of hot and cold water. Both types of faucets will eventually leak, and repairs are not too difficult, as long as you have the right tools and repair parts.

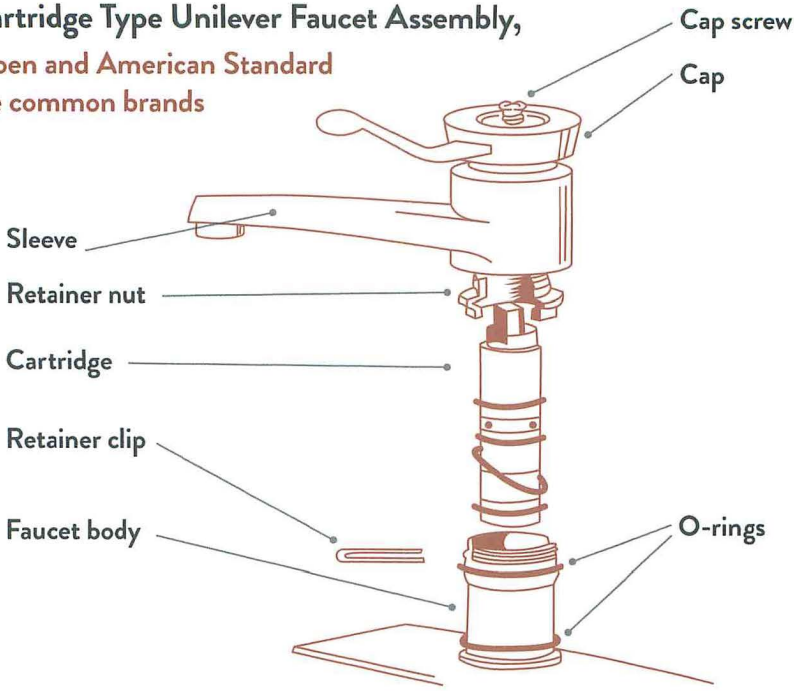
For both ball valve and cartridge valve type faucets it is best to buy a repair kit with all of the replaceable parts, rather than to purchase o-rings and gaskets separately. In addition to parts, kits often include the required hex wrench and silicone lubricant.

Repairing Cartridge Type Single-Handle Faucets

Cartridge faucets have only one moving part. The stem slides up and down to open and close the faucet and rotates to regulate the flow of hot and cold water. Any leak repair requires replacement of the cartridge. Purchase the matching cartridge, needed tools, and silicone plumbing lubricant (sometimes included with the cartridge). DO NOT use any other type of lubricant unless it is expressly approved for potable water plumbing fixtures.

Cartridge Type Unilever Faucet Assembly,

Moen and American Standard are common brands



Step 1	First, turn off the shut-off valve beneath the sink, and open the faucet. To remove the cartridge, you'll need to remove the handle and spout cylinder. Usually there is a set screw on top of the handle behind a decorative snap-on cap, or on the side of the handle. Some handles are attached with a retainer clip at the rear of the faucet just below the handle. The retainer clip may be hidden beneath the handle inside a lift-out tube. Some cartridge faucets use two retainer clips– one by the handle and another by the cartridge.
Step 2	After removing the handle and spout cylinder, look for a retainer clip that holds on to the cartridge. If a retainer clip is found, it can be pried out with a screwdriver. Once the retainer clip is removed, the cartridge simply pulls out (use pliers if needed).
Step 3	Install the new cartridge by applying a thin coat of silicone plumbing lubricant. Push the new cartridge into place.
Step 4	Replace the spout cylinder over the valve.
Step 5	Replace the clip(s) to secure the cartridge and or spout cylinder. Replace flow control handle and tighten set screws if necessary.

Repairing Ball-Valve Single-Handle Faucets

See illustrations on page 19

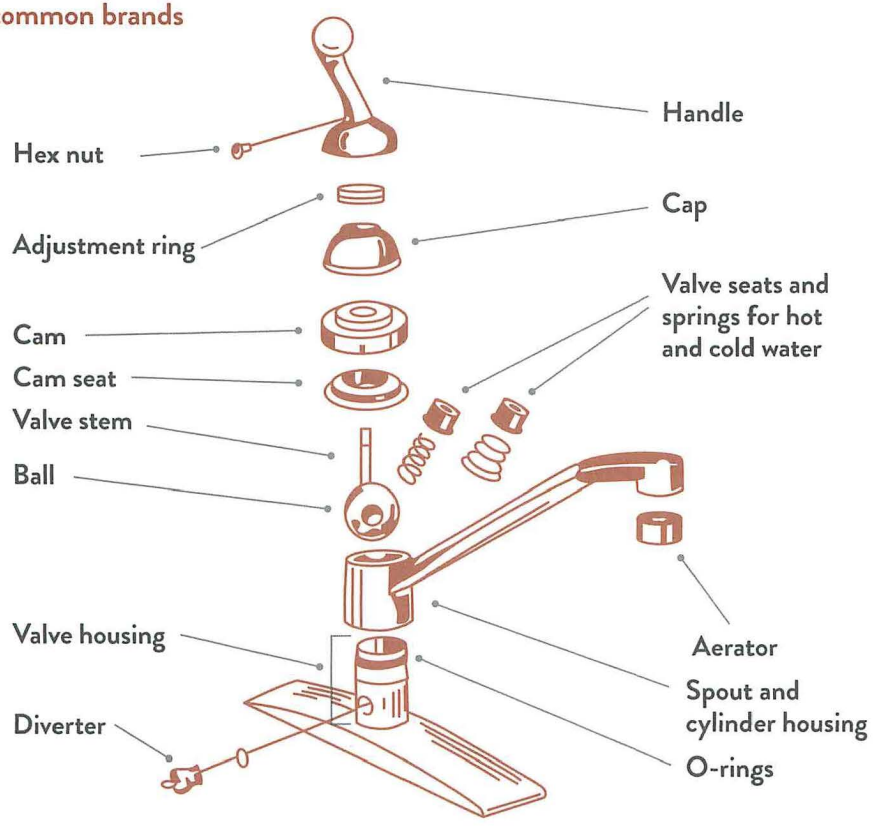
Purchase the matching ball-valve repair kit, needed tools, and silicone plumbing lubricant (sometimes included with the repair kit). DO NOT use any other lubricant unless it is expressly approved for potable water plumbing fixtures.

Step 1	Shut off the water leading to the faucet. Open the faucet to check that neither hot nor cold water are flowing.
Step 2	Close the drain and place a cloth in the sink, as there will be small springs, screws and parts that may easily fall into the drain.
Step 3	Remove the faucet handle by loosening the hex nut at the base of the handle. The handle should slip off the stem of the ball valve.
Step 4	Unscrew the cap using pliers (adjustable channel pliers work best). The cap will have a plastic adjustment ring at the top. You do not need to unscrew these pieces.
Step 5	Remove the cam assembly found under the cap. The cam merely sets on top of the ball-valve. Examine the cam, and notice the small slot on one side that matches up to a small pin on the cam seat. The cam assembly is often two plastic pieces that fit together. You usually do not need to replace these parts. Save both pieces to be reinstalled later.
Step 6	Lift the ball-valve out of the housing. You will find two small valve seats on springs inside the valve. Remove both of these valve-spring sets. These valve-spring sets will probably be worn, causing the leak, and will need to be replaced.
Step 7	Remove the spout and cylinder housing by gently pulling the part straight up. After removal, you should see two o-rings around the outside of the valve. These o-rings prevent leaks from around the base of the faucet and are often worn. Note their location: you'll need to put the new o-rings back on the exact same place.
Step 8	Slide the rubber o-rings off the valve housing. You may need a dull knife to assist you in prying the o-rings out of the grooves they set in. Install the new o-rings by sliding the rings over the top of the valve housing and rolling the rings into the same groove in which the old o-rings were located.

Step 9	Install the new valve seat-spring assemblies with the rubber valve seats up. Delta/Peerless assemblies come in two styles, brass ball and conical style short set. If you have the brass ball type, use long seats and springs. Be sure to replace the valve seat and springs with the type that is most similar to the pre-existing set. Most plastic, stainless steel balls use the conical style short set.
Step 10	Examine the ball-valve. This ball works in conjunction with the springs and seats. If the ball is nicked or scratched, it will wear out your new valve seats very quickly. Replace the ball if necessary. Notice the two holes and the one slot on the ball. The two holes allow water to pass through the valve. The slot corresponds to a pin at the bottom of the valve housing the ball sets inside.
Step 11	Put a THIN layer of silicone plumbing lubricant over the inside of the spout and cylinder housing, and then slide the housing over the top of the o-rings and valve until it sets onto the base.
Step 12	Place a THIN coat of lubricant on the ball, while holding the ball by the stem. Try not to get any grease on the stem.
Step 13	Replace the ball with the ball slot sliding over the valve pin. Be certain the valve spring sets are properly set inside the holes before replacing the ball-valve
Step 14	Replace the cam assembly with the small cam pin fitting into the small slot at the top edge of the cylinder. Re-install the cap assembly by screwing the cap in a clockwise direction.
Step 15	Using the adjusting fork attached to the hex-wrench from the repair kit, turn the adjustment ring on the cap so the valve stem can move snugly but freely. The two tines on the adjusting fork will fit into two small slots on the adjustment ring. If you adjust too tightly, the valves will wear out quickly ; if you adjust too loosely, water will leak out of the valve. A snug fit allowing the valve stem to move with slight effort is perfect.
Step 16	Replace the handle over the stem of the ball-valve. Tighten the hex-nut to secure the handle.
Step 17	Turn the water back on at the shut-off valve. Test the faucet for both hot and cold water supply. Search for leaks. Brag to all your friends about your accomplishment.

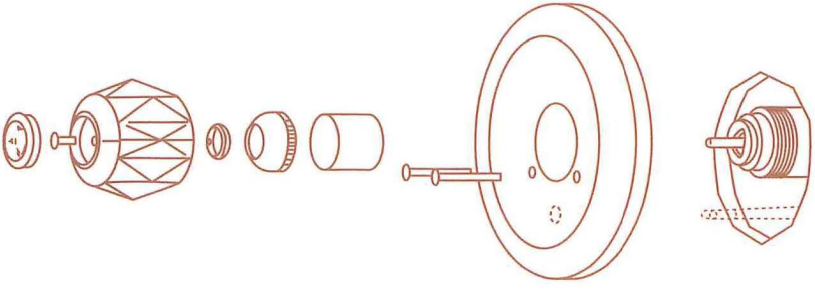
Kitchen Ball-Valve Unilever Faucet,

Delta and Peerless are common brands



Shower Ball-Valve Unilever Faucet,

Same parts as kitchen ball valve faucet



Aerators

Aerators are installed on most faucet spouts, and serve to mix air and water for a smooth flow. They often become clogged with minerals and debris, and need to be cleaned periodically. Unscrew the aerator and lay the aerator parts on the counter in the order in which you removed them (or make a sketch of their order, so that you put them back correctly). Flush the parts with water and clean the screen holes with a toothbrush or toothpick.

Hard-water scale can be removed by soaking the parts in vinegar or lime dissolver. Flush the faucet and all parts with water before reinstalling. If the aerator can't be cleaned, or is worn out, take it with you to a hardware store to find a proper fitting replacement. Check with your local water or energy utility to see if they offer aerators at no cost.

Faucet Aerator Installation

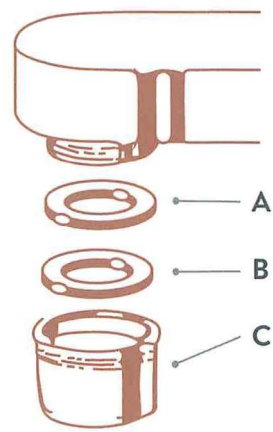
Remove old aerator.

Inside threaded faucets:

- Place upper washer (A) on lower washer (B) in top of aerator (C).
- Screw aerator into inside threads of faucet.

Outside threaded faucets:

- Discard upper washer (A). The top washer is for faucets with inside threads only.
- With lower washer (B) in top of aerator, screw aerator onto outside threads.



Plumbing Repair Tips

- Know the location of the master valve to shut off the house water supply before attempting any repair
- Turn clockwise or "righty-tighty" to tighten a fitting, and counter-clockwise to loosen a fitting.
- Turn off the shutoff valve beneath the fixture being repaired. If there is no shutoff valve or you are replacing a malfunctioning shutoff valve, turn off the house master valve.
- Keep towels and buckets handy for spills.
- Have the basic tools: regular and Phillips-head screwdrivers; channel lock pliers; adjustable wrench; and hex-key wrenches (often included in repair kits for ball type faucets).
- Use penetrating oil such as Liquid Wrench to help loosen frozen bolts and valves. (Note: WD-40 spray lubricant may not work as effectively as penetrating oil.)
- Perform home repairs during hours when hardware stores are open, so you can purchase parts and tools when needed.
- Note the order in which you disassemble faucets or any plumbing fixture, snap a photo or make a sketch of the fixture.
- Plug the sink for faucet repairs so parts don't fall down the drain.
- Keep the old worn parts, and take them to the hardware store to find the right replacement parts.
- When tightening or loosening plumbing parts such as supply tubing, use two wrenches: one to hold the fitting stationary while turning the other. This will prevent stress and the possibility of breaking supply tubing or pipes.

Showerheads

Replacing old showerheads with newer models can save substantial amounts of water. California currently has the strictest showerhead flow rate maximum, set at 1.8 gallons per minute at 80 psi. Other states and locales may set similar maximums. Water-efficient showerheads are often available from your water or energy utility.

Existing showerheads should be removed and cleaned once a year because mineral deposits often build up, causing a low or uneven shower flow. Remove the showerhead by using vise grip pliers or regular pliers to hold the shower pipe stationary, while using an adjustable wrench to remove the old showerhead. It's a good idea to wrap an old cloth around the chrome shower supply pipe to protect it from being scratched.

- Clean the showerhead by soaking it in vinegar, and then use a needle on the back surface to free plugged holes—or install a new head according to the manufacturer's instructions.
- Before reinstalling, apply pipe joint compound or Teflon tape to the threads on the end of shower pipe to prevent leaking.
- Water fixtures such as showerheads are designed for a certain optimum pressure (although most WaterSense-compliant showerheads today are pressure-compensating). If you suspect water pressure in your home is too high or too low, see the section on water pressure, page 7.

Toilets

There are two basic types of toilets found in the home: gravity-fed toilets and pressure-assist toilets.

Gravity-Fed Toilets

The most common type of toilet found in the home is the gravity-fed fixture that relies on the weight of the water and head pressure (height of the water in your tank) to provide the flush. If you see freestanding water when peering down into the tank, your toilet is gravity fed.

Pressure-Assist Toilets

The pressure-assist toilet relies on air pressure within a cylindrical tank (metal or plastic-like vessel) inside your toilet tank. Compressed air inside the cylinder forces a vigorous and very rapid flush. The cylinder, along with the "roaring/whooshing" sound when you flush it, are sure signs of a pressure-assist toilet. If you look inside your toilet tank, there should be very little (if any) freestanding water visible. The tuning or repair of a pressure-assist mechanism is a task best left to a plumbing professional trained in the service of these devices.

Toilet Tune-Ups

For Conventional Gravity-Fed Toilets

In most instances, it is quite simple to tune-up the toilet! The basic parts have not changed much over the years. Use the toilet parts diagram (page 24) and glossary (page 38) to guide you through the basics.

Some of the common causes of a continuously running toilet are:

◆	Water level in toilet tank is too high and water flows over the top directly into the bowl through the overflow tube
◆	Toilet fill valve is broken and will not shut off completely
◆	Flush valve flapper seal is leaking and allowing water to escape the tank into the bowl continuously
◆	Trip lever chain is obstructing the flapper valve from closing and sealing
◆	Short trip lever chain (due possibly to being tangled) preventing a tight seal of the flapper valve

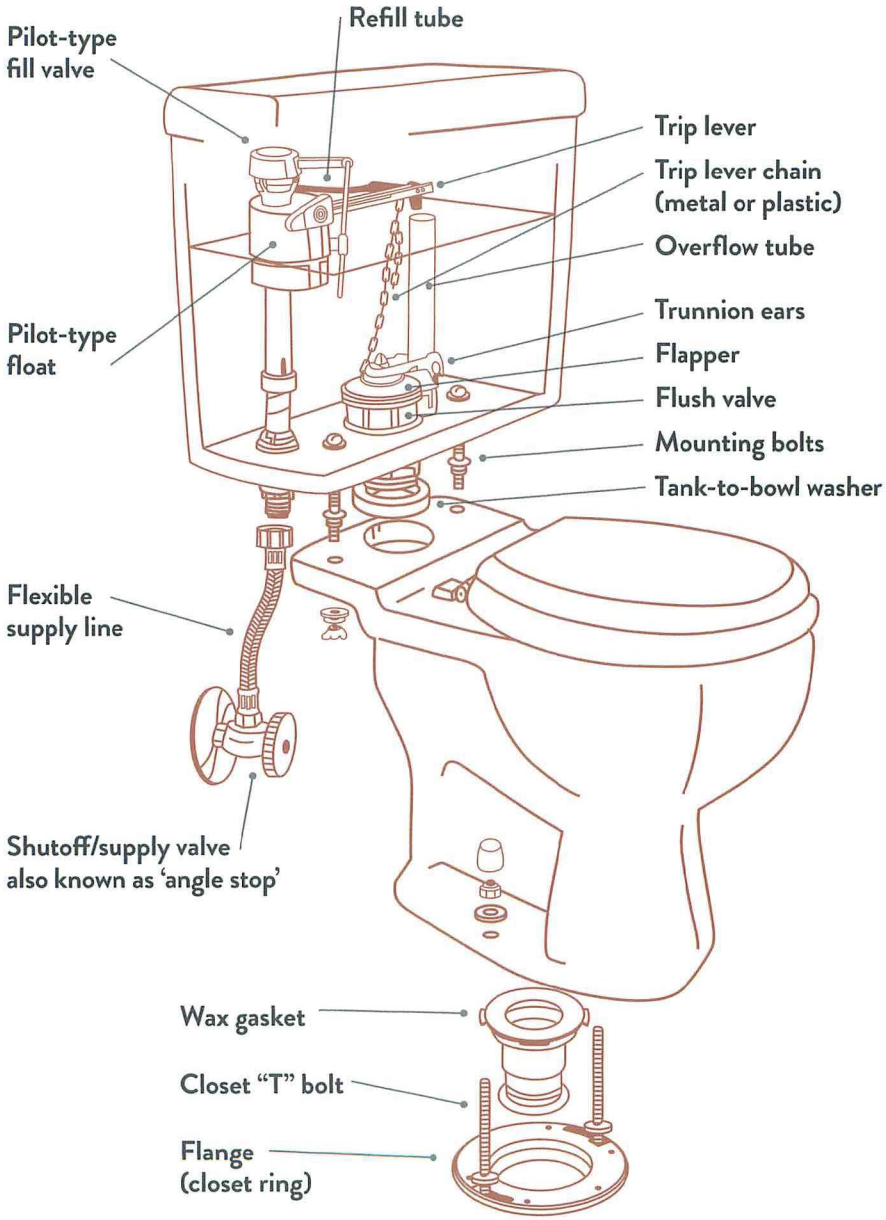
Some of the common causes of a toilet not flushing well are:

◆	Water level in toilet tank is too low
◆	Waste line (drainline) is clogged

Read on to fix these problems . . .

Conventional Gravity-Fed Toilet,

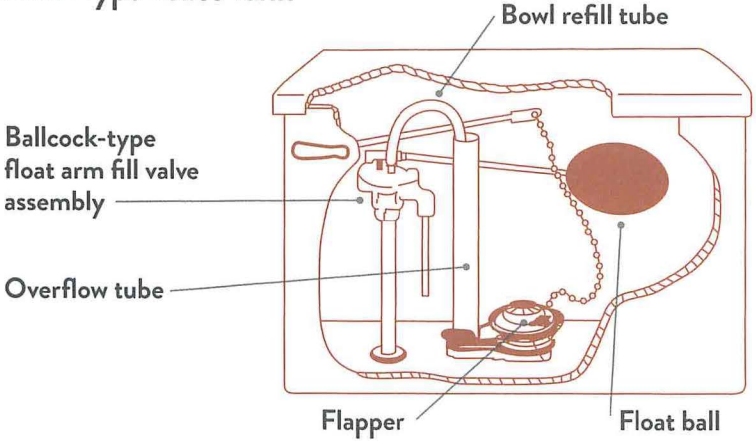
See Glossary on page 39 for explanation of each part



Toilet Tank Water Level Adjustment

If your toilet runs continuously, the water level in the tank may be too high, resulting in water flowing over the top of the overflow tube into the bowl and then into the drain. Such a condition can occur in very early morning hours when your water utility's water pressure can increase, but only if you have a float arm ballcock fill valve (see illustration below). On the other hand, if the toilet is not flushing well, the tank water level may be too low (or you have a clogged waste line). The correct water level is shown as a line inscribed on the inside of the tank; others will have the line indicated on the overflow tube. If you are unable to find a water level mark, a good rule of thumb is to adjust the level to one inch below the top of the overflow tube.

Ballcock Type Toilet Tank



Ballcock fill valves have ball floats hanging off the end of metal or plastic float arms attached to the fill valve barrel. To change the water level in your tank, find the adjusting screw on the top of the fill valve. To lower the level, turn the screw clockwise. To increase the level, do the opposite. Older ballcock fill valves may not have an adjustment screw. In this case bend the float arm down to lower the water level (If your toilet is this old, it's probably time to get a new Premium High-Efficiency Toilet, all of which use Pilot-type fill valves!).

A **Pilot-type** fill valve will have a float-cup sliding up and down the fill valve barrel. To lower the water level, lower the stiff wire-like link using the "V" shaped clip.

Please note that even new toilets may need water level adjustments as the toilet is "broken in."

Toilet Bowl Cleaners

Dropping certain toilet bowl cleaners (usually in the form of large white tablets and chlorine-based) into your toilet tank may result in serious damage to the parts within the tank (degrading the flush valve flapper, fill valve seals, etc.). Some manufacturers may even void the warranty on your toilet if you use these tablets.

If you do choose to use them, remember to flush your toilet at least once per day to prevent leakage resulting from failing parts. Periodically check the flush valve flapper and replace if it shows signs of breakdown.

"It only runs in the middle of the night."

Many toilets really do run continuously only at night; that's because people use much less water during those hours, and in many municipal water systems, the water pressure rises considerably during this time. If you have a typical old-style ballcock-type fill valve, this rise in pressure can cause water levels to rise inside your gravity-fed toilet tank, resulting in water flowing over the top of the overflow tube to the drain. All of that water is wasted. It should be noted, though, that all of today's WaterSense-rated toilets only use pilot-type fill valves, which do not respond to these unexpected changes in water pressure. Manufacturers of toilets normally suggest that the water level to be set at approximately one-inch below the top of the overflow tube.

If you only notice your toilet running in the middle of the night, there is a good chance that either the water level in your tank is set too high, or the fill valve is leaking due to system water pressure (to fix, see *Tank Water Level Adjustment*, page 25).

Toilet Fill Valve Replacement

In isolated cases, the water will creep up on the overflow tube, even though the water level is initially set correctly. If water is escaping through the overflow tube, your fill valve is likely the culprit.

The replacement of the fill valve is relatively simple. Turn the water off at the supply shutoff valve behind the toilet, flush the toilet to empty the tank, remove the supply line from the fill valve and capture any remaining tank water in a bucket. Remove the flange nut on the underside of the tank that anchors the fill valve, disconnect the refill tube and pull out the old valve. Take the old valve to the hardware store and check with a plumbing specialist for the best replacement.

New fill pilot-type valves are a great improvement over the older designs. Install your new model following the manufacturer's instructions. We strongly recommend replacing a ballcock-type valve with a modern pilot valve that uses a float sliding up and down on the vertical barrel or shaft.

Toilet Flapper Replacement — "The Dye Test"

Most people will say their toilet does not leak. There is one sure way to find out: put some food dye in the toilet tank. After 15 minutes, check the bowl to see if there is now dye color in the water. If there is color, or if you already can hear and or see water running in your bowl, it's time for a new **flapper**!

The flapper is the rubber-like flush valve seal that controls the volume of water passing from the tank to the bowl during the flush cycle. Over time, the rubber-like flapper deteriorates and may leak. It is very important to get the correct replacement flapper. Go to your toilet manufacturer's website to find the correct flapper part number and retail source.

When removing your old flapper, first turn the water off at the angle stop behind the toilet. Next, disconnect the chain from the trip lever arm, and slip the ears of the flapper off of the trunnion ears on the flush valve. Take the old flapper with you to the hardware store with the make and model number of the toilet to select a new flapper that matches the old one. If you only have one toilet, it's a good idea to keep the old flapper handy until you've found a suitable replacement.

While the flapper is out, slide your finger over the seating surface of the flush valve. If the surface is rough, use 400 grit wet or dry sandpaper to lightly clean the entire surface. Repeat the process until the surface is smooth. For toilets with a flat, washer-like seal type of flapper, simply slip it off the piston or other holding device, and replace it with a new one.

After installing the new flapper, run the dye test again to ensure that you have no leak. If the leak persists, you are probably going to have to replace the entire flush valve.

Toilet Flush Valve Replacement

To do this, you will need to again turn your water off, and disconnect the supply line at the shutoff valve/angle stop. Flush the toilet to drain the tank and then loosen the bolts that hold the tank to the bowl and remove the tank from the bowl and the tank-to-bowl washer. Using large channel lock pliers, remove the flange nut on the bottom side of the tank that holds the flush valve in place. Next, purchase a replacement flush valve assembly from your hardware store, making sure that the new assembly has an overflow tube at least as tall as the old one. If the new tube is taller, note the correct height from the old one, mark that height on the new one and, using a hack saw, cut it to the proper length. Using new seals, reassemble in the reverse order as used in removing the old valve.

"It takes forever to refill my toilet and it's noisy"

If it is taking a long time for the water in your toilet tank to refill, the shutoff valve behind the tank (the "angle stop") may be partially turned off. Shutoff/supply valves should always be fully open. If this isn't the problem, the supply tubing may be partially blocked. Turn off the shutoff/supply valve and drain the toilet tank by flushing. Disconnect the supply tubing and check it for blockage.

If the problem is not the line then it may be the fill valve mechanism in the toilet tank. Some mechanisms have inlet strainers. If so, simply remove and clean the strainer. If there is no strainer, then remove the fill valve from the toilet, disassemble and clean it. If the toilet still fills slowly, then replace the fill valve. (See *Fill Valve Replacement Procedure*, above.)

"Lately I have to flush it at least twice"

If, in the past, your toilet has only required double-flushing in rare circumstances, and now you are having to double-flush it quite often, you may have one of two problems.

The first is a low water level inside the tank, and the second is a partially blocked toilet trapway OR building waste line (drainline). The water level inside the tank should be approximately one inch from the top of the overflow tube. If it's not, see the previous section on *Toilet Tank Water Level Adjustment* (page 25). If the tank water level is not the problem, then try working a toilet clean-out "snake" through the trapway from the inside of the bowl. If this fails, it's time to break out your work clothes and a few wrenches, or call a plumber to clean out a blockage in the waste line to the sewer.

Water Efficient Toilets

In 1994 new water-conserving toilets, called ultra-low-flush toilets (ULFTs), were required in all new construction in the U.S. ULFTs use 1.6 gallons or less per flush and are more water efficient than older toilets, which used up to 7 gallons per flush. Some of the early ULFTs performed poorly. Over the years improvements were made to ULFTs that increased performance and consumer satisfaction. ULFTs continue to save a typical family 70 gallons per day in water use.

Beginning in 2014, some states mandated that all toilets sold or installed in that state are legally required to be high-efficiency toilets (HETs). Single-flush HETs set a maximum flush volume of 1.28 gallons per flush. Dual-flush type HETs provide the user with two options: a maximum 1.6-gallon full flush for solids and a reduced flush maximum of 1.1 gallons for liquid-only flushes. Newer dual-flush toilets use 1.28 gallons for the full flush and 0.8 gallons for the reduced flush. To learn more about the types of toilets and their terminology, go to: **map-testing.com/toilet-types.**

If your home has any pre-1994 toilets, consider replacing them with a new HET. Many local water suppliers and municipalities offer rebates for the installation and/or purchase of HETs. To compare the flush performance of nearly 4,000 types of WaterSense-rated toilets, go to the Maximum Performance (MaP) testing website: **map-testing.com**. MaP's independent testing has shown that many inexpensive models perform just as well as expensive ones. It also shows that the flush performance of today's HETs is significantly better than that of the older 1.6, 3.5, 5 and 7 gallon toilets of the past.

See page 36 for instruction on how to replace toilet.

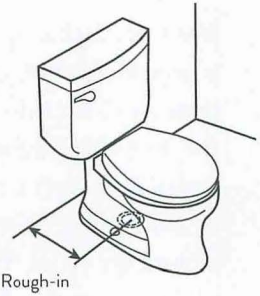
Consider these 15 STEPS before you purchase a toilet

Developed by MaP Testing www.map-testing.com

Before you ever leave the house to shop for a toilet, get out your tape measure and gather the information you need!

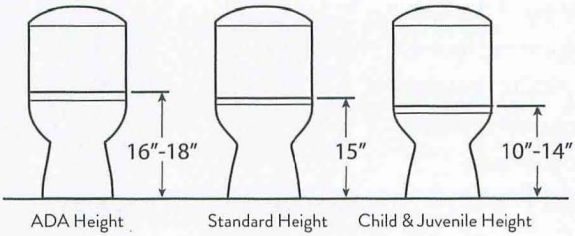
Rough-in

Know the rough-in dimension of your toilet installation. The distance from the flange bolts (that anchor your bowl to the floor, usually covered by small plastic caps) to the wall behind your toilet is known as the rough-in. In most North American homes that dimension is either 10, 12, or 14 inches, the most common in today's homes being 12 inches.



Bowl Height

The distance from the floor to the top rim of the bowl (not including the toilet seat). In North America, that distance has traditionally been about 14 to 15 inches. However, the trend for many families today is to install bowls with a height of 16 to 18 inches. Manufacturers use terms such as "Comfort Height", "Chair Height", "Easy Height", "Right Height", "Highboy", "Smart Height", "ADA Height", or some other similar description. The added height makes getting on and off the bowl easier, especially for the elderly or infirm, but many younger persons have also discovered the benefits. Decide whether or not you want a toilet with a taller bowl.



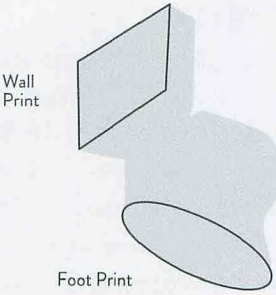
One-Piece vs. Two-Piece

One-piece Toilet

Two-piece Toilet

Two-piece toilets are the most common design found in homes today. They are typically less expensive and usually have a taller tank. One-piece toilets, on the other hand, are generally more expensive but they are often easier to clean and may provide a smoother or sleeker appearance. Decide on one-piece or two-piece.

Footprint



If you are replacing an existing toilet that has a large footprint (i.e., the base covers a large floor area), consider the patching and repair to the floor that might be required if a bowl with a smaller footprint is chosen. This is especially an issue where ceramic tile covers the floor around the toilet. Will additional matching tile be required and will the appearance be satisfactory? Footprint dimensions of most new toilets may be found on the manufacturers' websites.

Wall-Print

Again, if you are replacing an older toilet that has a large tank AND the wall area that is hidden behind that tank is unfinished or unpainted, consider that the installation of a smaller tank (typical of many of today's toilet models) may leave those unpainted areas visible. As such, you may be required to repaint a portion of the wall or even the entire bathroom.

Bowl Shape

Choosing the bowl design is another important factor. Bowls are typically designed with either a smaller, round-front bowl or a longer, elongated-front bowl.

Special Shape Bowl

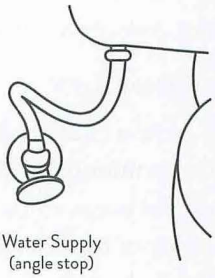
Elongated Bowl

Round Bowl

The round-front bowl is ideal for compact bathroom spaces. Elongated bowls have a longer rim dimension (as much as 2 inches longer). They are more comfortable for adult use and they help improve hygiene. Be sure to measure the dimensions of your existing bowl and consider the size of the toilet space in your bathroom before replacing a round-front model with an elongated model. There have been cases where doors and drawers could not be opened when the old round front bowl was replaced with an elongated model! Check manufacturer websites for the dimensions of bowls and tanks. Decide on the bowl shape.

Water Shutoff Valve and Hose

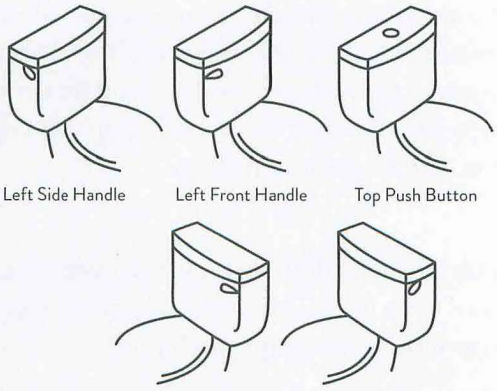
Check the condition of your existing shut-off valve (called the 'angle stop') that supplies water to the toilet and the supply hose connecting that valve with your toilet tank. If you need to replace the supply hose, consider one encased in stainless steel mesh for long-term durability. If the shut-off valve needs replacing, it may be necessary to call your plumber.



Water Supply
(angle stop)

Flush Handle Location

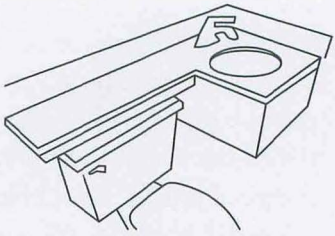
Manufacturers place flush handles at various locations on the tank: right side, right front, left side, left front, and at the top-center of the tank lid. You should determine if the handle's location is important.



Left Side Handle | Left Front Handle | Top Push Button

Right Front Handle | Right Side Handle

"Banjo Top" Issues



"Banjo Top" Counter

Do you have a shelf installed directly above your toilet, such as the type occasionally found in older homes? If so, be sure to measure the distance from the floor to that shelf. Then consider that distance to be a limit upon the overall height of the combined bowl and tank you plan to purchase. It is important to leave sufficient room between the tank lid and the shelf such that the lid can be removed and the parts inside the tank can be accessed when required.

Insulated Tank

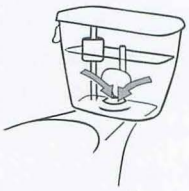
In certain climates (especially in humid climates and in buildings without air conditioning), sweating and dripping toilet tanks can be a problem. As icy cold water refills the tank after a flush, condensation can form on the outside of the tank and drip on the floor. This problem is far more common in older high flush volume toilets where the tank would totally empty and refill for each flush cycle. Many new water efficient toilet models discharge only a portion of the water in the tank each flush, so the volume of cold water refilling the tank is less and the risk of condensation is far lower. If you do have issues with condensation, there are two readily available solutions: choosing a pressure-assist model toilet OR choosing an insulated toilet tank. In a pressure-assist toilet, the water is contained within a separate pressure vessel inside the toilet tank; therefore, condensation does not form on the outside of the tank. An insulated tank in a conventional gravity toilet (the type found in most homes) will keep that cold water from causing condensation on the outside of the tank.

MaP Score

Of course, if you want a toilet with the best flush performance, you MUST check the MaP scores! Go here to do a search for just the right toilet to meet your needs: **map-testing.com/map-search.html**.

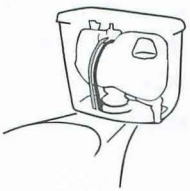
Remember that toilets with scores of 500 and above should provide you with excellent performance.

Flush Type



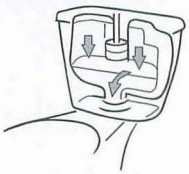
Conventional Gravity

Gravity Fed: Fixtures that only use gravity (weight of the water in the tank) as the source of energy for flushing.



Pressure-Assist

Pressure-Assist: Fixtures that use the potential energy in the building's pressurized water line to compress air within a containment vessel inside the toilet tank. Compressed air behind the water provides a more vigorous flushing action than the gravity fed.

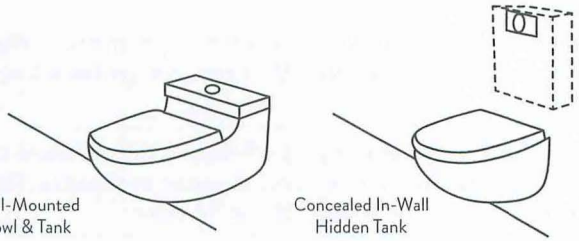


Vacuum-Assist

Vacuum-Assist: Fixtures that create a low level of vacuum (negative air pressure) to assist with the flushing action.

Wall Mounted Toilets

Wall Mounted: Entire fixture is affixed to the wall and the entire weight of the bowl and tank are born by a carrier structure in the wall.



Wall-Mounted
Bowl & Tank

Concealed In-Wall
Hidden Tank

Color

Generally, a colored toilet can be a disadvantage, particularly if choosing a trendy color requires you to also replace the bathroom lavatory sink and the tub in order to maintain continuity. In addition, when it's time to sell your home, today's 'popular' color may be tomorrow's albatross. We recommend sticking with white or off-white (sometimes referred to as biscuit or beige or bone), all of which are commonly found in homes today.

Cost

Presumably the toilet you choose will be installed and operating for at least 20 years. Don't attempt to save a few dollars on a toilet purchase when you are making an 'investment' in your home that will have lasting functionality and use. Also note that flush performance and user satisfaction *is not directly related to what you paid for the toilet.* In fact, some of the best performing toilets are also the least expensive; and some of the most expensive are only marginal when it comes to performance.

Toilet Replacement and/or Clearing a Waste Line Blockage

Below are instructions on how to replace a toilet and/or clean a blocked waste line. See the toilet parts diagram on page 24.

If you have to remove the toilet to clear the waste line, this is an excellent time to consider buying a new HET if the existing toilet is pre-1994. See page 29 for advice.

First, make a trip to your hardware store and buy two wax rings, some plastic shims, and a solid brass closet "T" bolt set.

Step 1	Clear your bathroom floor of everything in the way. Wear rubber gloves, and have a few old bath towels and garbage bags handy for waste.
Step 2	Shut off the water at the shut-off/supply valve ("angle stop"), and flush the toilet to remove as much water as possible. Remove the flex tubing from the shutoff to the fill valve.
Step 3	Remove the caps covering the "T" bolts that secure your toilet to the closet flange. Remove the nuts and washers from the "T' bolts, and remove the toilet from the closet flange. If you are doing this by yourself, you may want to separate the tank from the bowl by removing the tank mounting bolts, sincethe whole assembly is quite heavy.
Step 4	Using a putty knife, remove the old wax gasket that seals the base of the toilet to the waste line and then remove the "T" bolts. Check the waste line for any blockage.

Step 5	If you have a clogged waste line, you will need to clear it (below), otherwise proceed to the next step with new installation. Run a plumber's snake down the waste line until you clear the obstruction. If the snake is not long enough or, the obstruction won't clear, it's time to call out the professionals! Once you, or they, have finished the dirty work, it's time to reinstall your toilet.
Step 6	First install the new "T" bolts in the slots on the closet ring, carefully positioning them across from each other, and parallel to your back wall. Next place the oval-shaped brass washer with the round hole in the center over the "T" bolts and positioning slots in the flange. Now use the brass "jam" nuts or thin spring steel fastener to secure the "T" bolts and oval washers in place.
Step 7	Take extra care to center the new wax ring over the closet flange opening or alternatively, over the outlet on the underside of the bowl. Next, install the bowl (or the whole toilet, if you have left the bowl and tank assembled together). Be sure to get the bowl relatively level before tightening anything down. Use a 2-foot long carpenter's level placed over the center of the bowl to see if it is level. If leveling is required, use the plastic shims. Taking care not to disturb the wax ring, insert shim material until you reach the required height. Once this is accomplished, place the plastic "cap" washers (lip up!), over the "T" bolts, taking care to cover as much of the oblong holes provided in the base of the toilet as possible. Next, place one round brass washer on top of the plastic washer, and then use the "dome" nuts to snug down the bowl.
Step 8	Next, see if your new plastic caps will snap in place over the "T" bolt assemblies. If you hear the "snap," all is well and you are done. If not, take your hacksaw and cut off the excess threaded of the "T" bolt protruding from the dome nut and now snap your caps in place. The rest of your project will now be simple (and a lot less messy!). In completing the job, remember to caulk around the base of your toilet where it meets the floor.

GLOSSARY OF TOILET PARTS

Closet "T" Bolts – "T" shaped bolts, flat and dome nuts, and round and/or oval washers used to connect the toilet bowl to the flange.

Fill Valve (Ballcock or Pilot) – Ballcock or Pilot fill valves are found in gravity-fed toilets. It is the tall mechanism inside the tank on the left-hand side. A ballcock type fill valve will have a float connected to it by means of a metal rod or plastic arm. A pilot type fill valve will have a float sliding up and down the tube/barrel of the mechanism.

Flange (aka Closet Ring) – The metal or plastic flange that is permanently installed at the end of your waste line (at floor level), and has slots for the closet bolts. The inside diameter is normally three to four inches. The closet ring mates with the outlet on the bottom of your bowl and provides the means for evacuation.

Flapper – Found in most gravity-fed toilets, the flapper is the rubber-like flexible flush valve seal that controls the volume of water passing from the tank to the bowl during the flush cycle. It mates with the seat on the flush valve to complete the seal, when closed, and prevents water leaking from the tank into the bowl between flushes.

We cannot stress enough how important it is to the functioning of your toilet to use the correct flapper when replacing your flapper. Consult the toilet manufacturer's website for the correct replacement flapper part number and the possible sources to purchase.

Almost all flappers are shaped, in part, like a "flying saucer," that is, with a slight "dome" on top, flat like a "pancake" in the center and then a "funnel" or "bulb" shape on the bottom. This whole assembly is usually one molded part and is made of flexible rubber-like material (although it is NOT rubber). The center or pancake shaped midsection is approximately 3 inches in diameter. Other flappers (or seals) are of a flat washer-like design.

Types of Toilet Flappers:

1. **Non-air bleed** – Usually found in 3.5 gallon to 7 gallon toilets and occasionally in some ULFTs. The non-air bleed or "standard" flapper has an air chamber in the funnel-shaped section. In the small end is an opening approximately 1/2-inch in diameter. This small end faces down, and there is no way for the air caught inside to escape. Therefore, it floats on top of the water in the tank until the force of the water going through the opening in the flush valve causes the flapper to close and seal.

2. **Air bleed with calibrated orifice** – Often called an "early closing" flapper. This flapper is sometimes used to achieve the 1.6-gallon flush volume in a number of ULFTs where tanks are much larger than 1.6 gallons in capacity. This flapper also has an air chamber, but in the upper portion of the funnel is a round "air-bleed" hole of various diameters. An insert with a very small orifice may sometimes be found in the small 1/2-inch section of the funnel. There are a number of different-sized holes to accommodate different toilet manufacturers' requirements. (In some cases, the hole size is adjusted through a "dial" type insert, thereby making it an "adjustable" flapper.) The size of the hole determines how quickly water enters the funnel-shaped chamber to displace the air that escapes through the 1/4-inch air-bleed hole near the top, thus affecting the buoyancy of the flapper. When enough air is displaced with water, the flapper is no longer buoyant and sinks to seal off the escaping water long before all of the water can evacuate the tank—hence the term "early closing."

3. **Air bleed with float** – Also known as an "early closing" type, this flapper is similarly used to achieve the 1.6 gallon flush volume in a number of ULFTs. It also has an air chamber with a round air-bleed hole in the upper portion of the funnel-shaped chamber. There is usually no insert in the small 1/2-inch section of the funnel to regulate how quickly the water displaces the air in the chamber. Instead, a float (usually Styrofoam) is connected to the top of the flapper by means of a chain. The float remains on top of the water in the tank, and the length of the chain connected to the flapper determines how quickly the flapper (which has quickly filled with water) will reach the flapper seal and shut off the flow of water between the tank and bowl.

4. **Flat seal** — A washer-like disk with a flat surface and a hole in the center. The flat seal is common to all toilets that use a pistontype or tower-type flush valve (as opposed to the conventional flush valve used on most toilets today). This type of seal is also used in some with unique flush valve designs, particularly the new dual-flush designs. The flat seal is between 2- and 3-inches in diameter, of flexible rubber-like synthetic material, and is easily installed on the body of the flush valve.

Flapper Seat — The hard, round surface at the base (or seat) of the conventional flush valve. The flapper rests on the seat when the valve is closed. The seat surrounds the 2- to 3-inch opening at the base of the flush valve, which is almost always made of PVC material, although some older toilets are equipped with brass valves. All water used during the flush cycle passes through the valve.

Float – On a ballcock-type fill valve, the bulb-shaped sphere on the outer end of the float rod/arm. On a pilot-type, the canshaped float that slides up and down over the fill valve tube.

Float Adjusting Screw – This screw is usually only found where the float is connected to the shutoff lever by means of the metal rod or plastic arm. When turned clockwise, this screw causes the water flowing into the tank to shut off earlier. The same effect is accomplished by moving the stiff wire link downward using the adjusting clip for the slide-type float mechanism.

Float Arm – The metal rod or plastic arm that connects the ballcock's float to the shutoff mechanism on the ballcock valve itself. On a pilot valve, a rod-like stiff-heavy wire link with an adjusting clip that connects the shutoff to the float, performing the same shutoff function.

Flush or Trip Lever Arm – The metal or plastic extension inside the tank connected to the flush handle. It reaches from the handle directly to a location over the top of the flapper and is usually connected to the flapper with a chain.

Flush or Trip Lever Chain – The connecting link between the flush/trip lever arm and the flapper. When adjusted properly, this connecting link allows the arm to pull the flapper open to initiate the flush cycle. The chain may be made either of metal links or a synthetic flexible material. A linked chain is always preferred.

Overflow Tube – The approximately 1-inch diameter hollow tube to which the 1/4-inch refill tube is connected. This is the passageway for the water refilling the bowl and allowing the sanitary seal. When the water level is incorrectly adjusted too high (overflowing into the pipe), or the fill valve isn't working properly, the water in the tank will overflow into this tube and down the drain to wastewater.

Refill Tube – The small plastic tube usually connected near the top of the fill valve mechanism on one end, and to the inside of the overflow tube on the other end. Water flows through this tube only during the flush cycle to refill the bowl. Not all gravity-fed toilets have such a tube.

Shutoff/Supply Valve – The valve on your wall near the base of the toilet with a round or oval handle that allows you to shut your water off while servicing the toilet (Also known as an angle stop).

Supply Line – The solid or flexible line between the shutoff/ supply valve and the connection on the bottom of your tank (fill valve fitting).

Tank – The tank is the top portion of the toilet that contains the freestanding water and the flushing mechanism for a gravity-fed toilet. For a pressure-assist type toilet, the tank contains the pressure-assist vessel.

Tank to Bowl Washer – The round "donut-shaped" seal between the tank and bowl in a two-piece toilet. This seal provides a cushion upon which the tank rests, and acts to prevent water leaks around the coupling between the tank and the bowl.

Trunnion Ears and Trunnion-ring – The "mounting ears" protruding out from the overflow tube near the base. These are the "ears" to which the flapper connects. In some cases, the overflow tube is devoid of these ears; a "rubber" type round "trunnion-ring" with two mounting ears slides down over the tube to provide the connecting points for the flapper.

Water Level – The water level inside the tank of a gravity-fed toilet. Some manufacturers cast a "fill-line" on the inside wall of the tank, while other manufacturers put a fill mark on the overflow tube. In some cases, no fill line is indicated. In such circumstances, a good rule of thumb is to adjust the water level to 1 inch below the top of the overflow tube.

Wax Ring – The yellowish wax ring between the bottom of the toilet bowl and the mating closet-ring (flange). It is "donut" shaped, about 1-inch thick. A seal is achieved when the wax ring is squeezed between the bottom of the toilet bowl and the top of the closet-ring. A permanent seal can also be used instead of the traditional wax seal.

Flexible Water Supply Tubing

Flexible metal tubing or "flex line" supplies water from a pipe to a faucet, toilet, dishwasher, and refrigerator (for an automatic icemaker or water dispenser). Supply tubing leaks are common and are often detected as water damage to walls or cabinet surfaces under sinks.

Supply tubing often leaks at the fittings. Turn off the master water supply valve to the house, and then try tightening the fitting. Use two wrenches (or pliers and a wrench): one to hold the fitting stationary while turning the other clockwise to tighten the fitting. (This avoids putting stress on, and possibly breaking, supply tubing or pipes). Usually a quarter or half turn is sufficient to tighten the fitting to the tubing "nipple" to stop the leak. If not, or if the tubing itself is leaking, replace the supply tubing and fittings. There are subtle differences in fittings and nipples so bring the old parts with you to the hardware store to get the proper replacements. Be prepared to replace the fixture's shutoff valve as well as the tubing. Old valves that no one has turned for years may spring a leak when suddenly turned.

To replace supply tubing: first shut off the house water supply, and then disconnect the supply tubing from the shutoff valve using two wrenches, as described above. Place a bucket under the pipe coming from the wall, and turn the water on **briefly to flush rust** from the pipe—by turning on the house water supply and opening the shutoff valve. (If the old fitting is damaged or recessed too far into the wall to get a pipe wrench on it, call a plumber.)

If the shutoff valve needs to be replaced, buy a valve with female thread to screw onto the nipple. Wipe the nipple with pipe joint compound, and then screw on the new valve with an adjustable wrench. Be sure to point the valve outlet toward the fixture as you finish the last tightening turn. Turn the house water supply back on, and test for leaks. If it leaks, try a quarter or half turn to tighten it.

Frozen Pipes

Water expands as it freezes. Blocked or restricted water flow is the first indication that pipes may be freezing. If you don't act quickly, your pipes will burst. At the first sign of a blockage, open the faucet. Finding the blockage is critical. Trace the supply pipe to where it runs through exterior walls or other unheated parts of your house, such as the basement or crawl space. To melt the ice, use hot water, a heat gun, a hair dryer, heat tape or heating pad. **Do not use blow torches, as they can cause fire!**

Place a bucket under the faucet. While applying heat, leave the faucet open so water can drain into the bucket. Use the water for irrigation or watering indoor plants. Once the ice melts, prevent the pipes from refreezing by jacketing them with foam pipe insulation. Wrap all pipes that pass through unheated spaces.

If you live in a climate that rarely freezes and you expect a hard freeze, leave exposed taps dripping to prevent frozen pipes. But this solution should only be used overnight to avoid wasting excessive amounts of water. Placing a bucket under dripping faucet will help capture water and reduce waste. Use water for irrigation, watering indoor plants, or filling toilet tanks. For cold season areas, read the following section on preventing frozen pipes.

Preventing Frozen Pipes

Water pipes that are exposed to freezing temperatures should be wrapped with pipe insulation of R-2 or greater. Insulate pipes located in unheated basements or garages. Keep garage doors closed during severely cold weather. Disconnect garden hoses before you expect a hard freeze to prevent hose bibb damage. If your home is going to be unattended for several days during cold weather, and the heating system is turned off, use the following precautions:

◆	Shut off the water supply at the master valve to the house.
◆	Turn off the water heater and drain the hot water tank. To do this, open the relief valve on the top side of the tank, and then open the faucet at the bottom (see page 50 on water heaters).

◆	Drain water pipes by temporarily opening all indoor and outdoor faucets.
◆	Put a small amount of antifreeze in sink traps, bathtub drain, toilet tank and bowl.
◆	Make sure all horizontal pipes drain properly.
◆	If your house is heated by hot water or steam, the heating pipes and boiler must be drained. Consult a professional since this procedure is complex.
◆	Any burners and pilots should be completely out and the main gas/ electric supply turned off.

APPLIANCES

Clothes Washing Machines

The hot and cold water flexible water supply lines to your clothes washing machine have screens that can clog just like faucet aerators. Unscrew the supply lines and clean the screens per the aerator instructions (see the section on aerators, page 20). If flow is still restricted, check to see if the shutoff valves are fully open. If the hot water flow is still low, the inlet valve of the water heater may be partially turned off (see the section in this booklet on water heaters, page 49).

If a supply hose is leaking at the faucet, the hose may simply need to be tightened, or it may need a new rubber washer. In the most severe situations, the hose may need to be replaced. If the faucet valve is leaking, try tightening the valve a quarter turn using an adjustable wrench. Or the valve may need a new washer, or need to be replaced.

The supply hoses are usually made of rubber, which age and may crack over time. They should be replaced periodically to prevent leakage and potentially costly water damage to your home. For other types of washing machine leaks, consult your appliance owner's manual.

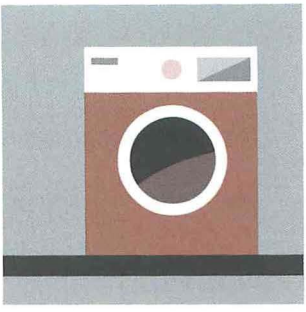
Clothes Washing Machine Troubleshooting

Always unplug an appliance before working on it!

PROBLEM	POSSIBLE CAUSE	ACTION
Washing machine leaks while filling	Loose or cracked hose or inlet valve	Tighten or replace inlet hose or valve
	Water temperature may be greater than 170 degrees or the house may be too cold in the winter	Adjust water heater temperature if necessary
Water drips down the outside of the machine	Cracked inlet nozzle or loose hose	Be certain that hose is tightly clamped. Replace if necessary
Water leaks from pump	Pump malfunctioning	May need to tighten or replace pump

Washing machines are one of the highest water users in the home:

Type of clothes washing machine	Water per load
Non-conserving	40-50 gallons
Water Efficient	30 gallons
High-efficiency	15-25 gallons



Water Conservation Tips for Clothes Washing Machines

Clothes washing machines account for approximately 17 percent of all indoor water usage. Installation of a high-efficiency washing machines can save over 5,000 gallons of water per year.

If you're buying a new washer, consider purchasing a high-efficiency washer. Some water and energy utilities have rebates available for water and energy-saving clothes washers. Check with your salesperson and utility companies.

Be sure to run full loads of clothing. For smaller loads, match water level with the load size. (This is done automatically on new high-efficiency washers.)

Dishwashers

A flexible tube or hose is used to supply hot water to the dishwasher. It usually runs under the sink between the dishwasher and the hot water faucet or pipe. If the water supply to the dishwasher is leaking, it can be replaced, or the fittings tightened following the instructions on flexible water supply tubing, page 43. Also check the dishwasher sprayer and drain strainer periodically for food particles or mineral build-up.

As with all appliances the most thorough instructions are included in the owner's manual. However, the table below provides a short list of additional preventive maintenance.

Dishwasher Troubleshooting

Always unplug an appliance before working on it!

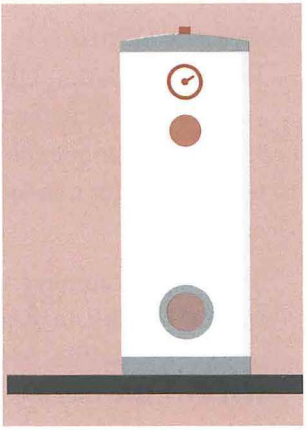
PROBLEM	POSSIBLE CAUSE	ACTION
Water leaks from door	Rubber gasket has become hard or cracked	Replace with new gasket if necessary
	Obstruction in the door preventing a proper seal	Clear obstruction
Dishwasher filled with water	Float switch malfunctioned	Be certain that the float is functioning
Water doesn't drain out of dishwasher	Pump may be clogged	Remove food particles from pump and impeller
	Sink may be clogged; discharge water may be connected to the sink drain or garbage disposal	Check sink drainage and clear sink if clogged; run garbage disposal to clear sink
Water doesn't enter tub	Pressure switch malfunction or the water supply filter screen is clogged	Replace switch or timer; clean the filter screen
Water leaks from bottom during wash cycle	Gasket may be either flattened or torn near the bottom	Pull the old gasket out of the slot in sits in and replace new gasket

Refrigerators

If your refrigerator has an icemaker or a cold-water dispenser, water supply tubing connects to the back of your refrigerator. The water line is connected under the sink and usually runs under or behind kitchen cabinets, or behind a wall to the back of the refrigerator. Be certain that you regularly check the line and the fittings for leaks.

Since the water line to the refrigerator is often concealed, any small leak can go undetected until it does expensive water damage to your home (see the section on fixing flexible water supply tubing, page 43).

Water Heaters



There are three types of water heaters commonly found in homes:

Electric Water Heaters

There are two types of electric water heaters: large tank types that heat and store 30-50 gallons of water, and small under-the-counter types that hold 1-3 gallons.

Electric water heaters are usually more expensive to operate than gas hot water heaters. They are relatively simple for the homeowner to replace.

Natural Gas and Propane (Bottled Gas) Water Heaters

Gas water heaters store 30-50 gallons of water. Natural gas-fired water heaters usually heat water more cheaply than electric. Some gas utilities offer rebates for installing them. Gas water heaters should be installed by a plumber because they require a hook-up to the gas line, a flue pipe to vent gasses to the exterior, and installation compliance with the local plumbing code. In certain earthquake-prone areas, these requirements also include strapping to more securely anchor the heater. Combustion gasses contain large amounts of carbon monoxide and are very hot! If you suspect a problem with the heater vent, call the gas supplier or a service technician.

Solar Water Heaters

On sunny days, solar water heaters heat water directly for use. On cloudy days they can "pre-heat" water for a gas or electric water heater, which boosts the temperature up to the desired level. Either way, solar water heaters save energy. Identification of solar equipment is easy. You will usually see solar collectors on the roof.

Water Heater Maintenance for Traditional Electric or Gas Types

Water heaters are often set too high and waste energy. But, if set too low, they can become a breeding ground for Legionella bacteria and create a very dangerous unsafe environment. You can increase the life of the heater and

save a lot on your energy bills by lowering the heater's thermostat to NO LESS THAN 130 DEGREES F. In fact, setting a higher temperature on your water heater effectively increases its capacity, in that less hot water is required at the hot-cold mixing valve inside the home to achieve the desired temperature for a shower. Turn the thermostat to the lowest setting while on vacation.

The temperature-pressure relief valve, located on the upper side of the hot water tank with an overflow pipe attached, prevents the build-up of pressure inside the tank that could become a hazard. It should be opened once a year to ensure that it is working properly. Lift or depress the handle and water should drain from the overflow pipe. If it doesn't, the valve should be replaced.

Over time, sediment builds up inside the hot water heater, shortening the life of the unit. It's a good idea to drain and flush the hot water tank at least once a year:

Step 1	Turn off the power or gas, then attach a hose to the drain valve and run it outside. Care should be taken if draining to plants outdoors. Hot water can kill some plants. Allow hot water heater to cool prior to draining.
Step 2	Close the cold water inlet valve, and open the drain valve on the water heater.
Step 3	Open a hot water faucet inside the house. (This allows air into the tank so the tank will drain). Once the tank has drained, turn on the cold water inlet valve, allowing the tank to flush until the drain water runs clear.

Hot Water On-Demand Recirculation Systems

Substantial amounts of water can be wasted while people wait for hot water to arrive at showers and sinks. This also wastes energy and money.

Hot water recirculation systems involve installing an electric pump beneath the sink farthest from the water heater. When activated, cool water that normally would go to the drain is circulated back to the water heater either through a dedicated return line OR through the cold water line (NOTE: Be sure to check with your municipal code authority to verify that using the cold water line is permitted in your community). At the same time, the system fills the hot water line with hot water from the water heater. When hot water at a preset temperature reaches the pump, the pump senses it and shuts off automatically.

If your heater is far from your showers and sinks, you may wish to look into an on-demand recirculation system.

Water Heater Leaks

If the water heater is leaking from the drain valve, first tighten the valve. If that fails, install a brass hose cap with a hose washer inside. Tighten the hose cap with pliers. If it still leaks, check the pressure with a water pressure gauge. If the reading is between 45 and 60 psi, the problem is probably the pressure relief valve located on the upper side of the tank. To replace the pressure relief valve, turn off the water supply and the electricity or gas to the water heater. Partially drain the tank by opening the relief valve and the drain valve. Remove the overflow pipe from the relief valve (if it has one). Remove the old relief valve, and install a new one.

Water Heater Pressure

Interior plumbing fixtures and water-related appliances perform best at pressures between 40 to 60 psi. Low hot water pressure can be frustrating, and high hot water pressure wastes water and energy and may damage fixtures and appliances if excessive. High hot water pressure can also cause fixtures to wear out sooner and shorten the life of water heaters.

If you have low hot water pressure to all faucets and appliances in your home, make sure the inlet and outlet valves on the water heater are fully open. If there is low hot water pressure to a single faucet or a water-related appliance, check to make sure the shutoff valve to the faucet or appliance is fully open (for the shower, check the shower head for clogs; for the washing machine, check the screens on hose connections). If this isn't the problem, there may be a clog in the valve itself or the water supply tubing (see the respective sections of this booklet to fix these problems).

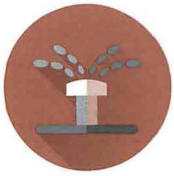
Water Heater Replacement

The average life expectancy for water heaters is between 8 to 12 years. If yours breaks down, check your warranty. Electric water heaters are relatively simple for the homeowner to replace. This will involve draining the old heater, and disconnecting the cold water supply line and hot water outlet. Follow the manufacturer's instructions for installing the new electric hot water heater.

Other types of water heaters will probably require a plumber to install, particularly gas heaters and tankless heaters, including point-of-use heaters.

When buying a new water heater, purchase energy-efficient models. (Look for the EPA Energy Star™ logo when shopping, or visit **EnergyStar.gov**). The small additional cost of an Energy Star heater will pay itself back quickly in lower utility bills. You may also want to consider a hot water demand recirculation type system (described above), especially if your current water heater is located far from showers and sinks, and if you must let the water run a long time before it gets hot.

OUTDOORS



Landscape Irrigation Systems

(a.k.a. Automatic Sprinkler Systems)

Landscape irrigation systems are essentially outdoor plumbing systems. Nationally, lawn and landscape irrigation consumes about half of all water supplied to homes and much of it is wasted.

We have all seen the water waste from poorly maintained and managed irrigation systems: sprinklers spraying onto the street or sidewalk, broken sprinkler heads spurting into the air, the over-application of water, and irrigating in the heat of the day when evaporation is highest. You can help curb landscape water waste by following the tips below. Section 3 *Resources,* at the end of this booklet, lists numerous websites with a wealth of information on efficient irrigation and water-wise landscaping.

Irrigation System Tune-up

◆	Check your sprinkler system frequently for broken spray heads and oversprays onto pavement or the house; check sprinklers blocked by plants.
◆	Adjust, clean or replace malfunctioning spray heads. Always replace broken heads with the same type and application rate.
◆	If grass is blocking the spray of existing pop-up heads replace them with taller 6" pop-up heads of the same manufacturer and type, or install taller risers under the existing heads.
◆	If the drip system is clogged, replace the clogged dripper(s), then clean the filter and flush the system
◆	Set your irrigation controller to apply the correct amount of water for your landscape's needs. Ask your water supplier or local University Cooperative Extension for an appropriate irrigation schedule for your grass type, climate and soil.

◆	Irrigate in the early morning when evaporation is lowest.
◆	Use 3-4 inch of organic mulch around plants to reduce evaporation, promote plant growth and reduce weeds.
◆	Consider removing some high water use plants, such as turf, and replacing them with low water use plants adapted to your climate.
◆	Contact your water supplier to see if they offer free irrigation audits which can provide you with specific suggestions for improving your system. If you see wasteful irrigation on another property, you may want to report it to the water supplier so they can provide assistance.

Irrigation System Retrofits

Contact your water provider to see if they offer free irrigation audits that can provide you with specific suggestions for improving your system. Many providers will also offer rebates for irrigation hardware upgrades, such as controllers, drip kits, or efficient sprinkler heads. If you see wasteful irrigation on another property, you may want to report it to the water provider so they can provide assistance to that property owner.

◆	Install a "smart" weather-based irrigation controller (WBIC) that automatically adjusts watering to the local weather and climate. For more information on smart controllers visit: **epa.gov/watersense/irrigation-controllers**
◆	Optimize your irrigation pressure. Different irrigation systems require different operating pressures. See page 69 for website resources to identify your pressure and irrigation needs.
◆	Check your system for uneven application of water by setting out several shallow tin cans (tuna cans work well) spaced in the yard approximately 6 inches from each sprinkler head and half way between each sprinkler. Run the system 5-10 minutes and check the cans for the amount of water applied. Adjust or replace sprinkler heads (using the same type and flow rate) for more even application.
◆	Consider replacing conventional pop-up spray heads with new, more **efficient multi-stream rotary nozzles** that fit into a conventional popup spray body and provide a more even application of water. (Note: all heads must be replaced for an irrigation zone since rotary nozzles have a lower water application rate.)

◆	Convert overhead spray systems that are currently irrigating trees, planting beds and shrubs to more efficient **drip irrigation.** Simple retrofit kits are available to convert overhead spray to drip systems. For more information on designing, installing, and maintaining a drip irrigation system, visit **irrigationtutorials.com/.**
◆	Install a rain shut-off switch. Adding a rain switch will prevent overirrigating your landscape and will save water at the same time.

"How often should I water?"

Once you have fixed broken or misaligned spray heads and made necessary retrofits to improve efficiency, properly setting your irrigation controller is the most important thing you can do to reduce outdoor water waste. Unless you have a weather-sensitive controller to do the work for you, increasing or decreasing the frequency of watering should be your primary method of seasonal adjustment.

◆	Make sure to adjust your controllers to accommodate any local watering restrictions, which are typically in effect during the hotter summer months.
◆	Reset your irrigation controller to irrigate less in the wetter seasons (or turn off the irrigation altogether, depending upon climate).
◆	Irrigate at night or in the early morning when evaporation is lowest.
◆	To help prevent water runoff, make sure water has enough time to soak into the soil before beginning the next irrigation cycle.

Landscape Upgrades:

Landscape upgrades and improved maintenance can help reduce irrigation demand. Several online resources and landscape standards have been developed to help homeowners reduce their outdoor water demand, while generating additional benefits. Those looking for more comprehensive guidance should reference these sources and others listed in the Section 3, *Resources*, of this handbook. Basic steps you can take to help reduce landscape water demand include:

◆	Consider removing some high-water-use plants, such as turf, and replacing them with low-water-use plants adapted to your climate. Check with your local water providers to see if they offer rebates for turf removal and replacement with low-water-use plants.
◆	Integrate water capturing elements into your landscape, such as swales, rain barrels, or rain gardens, to help offset irrigation with potable water.
◆	Use 3-4 inches of organic mulch around plants to reduce evaporation, promote plant growth and reduce weeds.
◆	Hire WaterSense-certified professionals, such as Qualified Water Efficient Landscapers or Watershed Wise Landscape Professionals, that can assist with improving your landscape water management (**epa.gov/watersense/professional-certification-0**).

Outdoor Faucets & Hoses

Check outdoor faucets (hose bibbs) annually for leaks, especially in cold climates where valves can be damaged by freezes. Replace valve washers, or valves themselves if they are leaking. If a hose connection or spray nozzle is leaking (cannot be fully shut off), simply replace the rubber washer in the hose fitting or sprayer. Burst or leaky hoses can be repaired by cutting out the damaged section and reconnecting the ends with inexpensive fittings available at most home and garden centers.

To save water outdoors:

◆	Water plants and lawn in the evening or early morning hours when evaporation is low.
◆	Never let the hose run when washing cars. Use a spray nozzle with a shutoff.

◆	Use a broom instead of a hose to clean driveways, patios or sidewalks.
◆	After hose use, turn off outdoor faucet (hose bibb) and release hose pressure to avoid bursting hoses.
◆	If you have an automatic irrigation system, refer to the previous section. Tuning up your irrigation system can save a tremendous amount of water.

Pools & Spas

The actual amount of water that your pool or spa uses is affected by a variety of factors including pool size, rate of evaporation (related to local climate and pool water temperature), leaks, frequency of filter backwashing, and individual maintenance habits.

Conserving Water

◆	Use a pool or spa cover to save water and energy, while keeping your pool or spa free of debris.
◆	Curtail use of fountains and waterfalls to minimize evaporation.
◆	Turn off the tile-spray device on your automatic pool cleaner.
◆	Maintain proper chemical levels and adequate circulation to prevent algae and other water quality problems, thereby eliminating the need to drain your pool or spa.
◆	When you are filling your pool, carefully watch the water level, and plug the overflow line.
◆	Reduce the temperature of your spa or heated pool to reduce evaporation and save energy.

Detecting Leaks

Even minor swimming pool leaks can cause substantial damage and result in large water bills. Warning signs of hidden leaks in pools and spas:

◆	Algae formation soon after chemical treatment
◆	Loose or falling tiles

◆	Pool deck cracks, gaps and cracks in the pool shell
◆	Settling of pool or spa structure into the ground or constantly damp soil surrounding the pool and/or under the house

If you are unsure if the water loss in your pool or spa is caused by evaporation or a leak, try placing a bucket on the top step of the pool and filling it with water to the pool's water level. After a day, if the water level in the pool is lower than in the bucket, there is probably a leak in the pool structure or plumbing system.

To further detect whether the cause is the structure or the plumbing system, measure the water loss with the pump running for 24 hours; repeat the 24-hour measurement again with the pump off. If more water is lost when the pump is running, the plumbing is likely the cause. If you cannot determine whether a leak is present, you may have to call a pool professional.

Pool repairs range from fixing electrical wiring to replacing broken tiles to patching leaks. For specific information on repairing your pool check this website: **naturalhandyman.com/iip/infpool/infpool.html.**

WATER TREATMENT

Water Filters – Reverse Osmosis

A reverse osmosis drinking water purification systems acts like a sieve to filter and extract unwanted substances from water. A reverse osmosis system may be mounted under a sink cabinet or set on the counter (usually in the kitchen), or it may be connected to the main water intake plumbing in your home.

A reverse osmosis (RO) system is very water use-intensive. It not only uses water, but also puts unused water into the sewer system. Any time the unit is filling the treated water tank, water can be wasted. Some under-sink models run a small amount of water into the drain constantly, even when the treated water tank is full and no drinking water is used. A reverse osmosis system can account for 7 to 8 percent of inside household water consumption. It is important that the system be equipped with an automatic shutoff device.

RO systems periodically need their filters to be cleaned or replaced. Be alert for noticeable changes in sediment, water pressure, and taste in your water. These may indicate that your filter should be replaced. Consult the operating instructions to determine how often to clean and/or replace filters.

Water Softeners

As rainwater filters down through the earth, it absorbs calcium, magnesium, and other minerals. When these materials are not dissolved in the water but suspended in it, the water is called "hard." Hard water reduces the sudsing action of soap. A water softener removes calcium and magnesium and replaces them with sodium. People on low-salt diets should not drink softened water. Water softeners need to be "regenerated" periodically, wherein the resin bed inside the softener is rinsed to remove the accumulated minerals to allow for continued operation of the softening process.

There are four basic types of water softeners:

Manual Water Softeners

Manual units require you to initiate some or all of the regeneration cycle.

Automatic Water Softeners (Two Types)

Semi-Automatic: You initiate the regeneration cycle, and the resin bed is rinsed and returned to service automatically.

Fully Automatic: A clock timer automatically initiates every step in the regeneration cycle. The fully automatic version regenerates at preset times whether or not the resin needs it. Therefore, this type of water softener can waste a lot of water.

Demand-Initiated Regeneration Water Softeners

If all operations are performed automatically only in response to the actual demand for treated water, the softener is called a demand style. This type measures the volume of water used, senses changes in water hardness, and measures changes in the electrical conductivity of the resin bed before initiating a regeneration cycle efficiently.

Portable Exchange Water Softeners

Water softener tanks can be permanently installed units or portable exchange units. When the resin is exhausted in the portable exchange unit, the tank is removed and replaced with another containing regenerated resin, usually by a service company equipped to deliver new tanks and pick up depleted tanks. The exhausted tank is returned to the service company for regeneration.

Water Conservation Tips for Water Softeners

- The fully clock timer-based automatic softener can be very inefficient and water-wasting.
- The demand initiated regeneration type of water softener is one of the most water efficient.
- No matter which type of water softener you have, it is a good idea for all automatic water softener tanks to be equipped with on/off switches to prevent wasteful and costly regeneration when the units are not in use, such as during vacations.
- Check with reputable plumbing service company to find out whether water softeners should be used or are even needed with your specific type of water.

Some softener installations are plumbed to provide all the water supplied to fixtures and appliances inside the home. However, a better approach may be to only supply the hot water side by connecting the softener to the water heater input. Softening water can impact the taste of cold water. By softening only the hot water, homeowners can retain better tasting cold water.

SECTION 3

Resources

GUIDES/BOOKS

Ultimate Guide: Plumbing, 4th Updated Edition
Creative Homeowner, January 2017

Black and Decker. The Complete Guide to Plumbing, Updated 7th Edition
Cool Springs Press, January 2019

Sunset You Can Build: Plumbing
Sunset Publishing Corporation, January 2010

Sunset Western Garden Book of Landscaping
Sunset Publishing Corporation, February 2014

Ortho's All About Plumbing Basics
Ortho Books, January 2010

WEBSITES

Note to the reader: The following list of water efficiency-related websites is current as of the date of this publication. The URL for websites often change. A good rule of thumb when searching for sites is to use a search engine, such as Google, to help locate the site's current URL.

General Plumbing

Water Saving Tips	home-water-works.org
Plumbing Handbook	theplumber.com/plumbing-handbook
Plumbing Education and Information-sharing	plbg.com
The Natural Handyman	
Faucets:	naturalhandyman.com/iip/infplumb/inffau/inffau.html
Sink repair:	naturalhandyman.com/iip/infplumb/infpopup.html
Toilets:	naturalhandyman.com/iip/inftoi/inftoi.html
Clothes washers:	naturalhandyman.com/iip/infxtra/infwas.html
Dishwashers:	naturalhandyman.com/iip/infapplianceinstallation/infdishwasher_installation.html
Water heaters:	naturalhandyman.com/iip/infwaterheater/infwaterheater.html
Humidifiers:	naturalhandyman.com/iip/infhumidifier/infhumid.html
Leak detection systems:	naturalhandyman.com/iip/infplumb/infleakdetect.html
Pools & spas:	naturalhandyman.com/iip/infpool/infpool.html
Septic systems:	naturalhandyman.com/iip/infsep/infsep.html
Do-it-yourself: Plumbing	
Fix running toilets:	doityourself.com/stry/how-to-fix-a-running-toilet **Install toilets:** doityourself.com/stry/bathinstallatoilet
Faucets:	doityourself.com/stry/h2repairvalve
Showerheads:	doityourself.com/stry/showerhead

Family Handyman: Plumbing Videos	
Remove toilets (video):	familyhandyman.com/videos/?video_id=rWPJQilB&playlist_id=Vt36xphy&playlist_title=bathroom
Install toilets (video):	familyhandyman.com/videos/?video_id=sRxmC4Ud&playlist_id=Vt36xphy&playlist_title=bathroom
Fix a running toilet (video):	familyhandyman.com/videos/?video_id=e5YhRM9I&playlist_id=Vt36xphy&playlist_title=bathroom

Toilets

High and Premium High Efficiency Toilets (HET/ Premium HETs)	map-testing.com/toilet-types
Flush Performance Report (over 4,000 U.S. models)	map-testing.com
Toilet Maintenance and Repair	toiletology.com

Water Efficiency and Conservation

General Water Efficiency and Conversation Resources

The California Water Efficiency Partnership	calwep.org
The Alliance for Water Efficiency	allianceforwaterefficiency.org/
Water Efficient Products	epa.gov/watersense
General Water Saving Tips for Homeowners	bewaterwise.com/toolkit.html#water-saving-tips
	home-water-works.org/

Energy Efficiency

Consortium for Energy Efficiency	cee1.org
USEPA & USDOE Energy Star Home Appliances	energystar.gov

Landscape Irrigation

Home Water Works General Landscape Irrigation	home-water-works.org/landscape-irrigation/irrigation
Design and Installation Tutorials for Efficient Irrigation Systems	irrigationtutorials.com
Smart Irrigation Controllers	calwep.org (search: Landscape Irrigation Technologies)
	ucanr.edu/sites/UrbanHort/Water_Use_of_Turfgrass_and_Landscape_Plant_Materials/Smart_Irrigation_Controllers_947/
Find a Qualified Irrigation Contractor	irrigation.org/IA/Certification/Hire-Certified/IA/Certification/Hire-Certified
Find a Qualified Landscape Contractor in Your State	lcamddcva.org/page/MemOnlyStateOrg/Industry-and-State-Organizations.htm
Find a WaterSense Certified Irrigation Professional	epa.gov/watersense/irrigation-pro
Landscape Water Conservation and Irrigation Management	ucanr.edu/sites/UrbanHort/Water_Use_of_Turfgrass_and_Landscape_Plant_Materials/

DAILY WATER USE: EFFICIENT VS. NON-EFFICIENT

TIPS

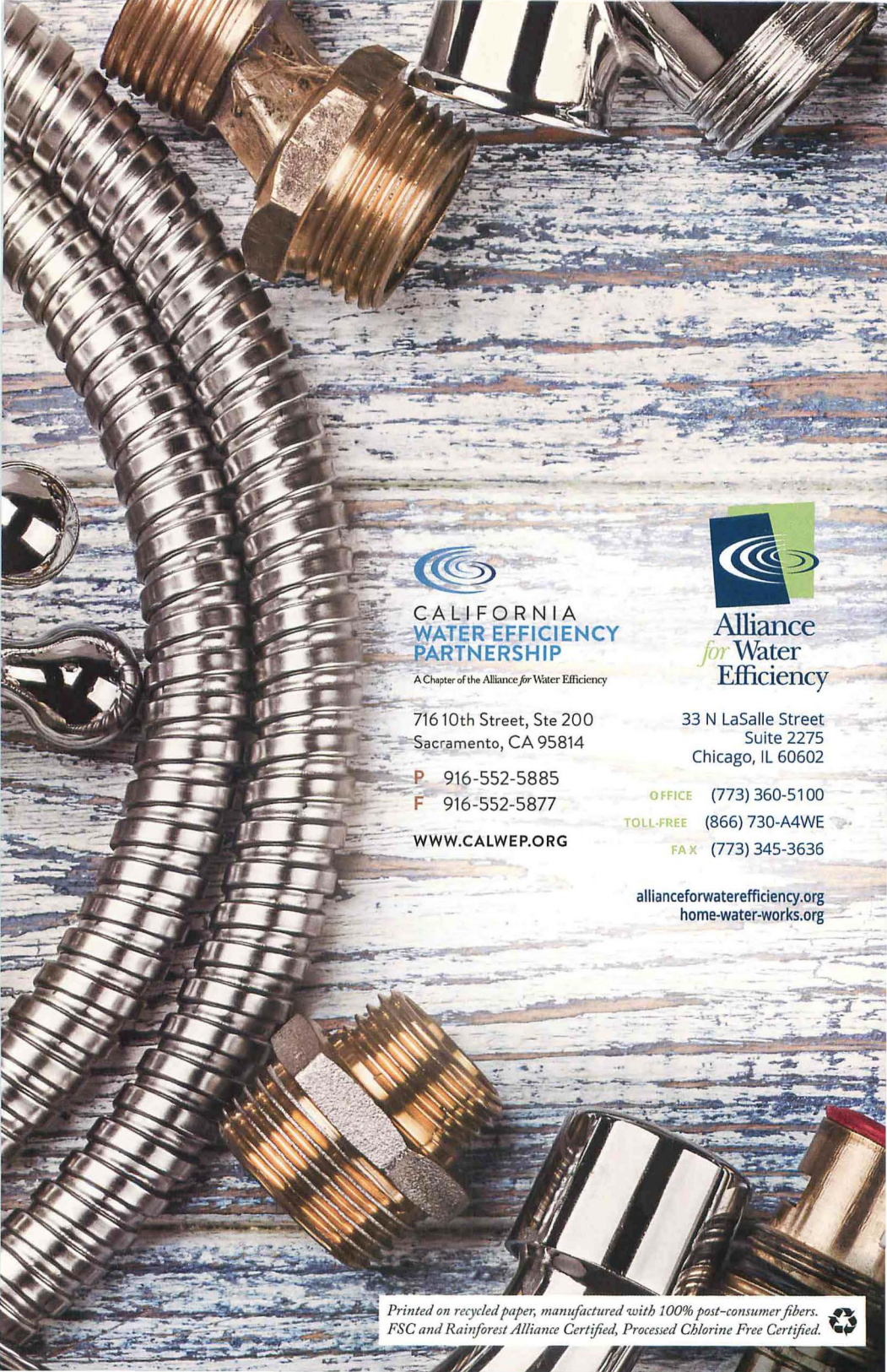
The table compares reasonable estimates of efficient vs. non-efficient water use for residential water use.[1]

Category	Type	Water used per activity (gallons)	Frequency of use per day per person	Gallons used per day per person: Efficient (gpcd)[3]	Gallons used per day per person: Non-Efficient (gpcd)[3]
Toilet	WaterSense/CalGreen high efficiency toilet	1.28 gal/flush or less	5 flushes/ day	6	
	EPAct 1992 compliant toilet	1.6 gal/flush		8	
	Pre-1992 legacy toilet	3.5-7.0 gal/flush			25
Shower	High-Efficiency showerhead	1.8 gal/minute	8 minutes/ day	14	
	WaterSense Showerhead	2.0 gal/minute		16	
	EPAct 1992 compliant showerhead	2.5 gal/minute		20	
	Pre-1992 legacy and non-compliant multi-showerheads	5.0-7.0 gal/ minute			48
Residential Clothes Washer	Highest efficiency/CalGreen (WF[2] 5.0 or less)	16 gal/load	3 loads/ week	6	
	High-efficiency (WF 6 - 7)	22 gal/load		9	
	EPAct 1992 compliant washer	26 gal/load		10	
	Standard Pre-EPAct efficiency (WF 9)	35 gal/load			14
Residential Dishwasher	California dishwasher (CalGreen)	5.0 gal/cycle	2 cycles/ week	1	
	EPAct 1992 compliant dishwasher	6.5 gal/cycle		2	
	Pre-1992 legacy and non-compliant	14 gal/cycle			4
Residential Bathroom Faucets	WaterSense Lavatory faucet	2.0 gal/minute	5 minutes/ day	10	
	Standard EPAct 1992 compliant faucet	2.5 gal/minute		13	
	Pre-1992 legacy and non-compliant faucets	4.0 gal/minute			20
Indoors Total	WaterSense/CalGreen compliant new home		Indoor - gpcd	40	
	EPAct 1992 compliant new home			53	
	Pre-1992 legacy and non-compliant				111

1 Numbers are based on approximate, average household use. Water use will vary with individual habits, house water pressure and the age and model of appliances and fixtures.

2 Water Factor (WF) refers to the number of gallons it takes to wash 1-cubic foot of laundry.

3 gpcd = Gallons Per Capita Per Day



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