HOME SKILLS

# Plumbing

INSTALL & REPAIR YOUR OWN TOILETS, FAUCETS, SINKS, TUBS, SHOWERS, DRAINS

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## INSTALL & REPAIR YOUR OWN TOILETS, FAUCETS, SINKS, TUBS, SHOWERS, DRAINS


Cool Springs Press

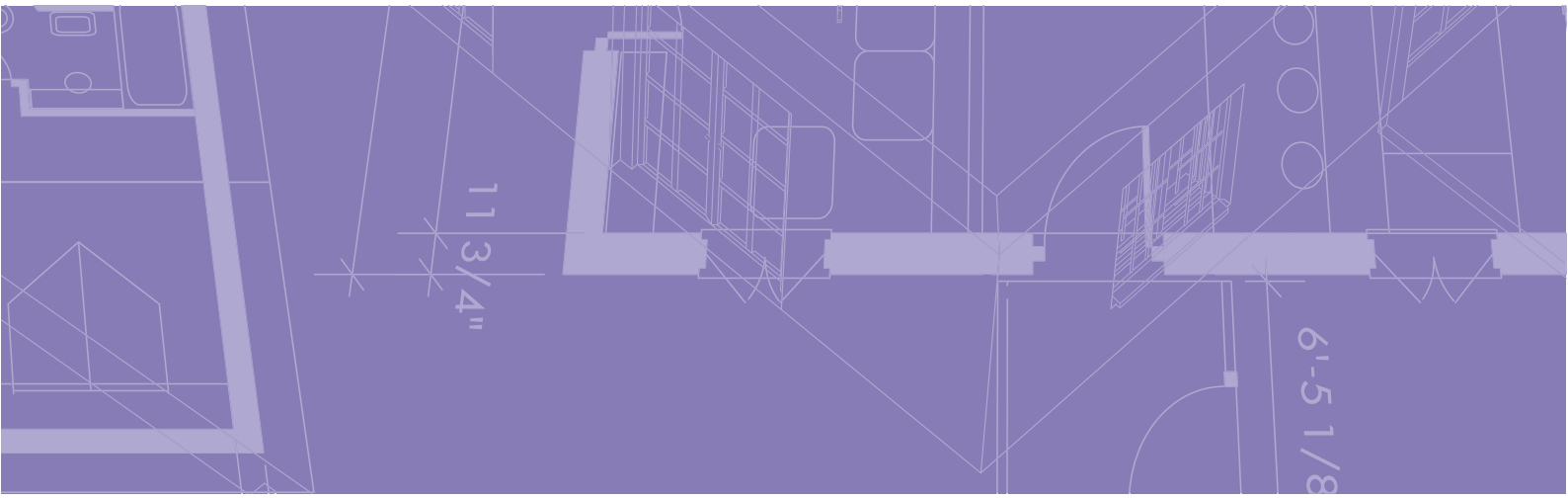
*Home and Garden Experts™*

MINNEAPOLIS, MINNESOTA

# CONTENTS



## The Home Plumbing System

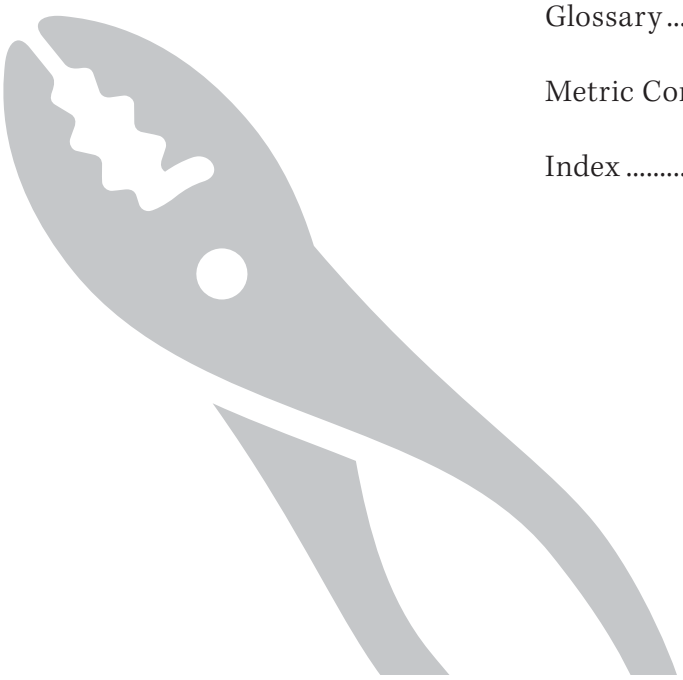



## Plumbing Repairs & Projects



## References





# Introduction

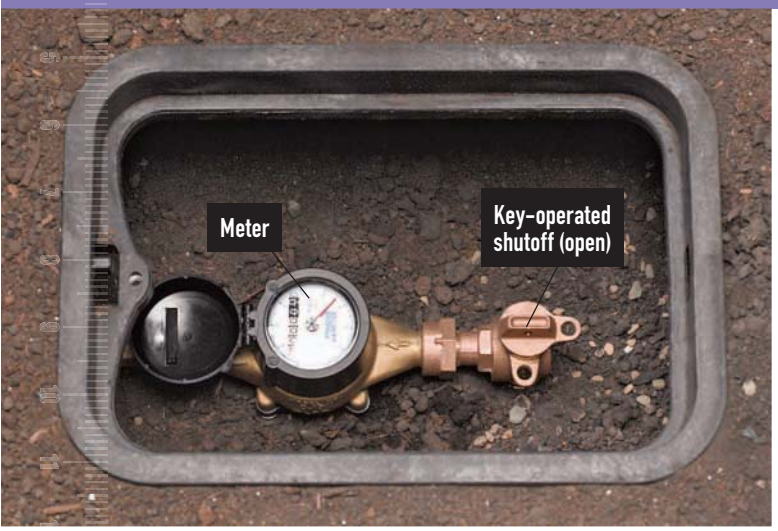
**EVERY HOMEOWNER SHOULD** have a good basic understanding of the plumbing system in their home. *HomeSkills: Plumbing* guides you through the layout of the standard plumbing system, the materials used, both past and present, the tools necessary for repairs and projects, and numerous projects and repairs you can easily accomplish.

The plumbing system, like the electrical system, may seem deeply mysterious at first glance. How does this seemingly jumbled assortment of pipes (especially in an older home that may have been updated many times) make any sense. You will see that it actually does make a good deal of sense.

While not as dangerous as the electrical system, improperly installing or repairing plumbing systems can cause serious damage to your home through water leakage. It is important to follow current code and building practices to assure a dry, functional installation.

# THE HOME PLUMBING SYSTEM

# The Home Plumbing System




**An outdoor main** shutoff may be as simple as an exposed valve that you turn by hand. Or it may be buried in a housing that is sometimes called a Buffalo box. In this example, both the meter and the main shutoff are housed in the box; in other cases, the meter is located inside the house.

**BECAUSE MOST OF** a plumbing system is hidden inside walls and floors, it may seem to be a complex maze of pipes and fittings. But the information in this book will help you gain a basic understanding of your system. Understanding how home plumbing works is an important first step toward doing routine maintenance and money-saving repairs.

A typical home plumbing system includes three basic parts: a water supply system, a fixture and appliance set, and a drain system. These three parts can be seen clearly in the photograph of the cut-away house on the opposite page.

Fresh water enters a home through a main supply line (1). This fresh water source is provided by either a municipal water company or a private underground well. If the source is a municipal supplier, the water passes through a meter (2) that registers the amount of water used. A family of four uses about 400 gallons of water each day.

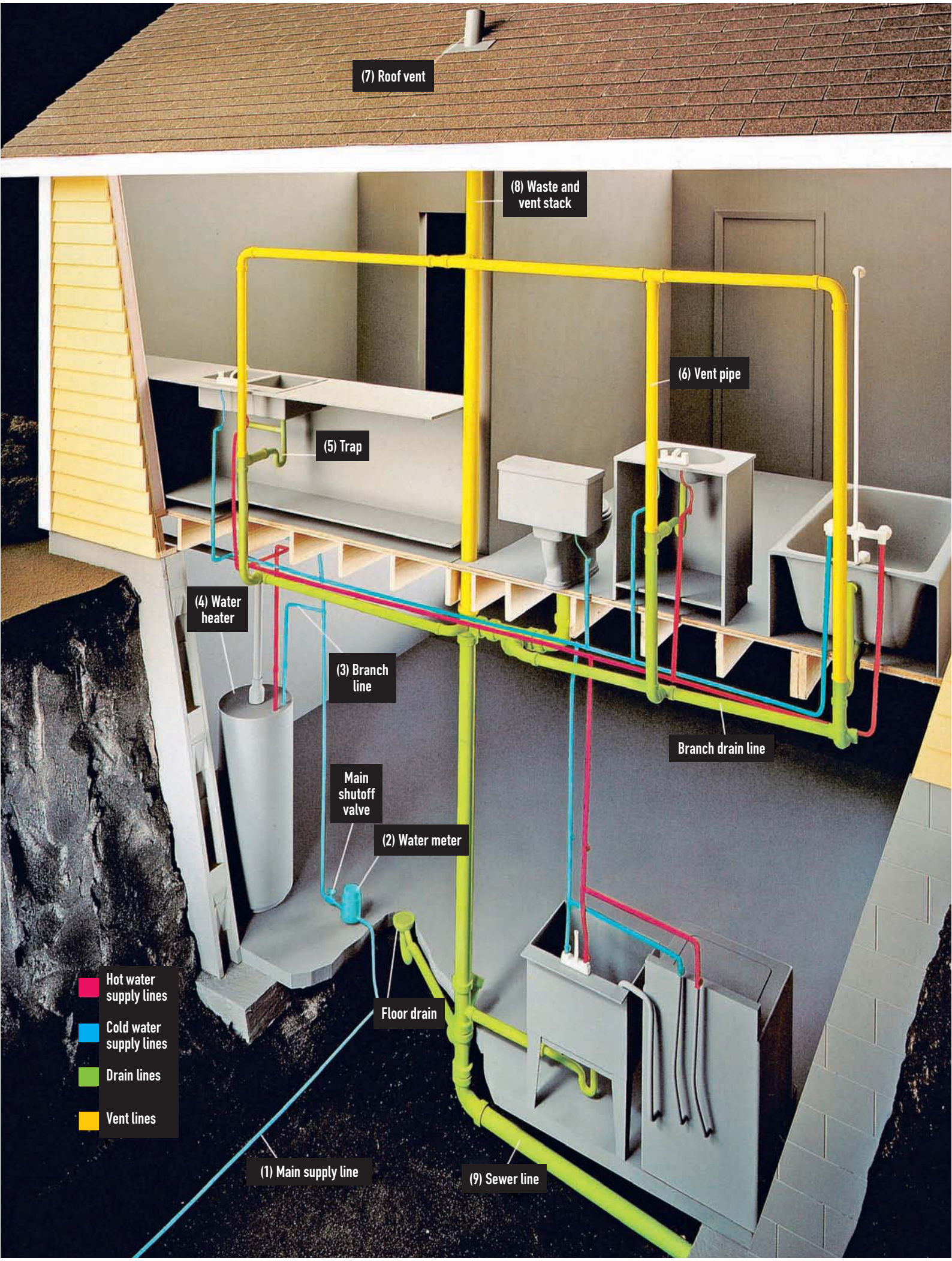
Immediately after the main supply enters the house, a branch line splits off (3) and is joined to a water heater (4). From the water heater, a hot water line runs parallel to the cold water line to bring the water supply to fixtures and appliances throughout the house. Fixtures include sinks, bathtubs, showers, and laundry tubs. Appliances include water heaters, dishwashers, clothes washers, and water softeners. Toilets and exterior sillcocks are examples of fixtures that require only a cold water line.

The water supply to fixtures and appliances is controlled with faucets and valves. Faucets and valves have moving parts and seals that eventually may wear out or break, but they are easily repaired or replaced.

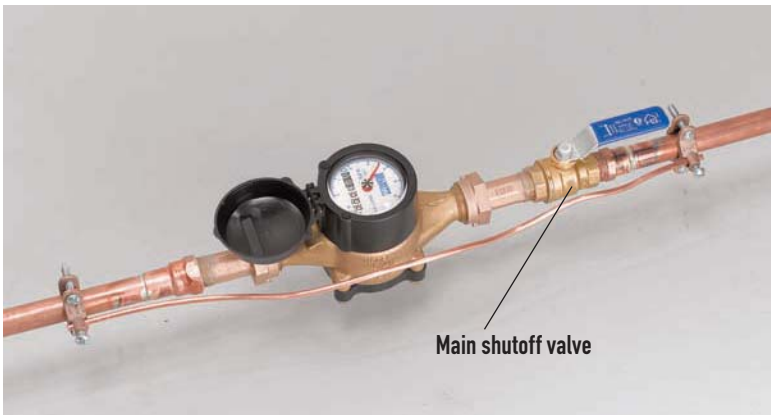
Waste water then enters the drain system. It first must flow past a drain trap (5), a U-shaped piece of pipe that holds standing water and prevents sewer gases from entering the home. Every fixture must have a drain trap.

The drain system works entirely by gravity, allowing waste water to flow downhill through a series of large-diameter pipes. These drain pipes are attached to a system of vent pipes. Vent pipes (6) bring fresh air to the drain system, preventing suction that would slow or stop drain water from flowing freely. Vent pipes usually exit the house at a roof vent (7).

All waste water eventually reaches a main waste and vent stack (8). The main stack curves to become a sewer line (9) that exits the house near the foundation. In a municipal system, this sewer line joins a main sewer line located near the street. Where sewer service is not available, waste water empties into a septic system.


(7) Roof vent
(8) Waste and vent stack
(6) Vent pipe
(5) Trap
(4) Water heater
(3) Branch line
Branch drain line
Main shutoff valve
(2) Water meter
Floor drain
Hot water supply lines
Cold water supply lines
Drain lines
Vent lines
(1) Main supply line
(9) Sewer line

**You may have** an inside main shutoff, usually located near the point where the main supply pipe enters the house near the water meter. There may be valves on each side of the meter; turn off either one of them to shut off water to the house. The copper grounding wire is an important part of the electrical system and should never be removed.




## Water Supply System

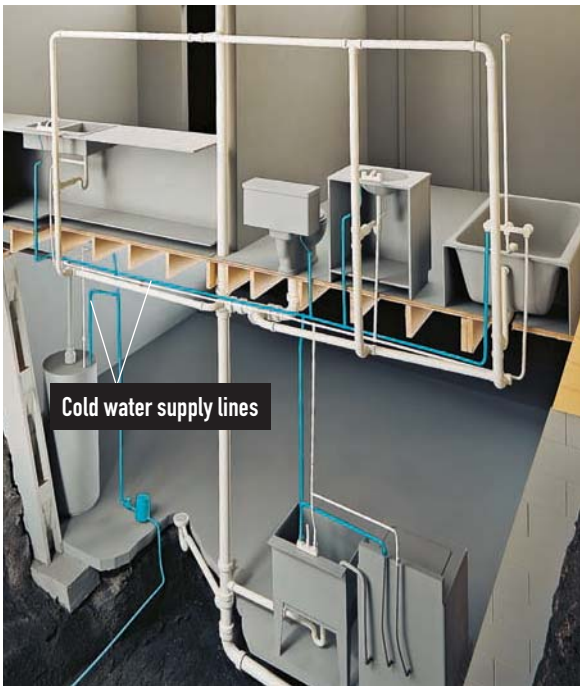
Water supply pipes carry hot and cold water throughout a house. In homes built before 1960, the original supply pipes were usually made of galvanized steel. Newer homes have supply pipes made of copper. Beginning in the 1980s, supply pipes made of rigid plastic (PVC or CPVC) became more commonplace, and the more recent plumbing innovations find PEX pipe widely used and accepted.

Water supply pipes are made to withstand the high pressures of the water supply system. They have small diameters, usually ½" to 1", and are joined with strong, watertight fittings. The hot and cold lines run in tandem to all parts of the house. Usually, the supply pipes run inside wall cavities or are strapped to the undersides of floor joists.

Hot and cold water supply pipes are connected to fixtures or appliances. Fixtures include sinks, tubs, and showers. Some fixtures, such as toilets or hose bibs, are supplied only by cold water. Appliances include dishwashers and clothes washers. A refrigerator icemaker uses only cold water. Tradition says that hot water supply pipes and faucet handles are found on the left-hand side of a fixture, with cold water on the right.

Because it is pressurized, the water supply system is occasionally prone to leaks. This is especially true of galvanized iron pipe, which has limited resistance to corrosion.

For some houses in older neighborhoods, the main supply line running from the street to the house is made of lead; this once posed a health hazard. Today, however, municipalities with lead pipes often add a trace amount of phosphate to the water, which coats the inside of the pipes and virtually eliminates leaching of lead into the water. If you are concerned about lead in your water, check with your local water supplier.

## Drain-Waste-Vent System

Drain pipes use gravity to carry waste water away from fixtures, appliances, and other drain openings. This waste water is carried out of the house to a municipal sewer system or septic tank.

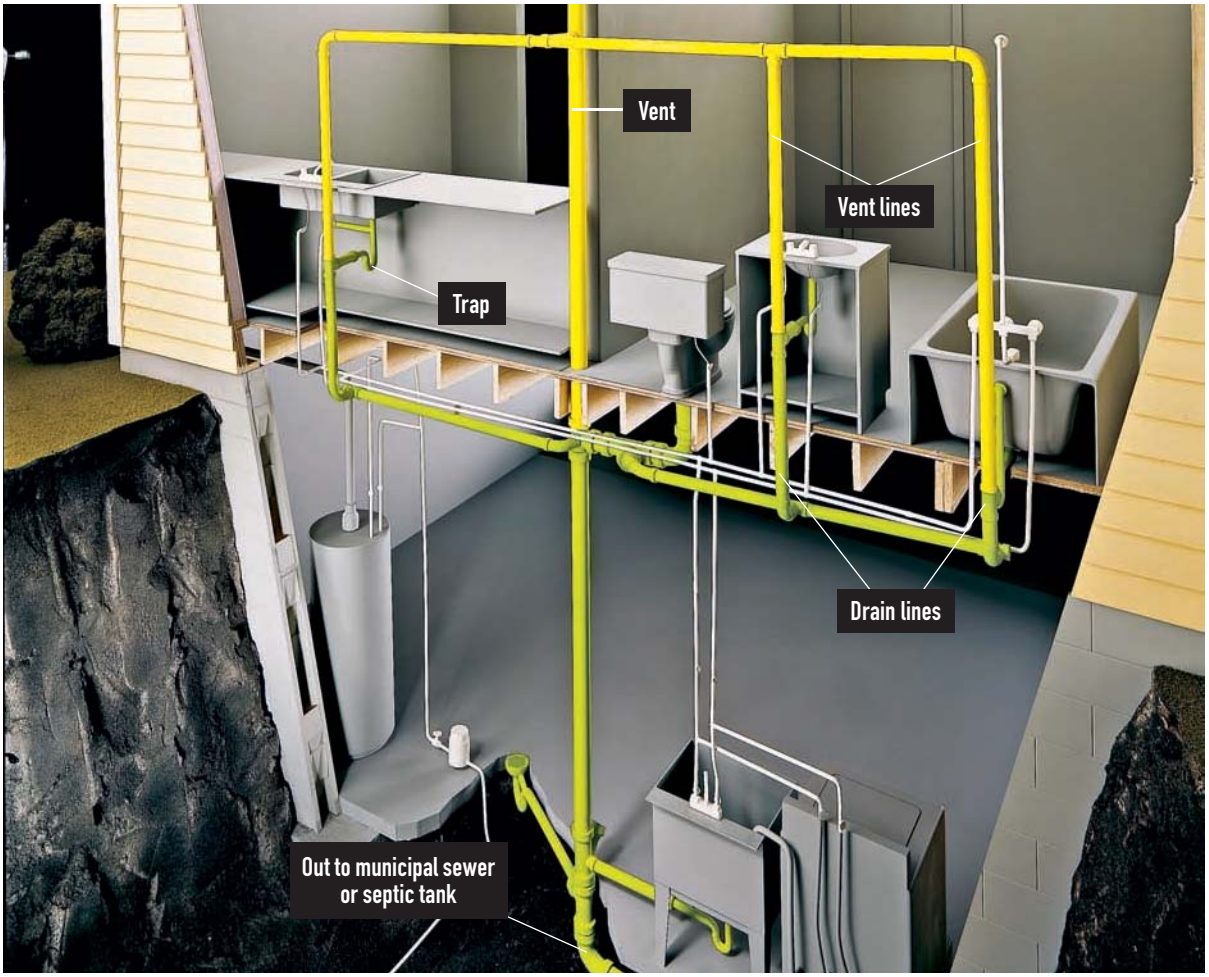
Newer drain pipes are plastic. In an older home, drain pipes may be cast iron, galvanized steel, copper, or lead. Because they are not part of the supply system, lead drain pipes pose no health hazard. However, lead pipes are no longer manufactured for home plumbing systems.

Drain pipes have diameters ranging from 1¼" to 4". These large diameters allow waste to pass through efficiently.

Traps are an important part of the drain system. These curved sections of drain pipe hold standing water, and they are usually found immediately after the drain tailpiece in the drain opening. The standing water of a trap prevents sewer gases from backing up into the home. Each time a drain is used, the standing trap water is flushed away and is replaced by new water.

In order to work properly, the drain system requires air. Air allows waste water to flow freely down drain pipes.

To allow air into the drain system, drain pipes are connected to vent pipes. All drain systems must include vents, and the entire system is called the drain-waste-vent (DWV) system. One or more vent stacks, located on the roof, provide the air needed for the DWV system to work.



## PLUMBING TOOLS

Many plumbing projects and repairs can be completed with basic hand tools you probably already own. Adding a few simple plumbing tools will prepare you for all the projects in this book. Specialty tools, such as a snap cutter or appliance dolly, are available at rental centers. When buying tools, invest in quality products.

Always care for tools properly. Clean tools after using them, wiping them free of dirt and dust with a soft rag. Prevent rust on metal tools by wiping them with a rag dipped in household oil. If a metal tool gets wet, dry it immediately, and then wipe it with an oiled rag. Keep toolboxes and cabinets organized. Make sure all tools are stored securely.


Metal files
Tape measure
STANLEY
FatMax
BladeArmor
16
Strainer wrench
Adjustable wrenches
Seat wrench
Screwdriver
Putty knife
Channel-type pliers
Needlenose pliers
Basin wrench
STANLEY
FatMax
24"
Level

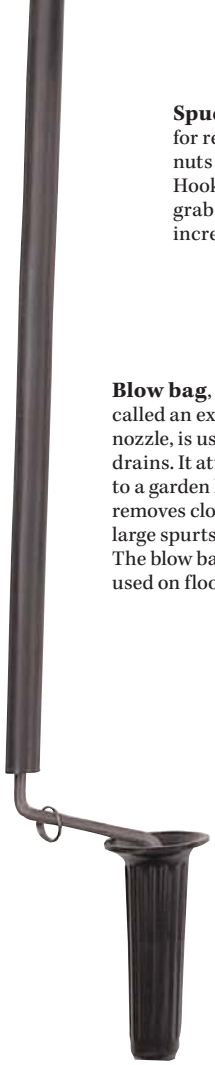
**Drill-powered auger** is stronger than a hand-crank auger for removing larger pipe obstructions. This auger can be cranked by hand or attached to a standard ⅜" power drill.


**Force cup** clears drain clogs with water and air pressure. The force cup is used for toilet bowls. The flange usually can be folded up into the cup for use as a standard plunger.

**Pipe wrench** has a movable jaw that adjusts to fit a variety of pipe diameters. Pipe wrench is used for tightening and loosening pipes, pipe fittings, and large nuts. Two pipe wrenches often are used together to prevent damage to pipes and fittings.

**Spud wrench** is specially designed for removing or tightening large nuts that are 2" to 4" in diameter. Hooks on the ends of the wrench grab onto the lugs of large nuts for increased leverage.

**Blow bag**, sometimes called an expansion nozzle, is used to clear drains. It attaches to a garden hose and removes clogs with large spurts of water. The blow bag is best used on floor drains.



**Tubing cutters** make straight, smooth cuts in plastic and copper pipe. A tubing cutter usually has a triangular blade for removing burrs from the insides of pipes.

**Plastic tubing cutter** works like a gardener's pruners to cut flexible plastic pipes quickly.

**Closet auger** is used to clear toilet clogs. It is a slender tube with a crank handle on one end of a flexible auger cable. A special bend in the tube allows the auger to be positioned in the bottom of the toilet bowl. The bend is usually protected with a rubber sleeve to prevent scratching the toilet.


**MAPP torch** (left) is used for soldering fittings to copper pipes. Light the torch quickly and safely using a spark lighter.

**Flame-resistant pad** helps keep wood and other underlying materials safe from the torch's flame.


**Rental tools may be** needed for large jobs and special situations. A power miter saw makes fast, accurate cuts in a wide variety of materials, including plastic pipes. A motorized drain auger clears tree roots from sewer service lines. Use an appliance dolly to move heavy objects like water heaters. A snap cutter is designed to cut tough cast-iron pipes. The right-angle drill is useful for drilling holes in hard-to-reach areas.


**Power hand tools** can make any job faster, easier, and safer. Cordless power tools offer added convenience. Use a cordless ⅜" power drill for virtually any drilling task.

# PLUMBING MATERIALS

## Common Pipe & Tube Types

**Benefits & Characteristics**

ABS (acrylonitrile butadiene styrene) was once approved for use in DWV systems. Most local codes now prohibit ABS for new installations, but in some cases it can be added to pre-existing ABS DWV systems.

Cast iron is strong but hard to work with. Repairs should be made with plastic pipe, if allowed.

PVC (polyvinyl chloride) is rigid plastic that resists heat and chemicals. Lightweight tubes and heavier Schedule 40.

CPVC (chlorinated polyvinyl chloride) rigid plastic is inexpensive and withstands high temperature and pressure.

Chromed brass has an attractive shiny surface and is used for drain traps where appearance is important.

PE (polyethylene) plastic is a black or bluish flexible pipe sometimes used for main water service lines as well as irrigation systems.

Black pipe (iron pipe) generally is threaded at the ends to accept female-threaded fittings. Not for potable water.

Rigid copper is used for water supply pipes. It resists corrosion and has smooth surfaces for good water flow.

Braided metal is used for water supply tubes that connect shutoff valves to fixtures.

Flexible stainless-steel (protective coated) connectors are used to attach gas appliances to supply stopcocks.

Flexible stainless-steel (uncoated) connectors are used to attach gas appliances to supply stopcocks

Chromed copper supply tube is used in areas where appearance is important. Easy to bend and fit.

PEX (cross-linked polyethylene) is flexible and is approved by major building codes for water supply.

Flexible copper tubing (not shown) bends easily and requires fewer couplings than rigid copper.

| Common Uses | Lengths | Diameters | Fitting Methods | Tools Used for Cutting |
|---|---|---|---|---|
| Pipes; drain traps | Sold by linear ft. | 2", 3", 4" | Glue and plastic | Miter box or hacksaw |
| Main drain- waste-vent stack | 5 ft., 10 ft. | 3", 4" | Banded neoprene couplings | Snap cutter or hacksaw |
| Drain & vent pipes; drain traps | 10 ft., 20 ft.; or sold by linear ft. | 1¼", 1½", 2", 3", 4" | Solvent glue and/or plastic fittings | Tubing cutter, miter box, or hacksaw |
| Hot & cold water supply pipes | 10 ft. | ⅜", ½", ¾", 1" | Solvent glue and plastic fittings, or with compression fittings | Tubing cutter, miter box, or hacksaw |
| Valves & shutoffs; drain traps, supply risers | Lengths vary | 1¼", ½", ¾", 1¼", 1½" | Compression fittings, or with metal solder | Tubing cutter, hacksaw, or reciprocating saw |
| Outdoor cold water supply pipes | Sold in coils of 25 to hundreds of ft. | ¼" to 1" | Rigid PVC fittings and stainless steel hose | Ratchet-style plastic pipe cutter or miter saw |
| Gas supply pipe | Sold in lengths up to 10 ft. | ¾", 1" | Threaded connectors | Hacksaw, power cutoff saw or reciprocating saw with bi-metal blade |
| Hot & cold water supply pipes | 10 ft., 20 ft.; or sold by linear ft. | ⅜", ½", ¾", 1" | Metal solder or compression fittings | Tubing cutter, hacksaw, or jigsaw |
| Supply tubes | 12" or 20" | ⅜" | Compression coupling or compression fittings | Do not cut |
| Gas ranges, dryers, water heaters | 36" or 48" | ⅝", ½" (OD) | Compression coupling | Do not cut |
| Gas ranges, dryers, water heaters | 36" or 48" | ⅝", ½" (OD) | Compression coupling | Do not cut |
| Supply tubing | 12", 20", 30" | ⅜" | Brass compression fittings | Tubing cutter or hacksaw |
| Water supply, tubing for radiant floors | Sold in coils of 25 ft. to hundreds of ft. | ¼" to 1" | Crimp fittings | Tubing cutter |
| Gas supply; hot & cold water supply | 30-ft., 60-ft. coils; or by ft. | ¼", ⅜", ½", ¾", 1" | Brass flare fittings, solder, compression fittings | Tubing cutter or hacksaw |

## COPPER

Copper resists corrosion and has smooth surfaces that allow good water flow. Copper pipes are available in several diameters, but most home water supply systems use ½-inch or ¾-inch pipe. Copper pipe is manufactured in rigid and flexible forms.

Rigid copper, sometimes called hard copper, is approved for home water supply systems by all local codes. It comes in three wall-thickness grades: Types M, L, and K. Type M is the thinnest, the least expensive, and a good choice for do-it-yourself home plumbing.

Rigid Type L usually is required by code for commercial plumbing systems. Because it is strong and solders easily, Type L may be preferred by some professional plumbers and do-it-yourselfers for home use. Type K has the heaviest wall thickness and is used most often for underground water service lines.

Flexible copper, also called soft copper, comes in two wall-thickness grades: Types L and K. Both are approved for most home water supply systems, although flexible Type L copper is used primarily for gas service lines. Because it is bendable and will resist a mild frost, Type L may be installed as part of a water supply system in unheated indoor areas, like crawl spaces. Type K is used for underground water service lines.

A third form of copper, called DWV, is used for drain systems. Because most codes now allow low-cost plastic pipes for drain systems, DWV copper is seldom used.

### Skillbuilder

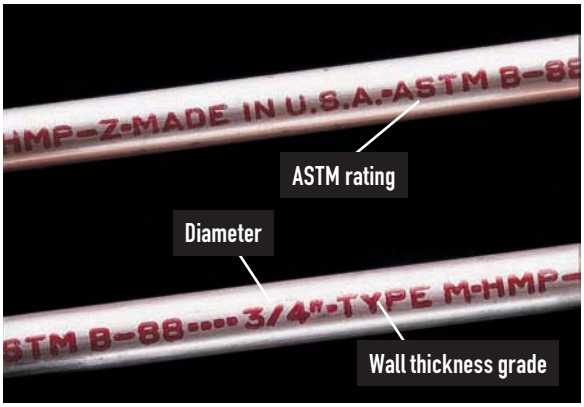
Practice makes perfect. If you have never soldered copper pipe before, practice sweating a few fittings onto a short sections of pipe before beginning an installation. This will acquaint you with process in a low stress setting.

Copper pipes are connected with soldered, compression, or flare fittings (see chart below). Always follow your local code for the correct types of pipes and fittings allowed in your area.

Soldered fittings, also called sweat fittings, often are used to join copper pipes. Correctly soldered fittings are strong and trouble-free. Copper pipe can also be joined with compression fittings or flare fittings. See chart below.

### Copper Pipe & Fitting Chart

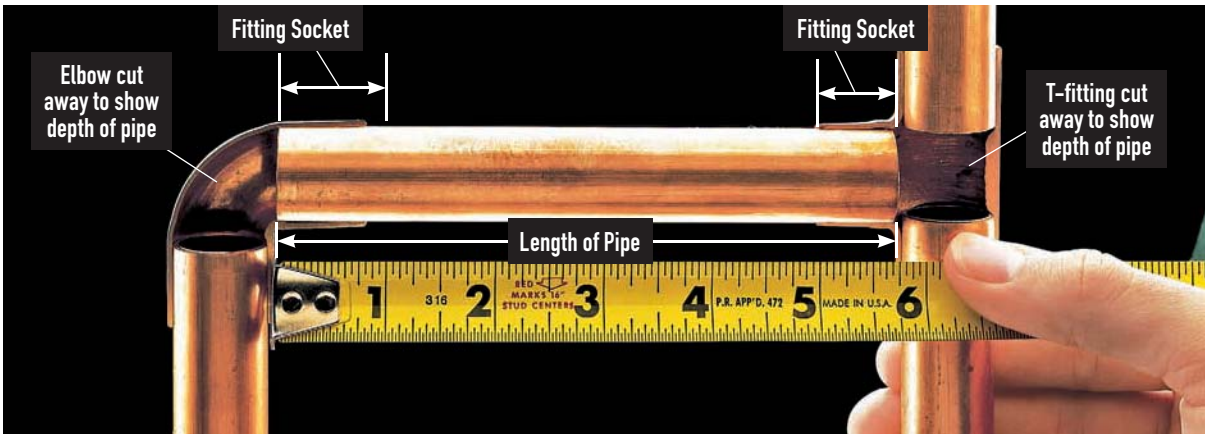
| Fitting Method | Rigid Copper | | | Flexible Copper | | General Comments |
|---|---|---|---|---|---|---|
| | Type M | Type L | Type K | Type L | Type K | |
| Soldered | Yes | Yes | Yes | Yes | Yes | Inexpensive, strong, and trouble-free fitting method. Requires some skill. |
| Compression | Yes | Not Applicable | | No | No | Makes repairs and replacement easy. More expensive than solder. Best used on flexible copper. |
| Flare | No | No | Yes | Yes | Yes | Use only with flexible copper pipes. Usually used as a gas-line fitting. Requires some skill. |




**Grade stamp information** includes the pipe diameter, the wall-thickness grade, and a stamp of approval from the ASTM (American Society for Testing and Materials). Type M pipe is identified by red lettering, Type L by blue lettering.

**Bend flexible copper pipe** with a coil-spring tubing bender to avoid kinks. Select a bender that matches the outside diameter of the pipe. Slip bender over pipe using a twisting motion. Bend pipe slowly until it reaches the correct angle, but not more than 90°.


**Specialty tools and** materials for working with copper include: flaring tools (A), emery cloth (B), coil-spring tubing bender (C), pipe joint compound (D), soldering paste (flux) (E), lead-free solder (F), wire brush (G), flux brush (H), compression fitting (I), flare fitting (J).




**Find the length of copper** pipe needed by measuring between the bottom of the copper fitting sockets (fittings shown in cutaway). Mark the length on the pipe with a felt-tipped pen.

## Cut & Solder Copper

The best way to cut rigid and flexible copper pipe is with a tubing cutter. A tubing cutter makes a smooth, straight cut, an important first step toward making a watertight joint. Remove any metal burrs on the cut edges with a reaming tool or round file.

Copper can be cut with a hacksaw. A hacksaw is useful in tight areas where a tubing cutter will not fit. Take care to make a smooth, straight cut when cutting with a hacksaw.

A soldered pipe joint, also called a sweated joint, is made by heating a copper or brass fitting with a propane torch until the fitting is just hot enough to melt metal solder. The heat draws the solder into the gap between the fitting and pipe to form a watertight seal. A fitting that is overheated or unevenly heated will not draw in solder. Copper pipes and fittings must be clean and dry to form a watertight seal.

### Tip

Never light a propane torch with a match. Ignition of the torch usually results in a small fire ball which will easily burn your fingers. A spark lighter keeps your hands and clothing at a safe distance.

## Tips for Safe Soldering

**Use caution** when soldering copper. Pipes and fittings become very hot and must be allowed to cool before handling.


**Prevent accidents** by shutting off propane torch immediately after use. Make sure valve is closed completely.

**Protect wood** from the heat of the torch flame while soldering. Use an old cookie sheet, two sheets of 26-gauge metal, or a fiber shield, as shown.

### Tools & Materials

Tubing cutter with reaming tip (or hacksaw and round file)
Wire brush
Flux brush
Propane torch
Spark lighter
Round file
Cloth
Adjustable wrench
Channel-type pliers
Copper pipe
Copper fittings
Emery cloth
Soldering paste (flux)
Sheet metal
Lead-free solder
Rag

## CUTTING RIGID & FLEXIBLE COPPER PIPE





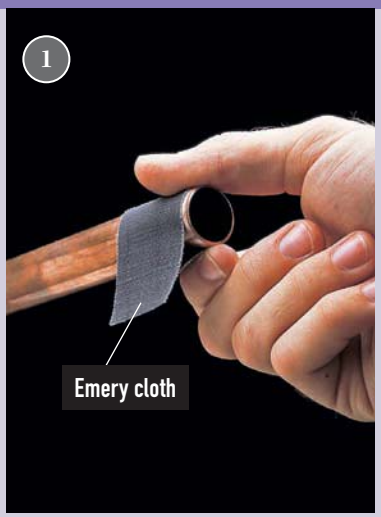
1 Place the tubing cutter over the pipe and tighten the handle so that the pipe rests on both rollers and the cutting wheel is on the marked line.

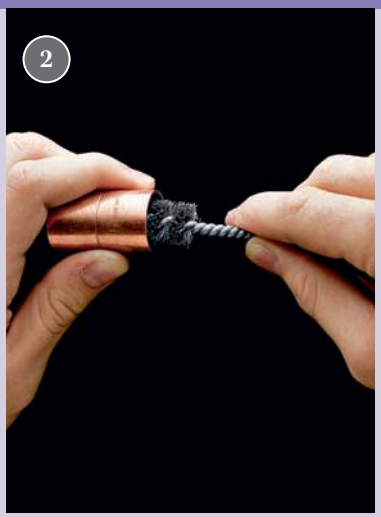
2 Turn the tubing cutter one rotation so that the cutting wheel scores a continuous straight line around the pipe.

3 Rotate the cutter in the opposite direction, tightening the handle slightly after every two rotations, until the cut is complete.

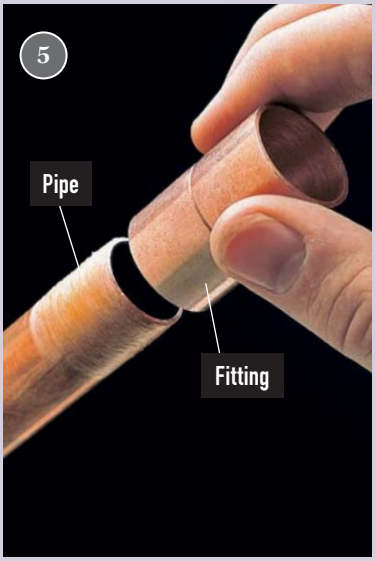
4 Remove sharp metal burrs from the inside edge of the cut pipe using the reaming point on the tubing cutter or a round file.

## SOLDERING COPPER PIPES & FITTINGS







1 Clean the end of each pipe by sanding with emery cloth. Ends must be free of dirt and grease to ensure that the solder forms a good seal.

2 Clean the inside of each fitting by scouring with a wire brush or emery cloth.

3 Apply a thin layer of soldering paste (flux) to the end of each pipe, using a flux brush. Soldering paste should cover about 1" of pipe end.

4 Apply a thin layer of flux to the inside of the fitting.

5 Assemble each joint by inserting the pipe into the fitting so it is tight against the bottom of the fitting sockets. Twist each fitting slightly to spread soldering paste.

6 Use a clean dry cloth to remove excess flux before soldering the assembled fitting.