



Block C: Plumbing Fixtures and Appliances

Block C: Plumbing Fixtures and Appliances

BC Plumbing Apprenticeship, Level 2

SKILLED TRADES BC

*BC PIPING ARTICULATION AND CURRICULUM SUBCOMMITTEE; ROD
LIDSTONE; AUDREY CURRAN; AND PAUL SIMPSON*

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In the field, there are many similarities or overlaps with the work of plumbers and gas fitters. Many plumbing and heating contractors employ both plumbers and gas fitters as well as tradespeople with dual certifications.

Upon completion of a Plumbing Apprenticeship, a plumber can receive cross-program credit for a portion of the Gas fitter apprenticeship. As such, training in fuel gas has been incorporated into all levels of the Plumbing Apprenticeship.

Block C of the **Plumbing Apprenticeship Program Level 2 Series** focuses on the installation of plumbing fixtures and appliances, providing apprentices with the essential skills to complete these tasks accurately and efficiently. This section equips apprentices with the knowledge required to install various plumbing fixtures and appliances, ensuring they can complete installations to industry standards and meet the needs of different plumbing systems.

Plumbing Apprenticeship Program Level 2 Series

The *Plumbing Apprenticeship Program Level 2 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Fuel Gas Systems (<https://a-fuelgas-bcplumbingapprl2.pressbooks.tru.ca/>)

- A-1: Gas Fired Appliances
- A-2: Gas Codes Regulations and Standards
- A-3: Gas Appliance and Building Air Requirements
- A-4: Technical Instruments and Testers

Block B: Heating and Cooling Systems (<https://b-heating-bcplumbingapprl2.pressbooks.tru.ca/>)

- B-1: Types of Heating and Cooling Systems
- B-2: Hydronic Heating and Cooling Generating Equipment
- B-3: Hydronic Heat Transfer Units
- B-4: Hydronic Heating Piping and Components

Block C: Install Fixtures and Appliances (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/>)

- C-1: Plumbing Fixtures and Trim
- C-2: Plumbing Appliances

Block D: Drainage Systems

(<https://d-drainagesystems-bcplumbingapprl2.pressbooks.tru.ca/>)

- D-1: Sanitary Drain, Waste and Vent Systems
- D-2: Planning and Installation of DWV Systems
- D-3: Storm Drainage Systems
- D-4: Test and Drainage Systems
- D-5: Drainage System Maintenance and Repairs

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** is coming soon to TRU Open Press in 2025–2026!
- **Plumbing Apprenticeship Program Level 3 Series** (<https://collection.bccampus.ca/search/?q=%22pl3%22>) can be found in the BCCampus Open Collection (<https://collection.bccampus.ca/>).
- **Plumbing Apprenticeship Program Level 4 Series** (<https://bccampus.ca/projects/archives/zed-cred-z-degrees/ztc-open-educational-resources-for-trades/>) can be found in the BCCampus Open Collection. (<https://collection.bccampus.ca/>) (Block F: Commission and Service will be available soon.)

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Symbol Legend



Important Information



Potentially Toxic/ Poisonous Situation



Required or Optional Resources



Potentially Flammable Situation



Complete a Self-Test



Possibly Explosive Situation



Use Protective Equipment



Potential Electric Shock

Acknowledgments

The development of the *Piping Trades Learning Guides* was a collaborative effort driven by a commitment to excellence in trades education. These guides were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose leadership and guidance have been instrumental in shaping high-quality training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.



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The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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C-1 PLUMBING FIXTURES AND TRIM

Plumber Apprenticeship Program – Level 2



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C-1 Plumbing Fixtures and Trim Introduction

A plumbing **fixture** can be defined as a device used for supplying and holding water for cleaning, bathing, or removal of human waste. This is the “terminal equipment” used by the client each day. Plumbing fixtures — such as **water closets**, **lavatories**, sinks, and bathtubs — are found in homes, apartments, hotels, and countless other environments.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe types of fixtures and trim.
- Describe supports for fixtures.
- Identify barrier-free requirements.
- Use manufacturers' documentation.
- Install fixtures and trim.
- Connect fixtures to water distribution and drainage systems.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **angle stop:** A small shutoff valve installed at the water supply stub to control water flow to a fixture. (Section C-1.2)
- **architectural drawings:** Drawings that provide room dimensions, fixture arrangements, and building materials, serving as a primary reference for rough-in work. (Section C-1.2)
- **back lip:** The rear edge of a bathtub that is supported by a horizontal ledge to provide stability and prevent movement. (Section C-1.2)
- **cartridge faucets:** A type of faucet that control the flow of water using a cartridge inside. The cartridge is a small, replaceable part that moves to let water flow in or out when you turn the handle. These faucets are easy to use and can help control both the temperature and the amount of water that comes out. (Section C-1.1)
- **clearance:** The minimum space required between fixtures and walls or other structures, as regulated by codes and specifications. (Section C-1.2)
- **closet flange:** A fitting that connects the water closet to the waste pipe, ensuring a secure connection. (Section C-1.2)

- **composite stone:** A strong material made by mixing crushed natural stone with glue or resin. It looks like real stone but is made in factories and is often used for countertops, floors, and walls. (Section C-1.1)
- **compression fitting:** A plumbing connection method that uses a nut and ferrule to create a watertight seal on supply lines. (Section C-1.2)
- **Drainage, Waste, and Vent (DWV) System:** A network of pipes that remove wastewater and provide ventilation to prevent sewer gases from entering buildings. (Section C-1.2)
- **drop ear fitting:** A fitting used to anchor the showerhead securely to the wall, often with a female iron pipe thread (FIP). (Section C-1.2)
- **electrical drawings:** Diagrams showing the layout of electrical lines, outlets, and fixtures to prevent conflicts with plumbing installations. (Section C-1.2)
- **fire stop rating:** A classification system indicating how long a barrier (e.g., firewall, floor) can prevent the spread of fire. (Section C-1.2)
- **fixture:** A plumbing device, like a sink or toilet, that uses water. (Section C-1.1)
- **flushometer valves:** A special valve used in public bathrooms instead of a regular toilet tank. It releases a strong burst of water to flush the toilet or urinal quickly and refills right away, so it can be used often without waiting. Direct-flush valves are a “tankless” design that uses water pressure from the supply line rather than a tank of water to flush the fixture (Figure 10, Section C-1.1)
- **gray water or process water:** Used water from sinks, showers, bathtubs, and washing machines. It is not dirty like toilet water and can sometimes be cleaned and reused for things like watering plants or flushing toilets. (Section C-1.1)
- **High-Efficiency Toilets (HETs):** Toilets that use less water to flush but still work just as well as regular toilets. They help save water and lower water bills. (Section C-1.1)
- **isometric drawing:** A three-dimensional technical drawing that illustrates the layout, connections, and travel path of plumbing pipes. (Section C-1.2)
- **mechanical drawings:** Plans that depict the layout of supply piping, waste and vent lines, and other mechanical systems within a building. (Section C-1.2)
- **P-trap:** A U-shaped pipe that prevents sewer gases from entering a home by trapping water. (Section C-1.2)
- **pedestal basin:** A type of sink supported by a freestanding pedestal that conceals plumbing connections. (Section C-1.2)
- **plumber’s putty:** A pliable sealing compound used to create watertight seals around drains and fixtures. (Section C-1.2)
- **pressure-assist:** A toilet system that uses compressed air to create a stronger flush. As the tank refills, a vessel captures and compresses air, which helps push the water into the bowl more quickly. This results in a more powerful and efficient flush, using less water while improving cleaning performance. (Section C-1.1)
- **rough-in:** The initial stage of plumbing installation before walls and floors are finished. (Section C-1.1)
- **self-rimming basin:** A sink with a built-in lip or rim that rests on the countertop, requiring minimal installation support. (Section C-1.2)
- **specification sheet:** A document that includes technical details about a fixture, including rough-in dimensions and installation requirements. (Section C-1.2)
- **trapway:** The curved pipe at the bottom of a toilet or sink that helps carry away water and waste. It also keeps a little bit of water inside to stop bad smells from coming back up. (Section C-1.1)
- **vacuum-assist:** A system in some toilets that helps the flush work more powerfully. It uses air pressure to help pull the waste and water down the drain quickly, using less water. (Section C-1.1)

- **water closets:** Another name for toilets, which are used for flushing away waste. (Section C-1.1)
- **weir:** The top edge of the water inside a toilet or sink drain trap (the trapway's highest point). It helps control the flow of water and keeps some water in the trap to block bad smells from coming back up. (Section C-1.1)
- **wing back elbow:** A pipe fitting with mounting wings that allows secure attachment to a backing board, commonly used for shower and tub spouts. (Section C-1.2)

C-1.1 Types of Fixtures and Trim

Plumbing fixtures, such as bathtubs, sinks and water closets, are manufactured from a variety of materials and made to suit different operating demands and personal tastes. The hardware and fittings used to install and complete fixtures are called trim. The fixture trim is made from various material combinations to ensure durability and an appealing appearance. Faucets, drain fittings, shower heads, and chrome finish are all examples of fixture trim (Figure 1). The materials used to manufacture fixtures and trim will determine the final properties and cost of each component.

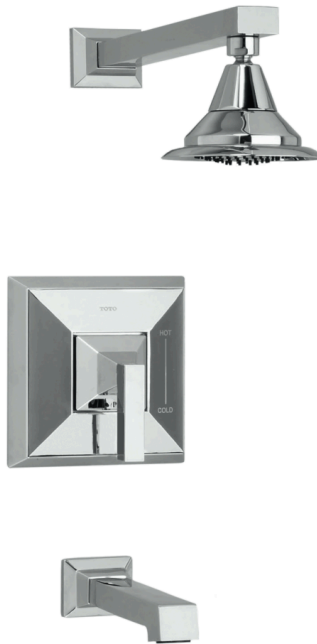


Figure 1 Bathtub and shower trim. (Skilled Trades BC, 2021) Used with permission.

Fixture Materials

The following information on materials is only intended to provide a general description of common materials used to make fixtures and trim. Each manufacturer uses different substances and alloys to produce unique products. For specific information on plumbing materials, consult specification sheets and other literature provided by each manufacturer.

Fixtures and trim can be made from a wide range of materials but must be resistant to **corrosion** issues caused by constant contact with water. National and provincial plumbing codes require that every fixture has a hard, corrosion-resistant surface that can be kept clean and sanitary.

Fixtures are often made from materials such as porcelain, cast iron, steel, stainless steel, fiberglass and various plastic composites. Trim can be made from combinations of chrome, cast brass, acrylics, and plastics.

Some older installations that use wood in fixtures, such as water-closet tanks, are still in use today. While no longer approved for new installation, these materials may still be encountered in the field. Often, you may need to replace these older plumbing items when servicing because replacement parts are limited, and repair can be difficult.

Vitrified Porcelain

The porcelain used to make plumbing fixtures is a mixture of kaolin, quartz, feldspar, and silica. Kaolin, a fine clay, is used to create delicate porcelain dishes, while silica, a crystalline substance, is found in quartz and glass. The porcelain mixture is poured into moulds and allowed to dry. After being coated with a liquid glaze, it is vitrified to give it a stain-resistant glass-like finish.

Vitrification is a process in which the porcelain and glaze are heated to a very high temperature, up to 1,400°C (2,600°F), then cooled rapidly.

Vitrified porcelain is also known as vitreous china and is commonly used to make items such as water-closet bowls, lavatory basins (Figure 2), and urinals. Vitrified fixtures have high strength and are resistant to chemicals. Although sanitary and easy to clean, vitrified porcelain fixtures are brittle.



Figure 2 Vitrified china lavatory basin with faucet trim – Prominence® Pedestal Lavatory. (Toto USA). Used with permission.

Coated Steel or Cast Iron

Steel coated with porcelain enamel is used to make inexpensive yet strong fixtures, such as bathtubs, basins, and sinks. Steel fixtures are generally manufactured by stamping the fixture shape into a sheet of alloy steel in a high-pressure

forming process. It is then coated with enamel (powdered glass), which is usually fused on at temperatures above 750°C (1,400°F).

Grey cast iron is cast (moulded) into fixtures and then coated with enamel. This material is often desired for bathtubs and sinks due to its high density and low noise transmission (Figure 3). Cast iron is strong, durable, and rigid, so it will resist damage from flexing during installation and use. Steel fixtures are generally less durable than cast iron fixtures. Steel fixtures are used less now due to the easy formability and durability of advanced composite materials.

Enamelled fixtures have an attractive, glossy finish. They are sanitary and quite durable if handled carefully during installation. They should not be cleaned with highly abrasive or caustic substances. Enamel prevents the corrosion of ferrous metals and resists mild acids and alkalis.



Figure 3 Enameled bathtub (Erika Wittlieb/Pixabay (<https://pixabay.com/service/license-summary/>))

Stainless Steel

Stainless steel is a durable alloy with a silvery, satin-like finish. Stainless steel differs from carbon steel in that it has the addition of chromium. Chromium produces a passive (rust-resistant) chromium oxide layer that blocks oxygen diffusion to the steel surface. It produces fixtures with a sanitary, easy-to-clean, and chip-resistant surface that does not require additional paint or other surface finishes.

300 series chromium-nickel stainless steel is commonly used for manufacturing kitchen sinks, drinking fountains, and many types of commercial and institutional fixtures. The addition of nickel increases impact resistance and assists in forming the fixtures.

Stainless steel sinks usually range from 16 gauge (thick) to 22 gauge (thinner). Heavier gauges of stainless steel are more resistant to dents and have better sound insulation when washing dishes or operating a garbage disposal.

Copper

Copper is sometimes used for manufacturing items, such as bathtubs, sinks, and basin vessels. Ductile copper is often formed by hand into the desired shape (Figure 4).



Figure 4 Hand-hammered copper tub. (Dora Smith/ Flickr) CC BY-NC 2.0
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Acrylic and Other Plastics

Bathtubs, hot tubs, spa tubs, and some basins are often made from relatively inexpensive acrylic plastic. These products are produced by vacuum-forming sheets of acrylic and then spraying a finishing coat of fibreglass and polyester resin to provide strength (Figure 5).

Acrylic plastic has the advantage of accepting a wide range of dyes in the forming process; the colour goes right through the materials because it is not just sprayed on top. It can be made into fixtures with a marble-like finish in a range of designer colours. It has a high rate of thermal expansion and may split when subjected to very high or very low temperatures.



Figure 5 Acrylic bathtub. (Mike Shaw/ Wikimedia Commons) CC BY SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0/deed.en>)

Polyester Resin and Fibreglass

“Gel-coat” fixtures are made from polyester resin reinforced with fibreglass to add strength and durability. The fixture is coloured by spraying a coat of paint gel onto a waxed mould. Then, resin and pieces of fibreglass are sprayed on, and the product is cured. This process allows polyester resin to be used to make complex shapes or large, one-piece fixtures, such as shower stalls and bathtubs. Polyester resin fixtures can be damaged by abrasives or harsh chemicals, but they are relatively easy to repair.

Natural and Composite Stone

Marble, terrazzo, granite, and other natural and **composite stone** products are used for vanity basin tops, sinks, bathtubs, and shower bases (Figure 6). Some fixtures can also be formed from concrete or terrazzo. Terrazzo is a composite material that consists of marble, quartz, granite, and glass mixed with a binder and poured in place or precast.



Figure 6 Marble basin. (Andrea Davis/ Pexels) Pexels License (<https://www.pexels.com/license/>)

Trim Materials

Trim can be made from a wide range of materials. Faucets can be made from brass combined with chrome, zinc, copper, plastic, or china. Cast brass and acrylic plastic are the most common base materials used for supply and waste trim. Specialized trim components can be made of hardwoods, stone, or even plated with gold.

Cast Brass

Brass is an alloy of copper and zinc used to make the internal or unseen components of trim. Visible parts and accessories are generally chrome-plated to provide a more attractive, easily cleaned surface. Less-expensive finishes are obtained by using polished brass or rough nickel-plating (known as brushed nickel). High-end finishes may use polished or brushed gold plating.

Valves are usually made of brass because it is highly resistant to the corrosive effects of hot and cold water. Cast brass is used to make shower heads, faucet valves, spouts, and other working components (Figure 7). Nickel and chrome can be scratched or dulled by chemicals, such as ammonia. Brass fittings manufactured for use in potable water plumbing systems are required to be lead-free. The existing lead-free standard requires that the maximum lead content of the wetted surfaces of plumbing products, such as pipes, pipe fittings, plumbing fittings and fixtures, be a weighted average of 0.25% or less.

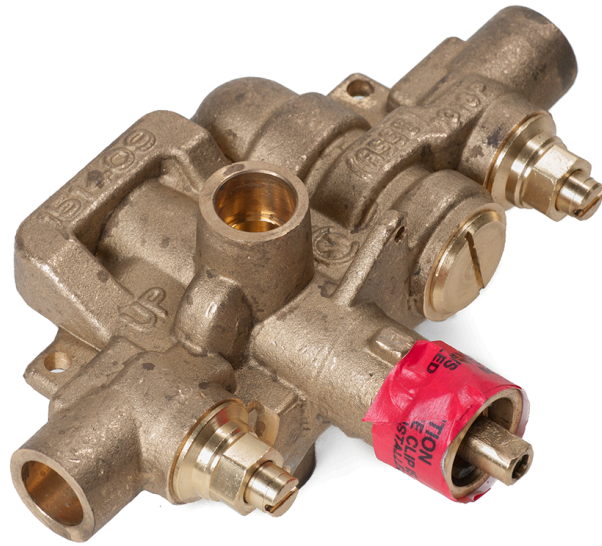


Figure 7 Cast brass shower valve body. (Skilled Trades BC, 2021) Used with permission.

Acrylic Plastic

Plastics are inexpensive, waterproof, and easily formed. Acrylic plastic is available in an endless array of colours and also used to make trim handles, toilet seats, and decorative covers.

Basic Fixture Types

Some plumbing fixtures are common to single-family dwellings, multi-unit developments, commercial, and industrial settings. There are many unique fixtures now available on the world market, but this competency will primarily discuss the most commonly available fixtures.

You may encounter some older fixtures discussed here when performing plumbing service in the field.

Fixtures are regulated by nationally developed (CSA or equivalent) standards. These standards specify the material, design, performance, and testing requirements. Most manufacturers of plumbing fixtures have their products certified by a third-party testing lab to prove conformance to the applicable standard. In Canada, fixtures must meet the requirements of the CSA B45 series of standards.

Fixtures installed in certain occupancies may also need to meet specific accessibility requirements. The basic plumbing fixtures used in most plumbing systems are:

- Water closets (toilets)

- Urinals
- Lavatories
- Drinking fountains
- Sinks
- Bathtubs
- Showers
- Bidets
- Floor drains
- Interceptors
- Hospital and institutional fixtures
- Emergency fixtures

Water Closets (Toilets)

The ancient Greek civilization of Crete, known as the Minoan civilization, was the first civilization to use underground clay pipes for sanitation and water supply. Their capital, Knossos, had a well-organized water system for delivering clean water, removing sewage, and using storm canals to accept overflow during heavy rain. The Minoans introduced one of the first uses of a flush toilet, dating back to the 18th century BC.

Modern water closet designs reflect the manufacturers' response to the demands of different installations, advances in technology, and ever-growing concerns with water conservation. Common materials in the construction of water closets are porcelain, stainless steel, and reinforced plastic. Vitrified water-closet bowls are cast in several pieces that are assembled into one unit prior to being fired in a kiln.

The two most common water-closet mounting patterns are floor-mounted (with either bottom outlet or back outlet) and wall-mounted (back outlet). Within these two categories, toilets are also available with round-front bowls or elongated bowls. National and provincial plumbing codes require that water closets installed in public washrooms be of the elongated type.

The closet tank may be a separate unit attached to the bowl, called **close-coupled** (Figure 8), separately wall-mounted (Figure 9), or a unibody design, where the tank is cast as part of the overall water-closet fixture. Tankless water closets (called direct flush) have a direct connection to a high-volume water supply for the flushing action (Figure 10).



Figure 8 Floor-mounted, bottom outlet, close-coupled, tank-type water closet or toilet. (Rosalie Boucher/FreePNGimg.com) CC BY-NC 4.0 (<https://creativecommons.org/licenses/by-nc/4.0/>)

Historically, water-closet tanks were mounted high above the bowl (Figure 9). This assisted in creating head pressure to flush the fixture. A chain allows the user to activate the flush valve in the tank. The tank and bowl are connected via a flush pipe and flush elbow that direct water from the tank down toward the bowl.



Figure 9 Floor-mounted, bottom outlet, high tank water closet. (Gregorydavid (<https://en.wikipedia.org/wiki/User:Gregorydavid>) at English Wikipedia) (<https://en.wikipedia.org/wiki/>) CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/deed.en>)

Floor-mounted water closets with closet tanks (called flush tanks) and bottom outlets are usually found in private residences and office washrooms. Floor-mounted toilets with back outlets are useful in areas that have very little space underneath the floor. They allow the drainage piping to be connected horizontally above the floor. Wall-mounted and floor-mounted toilets may be activated by a flush tank or a direct-flush valve (also known as **flushometer valves**). Direct-flush valves are a “tankless” design that uses water pressure from the supply line rather than a tank of water to flush the fixture (Figure 10).



Figure 10 Floor-mounted, bottom outlet, direct-flush water closet. (Toto USA). Used with permission.

Wall-mounted fixtures require additional support to avoid transmitting any weight to the wall finish. They are usually supported by a concealed fitting, called a carrier, mounted between the studs in the wall or to the floor below. Wall-mounted designs are popular in commercial and industrial installations because they allow for a more thorough cleaning of the floor around and underneath the fixture. Water closets with direct-flush valves and elongated bowls are the type often used in commercial and institutional buildings.

Water Usage

Modern toilets use jets of water near the trapway and/or from holes around the inner rim of the bowl. This, coupled with the partial vacuum created by the trapway design, empties the contents of the bowl.

Toilet flushing is the single highest use of water in an average home (approximately 30%, Figure 11) and presents a prime opportunity for water conservation. As such, regulations have had a profound influence on the design of water closets. Older units can discharge as many as 13–20 L (3–4.5 imperial gal.) of water on each flush cycle, which contributes to a tremendous amount of potable water being used to dispose of waste.

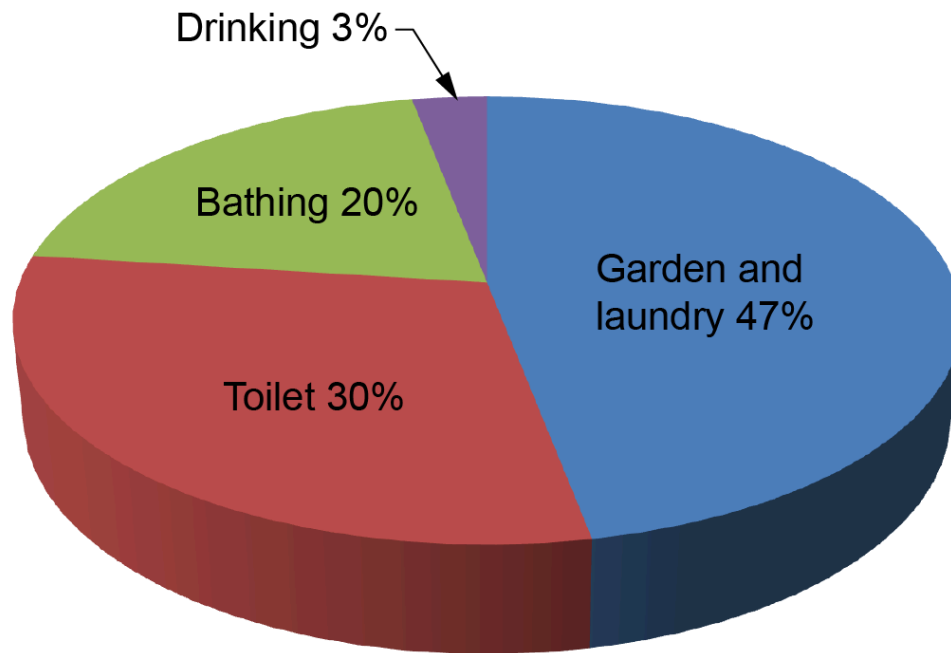


Figure 11 Typical domestic water consumption in North America. (Skilled Trades BC, 2021) Used with permission.

An average family of four people using an older water closet (13 L/3 gal.) will use approximately 98,000 L (21,500 gal.) of water per year, while the same family using an ultra-low flush (ULF, 6 L/1.3 gal.) would use only about 45,000 L (9,900 gal.) per year. **High-efficiency toilets (HET)** can use even less water (4.8 L/1 gal. or less). Dual-flush toilets have full flush and “half-flush” capabilities. These measures save more than half of the water needed to flush the fixture and equally reduce what is discharged to the sanitary waste system, which typically requires significant treatment. This provides a double financial benefit for most regional jurisdictions and a tremendous reduction in impact on the environment.

In terms of water consumption, dual-flush toilets are classified as HETs because the ratio of reduced flushes (up to 4.1 L/0.9 gal.) to full flushes (up to 6 L/1.3 gal.) results in an effective flush volume that is less than 4.8 L (1 gal.).

Effective since 2010, HETs or dual-flush toilets are required in new residential buildings in BC (or when major renovations occur). The requirement for toilets with a maximum flush cycle of 6 L (1.3 gal.) in industrial, commercial, and institutional buildings remains unchanged.

Many new buildings use alternative means to flush water closets (Figure 12). Means of using captured rainwater, **waste condensate**, **reclaimed water** (such as **grey water or process water**), or even seawater are most practical to install during new design and construction.



Figure 12 Signage is required to indicate when a fixture is supplied with non-potable water. (Skilled Trades BC, 2021) Used with permission.

The design used to evacuate waste and water from the closet bowl varies. The most widely used designs are:

- Siphon jet
- Reverse trap
- Blowout
- Washdown

Other types of unique toilet fixtures are common in some parts of the world (e.g., squat toilets and various types of dry toilets). They may be found in certain places locally as well, but their relevance is limited for a Canadian plumbing apprentice.

Siphon Jet

Standard **siphon jet** water closets function by evacuating the contents of the bowl with jets of water combined with a siphoning action (Figure 13). When water flows from the tank through the rim jets, standing water in the bowl rises, filling the elongated S-shaped siphon waterway. This starts the toilet's siphonic action, pulling nearly all of the water and waste down the drain. When most of the water is drained out of the bowl, the siphon is broken, and you may hear its characteristic gurgle at the end of the flush. There may also be an additional jet about 2.5 cm at the bottom of the bowl to create more flushing inertia.

The **trapway** is a moulded passage that carries waste and water from the bowl into the outlet. The trapway's highest point (called the **weir**) maintains a minimum level of water in the bowl, creating a seal so that no sewer gases can enter the dwelling.

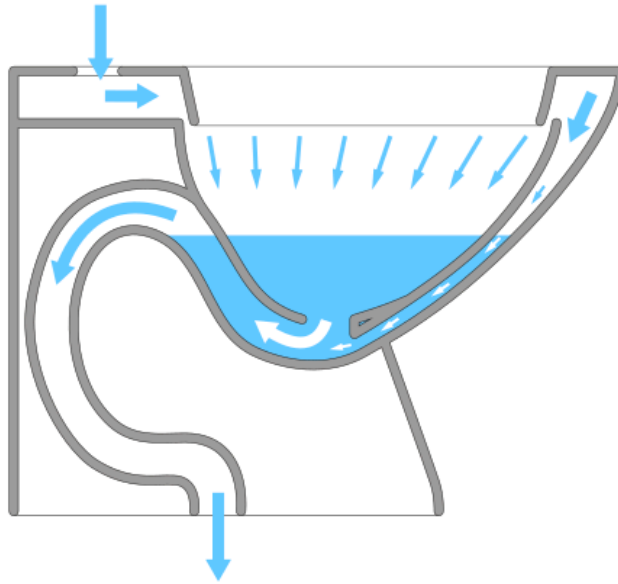


Figure 13 Siphon jet water closet. (SouthHamsian/Wikimedia Commons)
CC BY-SA 4.0 (<https://creativecommons.org/licenses/by-sa/4.0/deed.en>)

Siphon jet water closets have a large water surface and deep seal depth, which assist in keeping the bowl clean. The trapway is typically a minimum of 5 cm (2 in.) in diameter. For these reasons, siphon jets require larger volumes of water to effectively operate.

Vacuum-Assist

Vacuum-assist toilets use a passive vacuum system to create a HET, with the large surface area characteristic of a conventional siphon jet design. After the toilet is flushed (Figure 14a), water fills a special chamber inside of the tank.

As the inner chamber fills, air at the top is pushed down the transfer tube into the trapway, creating an air bubble between the water in the toilet bowl and water in the lower trap near the base of the toilet. This air bubble exerts a force on the water in the trapway, raising the water level in the toilet bowl and increasing the water surface area. When the toilet is flushed (Figure 14b), water exits the lower trap, pressurizing the trapway pulling the wastewater in and initiating the siphonic action.

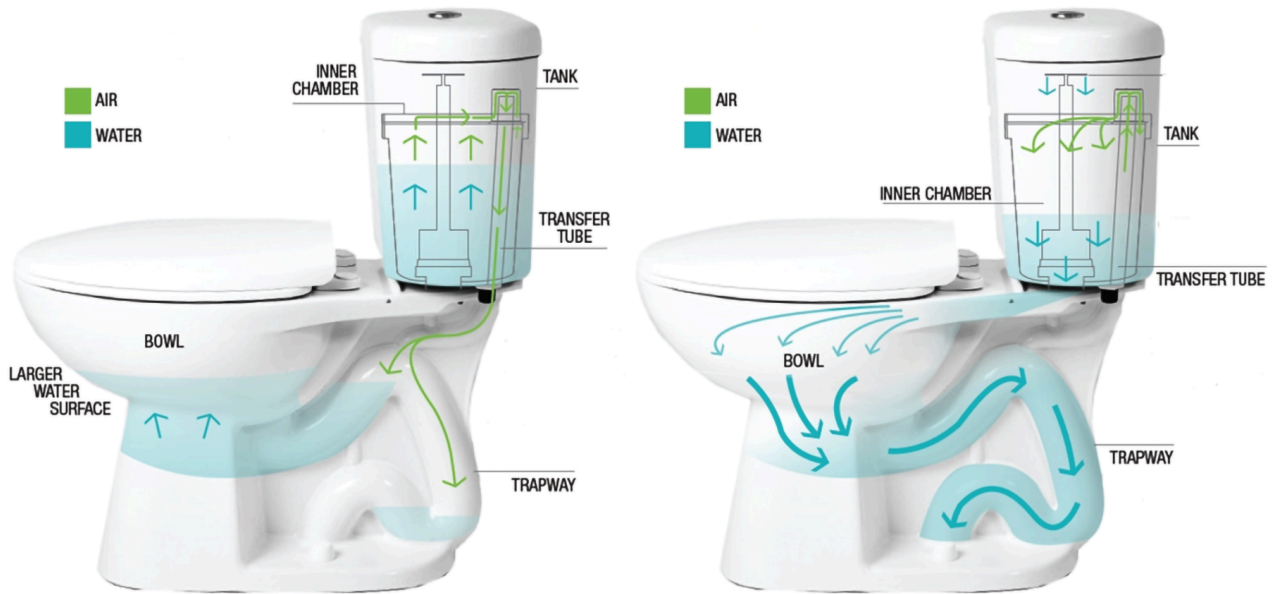


Figure 14 (left) vacuum assist water closet filling; (right) vacuum assist water closet flushing. (Fine Homebuilding[®], n.d.) Used with permission.

Reverse Trap

The name **reverse trap** was originally given to any style of water closet that had a trapway that discharged toward the back of the closet bowl. This was the “reverse” direction of how the earliest washdown-style toilet trapways were configured.

The modern reverse trap bowl (Figure 15) is a design developed in response to water conservation concerns. The reverse trap functions in the same way as the siphon jet, but the trapway is smaller (usually less than 5 cm/2 in. diameter) and there is less surface area of water in the bowl. Therefore, less water is required for flushing and operation.

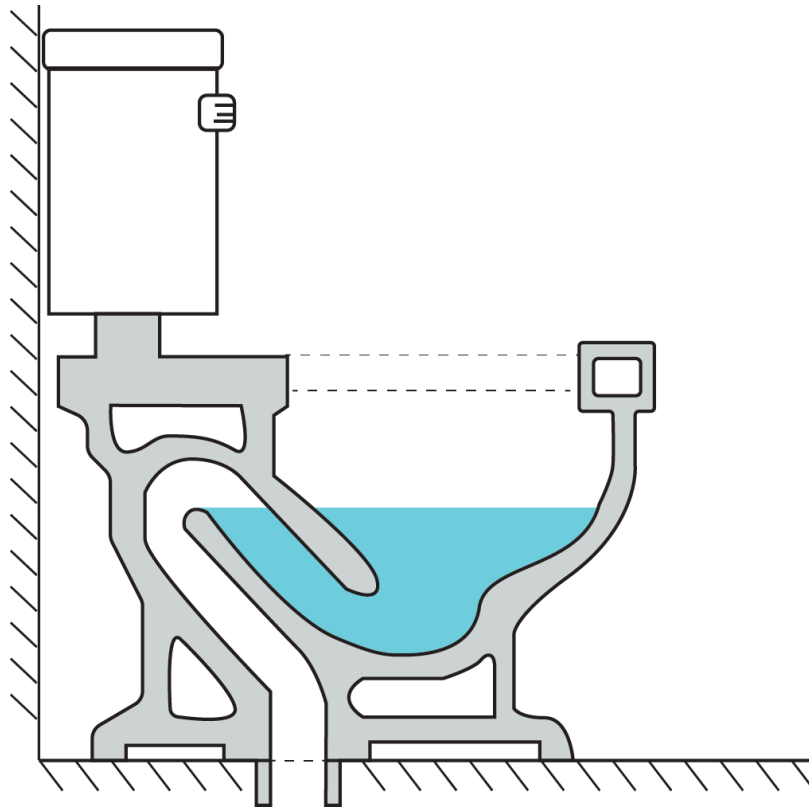


Figure 15 Reverse trap water closet. (Skilled Trades BC, 2021) Used with permission.

Pressure-Assist

Pressure-assist water closets (Figure 16) differ from a standard gravity flush toilet in that they use the addition of compressed air to assist the flush action. As water refills the tank, a captive vessel holds a volume of air compressed by the incoming water flow. Although pressure-assist toilets may be less desirable due to their loader flush, they may be a solution for locations prone to clogging issues. They are popular in public restrooms, where a blowout water closet may not prove practical because of water supply pressure limitations.

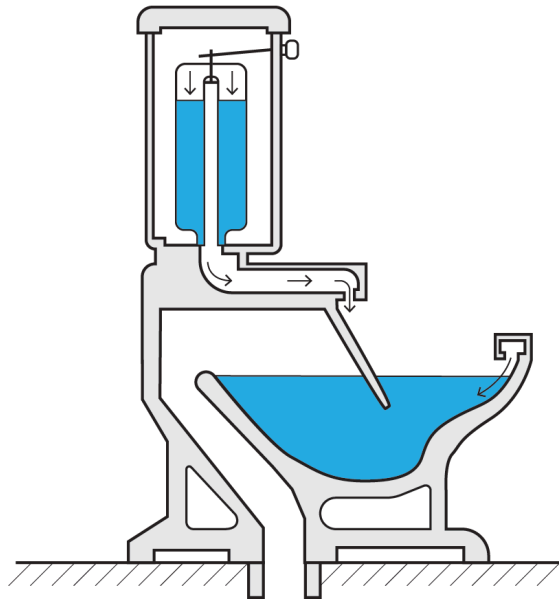


Figure 16 Pressure-assist, low flush, reverse-trap water closet. (Skilled Trades BC, 2021) Used with permission.

Blowout

A blowout bowl is generally installed in a wall-hung configuration (Figure 17). Blowout bowls have a very large water surface area and a deep water seal. The unrestricted trapway depends upon a large-volume jet of water to initiate the flushing action because the bowl lacks the articulated S-trap design common to most bowl types. Therefore, a direct-flush valve using a minimum 1 in. nominal size supply pipe is used to flush these types of bowls.

Wall mounting this fixture requires a considerable carrier support structure concealed in the wall cavity. Due to their significant mounting requirements, the large water supply needed, and substantial noise during operation, blowout water closets are not a common residential fixture.

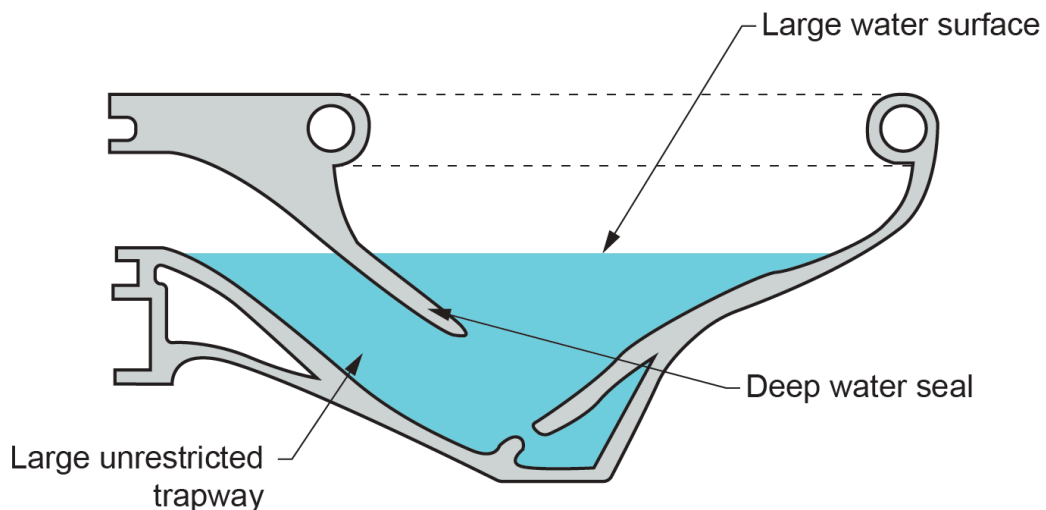


Figure 17 Blowout bowl. (Skilled Trades BC, 2021) Used with permission.

Washdown

Washdown water closets (Figure 18) are the earliest design of flushing toilet. Although no longer manufactured, some installations still exist. These water closets have a waste outlet located at the front of the bowl that is trapped below the water seal. The front passageway is situated above the water line and thus is more subject to staining and fouling.

Although technically a trap, the outlet passageway is a much simpler design than a siphon trapway, and suction is not developed to aid the removal of waste. Washdown water closets rely on only water head pressure to empty the bowl, and the water typically must rise to an alarmingly high level before the contents are removed.

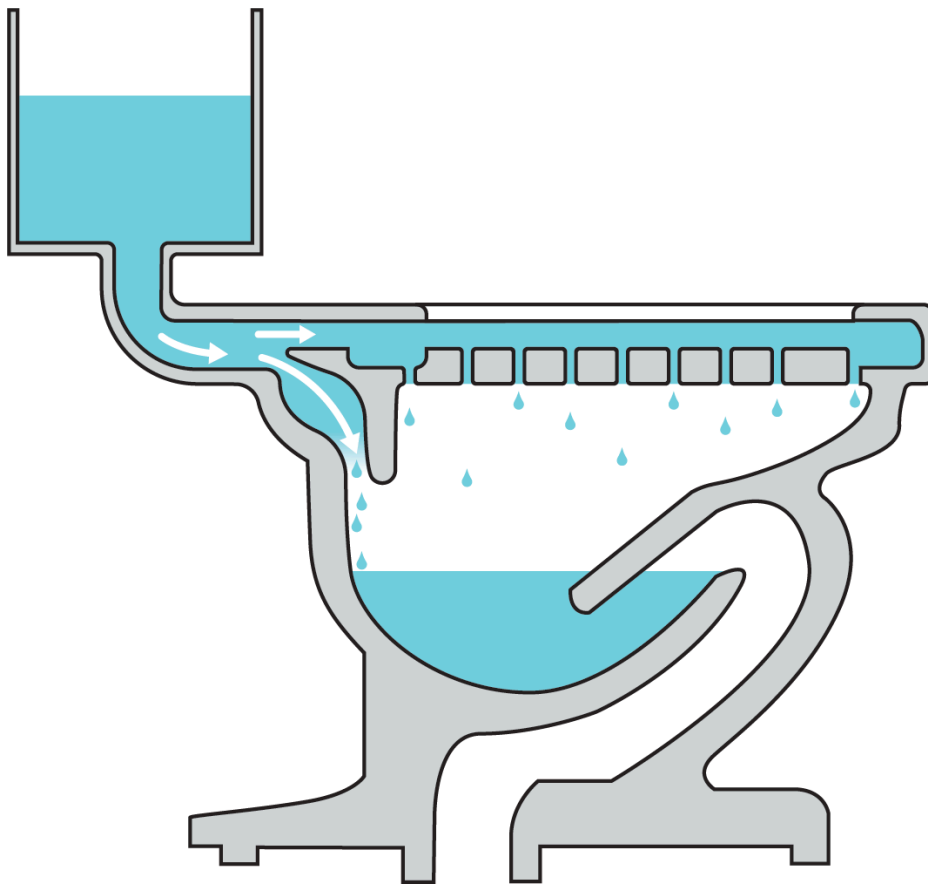


Figure 18 Washdown bowl. (Skilled Trades BC, 2021) Used with permission.

Urinals

Urinals are typically installed in men's public washrooms (although women's urinals are also manufactured). They are designed to receive only urine directly. Urinals are made from vitreous china or stainless steel.

There are two main types of urinals:

- Stall urinals
- Wall-hung urinals

Stall urinals (Figure 19) are not named such because they are located in stalls. In fact, more often than not, they are not equipped with dividing walls. Stall urinals are a washdown-style urinal, are floor-mounted, and have their drain outlet located near the user's feet. The trap is located below the finished floor level, and the urinal is flushed only by a gravity flow of water along the inner walls of the fixture. One or more stall urinals may be flushed by a flush tank, or individual units may be flushed by a flush or metering valve. Regardless of the method, the water supplied to the fixture enters slowly, and the trapway is not completely emptied on each cycle. This leads to generally unpleasant conditions. Cleaning the outlet and fixture drain is difficult, and the low lip level leads to frequent trash accumulation.

If a stall urinal is damaged after installation, removal and replacement are very costly and time consuming.



Figure 19 Stall urinal. (Skilled Trades BC, 2021) Used with permission.

Wall-hung urinals (Figure 20) differ based on flushing style. Some types are fed with water from a gravity-assisted flush tank, while others may be fed water via a metering or direct-flush valve. Water-free urinals are also increasingly installed where water conservation is vital.

Wall-hung urinals are supported by carriers or wall brackets. The height at which they are installed depends on the height of the intended user and is based on project specifications.



Figure 20 Wall-hung urinal with direct-flush valve. (Toto USA). Used with permission.

Water-less urinals use a special cartridge in the drain outlet to trap sewer gases and prevent them from entering the room (Figure 21). Undiluted urine is collected from some systems for its value as a high nitrogen- and phosphorus-based fertilizer.

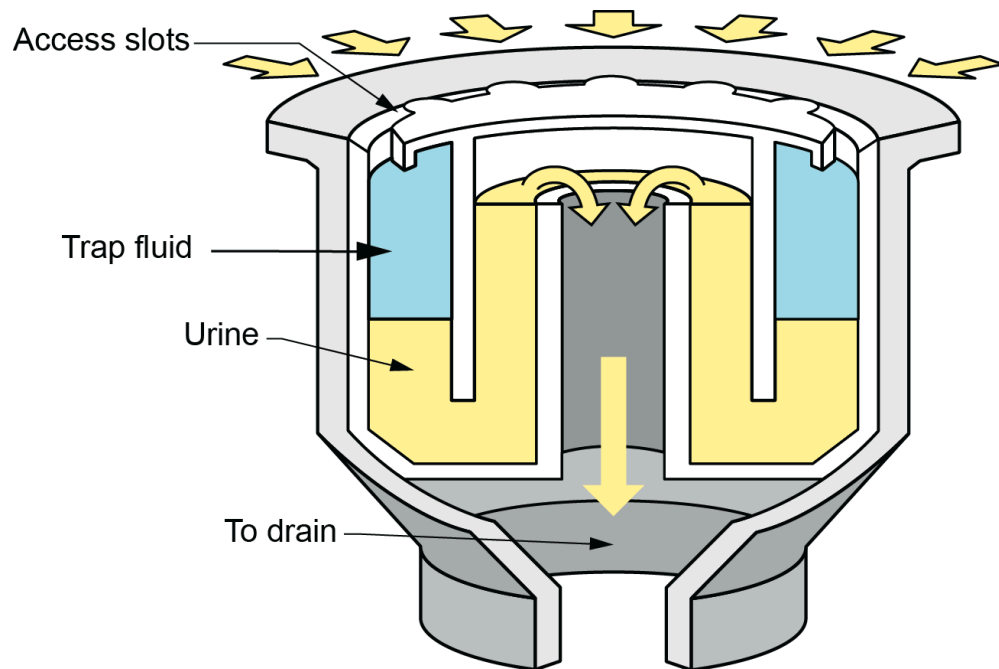


Figure 21 Waterless urinal cartridge. (Skilled Trades BC, 2021) Used with permission.

Urinal Flushing

There are several methods of urinal flushing:

- Washdown
- Automatic flush
- Siphon jet
- High-efficiency

Washdown urinals have a water connection at the top of the fixture from which water slowly flows to wash the inside surfaces of the urinal. Waste is washed out of the urinal rather than flushed out. They are usually flushed by a $\frac{1}{2}$ in. (13 mm) self-closing metering valve or from a flush tank. Washdown styles of urinals may have a trap located externally below the fixture or integral to the fixture.

Automatic urinal flush tanks (Figure 22) are seldom installed anymore due to their tendency to consume large amounts of water. These tanks fill slowly through a constant trickle of water and discharge automatically when full. To conserve water, building codes now require that urinal tanks be controlled to limit their operation to the hours when the building is normally occupied.



Figure 22 Urinal flush tank. (Skilled Trades BC, 2021) Used with permission.

Siphon jet urinals are a style of wall-hung urinal that typically have a jetted, integral trapway that flushes similar to a siphon jet water closet, where the water in the trapway is completely replaced on each flush. The more rapid flushing action of a siphon jet urinal is accomplished by installing a $\frac{3}{4}$ in. (19 mm) direct-flush valve.

A high-efficiency urinal (HEU) is a fixture with a flush volume of 1.9 L (0.4 gal.) or less. HEUs use approximately one-third of the amount of water used to flush the average urinal. Based on typical usage, a single HEU can save close to 18,000 L (3,900 gal.) of water per year.

Urinals installed in new buildings and during major renovations in BC are required to be high-efficiency (1.9 L/0.4 gal.) urinals.

Trough Urinals

Trough urinals are meant for use by several people at one time. The trough is either wall-mounted or installed at floor level. They are typically made from stainless steel (Figure 23), enamelled cast-iron, or site-built from tile or stone. Some trough urinals can be found in older buildings like arenas or at fair grounds. They have no dividing walls and offer no privacy to the user. Trough urinals are no longer permitted to be installed in new construction.



Figure 23 Stainless steel trough urinal. (Daniel Lobo/Flickr) Public domain (https://en.wikipedia.org/wiki/Public_domain)

Lavatories

Lavatories (also known as basins) are one of the most common fixtures found in homes and public buildings. Lavatories should not be confused with sinks; their primary purpose is to allow people to wash their hands and faces (sinks are used to wash food, dishes and other items).

Lavatories are made of vitreous china, enamelled cast iron, steel, copper, stainless steel, stone or plastic.

Lavatories often have a concealed overflow, which is an overflow drain opening that connects to the waste outlet via an assembly called a patent overflow (PO).

Lavatories are available in three basic styles:

- Wall-hung
- Vanity (or countertop)
- Pedestal

The wall-hung lavatory (Figure 24) may often be found in offices, schools, or other public buildings. This style may also be found in residential installations that may require free access for persons in wheelchairs. The wall-hung lavatory has no legs or external frame for support; it is entirely supported by a wall-mounted bracket or sometimes by a metal carrier located behind the wall finish.



Figure 24 Wall-hung lavatory. (Toto USA). Used with permission.

Wall-hung lavatories are available in a wide range of shapes. They may be designed to be mounted in a corner to save space or occasionally with a false centre leg that hides piping and valves, known as a pedestal basin (Figure 25).



Figure 25 Pedestal lavatory with concealed overflow. (Toto USA). Used with permission.

Countertop lavatories (Figure 26), also known as vanity basins, are designed to be partially supported by a frame, which may have an enclosed cabinet underneath it (vanity). This style of lavatory is found mainly in private homes. Most modern countertop lavatories are self-rimming so that the old metal finishing rings are no longer required. Self-rimming styles must be carefully measured so that they slip easily into the precut hole in the countertop.



Figure 26 Countertop lavatory. (Toto USA). Used with permission.

Hair salons use lavatories specially designed for washing people's hair. Commonly referred to as a shampoo basin (Figure 27), they are similar in construction to a standard lavatory but have a recess for the user's neck to rest and a pull-out hose used for washing.



Figure 27 Countertop lavatory for hair salon. (Michelle Raponi/
Pixabay) Pixabay License
(https://pixabay.com/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=3277314)

The dental cuspidor (Figure 28) is technically a small basin in which the patient can expectorate saliva during treatment. Cuspidors have a water supply, vacuum, and compressed air for providing patient care at a dental office or clinic.



Figure 28 Dental cuspidor. (Skilled Trades BC, 2021) Used with permission.

Sinks

Sinks may be made from stainless steel, enamelled cast iron, porcelain, fibreglass, stone, or plastic. There are various types of sinks:

- Kitchen sinks
- Service sinks
- Laundry sinks

Kitchen Sinks

Stainless steel sinks are the most popular type of kitchen sink and vary depending on finish and gauge of the metal. Stainless steel sinks usually range from 16 gauge (thick) to 22 gauge (thinner) and are mastic coated beneath to insulate sound transfer.

Kitchen sinks may have one to three flat-bottomed compartments and varying depths. Some have deep compartments for washing dishes and much smaller, shallower compartment for rinsing vegetables (Figure 29).



Figure 29 Double compartment stainless steel kitchen sink. (Brett Hondow/Pixabay) Pixabay License (https://pixabay.com/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=3277314)

Styles are available with or without holes to mount the faucet and accessories, such as a sprayer or soap dispenser. Kitchen sinks are prohibited from having concealed overflows, as they would trap food and organic waste. One method commonly used to prevent overflows in multi-compartment sinks is to build a slightly lower integral weir into the ledge separating the compartments.

Service Sinks

Also known as mop sinks, service sinks are wall- or floor-mounted sinks found in commercial and industrial settings or medical facilities. They are generally made of stainless steel, enamelled cast iron, stone, or plastic. They are typically installed in conjunction with janitor's faucets, with hose attachments to fill buckets quickly. The front lip of a wall-mounted service sink has a metal rim to protect the enamel from being damaged by buckets and other cleaning equipment.

Figure 30 shows a cast iron P-trap standard equipped with a cleanout. These are commonly used for a wall-mounted service sink. The trapway is typically a minimum of 3 in. to permit the quick discharge of wash buckets.



Figure 30 Cast iron P-trap standard. (Skilled Trades BC, 2021)
Used with permission.

Laundry Sinks

Also known as laundry trays (Figure 31), these are a common fixture in older residences. Made of concrete, stone, stainless steel, or plastic, they were used for hand washing clothing before automatic washers were adopted. Later, they proved to be convenient locations to indirectly drain the auto washer's discharge hose if a separate standpipe was not available. In newer homes, a laundry tray is a useful utility fixture for prespraying or soaking laundry, as well as for washing various other goods.



Figure 31 Laundry sink. (Skilled Trades BC, 2021) Used with permission.

Drinking Fountains

Drinking fountains are made from vitreous china or stainless steel. Commonly found in schools, public buildings, commercial enterprises, and factories or mills, drinking fountains provide easy public access to potable water. When located inside buildings, they are either wall-mounted (Figure 32), freestanding, or recessed into a wall. They often include a built-in bottle refill station.

The recessed model is preferred in high-traffic areas or where little space is available. Outdoor fountains, located in parks or green spaces, may be installed in durable, freestanding decorative bases or mounted on the outside of a structure. Some parks even have water fountains for dogs.



Figure 32 Wall-mounted stainless steel drinking fountain. (Skilled Trades BC, 2021)
Used with permission.

Bathtubs

Bathtubs are usually made of enamelled steel, enamelled cast iron, copper, or fibreglass-reinforced acrylic. Bathtubs may be designed to be fully recessed into a wall, set as a skirted or corner design, placed within a built-in structure, or freestanding.

Full surrounds are available for installation in conjunction with recessed tubs to provide a complete showering unit (Figure 33).



Figure 33 Recessed bathtub with surround. (MAAX Canada, n.d.) Used with permission.

In the latter half of the 20th century, the once-popular freestanding clawfoot tub (Figure 34) morphed into the recessed tub with a small apron front. This enclosed style afforded easier maintenance and, with the emergence of coloured fixtures, more design options for the homeowner. The Crane Company introduced coloured bathroom fixtures to the North American market in 1928.



Figure 34 Freestanding clawfoot tub. (lifeforstock/FreePik) Freepik License (<https://www.freepik.com/legal/terms-of-use#nav-freepik-license>)

The front of the tub, the side not touching a wall, is often referred to as the skirt or apron. Bathtubs have drains located on the left side or right side, as determined by facing the apron or opening to the tub. For example, if the drain is located to the left when facing the apron, it is considered a left-hand tub. Bathtub drains have overflows piped to the outlet of the tub prior to installation. The waste and overflow arrangement drains the tub to a trap located below the floor. Whirlpool tubs (Figure 35) first became popular in North America during the 1960s. A whirlpool tub (also known as hydrotherapy, jetted, or spa tub) is essentially an indoor hot tub and is sometimes still referred to simply as a “Jacuzzi” since the word has become somewhat generic after the Italian/American plumbing manufacturer Jacuzzi introduced the home spa whirlpool in 1968. Air bubbles are commonly introduced into the whirlpool tub nozzles as a 50/50 mixture of air and water through a venture-style pump.



Figure 35 Whirlpool tub. (jingdianjiaju2/ Flickr) CC BY-SA 2.0 (<https://creativecommons.org/licenses/by-sa/2.0/>)

Showers

Showers separate from bathtubs can be either freestanding or built into wall recesses or corners. The walls may be made from glazed tiles, stone, fibreglass-acrylic, or any waterproof material. Shower stalls can be supplied with one-piece moulded walls or separate wall panels bonded together. The base of the shower stall is usually shaped like a squared-off dish (Figure 36) with sides that rise above floor level. The base may be made of cast stone, granite, fibreglass, acrylic, or terrazzo. Shower bases are available in different heights, widths, and depths. Commonly available base sizes are 750 mm by 750 mm (30 in. by 30 in.) and 91 cm by 122 cm (36 in. by 48 in.).



Figure 36 Standard shower base. (MAAX Canada, n.d.) Used with permission.

Shower stalls for people with special access requirements do not have a separate base with high sides. Instead, the floor is usually lined and sloped (more than the standard 1:50 or $\frac{1}{4}$ in. per foot) so that water runs by gravity into a drain inside the shower area. A very slight lip extends around the perimeter or side and provides some additional overflow protection without interfering with ease of access. These types of shower stalls are generally designed larger than standard shower stalls. Site-built shower bases (Figure 37) are constructed in one of several methods. They can be made by creating a waterproof membrane of hot tar and tar paper (Hot Mop) laid upon contoured dry pack mortar or manufactured preformed liners. The clamping collar is tightened down to the the liner to create a seal. Weep holes (not shown) allow water above the liner, which seeps down through the grout to flow into the drain. Site-built shower walls are often constructed from tile on concrete wall board.

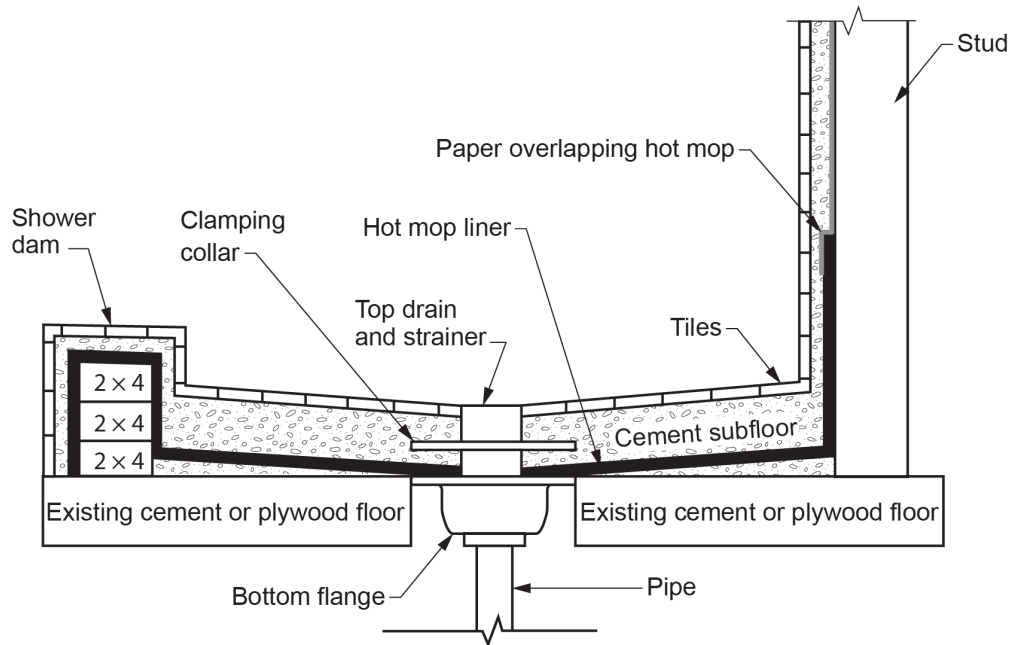


Figure 37 Site-built shower base. (Skilled Trades BC, 2021) Used with permission.

Bidets

Bidets (Figure 38) are fixtures widely used in Europe and Latin American countries but are not as common in North America. Designed primarily for washing the genital areas, bidets provide an extra level of personal cleanliness.



Figure 38 Bidet. (Toto USA). Used with permission.

Similar in appearance to a water closet with the functions of a lavatory, a bidet is only designed for clear-water waste. It has hot and cold water control valves, a spout, a drain outlet, and usually some form of integral water jets. The jets are formed as water is forced upward through a series of small holes in a raised nozzle.

Floor Drains

A floor drain is a plumbing fixture installed in the floor of a building to accept a flow of water or other liquid. Floor drains are considered either emergency or non-emergency. Emergency floor drains are not intended to receive the discharge of a continuous flow-type fixture; they are designed to protect against flooding in the event of a fixture overflow or a relief valve discharge.

Floor drains are typically 2–4 in. (5–10 cm) in diameter. The floor around the drain is also sloped to allow the water to flow to the drain. Most residential basements have one or more floor drains, usually near the water heater or automatic washer. They can also be found in commercial basements, restrooms, kitchens, refrigerator areas, shower rooms, laundry facilities, and near swimming pools, among other places.

Some floor drains have a strainer secured over them to prevent a tripping hazard and the entry of foreign objects. Some have a funnel or hub over the drain body to provide a neat installation for drainlines indirectly connected to the floor drain (Figure 39).



Figure 39 Floor-drain body with funnel. (Skilled Trades BC, 2021) Used with permission.

Interceptors

Interceptors are fixtures installed to intercept unwanted particles or substances before they can enter the downstream drainage system. Various types of interceptors are required by codes and regulations to protect municipal sewer systems. Isolating materials, such as grease, oil and toxic materials, at the source protect both the infrastructure and environment from pollution and contamination. Interceptors are often made of coated steel, reinforced concrete, or plastic.

Grease interceptors (Figure 40) are commonly installed in commercial and institutional kitchens or wherever large amounts of fats, oils, or grease (FOG) are expected. Grease interceptors are intended to remove up to 90% of the grease and oils from sink wastewater to prevent clogging of drain piping. Their primary purpose is to slow the flow of FOG and separate it from the liquid waste. Grease interceptors are referred to as grease traps when they are used as the actual trap for a fixture. Grease traps must maintain a minimum 38 mm ($1\frac{1}{2}$ in.) water seal.



Figure 40 Grease interceptor. (Skilled Trades BC, 2021) Used with permission.

Grease interceptors have a series of internal baffles that encourage fats and grease to separate from the wastewater as it cools. A removable cover allows access to clean out accumulations of congealed grease. Flow control devices may also include inlet orifice plates to maintain design flow rates through the unit. Inlet air admittance fittings are used by some manufacturers to add air to the inlet flow and assist in making the FOG more buoyant (Figure 41).

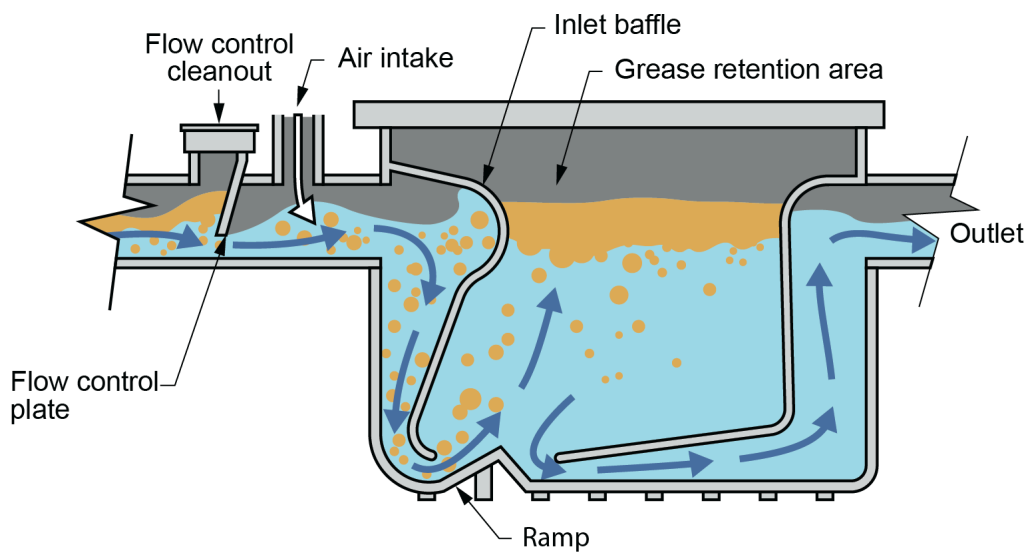


Figure 41 Grease interceptor parts. (Skilled Trades BC, 2021) Used with permission.

A grease interceptor must be periodically cleaned to remove the contents. The frequency of cleaning depends on the

usage factors of the system. Waste FOG is usually recycled at an appropriate facility and can often be used as a source of biofuel.

Food particles and other solids should never be allowed to drain to a grease interceptor because it decreases the interceptor's effectiveness and increases the requirement for cleaning and maintenance.

Oil interceptors (Figure 42) are installed at automotive, marine, and similar sites that use heavy motor oils, lubricants, or lubricating grease. An oil interceptor separates oil from wastewater as it flows through wire mesh interceptor panels and baffled chambers. The panels are often made from steel coated with epoxy. A calibrated orifice plate regulates the required flow rate, and removable covers allow the panels to be removed for cleaning.

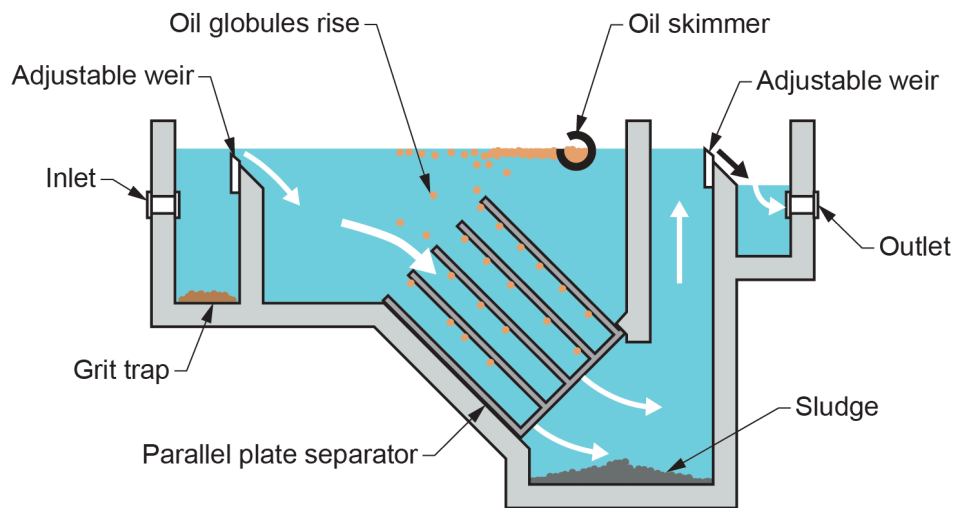


Figure 42 Oil interceptor. (Skilled Trades BC, 2021) Used with permission.

Industrial and commercial establishments may also use interceptors to remove debris, such as hair, lint, plaster, fish scales, or other sediment. These devices all have similar functions. Perforated baffles or steel mesh baskets, sized for the material being filtered, prevent foreign material from entering the drainage piping (Figure 43).



Figure 43 Barber lavatory hair trap/interceptor. (Skilled Trades BC, 2021) Used with permission.

Hospitals and Institutional Fixtures

Fixtures with special adaptations are found in hospitals, institutions, laboratories, and medical clinics. Sinks and lavatories often have controls that can be operated by knees, arms, feet, or sensors. Because of the need for greater control for the safety of patients, thermostatic control valves are used in many showers and bath fixtures. Toilets, bathtubs, and showers also have grab bars installed in strategic locations.

Barrier-free washrooms have minimum dimensions required for suitable access and use of the fixtures. Many institutions also have specifications for installing fixtures that may exceed minimum code requirements. Always check the fixture specifications very carefully when installing this equipment.

Manual types of bedpan washing equipment use a water supply to a spray attachment. They are essentially a toilet-style wash station that can be used to readily empty, clean, and flush the contents of a patient's bedpan. The flushing bowl

is commonly called a clinic sink and is equipped with a direct-flush valve. Newer hospitals typically employ automatic types of bedpan washing equipment that use chemical and thermal disinfection for improved hygiene.

The sitz bath is typically made of vitreous china or acrylic plastic and looks somewhat like a deep sink with a front face lower than the back. These are used as a method for lower body bathing and soaking for relaxation and therapy.

Combination arm and leg baths are oval-shaped stainless steel tanks with a thermostatic water mixing assembly and an electric turbine ejector. The ejector is equipped with an aerator and an elevator for lowering and raising.

Autoclaves and portable sterilizers are fixtures used to sterilize dressings, instruments, and glassware with moist heat. Moist heat is supplied by boiling water, free-flowing steam, or pressurized steam. High-pressure autoclaves (Figure 44) have air and condensation ejectors that draw air and moisture out of the sealed unit before it is filled with steam. Regardless of the arrangement of valves and safety devices available, all autoclaves have a method of creating a vacuum in the sterilizing chamber to vent steam and a method of drying the contents after the steam cycle is complete.

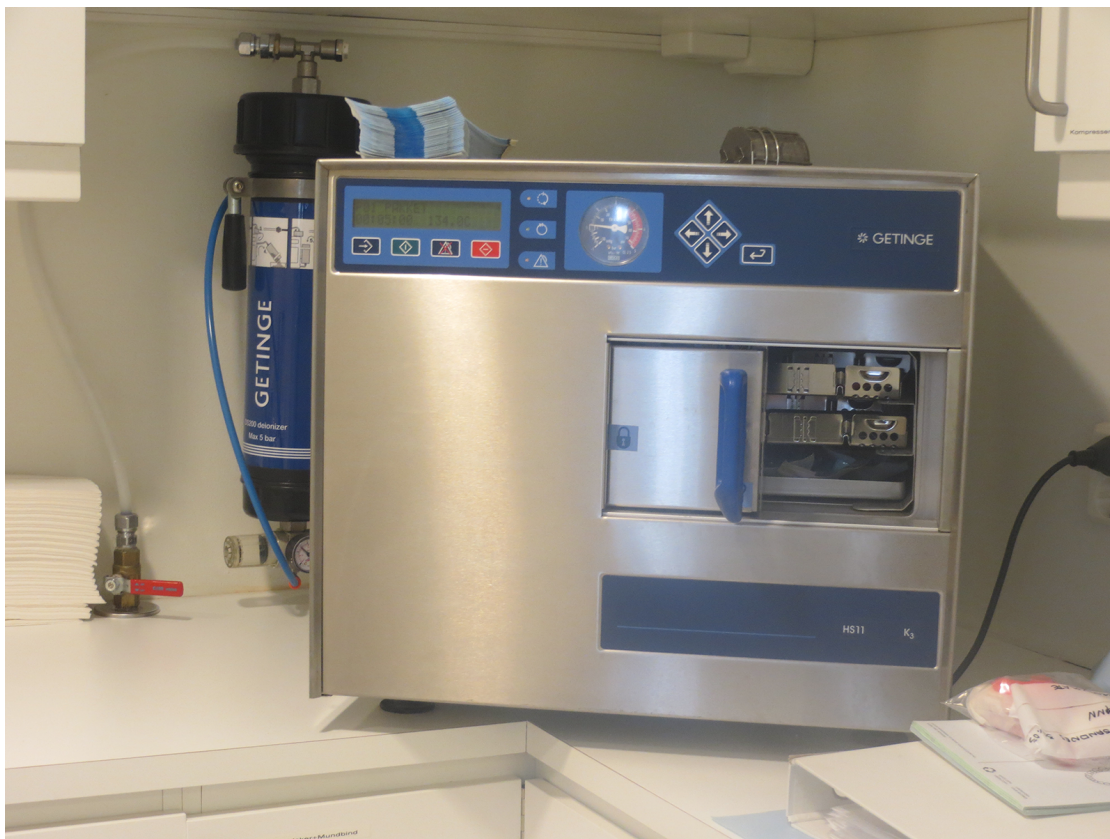


Figure 44 Steam sterilizing autoclave. (Skilled Trades BC, 2021) Used with permission.

Portable or installed sterilizers, referred to as sanitizers, submerge instruments or needles in boiling water for a fixed period of time (Figure 45). These fixtures consist of a covered heating container and a heat source to raise the water to boiling point. This method only kills a limited range of bacteria; pathogenic (disease-producing) spore-forming bacteria is only affected by high-pressure steam.



Figure 45 Hospital instrument sanitizer. (Skilled Trades BC, 2021) Used with permission.

Pedestal-mounted autopsy tables (Figure 45) are heavy-gauge stainless steel fixtures that have large integral sinks, a hot and cold faucet with spray assembly, and some form of hydro aspirator to remove fluids from the cadaver.



Figure 46 Hospital autopsy table. (Ralf Roletschek/Wikimedia Commons) CC BY-NC-ND 3.0 (<https://creativecommons.org/licenses/by-nc-nd/3.0/>)

Fixtures used in detention occupancies, such as prisons, are made with durability. Stainless steel water closets often incorporate a small, recessed basin above them for washing, while all seams and fasteners remain out of sight to the

prisoner (Figure 47). Mechanical systems in prisons are often contained in a chase that houses all required facilities without exposing any wiring, control valves, or other components.



Figure 47 Stainless steel one-piece prison washroom unit. (Édouard Hue/Wikimedia Commons) CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/deed.en>)

Detox toilets are designed for in-floor installation in holding cells, infirmaries, and correctional institutions. They are designed with a vigorous flushing action and are usually activated by remote means.

Emergency Fixtures

Emergency eyewash stations and emergency showers (Figure 48) are found in laboratories, shops, and industrial locations that have a risk of exposure to chemicals. Users can quickly turn on the water supply to these fixtures by activating large handles or paddles. Some types activate when the user stands on a sensor-equipped platform in front of the station.



Figure 48 Emergency shower and eyewash station. (Skilled Trades BC, 2021) Used with permission.

Fixture Trim

Fixture trims are available in almost any type of finish desired. Faucet handles and spouts may have rough, brushed-steel finish or be gold plated. Drains and strainers may be stainless steel, yellow brass, or plastic. Other types of trim, such as faucets and water fountain bubblers, are available in a variety of operating designs to suit the needs of different installations, budgets, or personal tastes.

Outlet Fittings

Outlet fittings used in standard sanitary fixtures, such as lavatories, showers and bathtubs, are designed to be flush with

the surface of the fixture to prevent dirt and debris from collecting at the rim. Different types of grating designs are available to cover the drain opening. Standard shower stalls have drain outlets located in the centre of the sloped base. A strainer made of chrome, stainless steel, brass, or fibreglass covers the drain opening and minimizes plugging problems. Lavatories, sinks, and water fountains also have drains located in the centre of the fixture. Drains may be open or have built-in strainers. Kitchen sinks have a metal or plastic removable strainer basket that prevents food particles and pieces from entering the drain pipe.

The most common types of tub and basin drain mechanisms are:

- Plug and chain
- Pop-up
- Mechanical stoppers
- Mechanical lever and linkage

Plug and Chain

Lavatories can simply be sealed with a shallow rubber plug that fits into the outlet opening of a patent overflow (PO) outlet tailpiece. The plug is attached by a chain to the faucet spout (Figure 49).



Figure 49 PO tailpiece with plug and chain. (Skilled Trades BC, 2021) Used with permission.

The PO is designed to accept drainage from the basin and overflow (if so equipped). If the basin is filled with water to the inlet of the integral overflow, the PO assembly allows the flow to enter the fixture drain (Figure 50).

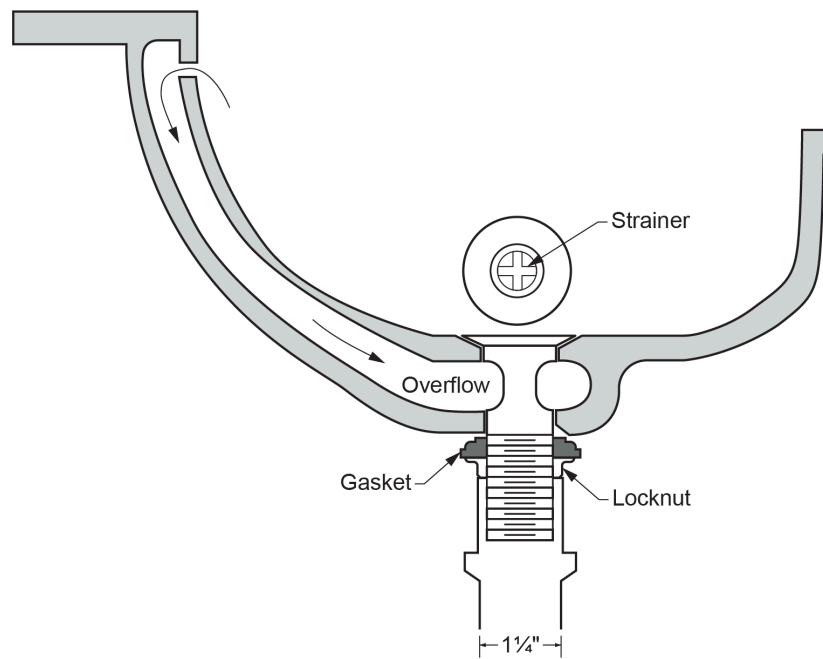


Figure 50 Basin patent overflow (PO) fitting. (Skilled Trades BC, 2021) Used with permission.

The fitting may have an integral strainer and a threaded bottom section that act as a locknut, holding the PO tightly in the drain opening. Lavatories have minimum $\frac{11}{4}$ in. (28 mm) outlet pipes.

Pop-Up Waste

The pop-up waste, sometimes referred to as a mechanical PO (Figure 51), is a common type of basin drain. A simple mechanical linkage pushes a lever or knob on the basin ledge or faucet centrepiece, causing the plug in the drain to lift to allow the basin to drain. Lifting the lever or knob reseats the plug, sealing the basin. Different designs of mechanical linkages are available.



Figure 51 Mechanical PO. (Skilled Trades BC, 2021) Used with permission.

Bathtub Waste and Overflow

Bathtubs use a waste and overflow fitting to prevent overflowing if the water is left running. The waste and overflow fitting consists of a tee that connects a tube from the overflow plate in the wall of the tub and to the tub drain outlet (Figure 52).

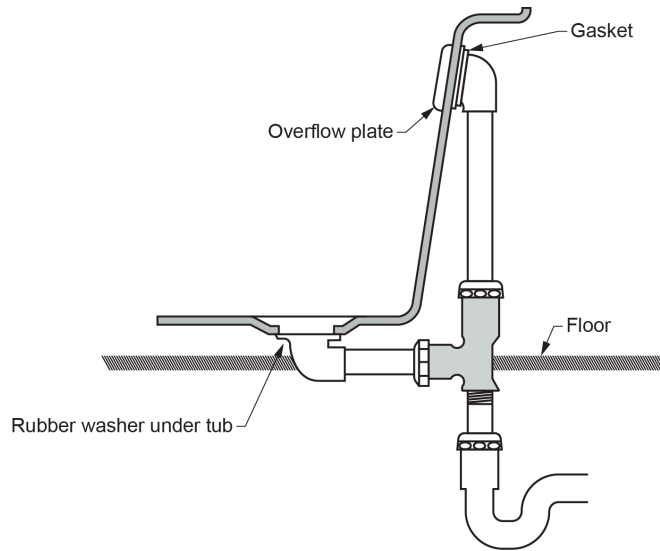


Figure 52 Bathtub waste and overflow assembly. (Skilled Trades BC, 2021) Used with permission.

The plug itself may be the older style plug and chain, mechanical stopper, or one of the types of lever and linkage plugs.

Mechanical Stoppers

A common type of stopper fitting is the lift and turn (Figure 53). The fitting attaches to the shaft using a screw threaded into the plug. The screw also acts as a positioning device. The fitting is attached to a pin in the drain that has a flat area on half of the shaft. When the fitting is lifted and turned, the screw sits on a shoulder that keeps it in the open position. Turning the fitting moves the screw off the shoulder and onto the flat area of the pin, allowing the fitting to drop and seal the outlet.

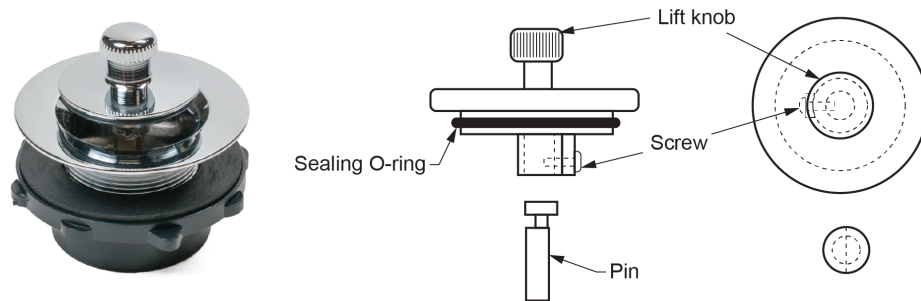


Figure 53 Lift and turn stopper and outlet fitting. (Skilled Trades BC, 2021) Used with permission.

The toe touch or tip-toe drain assembly (Figure 54) is a spring-loaded fitting that can be pushed open or closed with a simple touch. It is a simple arrangement that is quick to operate.



Figure 54 Toe touch. (Danco, n.d.) Used with permission.

Bathtub Lever Linkages

Common types of mechanical linkages used to raise and lower the bathtub plug are as follows:

- Brass plug
- Rocker arm
- Cable-driven

A brass-plug waste and overflow fitting has a lever mounted on the overflow plate on the tub. The lever lowers or raises a brass plug, which is suspended by a threaded hanger within the overflow tube. When the plug is in place, water cannot enter the downstream drain piping (Figure 55).

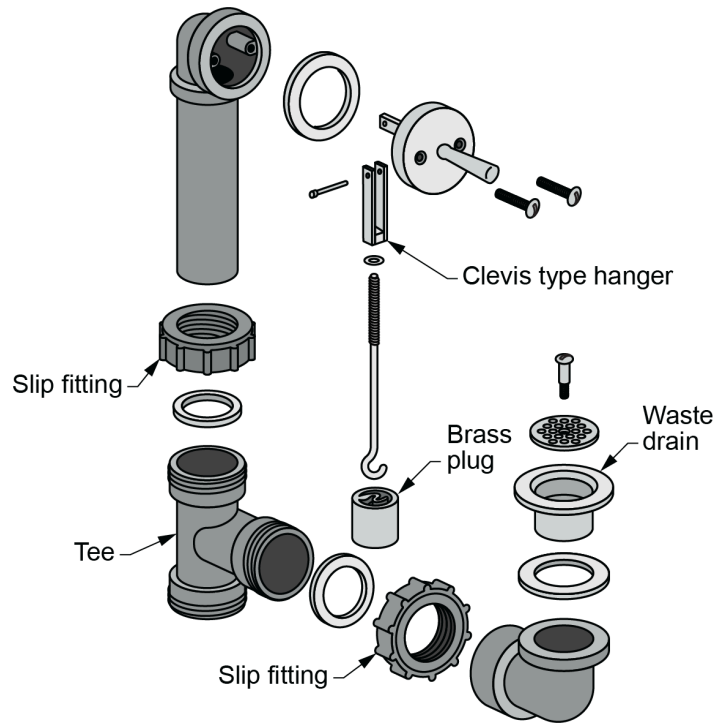


Figure 55 Brass plug-type mechanical waste and overflow assembly.
 (Skilled Trades BC, 2021) Used with permission.

A rocker-arm waste and overflow fitting has a linked rocker arm that moves up and down to raise and lower the stopper in the bathtub outlet fitting (Figure 56). A manual lever mounted on the overflow plate also triggers the action of the rocker arm.

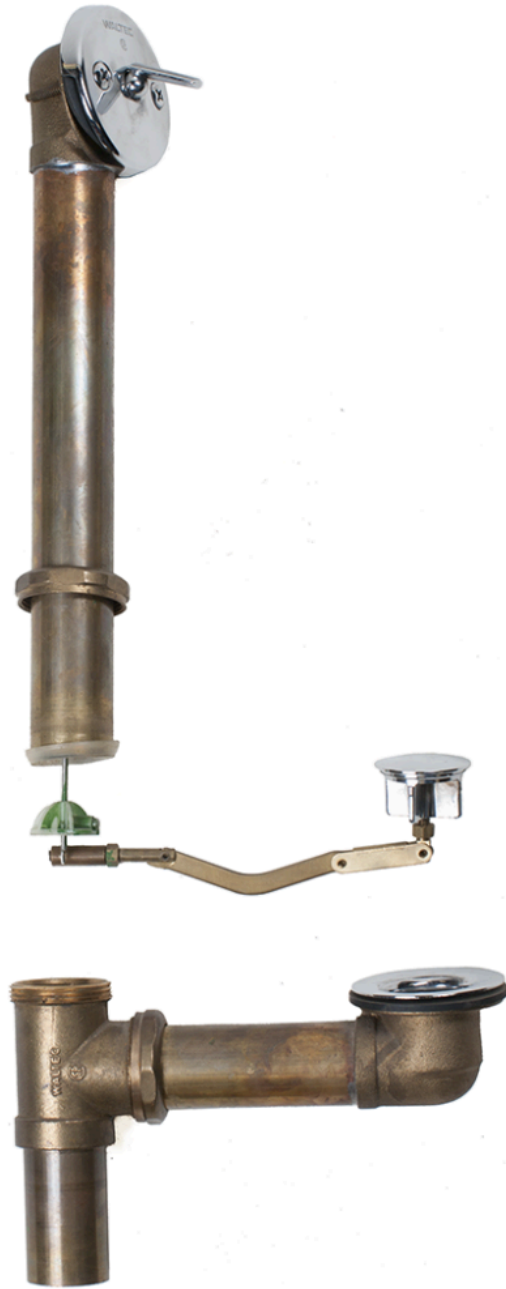


Figure 56 Mechanical rocker arm. (Skilled Trades BC, 2021) Used with permission.

Cable-driven styles simply use a cable to activate the drain assembly instead of a linkage. The cable is activated by turning the faceplate located on the overflow cover (Figure 57).



Figure 57 Cable-driven waste and overflow assembly. (Skilled Trades BC, 2021) Used with permission.

Kitchen Sink Drains

Kitchen sinks have a minimum $1\frac{1}{2}$ in. (38 mm) outlet tailpiece that extends from a $3\frac{1}{2}$ in. (89 mm) basket-strainer assembly (Figure 57). These assemblies are commonly made of stainless steel or plastic. Basket strainers house a plug mechanism sometimes called a crumb cup.



Figure 58 Kitchen sink basket-strainer assembly with crumb cup. (Skilled Trades BC, 2021) Used with permission.

Kitchen sinks may have more than one compartment. In these cases, the drain outlets from each compartment are piped to a common trap with a drainage assembly called a continuous waste (Figure 59). The common trap for multi-section sinks can be a minimum $1\frac{1}{2}$ in. (38 mm) for up to two compartments. Three-compartment sinks require a minimum 2 in. (50 mm) common trap.

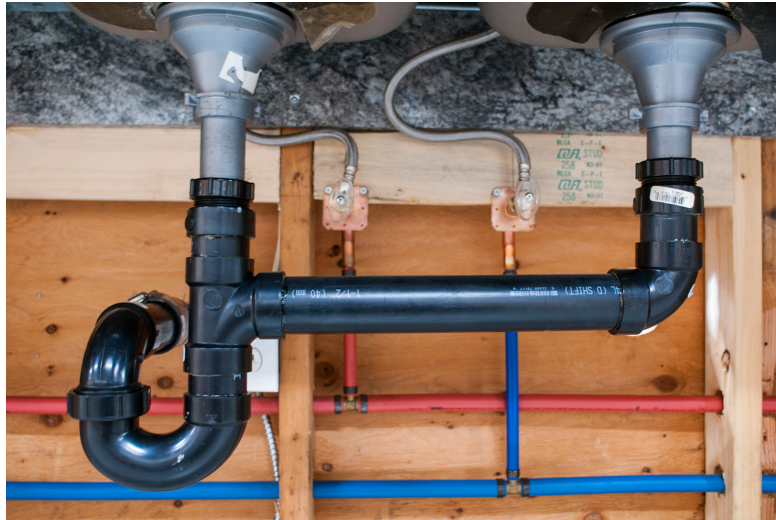


Figure 59 Kitchen sink continuous waste. (Skilled Trades BC, 2021) Used with permission.

When dishwasher drainlines are connected to the outlet pipes of an adjacent kitchen sink, the connection must be made upstream of the sink's trap to avoid the entry of sewer gas into the dishwasher. Dishwasher drain fittings (Figure 60) allow the discharge hose to connect to the outlet piping. The discharge hose from the dishwasher must be fastened under the counter as high as possible to avoid backflow of sewage from the sink into the dishwasher sump in the event of a fixture drain blockage.



Figure 60 Dishwasher wye drain fitting. (Skilled Trades BC, 2021) Used with permission.

Toilet Flanges

Water-closet floor flanges (Figure 61) are available in ABS, PVC, CPVC, brass, and cast iron. Brass floor flange rings are used when connecting a water closet to a lead stub or bend. Floor flanges and lead fittings act to connect floor outlet toilet bowls to the water closet trap arm and provide a finished mounting of the fixture. Flanges are available in extension fittings and offset patterns to accommodate different installation requirements.



ABS water closet floor flange



Brass flange ring for lead stub installation

Figure 61 Toilet flanges. (Skilled Trades BC, 2021) Used with permission.

Fixture Stops and Supply Tubes

Fixture stops, also known as shutoff valves (Figure 62), are used as an accessible means to isolate the water supply to a fixture. Installed at the point of use, these valves are commonly used to reduce the supply pipe size from the water distribution system to a smaller connector (supply tube) size. Available in a multitude of connection methods and patterns, they offer a convenient way to service or replace fixtures, such as faucets, sinks, water closets, and dishwashers.



Figure 62 ½ in. PEX by 1/8 in. compression, angle supply stop. (Skilled Trades BC, 2021)
Used with permission.

Fixture supply tubes (also known as supply risers, supply connectors, or supply lines) (Figure 63) are permitted by plumbing codes to be used to connect certain fixtures if the maximum length of the connector does not exceed 750 mm (30 in.) and the minimum ID of the tube is at least 6.3 mm ($\frac{1}{4}$ in.). These may be commonly referred to as $\frac{3}{8}$ in. supply tubes, as their outer diameter (OD) is $\frac{3}{8}$ in. (9.5 mm). Figure 62 shows various types of supply connectors. Braided supply lines are a popular choice because they offer the greatest flexibility during installation and do not require the use of tubing ferrules. Copper and chrome-plated supply tubes are usually offset with a $\frac{3}{8}$ in. OD tubing bender to accomplish the change in direction required from the supply stop to the fixture.



Figure 63 Various types of fixture supply tubes. (Skilled Trades BC, 2021) Used with permission.

Escutcheons

Wherever piping protrudes through holes in walls, chrome-plated metal or plastic finishing flanges known as **escutcheons** (Figure 64) should be installed. Some escutcheons have a deeper shell that can be used to cover a coupling or fitting. Some of these flanges are one piece and are intended to be installed during construction, while others are multi-piece and are intended to be installed after the piping system is fully connected. Escutcheons should be sized to the exact outside diameter (OD) of the pipe or tube.



Figure 64 One-piece and split escutcheons. (Skilled Trades BC, 2021) Used with permission.

Faucets

Faucets are sometimes commonly known as taps. A faucet supplies hot and cold water for baths, sinks, and lavatories. Older installations once used separate taps (or spigots) for hot and cold supplies. Modern faucets are of the mixing style, where hot and cold water are mixed within the faucet body before being emitted at the spout as a single stream.

Faucets for lavatories and sinks are limited by code to a maximum permitted flow rate of 8.3 L/min (2.1 USGPM). Faucets must comply with the CSA B125 standard for supply fittings. Whenever a faucet's outlet is provided with a means to attach a hose, such as a janitor's faucet, the outlet must be protected by the installation of a vacuum breaker to prevent back-siphonage backflow.

There are four basic types of faucet mechanisms:

- Compression
- Cartridge
- Ball
- Ceramic disk

Compression Faucets

Among the various faucet tap technologies in use, two-handed **compression-type faucets** (Figure 65) that use washers have been around the longest. They are also the least expensive type.

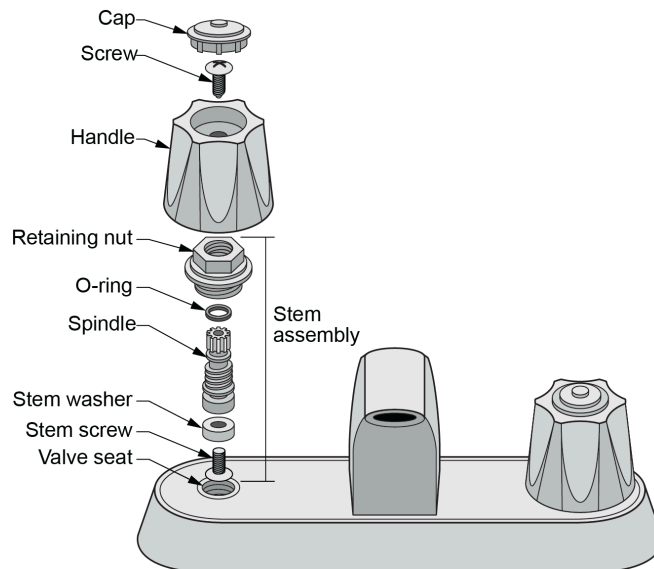


Figure 65 Compression-style faucet. (Skilled Trades BC, 2021) Used with permission.

With a compression faucet, the handle is rotated to raise or lower a stem. At the stem's base, a washer opens or closes the water passageway (the valve disk and seat). The fundamental problem with a compression faucet is that the rubber washer wears out over time. When this happens, the tap drips.

Some newer types of compression faucets lower and raise the washer without grinding it into the valve seat. For example, one faucet is designed to lift and lower the rubber washer vertically without rotating it. Because it does not grind the washer against the seat, the washer tends to last longer.

The remaining three styles are commonly referred to as washerless faucets (although they still utilize O-rings or seals) and are variations on the simple and effective plug- or ball-style supply valve. Water flow is controlled by turning components within the valve until they are aligned with the water flow passageway. The degree of alignment controls the mixture of hot and cold water. Many are of the single-handed variety.

Cartridge Faucets

Cartridge faucets (Figure 66) have a hollow metal or plastic cartridge insert which seals against the spout or faucet body. Depending on how a series of holes in the cartridge align with the stem, water is mixed and controlled. Dripping usually means the cartridge needs replacing.

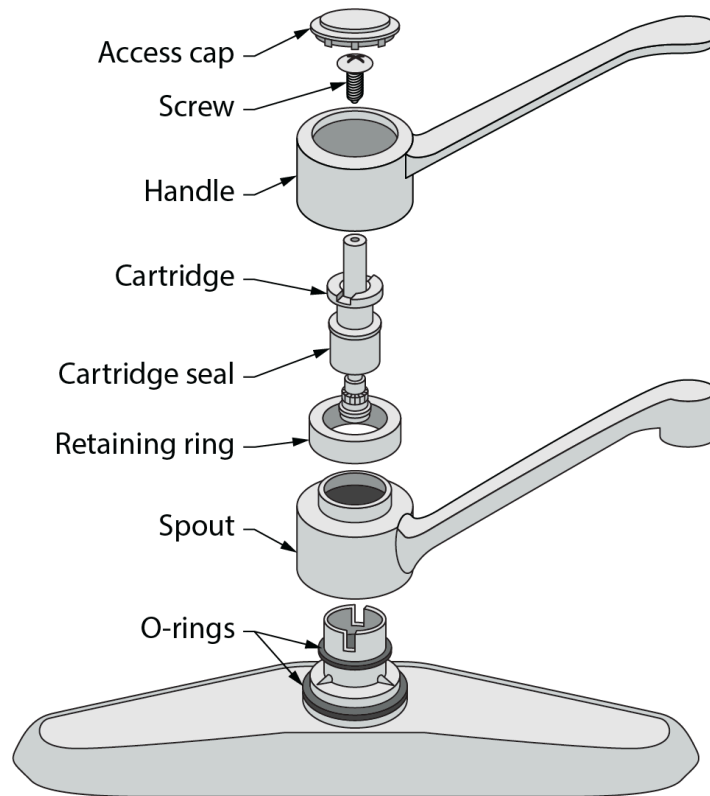


Figure 66 Cartridge faucet. (Skilled Trades BC, 2021) Used with permission.

Cartridge faucets control flow using methods other than a disk washer and valve seat. Water flow is controlled by an up-and-down movement of the cartridge; to change water temperature, rotate the single handle.

These faucets are very reliable; many leaks are generally due to a simple O-ring failure.

Ball Faucets

Seat-and-spring (ball-type) faucets have a stainless steel or plastic ball with slots that are turned and aligned with water flow openings in the faucet body (Figure 67). These openings have spring-loaded rubber caps or seats that press against the globe as it rotates to maintain a tight seal.

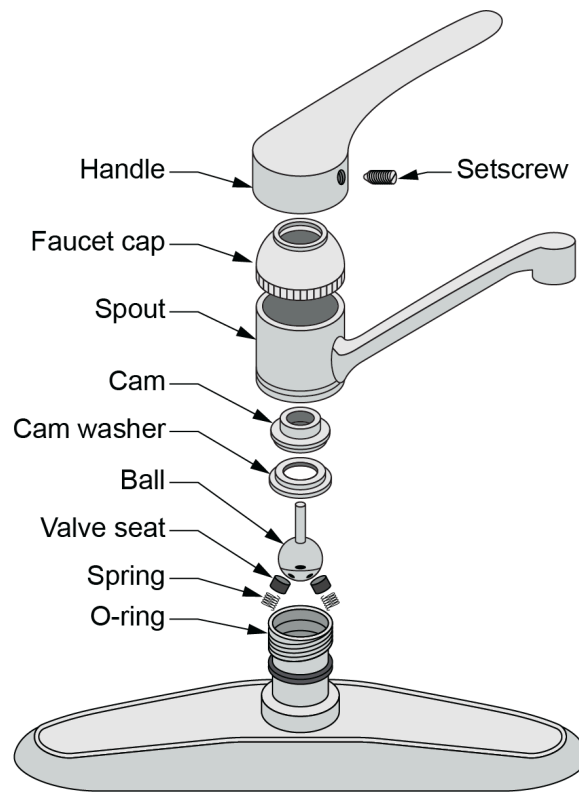


Figure 67 Seat-and-spring ball-type faucet. (Skilled Trades BC, 2021) Used with permission.

Ceramic Disk Faucets

Ceramic disk faucets (Figure 68) have two fire-hardened ceramic disks – an upper one that moves and a fixed lower one. One disk moves against the other in a shearing action, blocking water or allowing it to pass through. The seal between the two disks is watertight because they are polished to a near-perfect flatness. Ceramic disk faucets were first made popular by high-end European faucet makers and are now produced by many North American faucet manufacturers.

Ceramic disk faucets are nearly maintenance-free. Ceramic valves are more durable over a variety of water conditions than any other variety of valve on the market. The disks themselves have diamond-like hardness – they are impervious to line debris, mineral buildup, and other common problems that affect valve life.

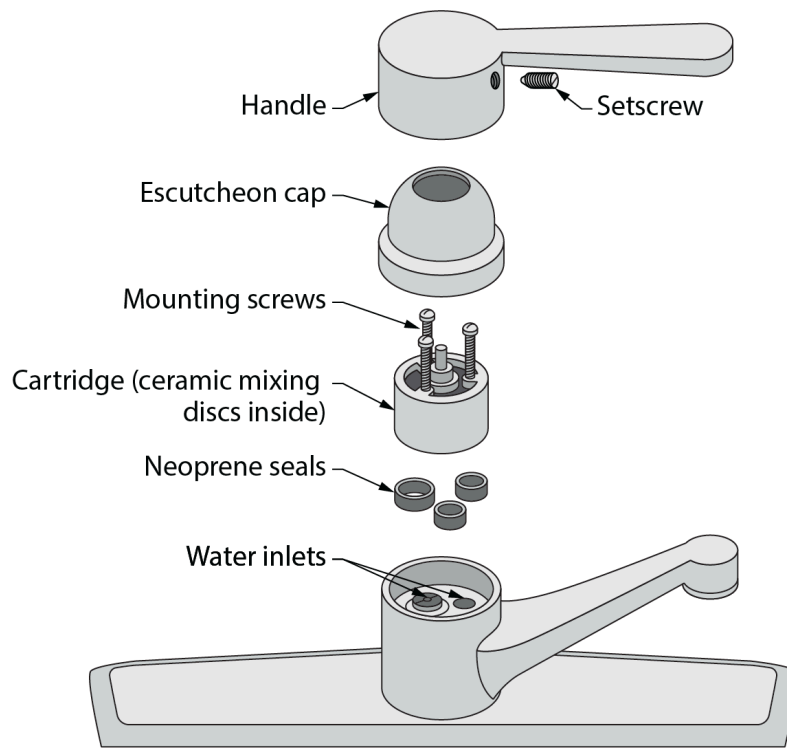


Figure 68 Ceramic disk faucet. (Skilled Trades BC, 2021) Used with permission.

Faucet Controls

A single-lever-type faucet has a long handle or lever mounted on the spout. Lifting the lever turns the water on and controls the volume delivered. Moving the lever to the right or left adjusts the mixture of hot and cold water. Most faucet spouts have aerator assemblies, which are a fine mesh screen assembly mounted at the outlet to limit maximum flow and create a soft spray pattern.

Faucet spouts used in bathtubs are referred to as tub fillers (Figure 69). When combined with showers, they are known as combination tub and shower valves; sometimes, the entire **rough-in** assemblies are generically known as tub diverters. Tub fillers may have separate hot and cold compression-style controls or one single-handled cartridge-style mixing valve and a central spout. Telephone showers (handheld shower units with a hose attachment) can be connected to the spout of a tub filler unit or be integrated into the shower head outlet.



Figure 69 Tub filler with diverter rod for showering. (Skilled Trades BC, 2021) Used with permission.

Combination tub and shower valves commonly use a central mixing valve that controls the flow volume and temperature to the shower or to fill the bathtub. The actual diverter valve is controlled by a lift rod installed on the tub spout (Figure 69) or by some other means. When the diverter valve is held in position, water flow is forced up through the shower riser and shower head instead of out the tub spout.

Shower head flow rates are limited by code to a maximum permitted flow rate of 9.5 L/min (2.5 USGPM). Codes also require that valves that supply fixed-location shower heads be either of the pressure-balanced or thermostatically controlled type. The maximum outlet temperature to a bath tub or shower head shall not exceed 49°C (120°F).

Sensor-Activated Controls

Sensor-controlled faucets (also known as hands-free, automatic, touchless, motion-sensor, or infrared faucets) (Figure 70) are faucets equipped with a proximity sensor and mechanism that opens its valve to allow water to flow in response to the presence of a hand or hands. The faucet closes its valve again after a few seconds or when it no longer detects the presence of hands. Most automatic faucets are battery-powered and incorporate an active infrared sensor to detect hand motion. Some are hard-wired and some have solar cells that can power the valve from any light source. Automatic faucets are common in public washrooms, particularly in airports and hotels, where they help to reduce water consumption and reduce the transmission of disease-causing microbes. They can also be found in some kitchens and washrooms of some private residences.



Figure 70 Sensor-activated faucet. (Skilled Trades BC, 2021) Used with permission.

Automatic faucets were first developed in the 1950s but were not produced for commercial use until the late 1980s, when they first appeared to the general public at airport lavatories. It is estimated that sensor-controlled faucets can reduce typical lavatory water consumption by as much as 70%.

Automatic faucets have the advantage of shutting off automatically after handwashing, thereby reducing water waste. They can also benefit the elderly and those suffering from arthritis or other mobility-limiting conditions since there are no handles to twist or pull. Their automatic shutoff mechanism also greatly reduces the risk of sink overflow due to a faucet being left on either inadvertently or deliberately.

Automatic sensor controls are also used frequently in commercial installations of urinals and water closets that use direct-flush valves (Figure 71). Even residential hands-free options are now available, like foot-activated flush kits. Retrofit sensors are also on the market, even for flush tanks.



Figure 71 Sensor-activated direct-flush water closet. (Toto USA). Used with permission.

Sensor-activated water-closet motorized flush valves were first widely introduced commercially in the mid 1970s, but they were much more elaborate devices than the compact units installed today. Because water closets and urinals have a fixed cycle when they operate, automatic sensors are used mainly to avoid spreading microorganisms by eliminating the need to touch the controls. Many users experience problems when using these fixtures if the sensors are not set up correctly.

Pressure-Balanced and Thermostatic Control Valves

Single-control pressure-balanced valves (Figure 72) sense the proportion of cold and hot water as the user turns the handle. The pressure balance valve does not sense the actual temperature of the water, just the ratio of hot and cold water supplied to the valve. When a toilet is flushed or another fixture is used while someone is showering, an internal cartridge automatically balances hot and cold water pressures to prevent shock to the bather. Each time the valve is turned on, full flow is provided to the shower head or tub, but users must select the temperature of the shower each time it is used. A mechanical limit stop restricts the travel of the control lever to set the maximum temperature delivered to 49°C (120°F).



Figure 72 Pressure balanced control valve. (Skilled Trades BC, 2021) Used with permission.

Thermostatic valves (Figure 73) have two handles: one controls the mix of hot and cold and the other controls on/off and the volume of water passing through the valve. The mixing valve in the thermostatic valve senses the actual temperature of the water and constantly adjusts the mix to maintain the temperature selected. It is not necessary to turn the mix handle to turn the water off or on. Once the bather selects a temperature, the valve will automatically go to that temperature again when the water is next turned on.



Figure 73 Thermostatic control valve. (Toto USA). Used with permission.

Thermostatically-controlled water valves are commonly specified for installation in many schools, hospitals, recreation centres, and industrial workplaces. They are also used in quality residential tub and shower valves. Digital thermostatic valves are available that allow the user to preset water, steam, lighting, and music through an intuitive interface. A common design uses a liquid-filled expansion-type thermostat (housed within the valve assembly) to measure the temperature and mix the hot and cold water supply to achieve the selected delivery temperature. Usually, you turn a single handle or dial to select a general temperature range. The actual temperature range that will be achieved by turning the handle or dial is preset. The valve assembly includes a concealed adjustment for raising or lowering this range. The anti-scald safety feature built into the valve design ensures that water will automatically shut off whenever the cold water supply drops below a certain level or stops. This prevents any chance of scalding or burns from hot water.

Fountain Bubblers and Controls

Bubblers are the supply fitting used to deliver water in drinking fountains. The name bubbler may derive from the fact that the water is supplied with a slow head or delivery pressure that makes it appear to be bubbling from the fixture. Different designs are available, but all feature a protective hood or shield on one side of the outlet (Figure 74) and a raised spout to deliver the water above the flood level of the water fountain base. The water delivered from a fountain bubbler must be directed upward at an angle of approximately 45° to prevent contamination from the user's mouth.



Figure 74 Drinking fountain bubbler. (Skilled Trades BC, 2021) Used with permission.

Different types of bubbler controls are available. Some use a push button to open and close the supply valve. Another control type is a self-closing rotating stop that has a metal or plastic handle. The water is turned on only when the knob is held open by hand. As soon as the knob is released, the valve closes.

Drinking fountains must have a means to regulate flow from the orifice to an acceptable delivery rate. Automatic flow regulators (Figure 75) maintain constant stream heights under fluctuating line pressures. Most are $\frac{1}{4}$ NPT threads or a push-type fitting. Some fountains have the flow regulator built into the push button-style cartridge.

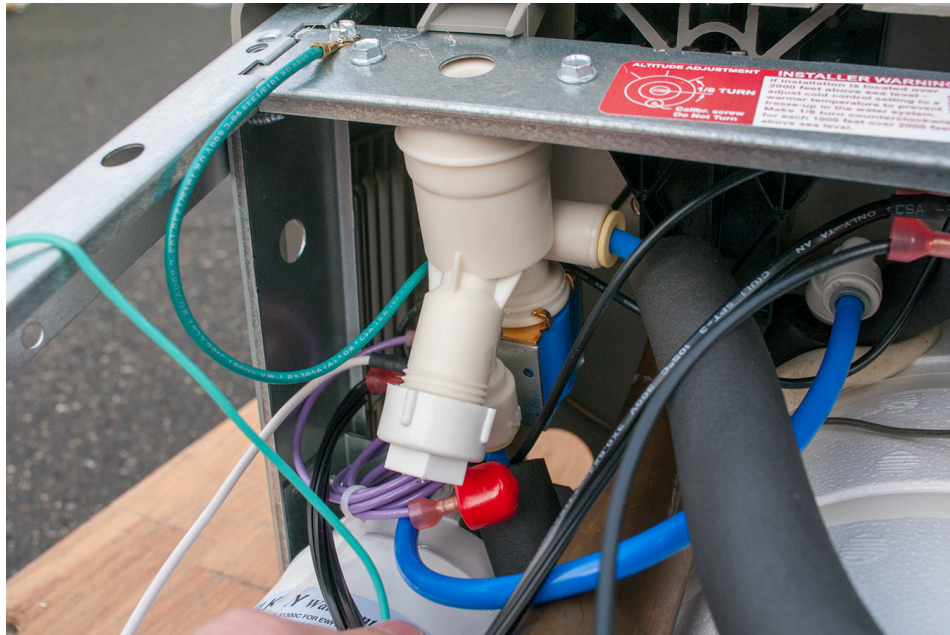


Figure 75 Drinking fountain flow regulator. (Skilled Trades BC, 2021) Used with permission. Used with permission.

Laundry Boxes

Laundry boxes (Figure 76) supply a set of hot and cold hose bibbs, often a 2 in. (50 mm) NPS drain connection for the laundry standpipe, and are available with built-in water hammer arrestors. Laundry boxes enable the standpipe and water lines to be concealed, providing a clean look to the installation. The clothes washer hoses are connected to the hot and cold supplies and the discharge line is placed into the drain inlet of the box.



Figure 76 Laundry box. (Oatey, n.d.) Used with permission

Carrier Fittings and Brackets

Available for commercial, institutional, and some residential lavatories, water closets, and urinals, concealed wall carriers provide increased strength for supporting a fixture. These steel carriers have arms, brackets, and attachment points that allow the fixture to be wall-mounted without strain or damage to the wall finish.

Wall-mounted fixtures require a sound base that can be anchored to a structural component. In wood-frame construction, carrier fittings and mounting brackets can be attached to studs in the wall (Figure 77).

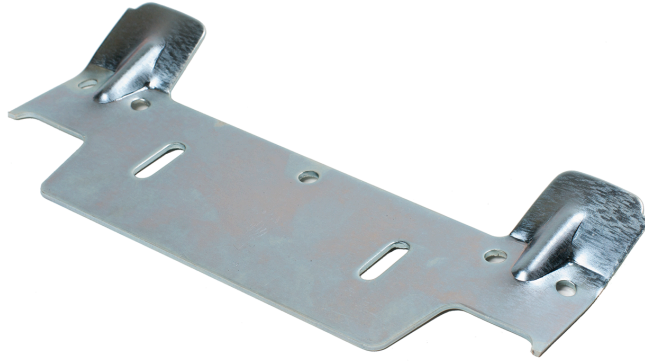


Figure 77 Wall-hung lavatory mounting bracket. (Skilled Trades BC, 2021)
Used with permission.

Commercial projects often require that the carriers and supports be freestanding in the wall cavity and fastened to the structural floor (Figure 78).



Figure 78 Floor-mounted urinal carrier supports. (Skilled Trades BC, 2021) Used with permission.

Water-closet carriers must support the weight of the wall-mounted bowl plus the full weight of the user without transferring any weight to the wall or piping. Closet carriers are often installed in batteries to accommodate multiple fixtures and may also be installed for back-to-back installation. Substantial provisions must be made for these types of fixtures when roughing in the drainage and venting system.

Wall-mounted water closets are mounted with either a four-bolt (siphon jet) or three-bolt (blowout) pattern. When ordering single carriers for horizontal connections (Figure 79), you must specify direction of flow. Determine direction of flow as if you were sitting on the fixture, facing away from the wall. Back-to-back carriers are reversible and do not require a flow direction specification.

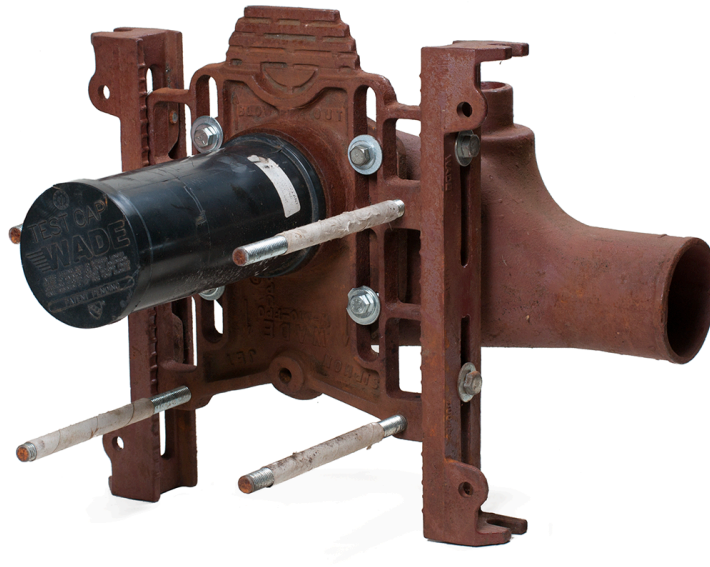


Figure 79 Horizontal, left-hand, siphon jet water-closet carrier. (Skilled Trades BC, 2021) Used with permission.

Carriers have adjustable threaded rods and threaded drain nipples to accommodate various wall thicknesses and finishes.

Barrier-Free/Universal Design Requirements

The presence and participation of people with disabilities in our communities is significant. The percentage of people with disabilities of all ages will increase, especially over the next few decades, with each type having their own specific design needs. Barrier-free or accessible in this context means that a person with disabilities can approach, enter, exit, operate, participate in, pass to and from, and make use of a building's facilities without assistance.

When referring to building code, specifically the sections dealing with building requirements for people with disabilities, plumbers must be aware of the strong impact that proper application of the code has on the day-to-day lives of people with disabilities.

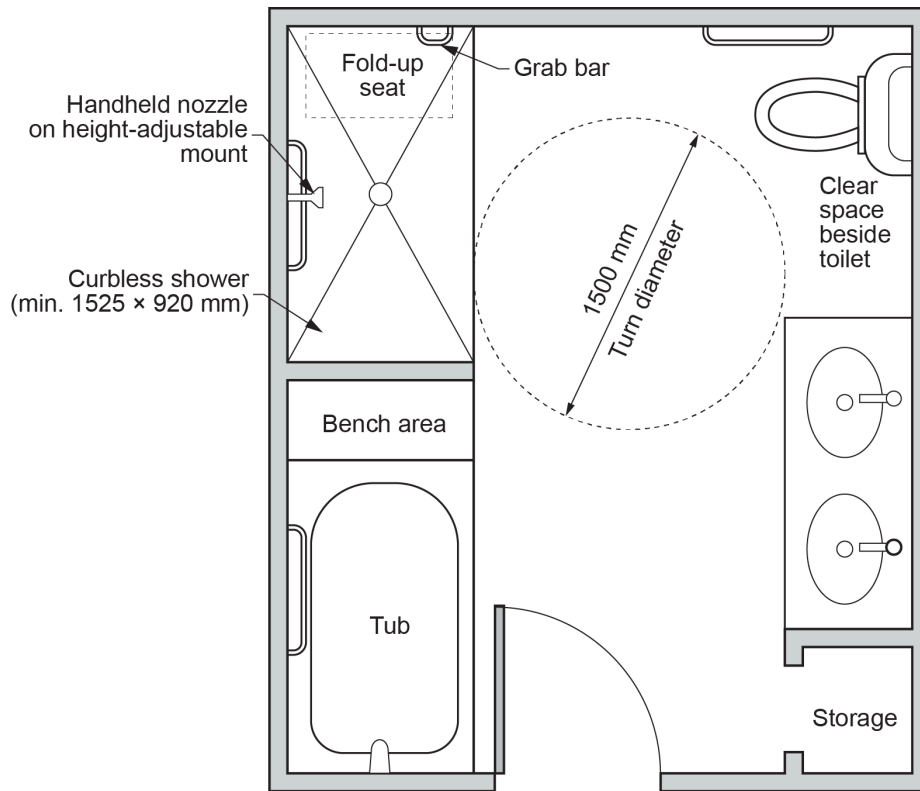


Figure 80 Example of barrier-free accessibility specifications. (Skilled Trades BC, 2021) Used with permission.

The BC Building Code Section 3.8 of Division B, “Accessibility,” comprises a large portion of the requirements of the code dealing with access for persons with disabilities, but there are requirements contained elsewhere in the code that also pertain to accessibility. Some of these requirements are design specifications for specific facilities, such as washrooms, which are contained in Section 3.7 of Division B, Health Requirements. Other items originated as requirements for persons with disabilities but have become universal requirements applicable to all building users, not just those with disabilities.

Requirements for a minimum turning radius for wheelchairs and clearances from obstructions are examples of good design (Figures 80 and 81). Always consult with job specifications to ensure that minimum code and specifications are being met.



Figure 81 Example of barrier-free accessibility specifications. (Skilled Trades BC, 2021) Used with permission.

Bathroom design has become increasingly sensitive and responsive to the needs not only of the physically challenged but also of an aging population. Universal design, while incorporating the spirit and some features of accessible design, has a broader scope. Universal design intends to create an environment that functions appropriately for all, regardless of physical capacity. This would include, for example, people with arthritic conditions; the elderly, injured or movement-impaired; and small children. Creating a bathroom environment that allows people of all ages and physical capacities to use the facilities safely and with ease is the motivating force behind universal design.

Gender-neutral washroom facilities are also increasingly common in public buildings and can be used by any person, regardless of gender identity.

A universal design bathroom incorporates and extends many of the features of an accessible design bathroom but focuses on users who are aging rather than disabled. Universal design relies on common sense and strives to be user-friendly for anyone who uses the bathroom.

Universal design principles focus on:

- Ease of use
- Easy access
- Adjustability
- Safety and stability

Ergonomic wing-blade faucet handles or motion-sensor taps, for example, aid those with arthritis who have difficulty

turning bathroom handles. A tub's faucet set placed on the outer rim of the bathtub makes it easier to reach for someone who has difficulty bending or is prone to dizziness. Adjustable-height handheld shower heads allow a shower to be customized for the tallest to the smallest. Built-in or installed seating in the bathtub or shower offers that option to those who cannot stand for extended periods. Grab bars placed strategically around the toilet and outside and inside the tub or shower not only help the frail and movement impaired but also provide an extra measure of stability in the bathroom to children and able-bodied adults.

Other universal design bathroom safety features, such as anti-scald devices on all faucets, shatterproof materials, and slip-resistant flooring, make the bathroom safer for everyone.



Self-Test C-1.1: Types of Fixtures and Trim

Complete the Self-Test C-1.1 and check your answers.

If you are using a printed copy, please find Self-Test C-1.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=5#h5p-1> (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=5#h5p-1>)

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C-1.2 Fixture and Trim Installation

Installing fixtures and trim is the most visible example of a plumber's work, and it becomes their signature. Most people's impression of the plumbing trade is reflected in their satisfaction with the fixtures that they use on a daily basis. Procedures to install bathtubs, water closets, sinks, and lavatories are not complex but require a great deal of care to ensure that fixtures operate reliably and that each installation has an attractive look. The professional appearance of fixtures and trim reflects the skill and knowledge of each plumber. As such, it is paramount that a plumber either meets or exceeds the required specifications and the client's needs.

Plumbing codes set out the minimum standards for fixture installation and support. Codes describe minimum **clearances**, types and sizes of piping and fittings required, and fixture finish and installation. Refer to your national and provincial plumbing and building codes for specific regulations that apply to fixture installation. Manufacturers provide detailed information on proper installation and finish that must be referred to during planning and installation.

Roughing in prior to installing fixtures must be considered carefully to ensure success. Although the supply, drainage, and vent piping may already be installed, some piping, valves, and other fittings can only be installed after confirming the type and number of fixtures. Rough-in for fixture installation may involve skills that include special **backing** between wall studs for lavatories and sinks or installing sections of piping, valves, and fittings to supply a showerhead or drain a bathtub. Before the final wall covering is on and the selected fixtures are installed, there are specific requirements in both provincial and national plumbing codes that must be satisfied.

Backing and Supports

All fixtures require some method of support. Lavatories may require backing installed within walls. Certain types of bathtubs, such as acrylic-fibreglass tubs, may require level, concrete platforms prior to installation. Some types of fixtures for persons with disabilities require additional support from steel frames called **carriers**. The types of supports and fastenings required for each type of fixture are detailed in manufacturers' specifications. Minimum requirements are described in local, provincial, and national codes.

Backing (or backing boards) is used to support fixtures attached to walls, floors, ceilings, or other structural members. Backing must be made from durable material, such as plywood, lumber, or metal, and installed behind a finished wall. If the backing is not adequate, the fixture's hangers or fastenings will tear through the wall finishing material (e.g., drywall) due to the weight of the fixture. In most cases, the backing should be fastened to studs in the wall to provide strong, reliable support for fixture fasteners.

Wall-hung lavatories require the installation of backing boards. The mounting bracket that supports and holds the lavatory to the finished wall is bolted to the backing.

Wall-hung water closets require very strong support because they must support the fixture and the user. Usually, a carrier fitting is installed to suspend the load of the water closet. This carrier holds the water closet to the wall and supports its working weight.

Backing boards are also necessary when installing combination shower-bathtub units (Figure 1). The shower curtain rod requires backing between the studs at the front (or apron) of the tub near the ceiling. This backing supports the curtain rod flanges and is usually installed at about 1.9 m (6 ft-6 in.) above the subfloor. Shower heads in bathtubs or stalls require a backing board between 1.9-2 m (6 ft-6 in. to 6 ft-8 in.) above the subfloor.

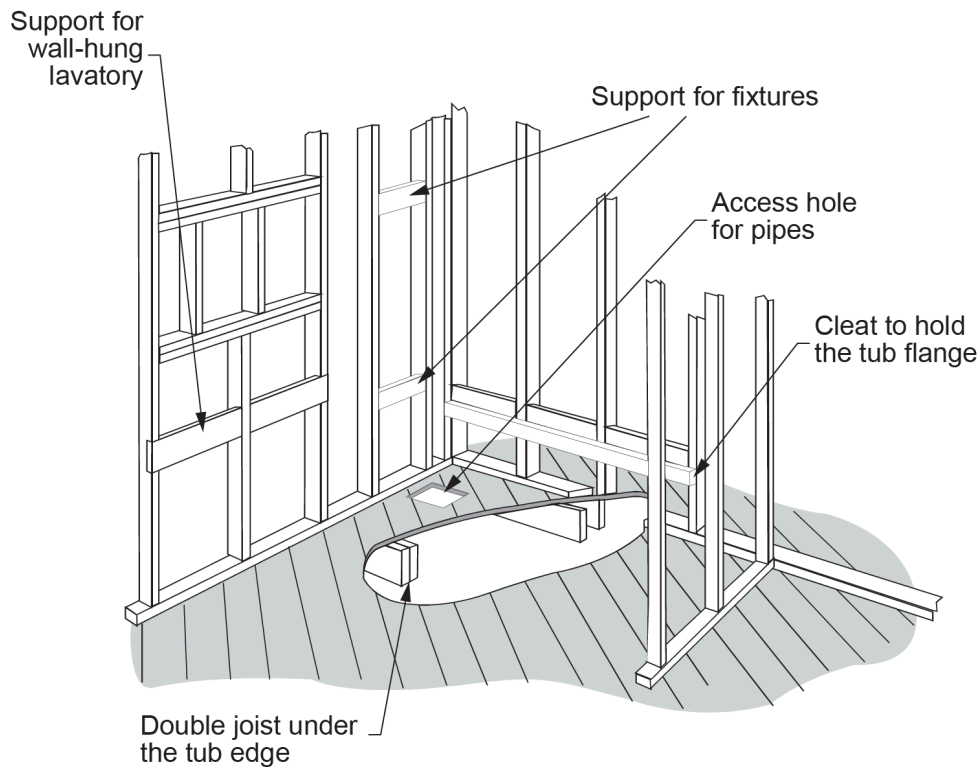


Figure 1 Backing for bathroom fixtures. (Skilled Trades BC, 2021) Used with permission.

Recessed bathtubs also require supports to hold the rear lip of the tub. If horizontal backing boards are used, perpendicular support legs are required. Otherwise, vertical support pieces can be cut and nailed to studs along the entire length of the back of the tub.

For fixtures that require the additional support provided by carriers, the main support legs are installed behind the finished wall and bolted to the floor and wall studs. The accurate measurement and location of these hidden support legs and the short connectors that protrude through the finished wall are critical. The fixture is held by two pipes or arms inserted into precast passageways inside the fixture. If the carrier legs have not been roughed in correctly, the wall will have to be cut open.

Fixtures must be connected to supply and drainage piping when installing them. These connections must be located to meet the installation requirements of the manufacturer and those outlined in plumbing codes.

The piping and valves that make up standard tub and shower or stand-alone shower installations are set into the wall before finishing. When provided, access may be from beneath the floor, built into the supporting wall, or in the wall of the next room or hall (Figure 2).



Figure 2 Bathtub access. (Skilled Trades BC, 2021) Used with permission.

The tub-filler valve (used to blend hot and cold water, the supply lines, and the spouts for shower or tub) must be positioned correctly and mounted securely. The wing-back fitting that supports the shower head must be anchored securely. This fitting, sometimes called a **drop-ear**, should be a $\frac{1}{2}$ in. (13 mm) female iron pipe thread (FIP). A short, reusable nipple is threaded into this fitting and protrudes through the finished wall until the shower is actually installed. At that time, it is replaced with the chromed shower spout or trim nipple, a finishing flange (**escutcheon**), and a shower head.

Typical bathtubs have **tub-filler valves** with integral stops connected to the supply lines (Figure 3). The stops may provide for a solder-type joint with the supply line or be equipped with unions that have threaded, crimped, or solder-type joints. Bathtubs with showers use combination tub fillers that have a **diverter valve** and integral stops to connect to supply piping. Always provide access so that maintenance can be carried out on diverters or other valves behind finished walls.



Figure 3 Bathtub and shower supply piping.
(Skilled Trades BC, 2021) Used with permission.

NPS $1\frac{1}{2}$ in. (38 mm) **waste and overflow fittings** are used to connect the bathtub to the trap. The drain of a bathtub must fit into a slot in the subfloor that is normally about 150 mm by 300 mm (6 in. by 12 in.).

When installing oversized bathtubs, whirlpools, and soaker tubs, have the fixtures on site at the rough-in stage to ensure accurate rough-in work. Always protect the finish of the fixtures from damage.

Lavatory water piping and fixture backing should be provided, as shown in Figure 4. Rough in the supports to meet manufacturers' recommendations and code requirements. Faucets on laundry sinks may be deck-mounted on the vertical backsplash. Water supply lines are connected in the same way as kitchen sinks.



Figure 4 Support backing. (Skilled Trades BC, 2021) Used with permission.

The stop for a water closet is generally a $\frac{3}{8}$ in. (9.5 mm) flexible supply. The stop is mounted 150 mm (6 in.) to the left of the centreline of the water closet and is usually 150 mm (6 in.) above the finished floor. Always check the manufacturer's installation procedures and site specifications to locate correct rough-in dimensions.

A lead closet bend or elbow fitting connects the **closet flange** to the waste piping (Figure 5). The floor flange should be installed so that it is 30 cm (12 in.) from the finished back wall or according to site requirements. Be sure to double check this dimension for accuracy. Side clearance is often 37 cm (15 in.) minimum from the side wall to the centre of the flange. Ensure that backing boards are installed if grab bars or hand rails are to be installed.

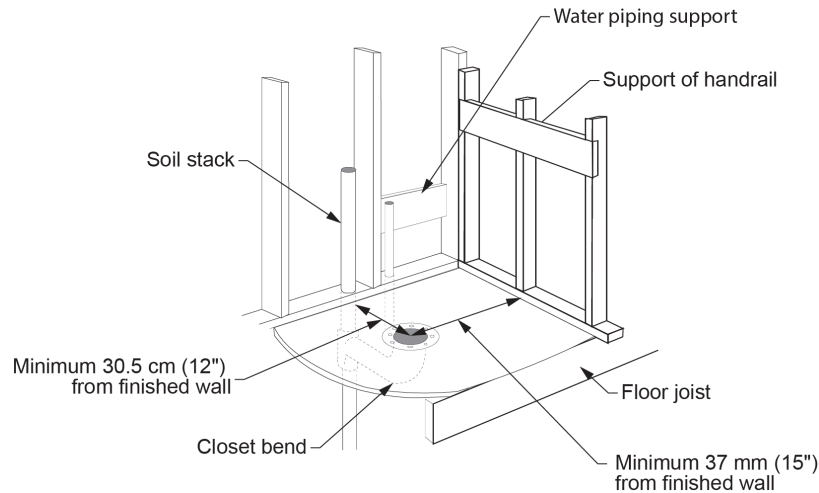


Figure 5 Water-closet rough-in example. (Skilled Trades BC, 2021) Used with permission.

Rough-in connections for a standard dishwasher are not usually complex. The drain from the dishwasher is connected to a wye fitting connected to the sink fixture outlet pipe upstream of the **P-trap**. A separate supply stop for the hot water supply connection to the dishwasher is usually installed, or it will originate from the sink's hot water supply.

Clothes washers must be connected to hot- and cold-water supply lines. Separate hot- and cold-water stops are installed 1.2 m (48 in.) from the floor so that they are higher than the back of a standard washer and more easily accessible.

Washing machines require a 5 cm (2 in.) P-trap and a minimum 600 mm (24 in.) **standpipe**. A standpipe is a vertical section of pipe that extends above the trap weir and must terminate above the flood level rim of the clothes washer. The drain hose from the washer empties into the top of the standpipe during the washer discharge cycle. **Laundry boxes** (Figure 6) can simplify the installation and provide a neat appearance.



Figure 6 Laundry box for clothes washer and laundry tub. (Skilled Trades BC, 2021) Used with permission.

Code Requirements for Fixture Rough-in

Plumbing codes govern the way in which piping, fittings, and fixtures can be installed and the type and placement of fixtures that a plumber may install. Codes also govern minimum sizes of piping, outline requirements for support, and provide a framework of acceptable solutions to the installation of plumbing systems. Plumbers must be familiar with the codes and specifications for each job.

A plumber may have to drill holes, notch, or cut into studs and joists in order to make connections to supply lines or **drainage, waste, and vent** lines. At times, access holes may have to be cut through firewalls or fire separations to allow supply or drainage piping to pass through. When a rough-in for fixture installation affects a building's structure, provincial or national building code requirements define minimum requirements. Engineered building materials state their own installation specifications.

While there are some common guidelines to follow when carrying out the rough-in and installation of fixtures, always check local building and plumbing codes and your provincial codes to meet minimum compliance.

Requirements pertaining to cutting, drilling, or **notching** support members ensure that the installation of piping and fittings does not weaken the structure. Building code requirements generally state that holes cannot be larger than one-quarter of the depth of a member and no closer than 50 mm (2 in.) from the edges (Figure 7). Notches on horizontal members must always be on the top, within half the joist's depth from the edge of the bearing and not deeper than one-third of the the joist's depth.

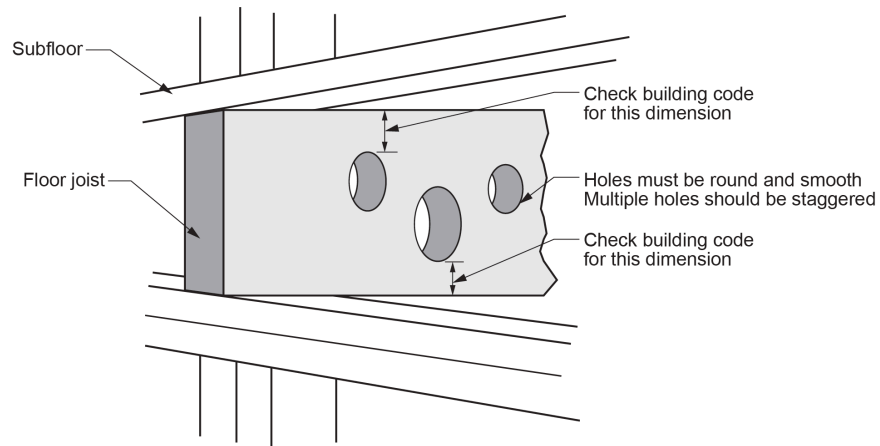


Figure 7 Drilling holes in joists. (Skilled Trades BC, 2021) Used with permission.

Before notching or drilling studs, always check to see if it will affect a load-bearing stud. If a stud is load-bearing, cutting or notching should not affect more than one-third of the stud's depth (roughly 33 mm/1 in. if the stud is a 2 by 4). If the stud is not load-bearing, cutting or drilling can take place within 40 mm ($1\frac{1}{2}$ in.) of the stud's depth. If these guidelines are exceeded so as to weaken studs, the studs must be reinforced in an acceptable way.

In some cases, piping must be carried through firewalls or fire separation in floors. There are specific code requirements that govern the treatment of piping that travels through fire-resistance-rated areas. Any piping that penetrates a firewall or fire separation must be sealed so that the wall or floor retains its **fire stop rating**. Fire stop ratings are a classification system that relates to the amount of time a barrier will hold back fire. Piping must be non-combustible or fire-rated thermoplastic piping. Combustible piping requires a fire-stopping system that seals the penetration when the piping melts due to exposure to high temperatures. Metallic piping can have a tendency to transmit heat from fire, so additional considerations may be required.

Fixtures should be located in the bathroom to make their usage comfortable and to not restrict movement. Plumbers should ensure that there is 530 mm (21 in.) clearance between the front of a tub, shower stall, or lavatory and the opposite wall. If another fixture is directly in front of the tub, shower, or lavatory, 450 mm (18 in.) clearance is recommended. Water closets should have 450 mm (18 in.) clearance between it and an opposite wall or fixture and a side clearance of 370 mm (15 in.).

Information Sources

Roughing in plumbing for fixtures is a process that requires accurate information about the:

- Location of existing supply lines and drainage
- Waste and vent lines
- Number and type of different fixtures
- Overall dimensions of a building

Different jobs will have varying amounts of information readily available; plumbers must know how to look for the information they need.

The range of information available to you when you begin a plumbing project depends on the size of the job. On small, single-family dwelling projects, there may be no information beyond an architectural and mechanical drawing and a list of specifications that includes a description of the type and number of fixtures required. Many small projects will have even fewer details available and will require that the plumber make suggestions as to the type and style of fixtures. Plumbers who deal extensively with this type of project should have a catalogue that contains a range of product specification sheets from different manufacturers. In this case, each manufacturer would provide the detailed rough-in information needed, and the plumber would decide on the arrangement of fixtures and the specific location of each one.

For more extensive projects, the plumber may be handed a number of different drawings that provide important information to guide roughing-in. You may only be provided with a set of working drawings when you begin a plumbing project. If piping layout drawings have not been prepared, you will have to gather information from different types of drawings. Large projects may supply:

- Architectural drawings
- Structural drawings
- Mechanical drawings
- Electrical drawings

Architectural drawings are the first source of information for rough-in within a building. They provide the dimensions for each room and identify the arrangement of fixtures. For medium to small-size projects, the architectural drawings contain information about materials, floor plans, and elevations and show details, such as location of drains and exterior hose bibbs and hot and cold water supply lines. Larger projects may have so much information that it cannot fit on one drawing, and separate floor plans or elevation plans may be required.

Structural drawings also help you plan how piping can travel within walls. These drawings identify load-bearing members. Remember that building codes prohibit cutting, notching, or drilling studs and joists in a way that would weaken the structure.

Mechanical drawings show where the supply piping (hot and cold water), drainage, waste, and vent lines travel. The architectural details are removed so that it is easier to see where the rough-in connections for fixtures should be made.

Electrical drawings show the location of all electrical lines and outlets. This information helps ensure that the planned path for piping and fittings does not interfere with electrical lines.

These drawings all provide pieces of information that are critical to accurate rough-in work. However, the plumber may also require more detailed information about the type and size of piping and fittings and how they will travel throughout the structure. An isometric or **piping layout drawing** may be available, or the plumber will have to prepare one from the information supplied by the architect. Piping **isometric drawings**, as shown in Figure 8, also show the connections between piping, the path of travel (both inside the wall and under the finished floor), and where piping will connect to fixtures.

Rough-in dimension heights of trap arms (from finished floor):

KS—19"
 LT—12"
 Lav—18"

Grade 1:50

Notes:

- All 2" and 3" drainage and vent pipes to be cast iron.
- All 1-1/4" and 1-1/2" drainage and vent pipes to be copper.
- Use clevis hangers.
- All piping must be straight and plumb.

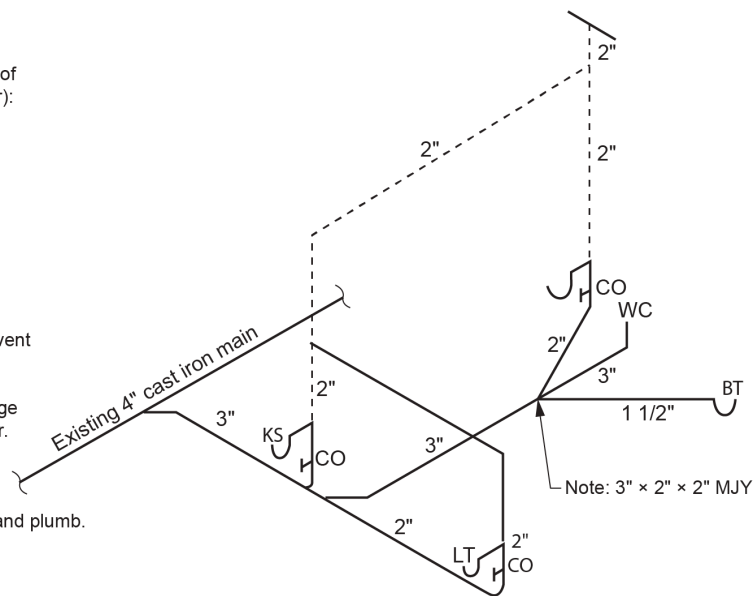


Figure 8 Isometric drawing of a drainage, waste and venting system. (Skilled Trades BC, 2021) Used with permission.

A piping layout drawing provides more detailed information, including piping lengths and exact fitting placements. This information will allow you to create a materials list before rough-in work is done.

Before a complete materials list can be done, you must also calculate the exact location of fixtures and the way they will connect to the supply and DWV piping that travels within the walls. One of the most important sources of information are the rough-in and product **specification sheets** available from the manufacturer.

Rough-in documents contain all the rough-in information required to install a range of fixtures. Figure 9 shows rough-in specifications for a standard water closet. Notice that the plan view and front elevation provide the dimensions necessary to install the closet flange and ensure that the water supply line protrudes through the wall at the correct height and horizontal position. These dimensions are common for most standard styles of water closets; the centreline of the closet flange is approximately 305 mm (12 in.) from the finished wall, and the supply line is located 152 mm (6 in.) to the left of the centreline of the flange.

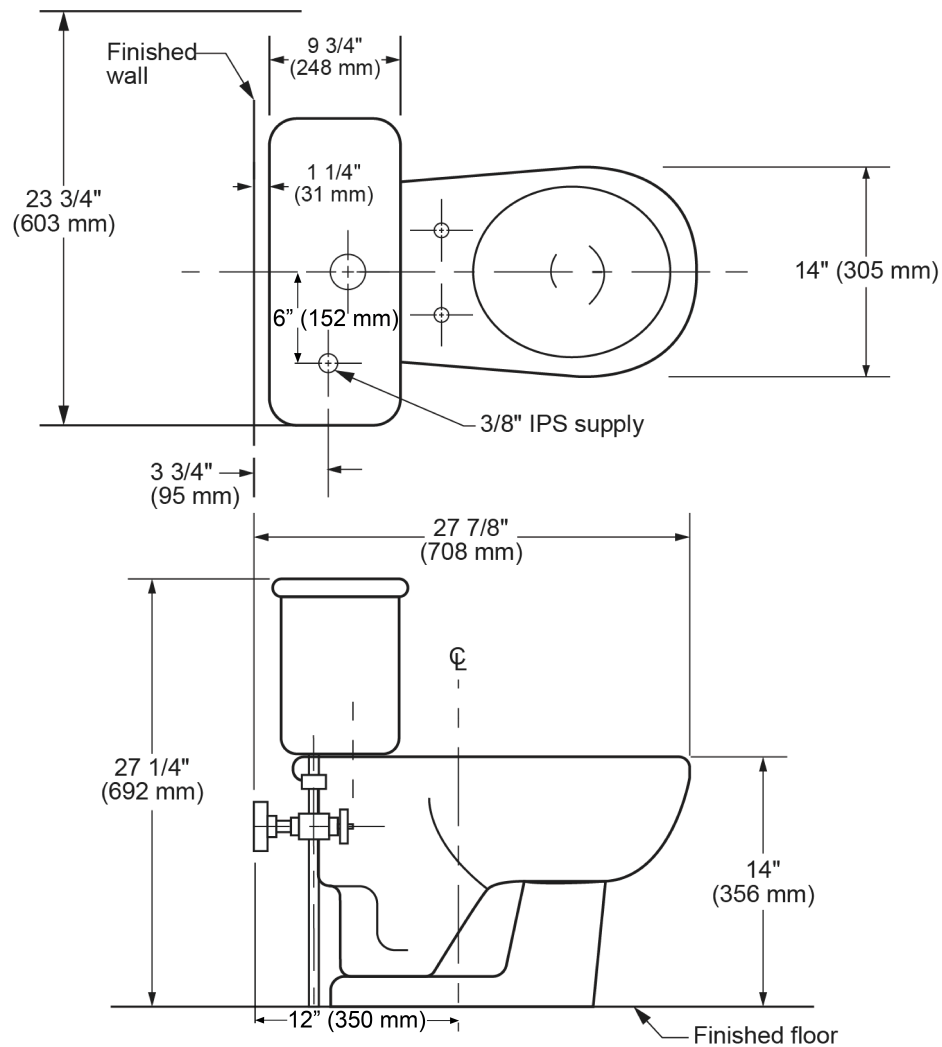


Figure 9 Rough-in information for a water closet. (Skilled Trades BC, 2021) Used with permission.

Never assume that you know the dimensions for rough-in; always refer to the manufacturer's rough-in information because the details may vary slightly for the style of fixture you are installing. Even minor differences in the location of supply connections or drains can result in time-consuming and expensive alterations when installing fixtures.

Figure 10 provides another example of rough-in details available from fixture manufacturers. This wall-hung lavatory is shown in a top view and a front view to illustrate the overall dimensions of the fixture and the exact locations for drain and supply line connections. This sheet also warns of a minor variation in measurement accuracy of plus or minus 7 mm ($\frac{1}{4}$ in.). The plumber must be aware that no published measurements can be exactly accurate, as there will be minor differences in size created during the manufacturing process.

In installations where tolerances are narrow, measure the fixture before rough-in to confirm the dimensions on the **rough-in documentation**.

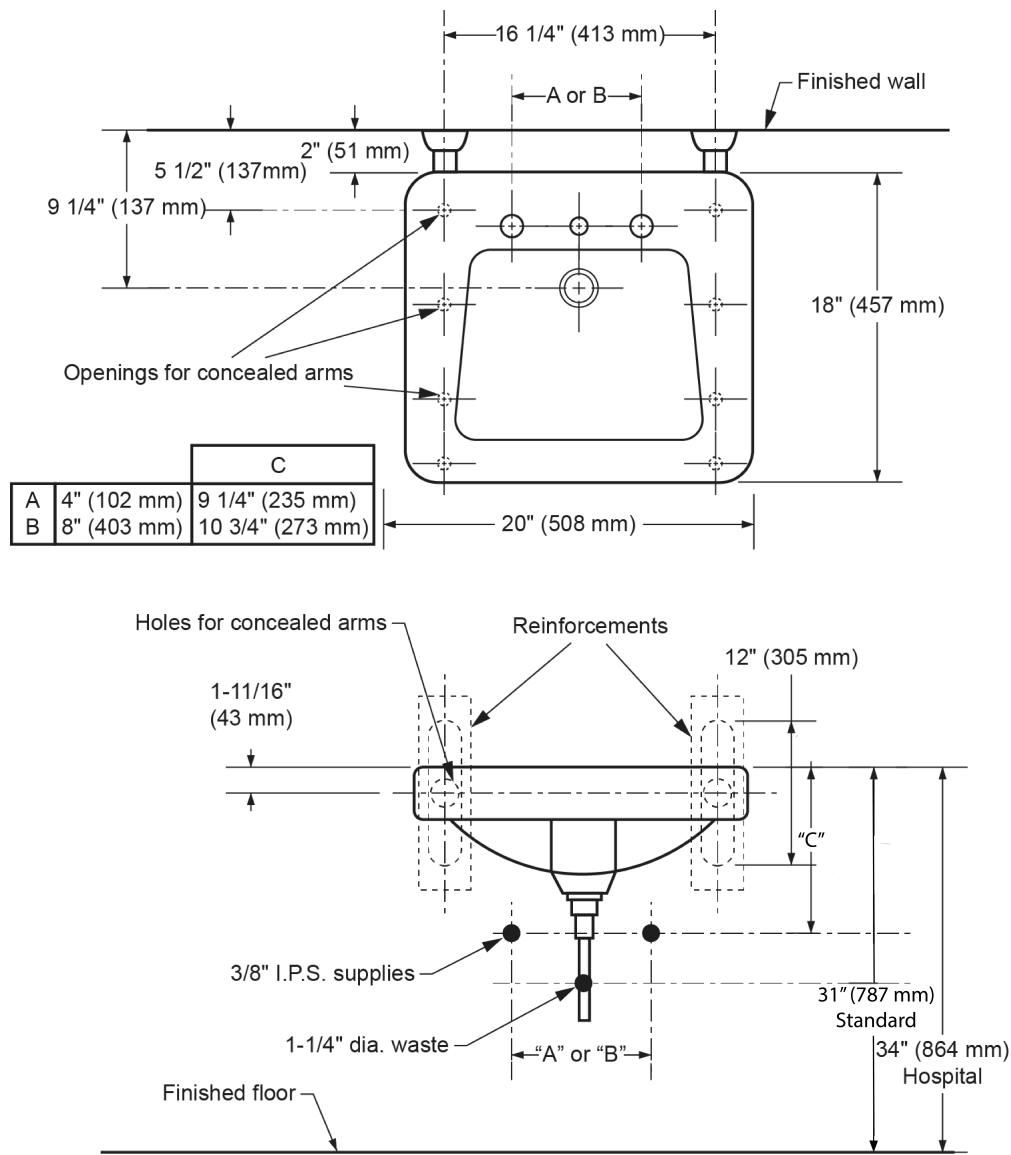


Figure 10 Rough-in information for a wall-hung lavatory. (Skilled Trades BC, 2021) Used with permission.

The wall-hung lavatory in Figure 10 is a model supported by metal arms concealed in the sides of the fixture. This requires the rough-in of carrier supports attached to studs in the wall. The measurement and actual installation of these supports is very important because they must match up to the precast holes in the lavatory. Any error in the measurement and rough-in might mean that the wall would have to be cut open to re-position the supports.

Most rough-in documents from manufacturers provide dimensions measured from the finished floor or walls. The plumber must find out how the walls or floors will be finished so that the difference in dimensions from the subfloor or unfinished wall can be added to actual calculations. For example, a rough-in sheet for a water closet may show the centreline of the drain to be 305 mm (12 in.) from the wall, but the plumber will be roughing in the drain piping when the wall and floor are both unfinished. Therefore, when measuring from the wall behind the floor flange, the thickness of the finished wall must be added. For standard drywall, add 12.7 mm ($\frac{1}{2}$ in.). The drain would be located 318 mm ($\frac{125}{8}$ in.) from the wall studs.

Not all rough-in sheets show the location or size of backing required for fixtures. The plumber may have to measure

the fixture and the distance between wall studs to determine how to size and install backing. Backing requirements for installing fixtures for people with disabilities are usually detailed in building codes, the owner's requirements, and manufacturer's specifications.

Minimum clearances between fixtures and walls are another measurement that the plumber must make before they can complete rough-in work. In the past, the plumbing code regulated the minimum fixture clearances for residential bathrooms. Currently, the only clearance requirements are contained in the building code for accessible washrooms.

Procedures for Finding Rough-in Information

The procedures you follow to collect rough-in information will vary depending on whether you are roughing in supply piping and drainage or waste and vent lines, or doing rough-in for fixture connections. Another factor that will influence the steps you follow is what information you receive when you start a job. Assuming that you are roughing in fixtures on a medium-sized project, complete with project drawings described above, you would do the following:

1. Read the architectural drawing. Make a note of the finish planned for the walls and floors (to estimate finished thicknesses). Look for the number of fixtures planned and their approximate locations, and check if the model and manufacturer of each fixture are identified.
2. Read the mechanical drawing. Look for the path of travel of important supply and DWV piping. If no piping layout or isometric drawings are available, sketch one and mark on it the connections required for fixtures.
3. Review the electrical and structural drawings. Make sure the planned piping connections will not interfere with electrical lines or outlets or require you to weaken supporting members.
4. Locate a manufacturer's rough-in documentation or individual rough-in sheets for the fixtures identified in the architect's information. Check the important dimensions for pipe connections and fixture supports. Measure at the intended installation location to confirm the actual location of connections and that clearances are adequate.



Fixtures are expensive and are not intended to be handled frequently. Take the time to check and verify rough-in dimensions so that you will not have to install and remove fixtures more than absolutely necessary. With accurate measurements, you can avoid breakage or damage to expensive fixtures.

5. Refer to relevant code requirements for rough-in work. Check that your planned piping connections and fixture supports will not conflict with any regulations.



Check with your local plumbing inspector for any special requirements for rough-in inspections. The Authority Having Jurisdiction (AHJ) has the final word regarding the acceptance of plumbing fixture installations.

As a plumber, you are responsible for ensuring that the backing for each fixture provides adequate support (Figure 11). Even when other tradespeople install this backing, you must verify their work and ensure that the backing will support the fixture you plan to install. You are ultimately responsible for this.

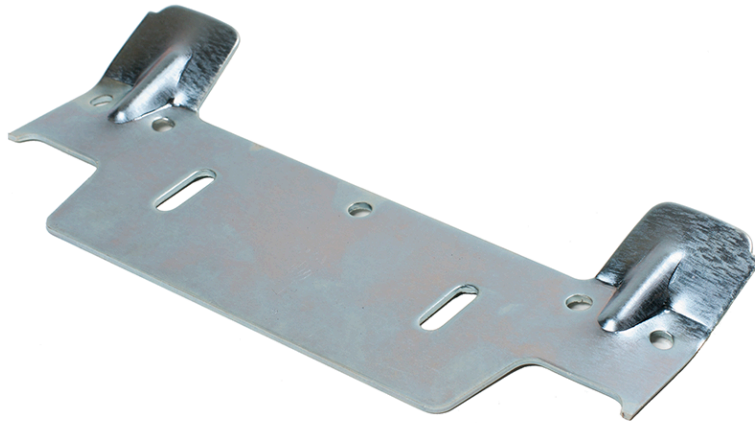


Figure 11 Support for wall-hung lavatory. (Skilled Trades BC, 2021) Used with permission.

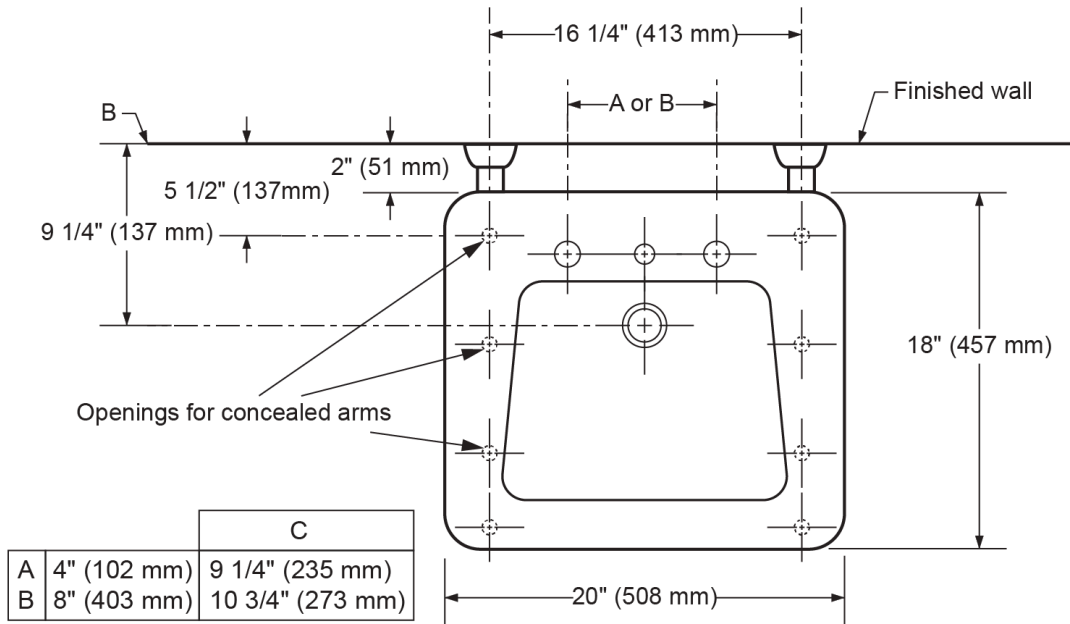
Installing Bathroom Fixtures

Most bathrooms have at least three fixtures: a lavatory, a bathtub and/or shower, and a water closet. The arrangement of these fixtures and the style and colour of each are decided by the owner and/or architect. Architects first visualize what they want to achieve; they decide what the bathroom should look like to suit the owner's needs and personal tastes. From this visualized design, architects prepare detailed drawings that other tradespeople use to actually construct the finished bathroom.

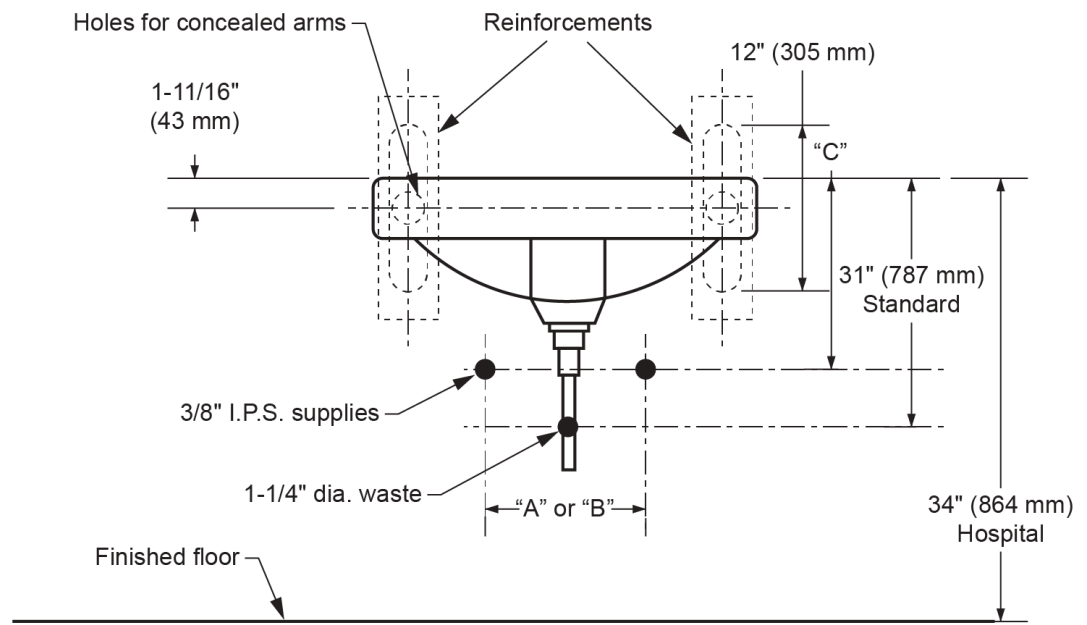
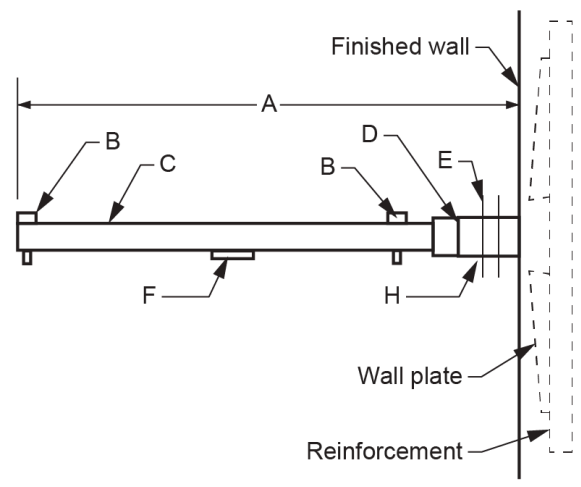
For example, if an architect decides that the lavatory should be placed 1 m (3 ft) from the far wall of a bathroom, this could affect three tradespeople. The carpenter may need the location and dimensions of the fixture to prepare a recessed area for the medicine chest. The electrician would use the same information to determine where to place wiring and outlets. The plumber must connect to water supply lines and make sure that drain and vent connections are appropriately placed.

Wall-hung lavatories are supported by different styles of metal brackets or supports bolted to the finished wall. A wooden backing is installed by bolting it to studs inside the wall. Heavy, long screws are used to attach the fixture support brackets through the finished wall to the backing boards. The board must be large enough to accept the support bracket screws and the screws used to secure the fixture. The rough-in sheets should show the location of all fastening screws. They prevent the lavatory from being easily lifted off the supporting bracket after final installation.

When wall-hung lavatories are designed for use by people in wheelchairs, they generally require arm carriers securely bolted to support plates installed in the wall. Figure 13 shows a typical support for plates, the carrier arms, and the rough-in details of the lavatory. The plates must be precisely aligned or the carrier arms will not fit into the holes cast into the sides of the lavatory.



Support	A	J	
		min.	max.
C-1198	15 3/4" (400 mm)	1 1/4" (32 mm)	2 1/2" (64 mm)
C-1199	17 1/4" (438 mm)		
C-1201	14 1/2" (368 mm)	2 1/4" (57 mm)	
C-1202	15 3/4" (400 mm)		



Note: For installation instructions of concealed arms refer to page 8
 Important: Dimensions may vary plus 1/4" or 7 mm and are subject to revision

Figure 13 Lavatory to be supported by carrier arms. (Skilled Trades BC, 2021) Used with permission.

All measurements for installing hangers and backing for lavatories should be done carefully. Most lavatories are manufactured from vitreous china and are very expensive. They are not designed to be lifted on and off supporting brackets frequently; if handled too frequently or roughly, they will break or crack. Careful attention to measurements and installation of supporting brackets and backing will ensure that expensive fixtures do not have to be replaced.

If you are installing a countertop basin, a carpenter will likely install the countertop. The countertop must be mounted at the correct height and attached securely to backing in the wall or supported by a floor-mounted cabinet. Some countertops are precut for the fixture; others must be cut to fit the basin. The manufacturer may supply the template, or the plumber or carpenter may have to trace the contours of the actual fixture. To trace a basin, place it upside down on the countertop and draw a line around its perimeter. Remove the basin and draw a second line at a specified distance inside the first line, usually about 13 mm ($\frac{1}{2}$ in.). This ensures that the basin will rest on a lip of the countertop. The cut is made on the inside line.

Water supply stubs should have the caps removed, and the pipe should be cut to the desired distance from the finished wall. Most bathroom basins use **angle stops** screwed onto the supply stub or connected with a **compression fitting** with a hexagonal nut and ferrule. The supply lines from the angle stops to the faucets are connected after the basin is installed.

Faucet assemblies come in many different configurations. Most can be adapted to fit the basin design.

Installing Faucets

You may install faucet fittings and pop-up drain assemblies before or after hanging the basin on wall supports or placing it in the countertop. Some plumbers find it easier to do as much pre-assembly as possible to reduce the amount of work that must be done underneath the basin or in a confined space. They hang the basin with the trim installed and hook up the water-supply tubing and drain piping last.

Manufacturers supply detailed installation instructions for each style of faucet. The following steps outline a general procedure to install a common model, single-handled, centre-set basin faucet (Figure 14):

1. Place the **gasket** under the faucet body. Turn the faucet over and align it with the holes in the basin. Clean off any excess putty.
2. Insert the faucet supply tubes and threaded attachment stud through the hole in the basin. Make sure that the gasket is properly seated and that the lift rod for the **pop-up drain assembly** is in place and operating freely.



Figure 14 Faucet body, supply tubes and attachment studs.
(Skilled Trades BC, 2021) Used with permission.

3. From the underside of the basin, place the retainers (or washers) on the attachment studs until they meet the basin. Thread the **locknut** onto the attachment stud and tighten it by hand until it holds the faucet firmly in place.
4. Holding the inlet tubing out of the way, use a wrench to tighten the locknut completely (Figure 15). The water supply tubing will be connected later.

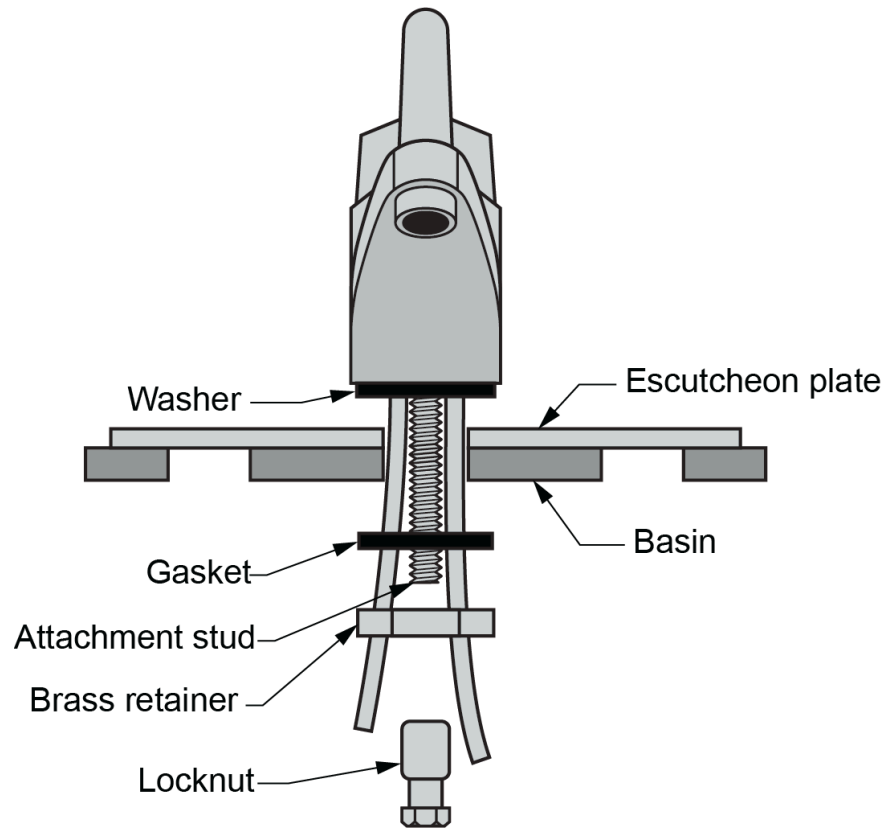


Figure 15 Secure fitting to basin with locknut. (Skilled Trades BC, 2021) Used with permission.

Installing Pop-Up Drain Assemblies

The following procedure describes the basic steps to install a mechanical pop-up assembly supplied with the faucet fitting described above. Always follow manufacturer's directions for the type of faucet and pop-up plug assembly you are installing.

1. Apply a bead of **plumber's putty** or silicone sealant under the edge of the drain plug flange (Figure 16). Insert the drain plug fitting into the drain hole in the basin.



Figure 16 Insert drain plug fitting. (Skilled Trades BC, 2021) Used with permission.

2. Hold the drain plug fitting firmly in place with one hand. With the other hand, place the gasket, washer, and locknut onto the threaded end of the plug. Tighten the locknut firmly by hand (Figure 17).
3. Turn the drain plug until the pivot rod of the mechanical coupling is pointing toward the back of the basin. Tighten the locknut completely. You may use a large hexagon wrench, spud wrench, or adjustable wrench. Never use a pipe wrench to tighten the locknut because it may mark the surface of the fixture. Be careful not to overtighten, as this can chip or break the fixture.



Figure 17 Install lower gasket, washer and locknut. (Skilled Trades BC, 2021) Used with permission.

4. Clean any excess putty that has been squeezed out from under the plug. Drop the stopper into the drain plug opening. Tighten the bushing on the mechanical coupling (Figure 18) until the pivot rod is snug but movable.

Depending on the outlet fitting design, there may be additional teflon washers required on either side of the ball to help it seal.



Figure 18 Install pivot rod. (Skilled Trades BC, 2021) Used with permission.

5. Clip the pivot rod to the perforated extension rod in the hole closest to the end of the pivot rod. Squeeze the clip gently; make sure that the clip slides easily onto the rod (Figure 19).
6. Move the pivot rod so the stopper/plug is in the open position; the horizontal rod should point down wards (away from the basin top).



Figure 19 Squeeze clip gently. (Skilled Trades BC, 2021) Used with permission.

7. Adjust the lift rod so that the stopper operates smoothly. When the lift rod is pushed down to the surface of the fitting, the stopper should be fully open. Pulling the lift rod to its furthest upward position should cause the stopper to seat tightly in the basin drain hole.

8. After the pop-up assembly has been installed, the final drain connection can be made.

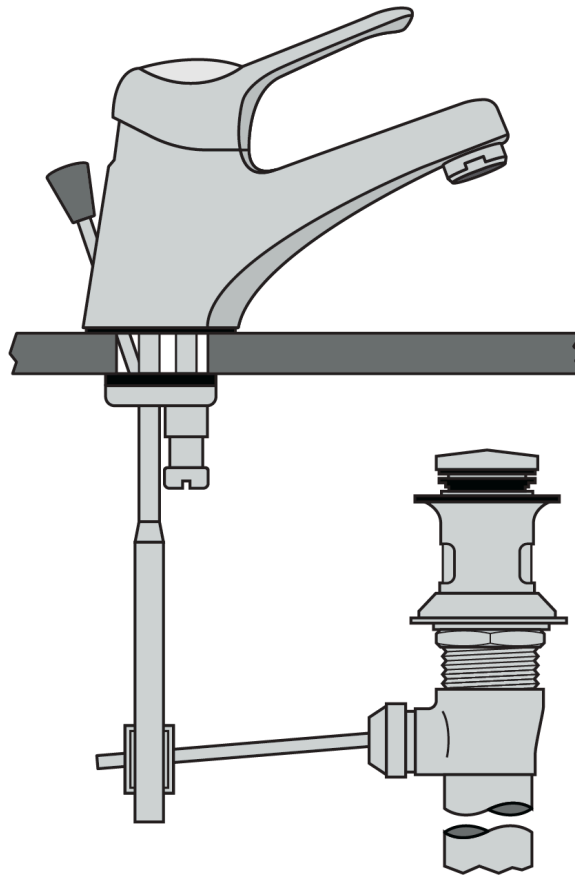


Figure 20 Faucet and pop-up assembly. (Skilled Trades BC, 2021) Used with permission.

Securing the Basin

Depending on the method you choose for installation, you may now have to secure the basin before making the final water supply and drainage connections.

For a wall-hung basin, slip the basin gently onto the hanger. Check that the basin is level and positioned correctly in relation to the supply and drain connections. When you are sure that the position is accurate, secure the basin to the wall using the holes cast into the bottom of the fixture.

If the basin is a **pedestal** style, connect water supply and drain piping, then slide the pedestal into place gently. It should fit the contours of the bottom of the basin exactly and hide the trap, drain, and supply piping. Seal the seam between the basin and pedestal with silicone.

For a countertop basin, slip the basin gently into the prepared opening. If the basin is an old style with a metal rim, run a bead of plumber's putty under the rim to seal the ring to the countertop. Some basins are clamped to the countertop with hidden screws.

Plumber's putty should not be used to seal trim to countertops or basins made of synthetic marble because it causes staining. When working with synthetic marble, use **silicone caulking** to seal joints and seams.

Some countertop basins are “**self-rimming**,” which means that they are supplied with a rubber gasket under the rim of the basin and do not require the use of silicone. The gasket has an extra strip that protrudes beyond the edge of the basin that helps hold the gasket on until the basin is installed. After you have installed the basin, peel away this extra strip to leave a clean, professional finish.

Making Final Connections and Testing

1. Gently bend supply tubes or flexible hoses from the faucet fitting to meet the supply stops. Usually supply tubing is attached to the supply stops with compression fittings. Supply tubes use a compression nut and ferrule supplied with the stop, whereas the flexible hoses come complete with a connection nut and internal rubber washer.
2. Make sure you connect the hot water supply to the left inlet tube (when you are facing the basin). Connect the cold water supply to the right inlet tube.
3. Connect drainage piping. Insert the threaded end of the fixture outlet pipe into the lower end of the mechanical coupling.
4. Connect the lower end of the fixture outlet pipe to the inlet of the basin trap. Most traps are connected with slip-type fittings. Then, connect the trap outlet to a trap arm long enough to connect to the waste pipe stub at the finished wall (Figure 21).

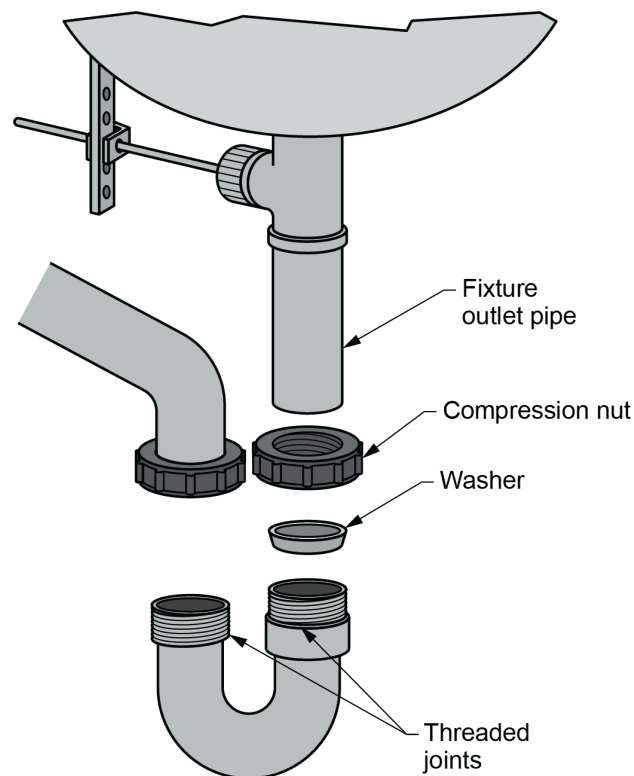


Figure 21 Connected P-trap to drain piping. (Skilled Trades BC, 2021) Used with permission.

5. Test your connections by moving the faucet control lever to the right and turning on the cold water supply stop. The water flowing from the faucet should be cold. Turn off the cold water supply and move the control to the left. Turn the hot water supply on and check the temperature of the water.
6. Ensure that the aerator is in place and turn both stops on. Test the general pressure control and temperature regulation of the faucet mechanism. The spray from the faucet spout should be fine, even, and have adequate

pressure.

7. When the water is flowing smoothly, plug the basin and let it fill with water to within 50 mm (2 in.) of the flood level rim.
8. Turn off the faucets and check for leaks at the supply stops and where supply tubing connects to the faucet under the basin.
9. Check that the overflow is draining the sink properly. Make sure the pop-up assembly is working smoothly. Look for leaks in the drainage piping.

Installing Bathtubs and Showers

A standard enamelled steel or fibreglass-skirted bathtub set into a recess in the wall requires supports along the entire back side of the tub (Figure 22). Some manufacturers suggest nailing short blocks of wood to wall studs at the appropriate height to support the lip of the tub. This system helps eliminate any shrinkage between the edge of the tub and the wall tile.

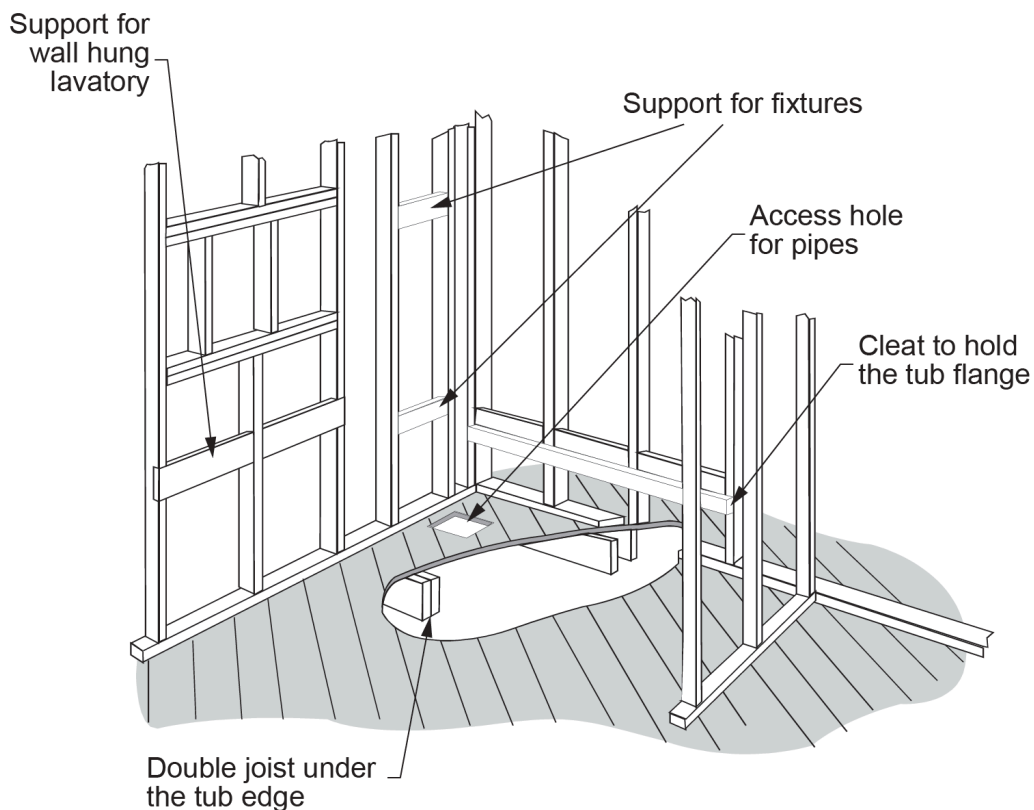


Figure 22 Bathtub supports. (Trades Training BC, 2021) Used with permission.

The bathtub is supported by horizontal and vertical members. A horizontal ledge, formed by pieces of stud fastened to wall studs, supports the bathtub and fits the integral clips on the bathtub lip. Measure the height of the horizontal ledge from the subfloor, and the height of the vertical supports from the top of the horizontal ledge to the subfloor. Vertical and horizontal supports must be checked with a level.

Some types of jetted tubs and whirlpool baths require continuous support from a **mortar base** under the entire bottom

of the tub. Manufacturers will supply recommended support specifications, and these must be followed, or the warranty of the fixture will be voided.

Information about the required location of backing and its dimensions is taken from the manufacturer's rough-in drawings. Most showers require a backing to which the **wing back elbow** can be secured. This fitting has an iron pipe connection end to which a short nipple is attached while rough-in is completed. When the wallboard is attached and the fixture is installed, the nipple is removed, and a shower arm or faucet spout is screwed in. In larger installations, the architect's specifications should also be consulted because special fixtures or placement of components may be required.

The drain piping and trap under the floor should be ready for final connections. An access hole large enough to accept the bathtub drain should have been cut in the flooring. Generally, these slots are 150 mm (6 in.) wide by 305 mm (12 in.) long. The 150 mm (6 in.) end will be centred on the centreline of the drainage piping.

Diverter valves, mixing valves, and faucet bodies hidden by the finished wall should be in place. The **shower pipe riser**, shower arm fitting (**drop ear** or wing back), and tub spout elbow and nipple connection should be in place. The tub filler and diverter connections inside the wall are most commonly centred in line with the bath waste and overflow.

To install a standard rectangular, right-hand or left-hand outlet recessed bathtub and shower, do the following:

1. Check that all rough-in details have been completed and located accurately.
2. Connect the overflow and waste assembly (Figure 23) to the tub. Remember to put plumber's putty or silicone sealant under the drain plug fitting to seal it to the tub drain hole. Also, make sure to check the fit of the **overflow gasket** onto the back of tub overflow opening. Because of the angle, this fit-up can fail if not aligned properly. Follow the detailed instructions for the type of waste and overflow fitting you are installing.
3. Move the tub into position. Slide the tub into place so that the **back lip** is supported by the horizontal support ledge. Make sure the tabs are hooked behind the horizontal supports and the tub has a minimal slope to the back lip.
4. Bathtubs should have a **perimeter lip** or tiling flange that extends behind the finished wall. This flange should be clipped to studs in the wall. When the wall is finished, the wallboard and tile or acrylic/fibreglass panels will cover the flange.

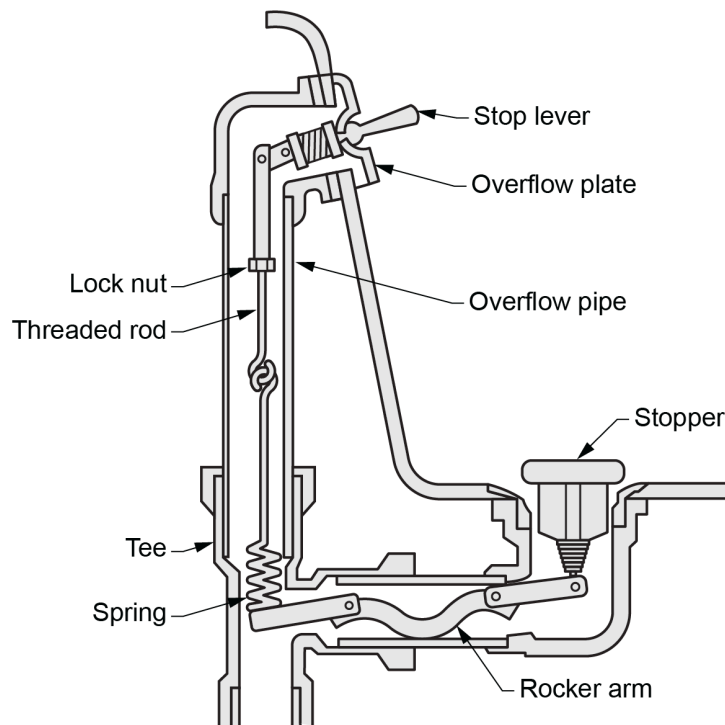


Figure 23 Mechanical waste and overflow assembly. (Skilled Trades BC, 2021) Used with permission.

5. Attach the bathtub and shower controls, escutcheons and spouts after the final wall finish is applied. Some faucet assembly styles will only have a central control lever and escutcheon, a diverter control, and the shower and tub filler spouts. Other styles will have separate handles for hot and cold water and a central diverter control. Follow the detailed manufacturer's directions to install all fixture trim.
6. After the drainage system has been tested, inspected, and approved, connect the bathtub drain. Connect the $1\frac{1}{2}$ in. (38 mm) fixture outlet pipe of the waste and overflow fitting to the inlet of the P-trap below the bathtub (Figure 24).

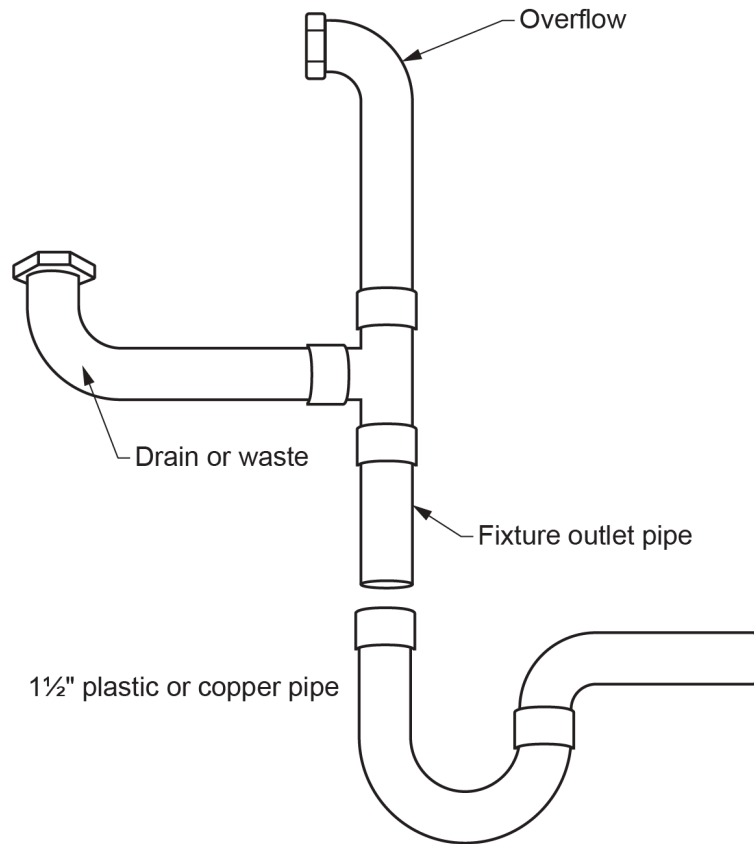


Figure 24 Bathtub connections to the drainage system. (Skilled Trades BC, 2021) Used with permission.

7. Plug the tub outlet and fill the bathtub with water so that the water level is higher than the overflow. Allow the water to flow out of the overflow.
8. Check that there are no leaks in the overflow.
9. Drain the tub and check that there are no leaks in the drainage piping.

Installing Water Closets and Urinals

The closet flange is essentially the only support for a floor-mounted water closet (aside from the floor itself). The measurement to locate a water closet flange should be taken from the rough back wall to the centreline of the final location. Remember to allow for the final thickness of the wall finishing (drywall, plaster or wall tile) when using the dimensions given on rough-in sheets.

Figure 25 shows rough-in information for locating a closet flange and installing a water closet. Notice that the closet flange dimensions and water closet dimensions are shown from the finished wall.

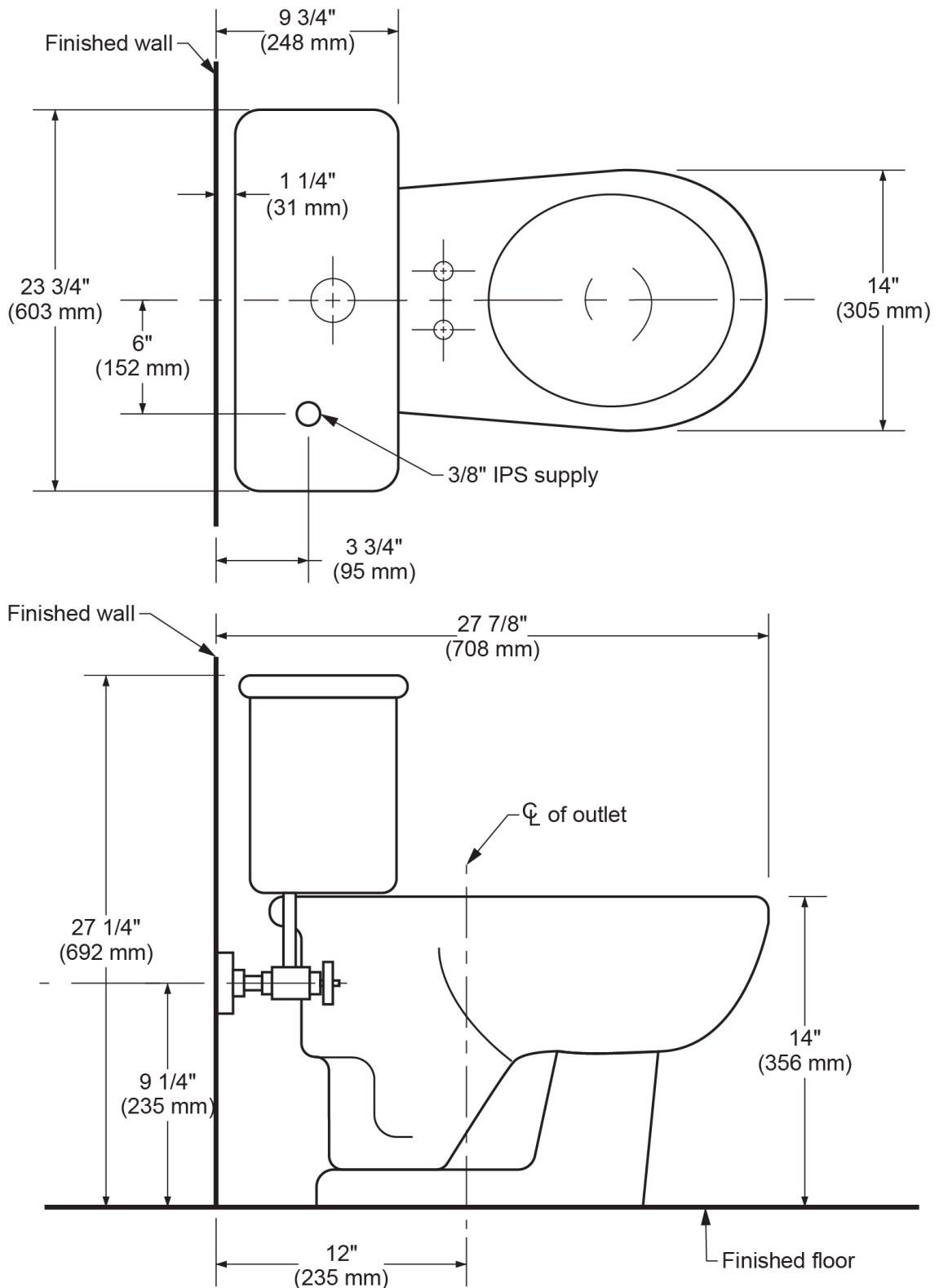


Figure 25 Locating a floor flange. (Skilled Trades BC, 2021) Used with permission.

The waste piping should have been roughed in to the point where the floor flange can be installed at the location

indicated on the rough-in drawing. The flange is attached to the drain piping and bolted to the floor. Code requirements specify the type of material that the flange and screws are to be made of.

Wall-hung water closets require support from chair carriers (Figure 26) similar in design to the arm carriers used to support some lavatories. Chair carriers provide steady support to the fixture and prevent any weight from resting on drain piping, the wall, or the wall flange. Detailed specifications for installing chair carriers are provided by each manufacturer.

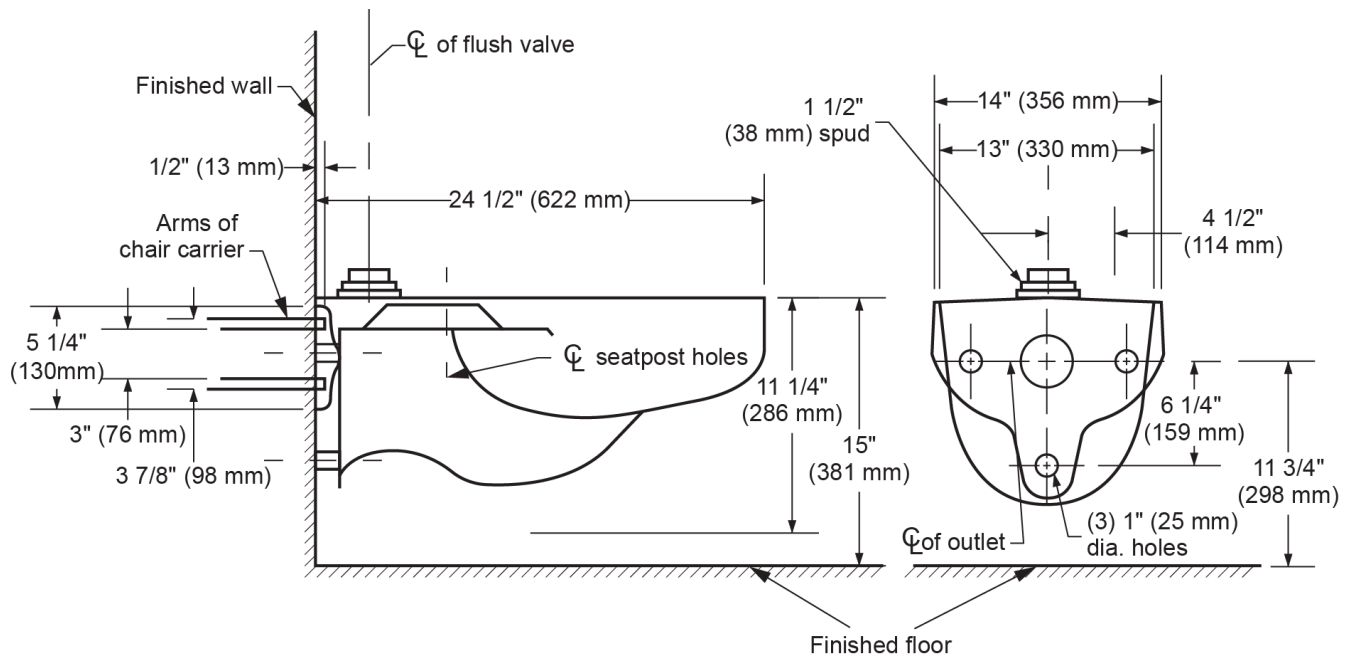


Figure 26 Wall-hung water closet. (Skilled Trades BC, 2021) Used with permission.



Figure 27 Supports for a wall-hung urinal. (Skilled Trades BC, 2021) Used with permission.

Installing a Floor-Mounted Water Closet

The rough-in work for the water closet should be complete before installation. The closet flange should be secured to the floor and connected to drainage piping. The supply piping should be available at the correct location. In new construction, the finished flooring is always installed before the water closet.

Install a standard supply stop. The cold water supply to the toilet tank is generally connected to a $\frac{1}{2}$ in. (13 mm) copper or PEX supply pipe with a $\frac{3}{8}$ in. (9.5 mm) flexible tube or hose. The stop is mounted 150 mm (6 in.) to the left of the centreline of the water closet and about 150 mm (6 in.) above the finished floor.

The steps to install a water closet are:

1. Slip the heads of the two closet bolts into the slots in the closet flange. Centre them on each side of the flange at equal distances from the rear wall. (This step may have been completed during rough-in.) Closet bolts must be made of brass or plastic.
2. Place the water closet onto the closet flange, and check that it is level. Gently try to rock the bowl. If it rocks even slightly, shim the fixture until it is stable. A slight wobble can eventually break the seal between a water closet and the closet flange.
3. Remove the test plate from the closet flange. Install a wax ring or gasket on the closet flange on the floor or on the horn of the closet. (Some wax seals have a plastic sleeve called a horn that extends from the bottom of the closet outlet into the opening of the closet flange.) The wax ring should stand at least 19 mm ($\frac{3}{4}$ in.) higher than the finished floor.
4. Lower the fixture onto the closet flange (Figure 28). Rock the bowl gently to squeeze out and distribute the wax.



Figure 28 Placing toilet. (Skilled Trades BC, 2021) Used with permission.

5. Cap the brass closet bolts. Drop metal closet washers over the bolts and tighten nuts to hold them in place (Figure 29). Cut the bolts shorter and place caps over the bolt ends.



Figure 29 Tighten nuts. (Skilled Trades BC, 2021) Used with permission.

6. If the water closet is a one-piece type with a moulded water tank, simply attach the water supply tubing or hose. For a separate, close-coupled tank, install the large, formed sponge rubber “tank to bowl” gasket over the threaded outlet on the bottom of the tank, and insert the tank mounting bolts complete with sealing washers in through the top of the tank (Figure 30). Lower the tank onto the bowl so that the tapered end of the gasket fits evenly into the bowl water inlet opening, and the tank mounting bolts go through the mounting holes in the bowl. Secure the tank with washers and nuts, ensuring that the tank is parallel to the wall. Tighten the nuts alternately until the tank contacts the front and back of the bowl, making china-to-china contact.

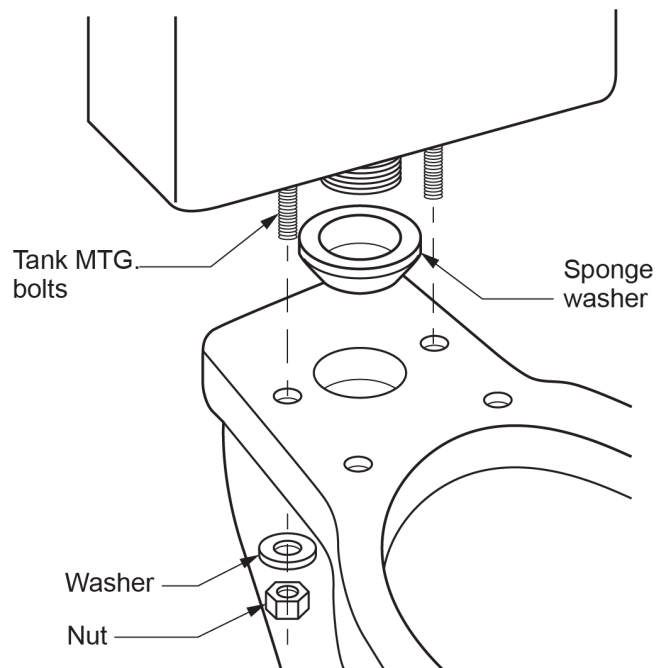


Figure 30 Close coupled tank. (Skilled Trades BC, 2021) Used with permission.

7. When the water supply is hooked up and the tank is in place, test the water closet for leaks.
8. Hold the ball-cock in the closed position and turn the water supply stop so that water is supplied at full force.

Check for leaks at the stop and at the connection to the tank. When you are sure the water supply is free of leaks, install the toilet seat.

Backing for Bathroom Accessories

Bathroom accessories may be attached to the finished wall with toggle bolts, or they may require additional backing. Shower curtain rods, toilet paper holders, soap dishes and dispensers, and towel bars will be more secure if attached through the finished wall to backing boards. Grab bars or handrails must be securely bolted to backing that is sufficient to support a person's weight and any expected pull forces that may be imposed upon them (Figure 31).



Figure 31 Bathroom grab bar. (Skilled Trades BC, 2021) Used with permission.

Installing Sinks

Sinks may have one or two compartments and use different configurations of faucets and drains. Some sinks are self-rimming and are sealed or clamped directly onto the countertop. Others require a metal frame called a sink rim that is attached to the sink then clamped to the counter. Undermount sinks are very popular, and their installation is a little more complicated, as they require a structure strong enough to support the weight of the sink filled with water. Mounting methods can include epoxied clips, rail systems, brackets, or wood support frame. Faucets may be installed in a back rim or in countertop holes.

Mounting Sink Faucets

Templates or exact dimensions for cutting countertop holes for faucets are usually supplied by the manufacturer. If they are not, follow the tracing procedure described in the previous description of installing lavatories. Due to the many different specialty countertop materials, the cabinet and/or countertop suppliers often prefer to cut the holes and even mount the sink.

If the sink has no ledge and the faucets mount directly into the countertop, install them before mounting the sink in the countertop. Otherwise, perform the following steps after installing the sink.

To install standard kitchen faucets (with no spray attachment), do the following:

1. If the faucet body does not have a sealing gasket that rests between the faucet and the deck of the sink, apply plumber's putty or silicone caulking before inserting the body into the sink holes. This will prevent water from leaking from the sink deck into the cupboard below.
2. If you are installing a single-control centre-set faucet design, run a bead of putty under the escutcheon plate and attach it to the sink deck.
3. Push the faucets through the ledge. Rock the faucets gently back and forth to compress any putty and seat the faucets.
4. If you are installing a single-control faucet, slide the unit and supply tubing through the hole in the escutcheon plate and sink ledge.
5. From under the countertop, place a washer and locknut onto each faucet body and tighten by hand. If you are installing a single-control faucet, tighten a single large washer and locknut onto the underside of the sink deck (Figure 32).
6. Tighten each locknut with a basin wrench or adjustable wrench. Apply tension alternately to one and then the other. This will pull the faucets tightly and evenly against the sink edge or countertop. Make sure that faucets stay centred and in line with the sink edge.
7. Attach water supply tubing to faucets.



Figure 32 Installing a single-handle kitchen faucet. (Skilled Trades BC, 2021)
Used with permission.

Installing Sink Strainers and Fixture Outlet Pipes

Most kitchen sinks have a centred outlet hole that is about 150 mm (6 in.) in diameter. A metal drain with a $1\frac{1}{2}$ in. (38 mm) fixture outlet pipe is seated in the hole and connected to the inlet of a standard $1\frac{1}{2}$ in. (38 mm) P-trap. Kitchen sinks also have a basket-type strainer that sits in the metal drain opening to prevent pieces of food from entering and plugging drain piping.

To install a standard basket-strainer drain and fixture outlet pipe:

1. Place a bead of plumber's putty, silicone sealant, or thin rubber gasket around the underside of the strainer flange (Figure 33). Insert the strainer body into the sink outlet opening from above.

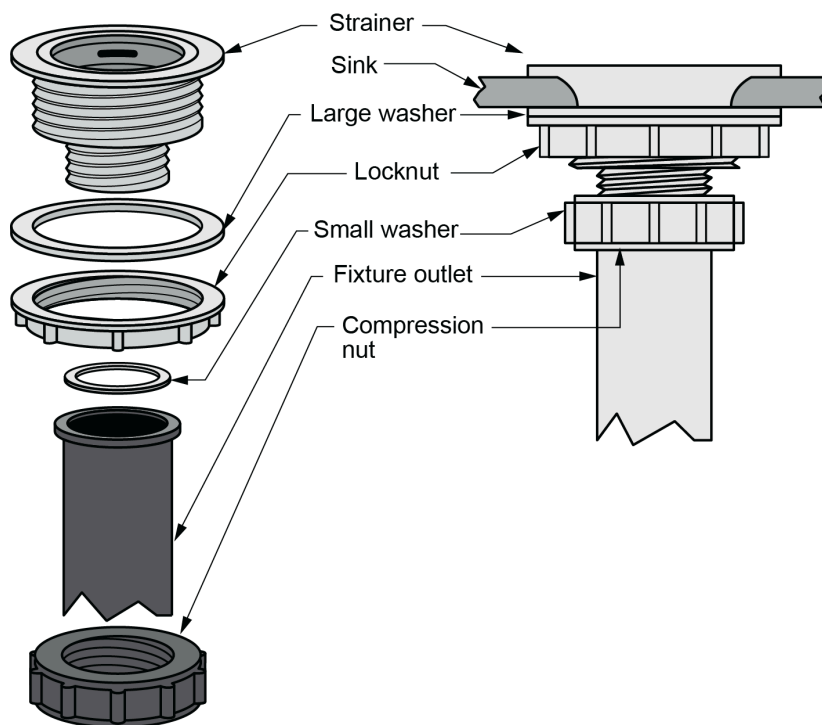


Figure 33 Kitchen sink basket strainer and drain assembly. (Skilled Trades BC, 2021)
Used with permission.

2. Install a large rubber washer from under the sink, sliding it over the portion of the drain that protrudes under the sink. A friction washer is used to hold the washer against the sink and to stop the locknut from binding onto the rubber washer.
3. Tighten the locknut on the fixture outlet pipe until the rubber washer (or metal friction washer) is compressed against the sink. This will also pull the flanged lip of the drain against the sink outlet, distributing the putty and sealing the edges. Some plumber's putty will be visible near the sink outlet.
4. Remove any excess putty with a paper towel.
5. Place a flared plastic washer into the opening of the flared chromed fixture outlet pipe. Connect the $1\frac{1}{2}$ in. (38 mm) fixture outlet pipe to the bottom of the strainer drain. Put a slip nut on the fixture outlet pipe, slide a $1\frac{1}{2}$ in. (38 mm) washer on and then tighten the slip nut to connect the tubing ends.

Installing Sinks and Connecting Piping

With the faucets installed and the strainer drain and fixture outlet pipe in place, you can mount the sink in the countertop. All sinks must be sealed so that water cannot seep underneath. As previously mentioned, undermount sinks are often mounted by the countertop supplier.

Some drop-in sinks have sealant applied by the manufacturer. If not, run a bead of silicone sealant under the lip of the sink before it is installed.

To install a drop-in sink:

1. Turn the sink upside down and run a bead of sealant along the edge flange of the sink that will rest on the countertop. If you are installing a stainless steel sink, you may prefer to put sealant around the cutout in the countertop and then place the sink on it.
2. Centre the sink in the cutout hole and press it down gently onto the countertop. If the sink must be held in place with clamps, gradually tighten the clamps. Apply pressure evenly and be sure not to overtighten. The fixture should be held tightly and evenly on the countertop.
3. Use paper towels to remove any excess sealant that has been forced out along the perimeter of the sink. If possible, allow the sealant to set fully before completing your installation. This prevents the sink from shifting.
4. Connect the water supply lines to the faucet stops. Hot and cold water supply lines are usually joined by compression fittings.
5. Connect the fixture outlet pipe to the P-trap and drain piping. For a two-compartment sink, a continuous waste should be connected to the fixture outlet pipe and the trap with $1\frac{1}{2}$ in. (38 mm) slip nuts and bevelled washers.

The procedures for testing the sink for leaks and proper faucet and drain operation are exactly as outlined for testing lavatories.

Installing Laundry Trays (Laundry Tubs)

Laundry trays may have one or two compartments. They have support legs and/or may be hung from supports on the wall. Installation usually consists of slipping together component parts (in some models) and attaching the fixture to studs or a wall backing with bolts (Figure 34).



Figure 34 Installing a laundry tub. (Skilled Trades BC, 2021) Used with permission.

Faucets, drains, and fixture outlet pipes on laundry trays are similar to those for kitchen sinks. Faucets can be deck-mounted on brackets attached to the fixture or anchored to the fixture's vertical backsplash. Drain fittings and fixture outlet pipes are $1\frac{1}{2}$ or 2 in. (38 or 51 mm) in diameter, and outlet drains are installed in the same way as the basket strainer drains found in kitchen sinks. Drains on laundry tubs usually have a cross-piece of metal slightly recessed in the mouth of the drain to prevent large pieces of dirt or debris from entering the drain. A rubber stopper may be used when the trays are to be filled with water. Test the laundry tray the same way you tested lavatories and sinks.

Uncrating and Checking Fixtures

Check the condition of plumbing fixtures as soon as you receive them at the work site. Although care is taken when packaging expensive fixtures, damage may occur during transport. If you find scratches, defects, or breaks, make a note on the packing slip and invoice at the time of delivery. Notify the shipping company or the manufacturer immediately to ensure that replacements arrive quickly.

Fixtures that are not installed immediately should be stored in their packing crates. Manufacturers often mark the position in which the crate should be stored. When you are ready to install the fixture, move the crate to the job site and unpack the fixture.

Although fixtures are strong, they are easily damaged if handled roughly or too frequently. Protect the finish of each fixture during the entire installation. Lay down cardboard or other protective material on the floor. Uncrate the fixture and place it on the protective floor covering. Check it carefully just before installing to ensure that no damage has occurred. Any damage must be reported to a supervisor immediately.

The packing frame for heavier fixtures, such as bathtubs, may be saved to use after installation. Because tubs are installed during the rough stages of construction, they must be protected from damage as building continues. Plumbers often like to re-attach bathtub frames and packaging after the tub is installed to protect the fixture until it will be used by the owner.

Installation Hazards

Take new plumbing fixtures out of packing crates carefully. Crates may be fastened with wire that can injure workers if the tension on the wires is released suddenly. Packing staples are a hazard when fixtures are packed in heavy cardboard boxes. Staples are sharp and long and can cause painful cuts or punctures as well as damage to the fixtures. The tools used to unpack fixtures can also present a hazard if handled incorrectly. Sharp knives or cutters must be handled with care.

Muscle strain is an ever-present hazard when handling heavy fixtures. Lifting incorrectly or lifting too much weight can cause disabling injuries. Most workplaces have information available about back safety and proper lifting procedures. Knowledge of safe methods can prevent most of these injuries. If you cannot find this information at your workplace, contact WorkSafeBC.

When installing fixtures and connecting trim, plumbers are often on their backs or working above their heads. Whenever you have to work below a fixture or piping, there is always a chance that material can fall and cause injuries to your eyes or face. You may be soldering piping or using toxic solvents. If safe procedures are followed and adequate ventilation is provided, the chances of injuries from burns or chemicals will be minimized.

You will often work on scaffolds, ladders, or other platforms. The danger of injury increases when safe working procedures are not followed. All working platforms should be properly positioned and secured.

Tools, such as wrenches and pipe cutters, can also present hazards if used improperly. Unused pipes, fittings, or fixture components left unorganized around a work site can present problems. Proper precautions and safe working habits can prevent many of the common injuries that occur at work.

Customer Relations

Fixtures are expensive and may be easily damaged if handled roughly. Even after installation, fixtures should still be protected. Bathtubs and showers are often installed in the early stages of construction, and there is a greater chance that they will be damaged. Cover fixtures with cardboard, cut from packing cartons.

Before leaving an installation, thoroughly inspect all fixtures and test their operation. Make sure hot and cold water runs freely, supply pressures are adequate, and each fixture drains quickly and completely. Clean the work areas and the fixtures thoroughly to leave a more professional appearance. Have the owner or general contractor inspect the fixtures for damage or flaws.

Damage done after that time is not the responsibility of the plumber. Take the time to explain the operation of any unusual controls to the owner. Discuss proper care and maintenance of fixtures and give the owner any warranty or operating instructions.



Self-Test C-1.2: Fixture and Trim Installation

Complete Self-Test C-1.2 and check your answers.

If you are using a printed copy, please find Self-Test C-1.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=32#h5p-2> (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=32#h5p-2>)

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Media Attributions

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Self-Test C-1.1: Types of Fixtures and Trim

Complete Self-Test C-1.1 and check your answers.

1. What best defines a plumbing fixture?
 - a. Made entirely of cast iron
 - b. Difficult to clean
 - c. Discharges sewage or clear-water waste
 - d. Must be connected to a hot water supply line

2. What common fixture material – although sanitary and easy to clean – is delicate and must be handled with care?
 - a. Vitrified porcelain
 - b. Polyester resin
 - c. ABS
 - d. Stainless steel

3. In the production of fixtures, what material is the most difficult to form?
 - a. Vitrified porcelain
 - b. Stainless steel
 - c. Polyester resin
 - d. Acrylic plastic

4. What process includes firing (heating) a porcelain mixture and glaze to temperatures up to 1,400°C?
 - a. Vitrification
 - b. Moulding
 - c. Tempering
 - d. Passivating

5. Steel fixtures are generally less expensive and less durable than cast-iron fixtures.
 - a. True
 - b. False

6. What material is often used for manufacturing valve parts because of its high resistance to corrosion?
 - a. Vitrified porcelain
 - b. Acrylic plastic
 - c. Polyester resin
 - d. Brass

7. What are water closets most commonly made from?
 - a. Vitrified porcelain

- b. Acrylic plastic
 - c. Stainless steel
 - d. Enamelled steel
8. What process is used to produce acrylic plastic fixtures?
- a. Vacuum forming
 - b. Cold bending
 - c. Forging
 - d. Casting
9. In which of the following would stainless steel most commonly be found?
- a. Water closets
 - b. Faucets
 - c. Bathtubs
 - d. Institutional fixtures
10. Why do all plumbing codes require that every fixture have a hard, corrosion-resistant surface?
- a. They are easy to install.
 - b. Products will be extremely lightweight.
 - c. They cannot be chipped or scratched.
 - d. They can be kept sanitary.
11. What is the primary function of a lavatory (basin)?
- a. Washing dishes
 - b. Scrubbing vegetables
 - c. Washing hands and face
 - d. Washing clothes
12. What is the name of a fixture that supplies potable water for drinking?
- a. Water fountain
 - b. Lavatory
 - c. Drink station
 - d. Bidet
13. What is a bathtub surrounded by walls on three sides known as?
- a. Pedestal
 - b. Recessed
 - c. Sunken
 - d. Peninsular
14. What is the maximum water temperature permitted for a bathtub or shower head?

- a. 40°C
 - b. 49°C
 - c. 52°C
 - d. 60°C
15. Why might a kitchen sink not have a concealed overflow?
- a. Backflow could occur.
 - b. It is too difficult to install.
 - c. It might trap food waste.
 - d. Loss of trap seal could occur.
16. What fixture is especially popular in Europe and is designed for washing the genital areas?
- a. Bum bath
 - b. Water closet
 - c. Bidet
 - d. Sitz bath
17. What is used to provide support for wall-hung water closets?
- a. Brackets
 - b. Support legs
 - c. Carriers
 - d. Pedestals
18. What is the maximum designed flush cycle for a high-efficiency toilet (HET)?
- a. 13.25 L
 - b. 6.0 L
 - c. 4.8 L
 - d. 2.5 L
19. How do water closets prevent sewer gases from entering a washroom?
- a. Integral traps
 - b. Drum traps
 - c. P-traps
 - d. Diaphragms
20. Why do blowout water-closet bowl designs not require a water tank?
- a. They are vacuum assisted.
 - b. They use air jets.
 - c. They use flushometer valves.
 - d. They are connected directly to the building drain.

21. What control method is often used for hospital fixtures?
- Physical operation
 - Voice command
 - Manual control
 - Sensor operation
22. Sensor-controlled faucets can reduce water consumption by approximately what percentage?
- 10%
 - 30%
 - 50%
 - 70%
23. Pressure-balanced showers generally have one control handle, while thermostatically controlled showers usually have two.
- True
 - False
24. What fixture is used to clean instruments or glassware with boiling water?
- Centrifuge
 - Boiler
 - Autoclave
 - Sanitizer
25. What is the primary purpose of an interceptor?
- Traps sewer gases
 - Maximizes project costs
 - Captures unwanted materials before they can enter the drainage system
 - Increases the flow of unwanted materials in the drainage system
26. What is the maximum permitted length of a $\frac{3}{8}$ in. (6.3 mm ID) supply tube for a fixture?
- 450 mm
 - 600 mm
 - 750 mm
 - 900 mm
27. What is an escutcheon?
- Chrome-plated flange
 - Pop-up plug
 - Decorative faucet
 - Water fountain outlet

28. The water delivered from a fountain bubbler must be directed upward at approximately what angle?
- 30°
 - 45°
 - 60°
 - 90°
29. What fixture has waste and overflow fittings?
- Bathtub
 - Faucet
 - Service sink
 - Water closet
30. What type of faucet is nearly maintenance-free and is more durable under a variety of water conditions than any other faucet?
- Cartridge faucet
 - Stem-and-seat faucet
 - Ceramic disk faucet
 - Ball faucet
31. What is the maximum permitted flow rate to a shower head?
- 13.25 L/min
 - 9.5 L/min
 - 6.0 L/min
 - 2.5 L/min
32. Why are hands-free controls more commonly found in public washrooms?
- Less expensive
 - More reliable
 - More hygienic
 - Less maintenance
33. How do thermostatic control valves achieve a desired output temperature?
- Monitor and control temperature and pressure
 - Measure outlet temperature and controls mixing of hot and cold water
 - Vary the inlet supply pressure accordingly
 - Monitor and control hot water supply

Answer Key: Self-Test C-1.1 is on the next page.

Answer Key: Self-Test C-1.1

1. c. Discharges sewage or clear-water waste
2. a. Vitrified porcelain
3. b. Stainless steel
4. a. Vitrification
5. a. True
6. d. Brass
7. a. Vitrified porcelain
8. a. Vacuum forming
9. d. Institutional fixtures
10. d. They can be kept sanitary.
11. c. Washing hands and face
12. a. Water fountain
13. b. Recessed
14. b. 49°C
15. c. It might trap food waste
16. c. Bidet
17. c. Carriers
18. c. 4.8 L
19. a. Integral traps
20. c. They use flushometer valves
21. d. Sensor operation
22. d. 70%
23. a. True
24. d. Sanitizer
25. c. Captures unwanted materials before they can enter the drainage system
26. c. 750 mm
27. a. Chrome-plated flange
28. b. 45°
29. a. Bathtub
30. c. Ceramic disk faucet
31. b. 9.5 L/min
32. c. More hygienic
33. b. Measure outlet temperature and control mixing of hot and cold water.

Self-Test C-1.2: Fixture and Trim Installation

Complete Self-Test C-1.2 and check your answers.

1. What is backing?
 - a. Material installed behind the finished wall used to support fixtures
 - b. An internal frame built into each fixture
 - c. Guards used to protect floor-mounted fixtures from damage
 - d. Material used to hide drain piping behind fixtures

2. What support is designed to carry the weight of the fixture and the user?
 - a. Fixture brackets
 - b. Backing boards
 - c. Fixture carriers
 - d. Plywood framing

3. What fitting is used to rough-in the water supply for a shower head?
 - a. Wing back
 - b. Spout bracket
 - c. Street tee
 - d. Angle stop

4. What is the minimum length required for a clothes washer standpipe?
 - a. 300 mm
 - b. 450 mm
 - c. 600 mm
 - d. 1,200 mm

5. What classification system relates to the amount of time a barrier will hold back fire?
 - a. Fire stop
 - b. Smoke screen
 - c. Heat barrier
 - d. Blaze guard

6. If a wall stud is load-bearing, what is the maximum amount of stud that can be removed?
 - a. One-half of the width
 - b. One-third of the depth
 - c. 50 mm of the width
 - d. 40 mm of the depth

7. What must be done when piping travels through a firewall or horizontal fire separation?
 - a. Be a minimum 300 mm above the finished floor
 - b. Be within 5 m of a fire sprinkler
 - c. Have a steel flange at the wall
 - d. Have a seal that maintains the fire-stop rating

8. What do plumbing codes define?
 - a. Suggested guidelines for installing fixtures
 - b. Minimum requirements for installing fixtures
 - c. Recommended design for installing fixtures
 - d. Best practices for installing fixtures

9. Which set of drawings provides the dimensions for each room and identifies the arrangement of fixtures?
 - a. Architectural
 - b. Structural
 - c. Mechanical
 - d. Electrical

10. In installations where tolerances are narrow, what should be done before rough-in to confirm the dimensions on the rough-in documentation?
 - a. Refer to previous installations.
 - b. Measure the fixture.
 - c. Ask the supervisor to check it.
 - d. Look up dimensions online.

11. Most rough-in documents from manufacturers provide dimensions measured from what surfaces?
 - a. Subfloor
 - b. Rough studs
 - c. Underside of joists
 - d. Finished walls or floors

12. What is the correct flood level rim height for the wall-hung lavatory shown in the rough-in documentation in Figure 1?
 - a. 187 mm
 - b. 432 mm
 - c. 546 mm
 - d. 787 mm

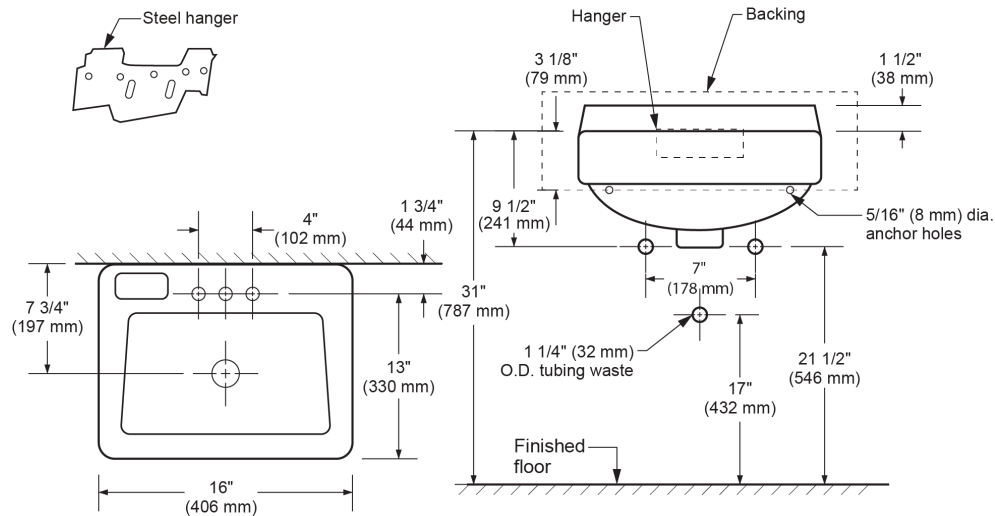


Figure 1

13. What is the correct waste outlet centreline height for the wall-hung lavatory shown in the rough-in documentation in Figure 1?
 - a. 241 mm
 - b. 432 mm
 - c. 546 mm
 - d. 470 mm

14. What type of drawing would show the size of pipes and fittings and the connections between piping, including the path of travel?
 - a. Piping isometric
 - b. Architectural drawing
 - c. Rough-in document
 - d. Structural drawing

15. What should be done immediately after receiving a delivery of fixtures from a plumbing supplier?
 - a. Take a coffee break.
 - b. Uncrate all fixtures.
 - c. Check fixtures for damage.
 - d. Ask a supervisor to inspect the shipment.

16. What should **not** be used to tighten the locknut securing the drain plug fitting to a basin's outlet?
 - a. Adjustable wrench
 - b. Pipe wrench
 - c. Spud wrench
 - d. Hex wrench

17. Who has the final word regarding the acceptance of plumbing fixture installations?

- a. Installer of the fixture
- b. Owner of the fixture
- c. Manufacturer of the fixture
- d. Authority having jurisdiction

Answer Key: Self-Test C-1.2 is on the next page.

Answer Key: Self-Test C-1.2

1. a. Material installed behind the finished wall used to support fixtures
2. c. Fixture carriers
3. a. Wing back
4. c. 600 mm
5. a. Fire stop
6. b. One-third of the depth
7. d. Must have a seal that maintains the fire stop rating.
8. b. Minimum requirements for installing fixtures
9. a. Architectural
10. b. Measure the fixture
11. d. Finished walls or floors
12. d. 787 mm
13. b. 432 mm
14. a. Piping isometric
15. c. Check fixtures for damage.
16. b. Pipe wrench
17. d. Authority having jurisdiction

C-2 PLUMBING APPLIANCES

Plumber Apprenticeship Program – Level 2



Luxurious Modern Bathroom with Whirlpool Tub (<https://www.pexels.com/photo/luxurious-modern-bathroom-with-whirlpool-tub-29887335/>) by (Alexander Mass/ Pexels) Pexels license (<https://www.pexels.com/license/>)

C-2 Plumbing Appliances Introduction

A plumbing appliance can be defined as a device supplied with water and/or a drainage system with an external power supply. Plumbing appliances, such as dishwashers, clothes washers and ice makers, are found in homes, apartments, restaurants, hotels and countless other environments.

Learning Objectives

After completing the chapters in this section, you should be able to:

- Describe types of plumbing appliances.
- Describe the operation of plumbing appliances.
- Use manufacturers' documentation.
- Install plumbing appliances.

Terminology

The following terms will be used throughout this section. A complete list of terms for this section can be found in the **Glossary**.

- **backflow preventer:** A plumbing device designed to prevent contaminated water from flowing back into the clean water supply. (Section C-2.1)
- **backsiphonage:** When dirty water flows backward into clean water pipes by accident. This can happen if water pressure drops, like when a water main breaks or a lot of water is used at once. It can let harmful stuff, like bacteria or chemicals, get into the drinking water supply. (Section C-2.2)
- **beer cabinets:** A refrigeration unit used to store and cool beer, sometimes equipped with a glass rinser for preparing glasses before pouring. (Section C-2.1)
- **booster heater:** A device that raises water temperature, often used in high-temperature dishwashers to ensure proper sanitization. (Section C-2.1)
- **clothes washer:** (Washing Machine); A household appliance that washes laundry using water, detergent, and an internal agitation mechanism. (Section C-2.1)
- **dielectric union:** A specialized plumbing fitting that prevents galvanic corrosion between different metal pipes. (Section C-2.2)
- **dishwasher:** An electrical and mechanical appliance that cleans dishes by spraying them with hot water and detergent, followed by rinsing and drying cycles. (Section C-2.1)
- **dishwasher drain hose:** A flexible tube that connects a dishwasher to a drainage system to remove wastewater. (Section C-2.2)

- **drain pan:** A shallow tray placed beneath a water heater to collect and direct water from leaks or pressure relief discharge. (Section C-2.2)
- **electric emersion elements:** A heating element inside a water heater that converts electrical energy into heat to warm water. (Section C-2.2)
- **flanged drain:** A type of sink drain connection where a flat, circular rim (flange) helps secure the drain to the sink. (Section C-2.2)
- **garbage disposal:** (Garburator); A device installed under a kitchen sink that uses a motorized grinder to break down food waste into a slurry that can be washed down the drain. (Section C-2.1)
- **ice maker:** A device that automatically produces ice cubes, commonly found in refrigerators or as standalone units. (Section C-2.1)
- **master mixing valve:** A device that blends hot and cold water to deliver tempered water at a safe temperature to fixtures. (Section C-2.2)
- **reverse osmosis:** A water purification process that removes contaminants by forcing water through a semipermeable membrane. (Section C-2.1)
- **seismic restraint kit:** A set of straps and brackets used to secure a water heater to a structural component to prevent movement during an earthquake. (Section C-2.2)
- **solenoid valve:** An electrically controlled valve that regulates the flow of liquids or gases in appliances such as washing machines and dishwashers. (Section C-2.1)
- **steam shower:** A self-contained shower unit with an integrated steam generator for steam bathing. (Section C-2.1)
- **stop valve:** A shutoff valve used to control the flow of water to an appliance, such as a dishwasher or clothes washer. (Section C-2.2)
- **storage tank water heater:** A water heater that continuously stores and heats a supply of water in a cylindrical tank. (Section C-2.1)
- **tankless water heater:** (Also called on-demand water heaters); A water heating system that heats water on demand without storing it in a tank. (Section C-2.1)
- **thermal expansion:** A small tank installed in a water heating system to absorb excess pressure caused by thermal expansion of water. (Section C-2.2)
- **thermostat:** A device that controls the temperature of a water heater by regulating the activation of heating elements. (Section C-2.2)
- **threaded flange:** A type of drain flange with threads that allow for a secure connection to plumbing fittings. (Section C-2.2)
- **ultraviolet (UV) sterilizers:** A water purification device that uses UV light to kill bacteria and viruses. (Section C-2.1)
- **vacuum relief valve:** A valve that prevents a water heater tank from collapsing due to negative pressure caused by backsiphonage. (Section C-2.2)
- **water hammer arrestor:** A device installed on water supply lines to absorb shock and prevent noise caused by the sudden closing of valves. (Section C-2.2)
- **whirlpool tub:** A bathtub equipped with jets that mix air and water to create a massaging effect. (Section C-2.1)

C-2.1 Types of Plumbing Appliances

Plumbing appliances differ from plumbing fixtures in that they are not operated by water only. Their operation may depend on the setting of controls or on the characteristics of items, such as heating elements, motors, pumps or sensors. Plumbing appliances can be made from various materials to suit the intended application.

Garbage Disposal Units

Garbage disposals (Figure 1) (also known as garbage grinders or garburators) are devices that are installed under a kitchen sink and attached to the sink outlet fitting. A small but powerful 120 V electric motor is turned on manually after the vegetable cuttings or food debris is placed into the disposal unit. A constant flow of water from the faucet is needed to facilitate the process. Spinning blades (“hammers”) chop the large pieces until a thin slurry is formed that can be washed down the fixture drain.

Some jurisdictions do not allow the installation of garbage grinders because they contribute a significant amount of food solids to the public sewer system that must then be removed and treated. For the same reason, they should not be installed in systems that drain to a private sewage disposal system. With the trend toward composting organic materials and other food waste, fewer people use disposal units nowadays.



Figure 1 Garbage disposal. (Skilled Trades BC, 2021) Used with permission.

Dishwashers

A **dishwasher** (Figure 2) is an electrical/mechanical device for cleaning dishes and utensils. Dishwashers can be found in restaurants and private homes. Unlike manual dishwashing, which relies mainly on physical scrubbing to remove soiling, a mechanical dishwasher cleans by spraying the dishes with hot water, typically up to 60°C (140°F). These high temperatures are required for sanitization.

A mix of water and detergent is circulated by a pump to one or more rotating spray arms, which blast the dishes with the cleaning mixture. Once the wash is finished, the wash water is drained, and more hot water is admitted as the rinse cycle begins. After the rinse cycle finishes and the sump is drained again, the dishes are dried by one of several different drying methods (usually heating elements, although some may also use a fan to speed the process).

Mechanical dishwashing devices were developed in the mid to late 1800s. The domestic dishwasher was invented in the 1920s, but it did not see widespread use until the 1950s. By the 1970s, dishwashers had become a common item.

Present-day machines feature a drop-down front panel door, allowing access to the interior. The inside of a dishwasher is typically constructed of either stainless steel or plastic.



Figure 2 Residential dishwasher. (wax115/Freelimages®) Freeimages.com Content License (<https://www.freeimages.com/license>)

High-temperature commercial dishwashers use water heated to an extremely high temperature to clean and sanitize dishes and glassware. Because of this, there is no need for chemicals or dish detergent to be added during the dishwashing process. High-temperature dishwashers must meet National Sanitation Foundation (NSF) standards and heat water to an approved temperature of 82°C (180°F). In some cases, high-temperature dishwashers require the addition of a **booster heater** (Figure 3) to aid in this process. While some high-temperature dishwashers include a booster heater with the dishwasher, others do not; the booster heaters must be installed separately in the latter case. The booster heater elevates water temperature in the final rinse state to properly sanitize dishware and glassware.

Clothes Washers

A **clothes washer** (Figure 3) (also known as a laundry machine or washing machine) is an appliance used to wash laundry, such as clothing and linen. The term mostly applies to machines that use water and detergents as opposed to ultrasonic cleaners or dry cleaning (which uses alternative cleaning fluids and is performed by specialized commercial businesses).



Figure 3 Residential clothes washers. (Skilled Trades BC, 2021) Used with permission.

Automatic clothes washers use motors and gears to rotate agitator blades inside a steel or plastic cylindrical tub. They rely on electromechanical timers to sequence the washing and water extraction process. **Solenoid valves** and pumps control the flow of water in and out of these appliances. Hoses attached to a set of dedicated laundry hose bibbs or to a laundry box connect to hot and cold supplies.

The first domestic automatic washing machine was introduced in 1937. In appearance and mechanical detail, this first machine was not unlike the front-loading automatic washers produced currently. Although it included many of today's basic features, the machine lacked any drum suspension and, therefore, had to be anchored to the floor to prevent "walking." Because of the components required, the machine was also very expensive.

The modern process of water removal by spinning did not come into use until electric motors were developed. Spinning requires a constant high-speed power source and was originally done in a separate device known as an extractor. A load of washed laundry would be transferred from the wash tub to the extractor basket, and the water spun out in a separate operation.

What is now referred to as an automatic clothes washer was at one time referred to as a washer/extractor. These combine the features of the two devices into a single machine that also has the ability to fill and drain water by itself. Also available are compact appliances that merge the automatic washing machine and clothes dryer into a single device, called a combo washer dryer (not to be confused with stackable washers and dryers). While combo washer dryers are not as effective and efficient as some full-sized, fully functional, separate washer and dryer machines, the combos provide a viable option for those who can benefit from having a compact machine that is able to both wash and dry clothes (like smaller urban residences). Some top-loading clothes washers also come with a built-in sink.

Water Heaters

Water heaters heat potable water for cleaning and bathing purposes. They are also called domestic water heaters, or simply hot water tanks. There are two basic types of water heaters: tankless and storage tank.

Tankless water heaters (Figure 4) (also called on-demand water heaters) heat water as it flows through the device and do not retain any water internally except for what is in the heat exchanger coil (although some units do maintain a very small storage vessel to avoid initial delivery of cold water to the user). These appliances typically use electricity, natural gas, or propane. Copper heat exchangers are often preferred in gas-fired units because of their high thermal conductivity and ease of fabrication; however, stainless steel heat exchangers offer superior resistance to corrosion and leakage.



Figure 4 Gas-fired tankless water heater. (Skilled Trades BC, 2021) Used with permission.

The greatest advantages of these appliances are their small footprint (most units are wall-mounted and can be placed near the point of use) and the energy savings afforded by very low standby heat losses. Disadvantages include the high rate of energy consumption when in operation and the somewhat limited flow rates based on the temperature rise of incoming cold water and the setpoint required.

Storage tank water heaters have traditionally been the most common water heaters in household and commercial applications in North America. Also called storage water heaters or hot water tanks, these consist of a cylindrical vessel that keeps water continuously hot and ready to use. Typical sizes for household use range from 75–400 L (20–100 US gal.). These appliances use electricity, natural gas, propane, heat pumps, solar, or other energy sources.

The energy source may heat the potable water directly (like an immersed electric element or a gas-fired burner) or

indirectly (with an internal or external heat exchanger). Indirect storage tanks with heat exchangers are heated by energy that is transferred from other appliances, such as space heating boilers or solar thermal collectors.

Compared to tankless heaters, storage water heaters have the advantage of using energy at a relatively slow rate, storing the heat for later use. The disadvantage is that over time, the water inside the tank will cool down, causing the heating system to activate to heat the water back up. Additionally, once the tank's supply of hot water has been exhausted, there is a significant delay before hot water is available again. Larger storage tanks tend to provide hot water with less temperature fluctuation at moderate flow rates.

Whirlpool Tubs

Whirlpool tubs (Figure 5) use air and water jet combinations from an integral or remote pump. Whirlpool tubs first became popular in North America during the 1960s. A spa or whirlpool tub is sometimes referred to as a Jacuzzi, since the word became generic after plumbing component and pump manufacturer Jacuzzi introduced the Spa Whirlpool in 1968. Air bubbles are commonly introduced into the whirlpool tub nozzles as a 50/50 mixture of air and water through a venturi-style pump. Most piping is factory installed.



Figure 5 Whirlpool tub. (jingdianjiaju2/ Flickr) CC BY-SA 2.0 (<https://creativecommons.org/licenses/by-sa/2.0/>)

Steam Showers

Self-contained **steam showers** often come complete with seating for one or more people. The cabin provides adequate

floor space for everyday showering while offering the option to unwind with a steam session. Additional available features include overhead showers, hydro massage body jets, and Wi-Fi music capabilities. Special attention to design is required for multi-head showers, including adequate water pipe sizing. A steam shower may have a separate steam generator or a built-in unit. There may be special plumbing requirements for the steam generator such as a pressure reducing valve, backflow preventer, or relief valve drain.

Ice Makers

Residential **ice makers** are typically an integral component of the refrigerator, whereas commercial ones are stand-alone units.

Residential Ice Makers

Most residential ice makers (Figure 6) are installed in a refrigerator and use an electric motor, an electrically operated water valve, and an electric heating unit to produce ice cubes.



Figure 6 Residential refrigerator ice maker.

At the beginning of the cycle, a timed switch energizes a solenoid valve that allows in just enough water to fill the ice mould. Once the mould is filled, the machine waits for the water in the mould to freeze. The cooling unit in the refrigerator does the actual work of freezing the water not the ice maker itself. When the temperature drops to a specific level, an internal thermostat closes a switch in the electrical circuit, which energizes a heating coil underneath the ice

maker. As the coil heats up, it warms the bottom of the ice mould, loosening the cubes from the mould. The electrical circuit then activates the ice maker's motor, which rotates a set of ejector blades that remove the cubes from the mould. The cubes are pushed out to a collection bin underneath the ice maker. This system is effective for making ice at home, but it does not produce enough ice for commercial purposes, such as restaurants and hotels.

Commercial Ice Makers

Commercial ice makers (Figure 7) have dedicated refrigeration systems. Most types make their ice in a large metal ice-cube tray positioned vertically inside the unit. The ice maker has a water pump that draws water from a collection sump and pours it over the chilled ice tray. As the water flows over the tray, it gradually freezes, building up ice cubes in the well of the tray. After a set amount of time, the ice maker triggers a solenoid valve connected to the heat-exchanging coils. Switching this valve momentarily changes the path of the refrigerant gas within the cycle. As the hot gas is forced through the evaporator pipes, the pipes and the ice tray heat up rapidly, loosening the ice cubes so that they slide out into a collection bin below.

This sort of system is popular in restaurants and hotels because it makes clear ice cubes of a standard shape and size.



Figure 7 Commercial ice maker. (Skilled Trades BC, 2021)
Used with permission.

Water Purifiers

Water purifiers are appliances that use physical and/or chemical methods to treat water to a required condition. The most common types of physical purification systems use activated carbon to remove latent chemicals and trapped gases, providing water with a superior taste.

To remove minerals and fluorides from water sources, ion exchange-type water softeners are often used that operate between regeneration, service, and backwash modes using a sodium brine solution and a synthetic resin bed. Electronic timers operate the mechanical valves required to bypass equipment while in regenerating mode.

Reverse osmosis water treatment equipment is also effective at removing salts and minerals from raw water sources. These units use pre-filters, a thin film composite membrane, and post-filters to effectively remove pollutants and microorganisms.

Ultraviolet sterilizers (Figure 8) are used to kill viruses and bacteria in water supplies. They require an electrical connection to operate the UV bulb in the reactor vessel.

Most purification equipment operates without the use of additional pumps, relying on the pressure drop of the water system to provide the required flow. Some exceptions include the addition of chemical dosing equipment that uses electric pumps to administer the correct amount of solution required or in cases where supply pressure of the source water is inadequate, and a booster pump is required. A **backflow preventer** may be required on water purification installations. Check with the local jurisdiction for more information.



Figure 8 Ultraviolet water sterilizer with cartridge pre-filter. (Skilled Trades BC, 2021) Used with permission.

Beer Cabinets

Beer cabinets are often refrigeration-equipped appliances that cool bottles or kegs of beer (Figure 9). Some require a water supply and possibly an indirect connection to a floor drain. Some beer cabinets have an integrated glass rinser that can be used to condition the glass with cold water before pouring.



Figure 9 Beer cabinet. (Kyle Van Horn/Flickr). CC BY 2.0
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Self-Test C-2.1: Types of Plumbing Appliances

Complete Self-Test C-2.1 and check your answers.

If you are using a printed copy, please find Self-Test C-2.1 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=34#h5p-3> (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=34#h5p-3>)

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Trades Training BC. (2021). C-2: Install appliances. In: *Plumber Apprenticeship Program: Level 2*. Industry Training Authority, BC.

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C-2.2 Plumbing Appliance Installation

Procedures to install plumbing appliances are not complex but require a great deal of care to ensure that the appliances operate reliably and that each installation has an attractive look. The professional appearance of plumbing appliance installations reflects the skill and knowledge of each plumber.

Code Regulations

Plumbing appliances use electricity or some other form of external power supply. Electrical permits may be required in some areas, and if branch circuits must be installed for the appliances, the work must be done by a registered electrical contractor. Refer to your local jurisdiction for specific regulations that apply to appliance installation.

Installing Garbage Disposal Units

Garburators are requested by some homeowners. Check all local requirements and specific manufacturers' directions regarding garbage disposal installation.

If a dishwasher is also to be installed, the **dishwasher drain hose** will be attached to the drain fitting located on the garbage disposer. This helps to flush out the disposal unit during each discharge cycle of the dishwasher.

A garbage disposal installed under a single-compartment sink is connected directly to the sink drain outlet. Under a double-compartment sink, the garbage disposal is attached directly under one of the compartments, with an outlet pipe connecting it to the drain of the second compartment (Figure 1).

Some newer sink designs have a third compartment that is intended to be connected to the garbage disposer, and the two sink compartments can be drained either to the disposer or directly to the main drainage piping.



Figure 1 Garbage disposal installation. (Skilled Trades BC, 2021) Used with permission.

The disposer must be wired to the main junction box or plugged into an electrical outlet below the sink. A control switch should be installed in a more convenient location, usually on the wall above and behind the sink deck. Electrical circuit wiring should be done by an electrician.

The most common garburator drain outlet is a standard **flanged drain** without threads. Sealant or a gasket is applied to the underside of the flange, and the drain is dropped into the sink outlet. A collar is slipped onto the extension underneath the sink and three travelling bolts are threaded through the collar (Figure 2). As these bolts are tightened, they force the collar up to the underside of the sink.



Figure 2 Standard flange drain body without threads. (Skilled Trades BC, 2021) Used with permission.

Another style of garburator outlet has a **[pb_glossary id="817"]threaded flange[/pb_glossary]** similar to common sink drains (Figure 3).



Figure 3 Threaded garburator flange. (Skilled Trades BC, 2021) Used with permission.

The disposer is mounted onto the collar (Figure 4) and locked in place using the tightening tool provided with the unit.



Figure 4 Mounting the garburator to the outlet fitting. (Skilled Trades BC, 2021) Used with permission.

Installing Dishwashers

When installing a standard built-in dishwasher, the hot water piping should be roughed in so it will meet the dishwasher elbow (or adapter fitting) when the dishwasher is in place. Hot water inlet piping is typically either a flexible braided supply connector or PEX, polyethylene, or copper tubing.

Install a separate **stop valve** for the dishwasher supply line. The stop should be easily accessible.

The drain hose of the dishwasher is connected to a dishwasher tee or a wye-branch adapter fitting on the outlet pipe of the existing sink drain (Figure 5). If a garbage disposer is connected, the drain hose is connected to the garbage grinder, as described earlier in this learning task.

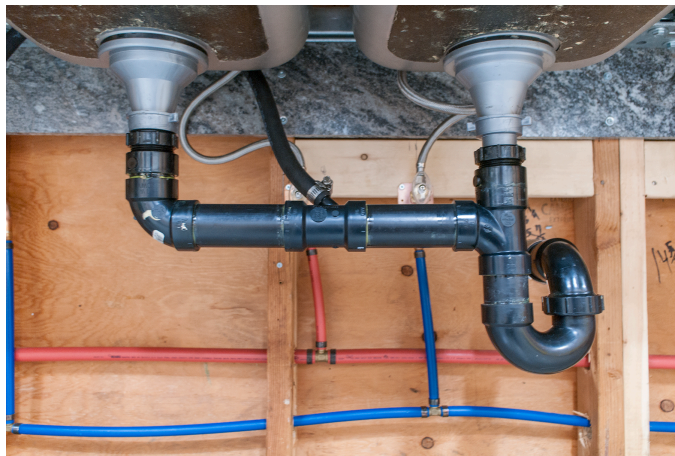


Figure 5 Dishwasher drain hose connection. (Skilled Trades BC, 2021)
Used with permission.

The dishwasher drain line must rise as high as possible and be securely fastened under the countertop before connecting to the sink's outlet pipe. This is intended to prevent possible backup of the sink drain (backflow) from flowing into the dishwasher.

Dishwashers may be wired from a junction box or plugged into a conveniently located ground-fault-protected electrical outlet. Electrical circuit wiring should be done by an electrician.

First, cut a hole in the side of the cabinet between the sink piping and the installation location. Thread the flexible drain hose through the hole and fasten it as high as possible under the cabinet. Attach it to the sink drain fitting with the supplied gear clamp or spring clamp.

Connect a dishwasher elbow or adapter fitting (Figure 6) to the hot water supply inlet on the dishwasher. Slide the dishwasher into place and attach the hot water supply connector to the stop valve.

Level the dishwasher with levelling screws or legs. When it is aligned correctly, fasten the hold-down brackets to the underside of the countertop with $\frac{1}{2}$ in. (13 mm) wood screws. (Note: Before installing, ensure that the screws will not penetrate the countertop.)

Cycle the dishwasher through the washing sequence, and check that all drain and supply connections are watertight.



Figure 6 Dishwasher supply connector and adapter fitting. (Skilled Trades BC, 2021) Used with permission.

Installing Clothes Washers

Before installing a clothes washer, rough-in piping should be in place. Standard rough-in drainage piping consists of a minimum 600 mm (24 in.) tall trapped standpipe. Standpipes are required to be a minimum 2 in. (51 mm) diameter, and their inlet must extend above the flood level rim of the washer. Hot- and cold-water supply lines should have risers that extend to a height of approximately 1,100–1,200 mm (42–48 in.). Standard hose bibbs are placed on hot- and cold-water supply lines, or a laundry box (Figure 7) is used to provide a clean and tidy installation.

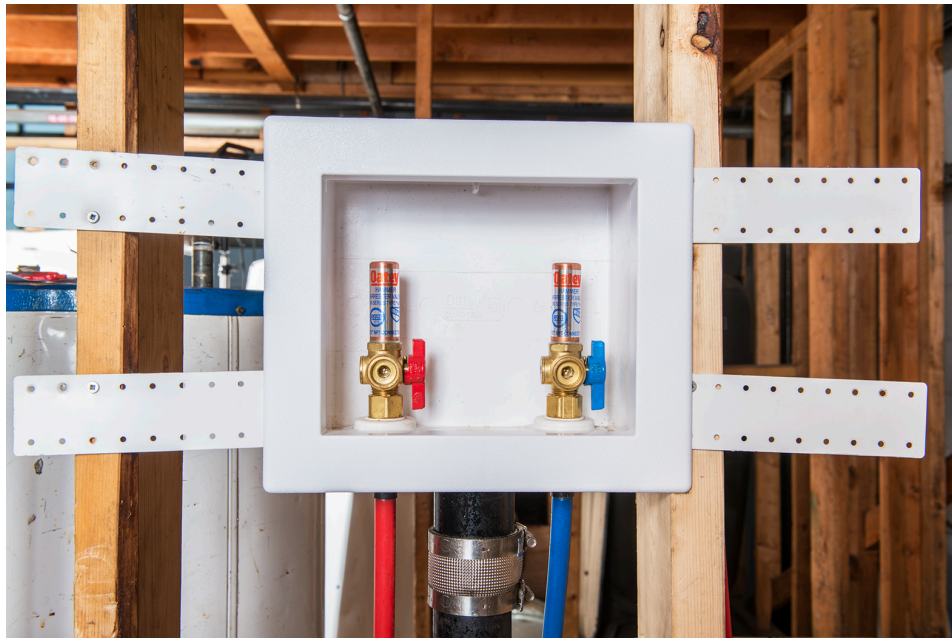


Figure 7 Laundry box with supply hose bibbs and 2 in. drain. (Skilled Trades BC, 2021) Used with permission.

Slide the washer unit into position and level it. Attach the rubber or braided supply hoses from the inlets on the washer to the hot and cold hose bibbs. Insert the washer's discharge hose into the top of the standpipe or drain opening in the laundry box. Cut the drain hose to the desired length, if required. Clothes washers may also drain to a laundry tray if no drain standpipe is available. **Water-hammer arrestors** are installed on both hot- and cold-water supply lines and act to prevent shock caused by the rapid closing of valves inside the clothes washer.

Clothes washers can be wired into the main junction box or plugged into a conveniently located electrical outlet. Electrical circuit wiring should be done by an electrician.

Cycle the clothes washer through the full sequence and check that all drain and supply connections are watertight.

Installing Electric Water Heaters

Unlike gas water heaters, electric heaters can be installed inside an unventilated space (e.g., a closet with a closed door) since they do not burn fossil fuel directly and require no combustion air supply or flue vent.



Do not expose a water heater's exterior to rain or water. Do not touch a water heater that is leaking, wet, or flooded without turning the power supply OFF.

Installing Storage Tank Water Heaters

The base for the tank placement must be firm and level. Ensure that the tank is placed on a **drain pan** (Figure 8) if the floor is constructed of wood.



Figure 8 Storage tank drain pan with side outlet. (Skilled Trades BC, 2021) Used with permission.

Place the tank in the proposed location and ensure that access panels, drain fitting, and rating plate information will be accessible and visible after installation.

Next, prepare all threaded adapters required for the tank connections. Most tanks are provided with $\frac{3}{4}$ in. (19 mm) NPS galvanized, plastic-lined, tank nipples. A minimum of 450 mm (18 in.) of copper tubing should be attached to the top of the tank to protect plastic water distribution lines from unnecessary exposure to high temperatures. After that, any variety of approved materials may be used.

Attach $\frac{3}{4}$ in. (19 mm) **dielectric unions** or FIP adapters with 450 mm (18 in.) of copper, as mentioned.

Shutoff valves are required for the supply to every tank, and **vacuum relief valves** are needed when the tank may be subject to **backsiphonage** (best practices dictate that all tanks have these). The vacuum-relief valve does not act as a backflow preventer to protect the drinking water; instead, it protects the tank from imploding due to the negative pressure that may be created by backsiphonage.

Finish connecting the cold inlet and hot outlet copper piping to the remainder of the water distribution system, then turn on the cold water to the tank. Ensuring that the drain valve is closed, relieve air from the tank by opening a hot faucet at a nearby fixture. Next, complete the piping for the relief valve discharge port and ensure that it terminates near the pan, floor drain, or other safe location, with a maximum air break of 300 mm (12 in.) (minimum of 38 mm/ $1\frac{1}{2}$ in.). The drain pan and relief valve piping should drain to a trapped connection to the sanitary drainage system (or storm drainage system, where approved).

Once you are satisfied that all the air is purged from the tank, have an electrician complete the connection to the branch circuit wiring. Ensure that the bonding conductor has been securely fastened to the ground screw in the appliance. Once this is complete, you can turn on the circuit breaker. Tank **thermostats** usually come preset to 60°C (140°F) and should remain at that maximum temperature for suitable disinfection of bacteria. If scalding is a concern at a fixture, the distribution system should include a tempering device.

If provision for **thermal expansion** is not already provided, install an adequately sized expansion tank (rated for use with potable water) or thermal expansion relief device (as per manufacturers' instructions) to comply with code.

In seismic velocity regions (e.g., BC coastal areas), storage tanks must be restrained to prevent them from overturning in the event of an earthquake. **Seismic Restraint Kits** are available that provide an attractive, secure installation (Figure 9). Typically, restrained tanks are secured on the top $\frac{1}{3}$ and the bottom $\frac{1}{3}$ of the tank and must be fastened to structural components to ensure their integrity.



Securing perforated steel strapping to drywall is NOT acceptable.



Figure 9 Hot water tank installation with potable expansion tank and seismic restraint kit. (Skilled Trades BC, 2021) Used with permission.

Installing Tankless Water Heaters

Installing piping for tankless heaters is similar to that for electric tank water heaters. Tankless heaters differ in that they are typically wall-mounted (Figure 10) and should be secured according to the manufacturer's instructions. Tankless heaters also have significant wiring considerations because they draw lots of power to heat the water quickly on demand.



Figure 10 Small point-of-use, on-demand, electric water heater. (Skilled Trades BC, 2021) Used with permission.

Operating Electric Storage Tank Water Heaters

Once the tank has been filled with water, it will contain no air. When a hot water faucet is turned on, hot water immediately leaves the top of the tank and travels through the piping system until it reaches the faucet. At the same time, new cold water enters the bottom of the tank through the dip tube or bottom fill port.

The drawing off of hot water and entry of cold water causes the temperature in the tank to drop; this is sensed by the thermostats, which then activate the elements. The heating of the water is performed by electric elements. Tanks have one or two elements, depending on their design. **Electric immersion elements** are similar to electric stove burners except they have elongated shapes and are designed to be immersed in water (Figure 11).



Figure 11 Electric emersion element. (Skilled Trades BC, 2021) Used with permission.

Elements are controlled by upper and lower thermostats. The thermostats read the water temperature through contact with the side of the tank and turn the elements on or off.

Elements instantly burn out if there is no water inside the tank. Elements can also fail for other reasons and can often be replaced. In two-element tanks, if the lower element burns out, the amount of hot water is greatly reduced. If the upper element burns out, the lower element stops receiving electric signals, so neither element works, and no hot water is available.

Both elements are never on at the same time unless specific wiring is changed. The upper thermostat is the main controller; it turns on the upper element until the top two-thirds of the tank reaches the temperature setting. After that, the upper thermostat turns off the upper element and sends power to the lower thermostat, which turns on the lower element. The lower element is energized until the entire tank reaches the preset temperature setting.

Residential water heater thermostats can be manually set to temperatures between 32 and 65°C (90–150°F) but should always be kept at a minimum of 60°C (140°F) to kill bacteria.

Tempered water (usually max. 49°C/120°F) can then be delivered to fixtures through a **master mixing valve** or point-of-use tempering devices.



Self-Test C-2.2 Plumbing Appliance Installation

Complete Self-Test C-2.2 and check your answers.

If you are using a printed copy, please find Self-Test C-2.2 and Answer Key at the end of this section. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=36#h5p-4> (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/?p=36#h5p-4>)

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Self-Test C-2.1: Types of Plumbing Appliances

Complete Self-Test C-2.1 and check your answers.

1. What minimum temperature is required for proper sanitization in a high-temperature dishwasher?
 - a. 40°C (104°F)
 - b. 55°C (131°F)
 - c. 60°C (140°F)
 - d. 82°C (180°F)

2. What is one advantage of a tankless water heater?
 - a. Small footprint
 - b. Large water storage
 - c. Not prone to fouling
 - d. Uses energy at a slow rate

3. What is unique to an indirect storage tank?
 - a. Has the heat source at the tank
 - b. Uses a heat exchanger
 - c. Has only two connection ports
 - d. Uses a dip tube

4. Residential ice makers have a separate cooling unit to produce ice in a refrigerator.
 - a. True
 - b. False

5. What is used in water purification units for superior-tasting water?
 - a. Sodium pellets
 - b. Potassium chloride
 - c. Activated carbon
 - d. Silica gel

Answer Key: Self-Test C-2.1 is on the next page.

Answer Key: Self-Test C-2.1

1. d. 82°C (180°F)
2. a. Small footprint
3. b. Uses a heat exchanger
4. b. False
5. c. Activated carbon

Self-Test C-2.2: Plumbing Appliance Installation

Complete Self-Test C-2.2 and check your answers.

1. When installed, why should the drain hose from an adjacent dishwasher be connected to the garbage disposal unit?
 - a. Preheats the motor
 - b. Flushes out the unit
 - c. Lubricates the cutters
 - d. Provides a trap

2. Why should the discharge hose from a dishwasher be mounted as high as possible under the countertop before being connected to the sink drain fitting or garbage grinder?
 - a. Prevents backflow
 - b. Prevents water hammer
 - c. Provides room for expansion
 - d. Permits removal and replacement

3. What is the minimum required height of a clothes washer standpipe?
 - a. 450 mm
 - b. 600 mm
 - c. 750 mm
 - d. 900 mm

4. Who is responsible for installing a new branch circuit for an appliance?
 - a. Plumber
 - b. Site foreman
 - c. General contractor
 - d. Electrical contractor

5. What is used to monitor the temperature of the water in a storage tank water heater?
 - a. Relief valves
 - b. Elements
 - c. Thermostats
 - d. Sensors

6. What is the recommended storage water temperature for a storage tank water heater to ensure sufficient bacteria kill?
 - a. 40°C (104°F)
 - b. 50°C (122°F)
 - c. 60°C (140°F)

- d. 80°C (176°F)
-
- 7. What is the minimum recommended length of copper tubing that should be installed when connecting to the top of a storage tank water heater?
 - a. 300 mm
 - b. 450 mm
 - c. 600 mm
 - d. 750 mm

Answer Key: Self-Test C-2.2 is on the next page.

Answer Key: Self-Test C-2.2

1. b. Flushes out the unit
2. a. Prevents backflow
3. b. 600 mm
4. d. Electrical contractor
5. c. Thermostats
6. c. 60°C (140°F)
7. b. 450 mm

Glossary

angle stop

A small shutoff valve installed at the water supply stub to control water flow to a fixture. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

architectural drawings

Drawings that provide room dimensions, fixture arrangements, and building materials, serving as a primary reference for rough-in work. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

back lip

The rear edge of a bathtub that is supported by a horizontal ledge to provide stability and prevent movement. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

backflow preventer

A plumbing device designed to prevent contaminated water from flowing back into the clean water supply. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

backing

Support materials (e.g., plywood, lumber, metal) installed behind finished walls to secure fixtures like lavatories and shower curtain rods. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

backsiphonage

When dirty water flows backward into clean water pipes by accident. This can happen if water pressure drops, like when a water main breaks or a lot of water is used at once. It can let harmful stuff, like bacteria or chemicals, get into the drinking water supply. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

beer cabinets

A refrigeration unit used to store and cool beer, sometimes equipped with a glass rinser for preparing glasses before pouring. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

booster heater

A device that raises water temperature, often used in high-temperature dishwashers to ensure proper sanitization. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

carrier arms

Metal brackets used to support wall-hung fixtures, ensuring they are securely attached to the wall structure. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

carriers

Steel frames used to provide additional support for fixtures such as wall-hung water closets, especially for persons with disabilities. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

cartridge faucets

A type of faucet that control the flow of water using a cartridge inside. The cartridge is a small, replaceable part that moves to let water flow in or out when you turn the handle. These faucets are easy to use and can help control both the temperature and the amount of water that comes out. (Section C-1.1 (#chapter-chapter-1))

centrelines

Reference lines used in plumbing rough-in to accurately position piping and fixture supports. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

clearance

The minimum space required between fixtures and walls or other structures, as regulated by codes and specifications. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

close-coupled

A type of toilet where the tank and the bowl are joined closely together as one unit. The water tank sits right on top of the bowl, making it compact and easy to install. (Section C-1.1 (#chapter-chapter-1))

closet flange

A fitting that connects the water closet to the waste pipe, ensuring a secure connection. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

clothes washer

(Washing Machine); A household appliance that washes laundry using water, detergent, and an internal agitation mechanism. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

composite stone

A strong material made by mixing crushed natural stone with glue or resin. It looks like real stone but is made in factories and is often used for countertops, floors, and walls. (Section C-1.1 (#chapter-chapter-1))

compression faucets

A type of faucet that works by turning the handles to press down on washers inside the faucet. This creates a seal that stops the water from flowing. When you turn the handle, it lifts the washer to allow water to flow, and when you turn it back, the washer closes to stop the water. These faucets are commonly found in older sinks. (Section C-1.1 (#chapter-chapter-1))

compression fitting

A plumbing connection method that uses a nut and ferrule to create a watertight seal on supply lines. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

corrosion

When metals slowly get damaged or worn away because of reactions with air, water, or other substances. A common example is rust forming on iron when it gets wet. (Section C-1.1 (#chapter-chapter-1))

dielectric union

A specialized plumbing fitting that prevents galvanic corrosion between different metal pipes. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

dishwasher

An electrical and mechanical appliance that cleans dishes by spraying them with hot water and detergent, followed by rinsing and drying cycles. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

dishwasher drain hose

A flexible tube that connects a dishwasher to a drainage system to remove wastewater. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

diverter valve

A valve in a combination tub-shower fixture that directs water either to the tub spout or the showerhead. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

drain pan

A shallow tray placed beneath a water heater to collect and direct water from leaks or pressure relief discharge. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

Drainage, Waste, and Vent (DWV) System

A network of pipes that remove wastewater and provide ventilation to prevent sewer gases from entering buildings. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

drop ear

A type of shower arm fitting with mounting ears for secure attachment to wall framing. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

drop-ear fitting

A fitting used to anchor the showerhead securely to the wall, often with a female iron pipe thread (FIP). (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

electric immersion elements

A heating element inside a water heater that converts electrical energy into heat to warm water. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

electrical drawings

Diagrams showing the layout of electrical lines, outlets, and fixtures to prevent conflicts with plumbing installations. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

escutcheons

A decorative cover or plate used in plumbing to hide gaps or holes around pipes, faucets, or other fixtures. It helps make the area look neat and clean by covering the space where a pipe or fixture meets the wall or surface.

Escutcheons are often used in sinks, showers, and toilets to improve the appearance and prevent water from leaking behind the fixture. (Section C-1.1 (#chapter-chapter-1))

fire stop rating

A classification system indicating how long a barrier (e.g., firewall, floor) can prevent the spread of fire. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

fixture

A plumbing device, like a sink or toilet, that uses water. (Section C-1.1) (#chapter-chapter-1)

fixture supply tubes

(Also known as supply risers, supply connectors or supply lines); The flexible pipes that bring water from the main water supply to a plumbing fixture, like a sink, toilet, or shower. They connect the fixture to the water lines, allowing water to flow in and out. These tubes are usually made of materials like copper, stainless steel, or plastic, and they are designed to be easy to install and connect to the fixture. (Section C-1.1 (#chapter-chapter-1))

flanged drain

A type of sink drain connection where a flat, circular rim (flange) helps secure the drain to the sink. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

flushometer valves

A special valve used in public bathrooms instead of a regular toilet tank. It releases a strong burst of water to flush the toilet or urinal quickly and refills right away, so it can be used often without waiting. Direct-flush valves are a “tankless” design that uses water pressure from the supply line rather than a tank of water to flush the fixture (Figure 10, Section C-1.1 (#chapter-chapter-1))

garbage disposal

(Garburator); A device installed under a kitchen sink that uses a motorized grinder to break down food waste into a slurry that can be washed down the drain. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

gasket

A sealing material used to prevent leaks between two surfaces, such as between a faucet and sink. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

grey water or process water

Used water from sinks, showers, bathtubs, and washing machines. It is not dirty like toilet water and can sometimes be cleaned and reused for things like watering plants or flushing toilets. (Section C-1.1 (#chapter-chapter-1))

High-efficiency toilets (HET)

Toilets that use less water to flush but still work just as well as regular toilets. They help save water and lower water bills. (Section C-1.1 (#chapter-chapter-1))

ice maker

A device that automatically produces ice cubes, commonly found in refrigerators or as standalone units. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

isometric drawing

A three-dimensional technical drawing that illustrates the layout, connections, and travel path of plumbing pipes. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

laundry box

A recessed box that simplifies connections for washing machine supply lines and drainage. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

lavatories

Sinks with running water used for washing hands and face, usually found in bathrooms. (Section C-1.1 (#chapter-chapter-1))

locknut

A threaded fastener used to secure plumbing fixtures and fittings in place. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

master mixing valve

A device that blends hot and cold water to deliver tempered water at a safe temperature to fixtures. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

mechanical drawings

Plans that depict the layout of supply piping, waste and vent lines, and other mechanical systems within a building. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

mortar base

A continuous bed of mortar used to support the bottom of certain types of bathtubs, such as jetted tubs and whirlpools. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

notching

In construction, means cutting a small section out of wood or another material to help pieces fit together properly. It is often done to make space for pipes, wires, or to join beams and boards securely. (Section C-1.1 (#chapter-chapter-1))

overflow gasket

A seal placed on the back of the bathtub overflow opening to prevent leaks. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

P-trap

A U-shaped pipe that prevents sewer gases from entering a home by trapping water. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

pedestal basin

A type of sink supported by a freestanding pedestal that conceals plumbing connections. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

perimeter lip (tiling flange)

A raised edge on a bathtub or shower base that sits behind the finished wall to prevent water from seeping behind the unit. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

pipng layout drawing

A detailed plan showing the exact placement of pipes, fittings, and connections needed for plumbing installations. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

plumber's putty

A pliable sealing compound used to create watertight seals around drains and fixtures. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

pop-up drain assembly

A drain mechanism with a pivot rod that allows the stopper to be raised or lowered using a lift rod. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

pressure-assist

A toilet system that uses compressed air to create a stronger flush. As the tank refills, a vessel captures and compresses air, which helps push the water into the bowl more quickly. This results in a more powerful and efficient flush, using less water while improving cleaning performance. (Section C-1.1 (#chapter-chapter-1))

reclaimed water

Water that has been used before and cleaned so it can be used again for things like watering plants, flushing toilets, or washing streets. It is not for drinking, but it helps save fresh water. (Section C-1.1 (#chapter-chapter-1))

reverse osmosis

A water purification process that removes contaminants by forcing water through a semipermeable membrane. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

reverse trap

A special type of plumbing pipe that helps prevent bad smells or gases from coming back into a building. It works by trapping a small amount of water in the pipe, but instead of the water being higher, like in a regular trap, it's lower. This helps keep the pipes clear and stops odors from escaping. (Section C-1.1 (#chapter-chapter-1))

rough-in

The initial stage of plumbing installation before walls and floors are finished. (Section C-1.1) (#chapter-chapter-1)

rough-in documentation

Manufacturer-provided specifications detailing fixture dimensions, pipe connection points, and installation guidelines. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

seismic restraint kit

A set of straps and brackets used to secure a water heater to a structural component to prevent movement during an earthquake. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

self-rimming basin

A sink with a built-in lip or rim that rests on the countertop, requiring minimal installation support. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

shower pipe riser

A vertical pipe that connects to the shower arm and directs water to the showerhead. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

silicone caulking

A flexible sealant used to waterproof joints and seams, especially in synthetic materials where putty may cause staining. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

siphon jet

A part of a toilet that helps flush water quickly and powerfully. It pushes water through a small opening to create suction, which helps remove waste from the bowl. (Section C-1.1 (#chapter-chapter-1))

solenoid valve

An electrically controlled valve that regulates the flow of liquids or gases in appliances such as washing machines and dishwashers. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

specification sheet

A document that includes technical details about a fixture, including rough-in dimensions and installation requirements. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

standpipe

A vertical section of pipe for washing machine drainage, ensuring proper waste disposal. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

steam shower

A self-contained shower unit with an integrated steam generator for steam bathing. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

stop valve

A shutoff valve used to control the flow of water to an appliance, such as a dishwasher or clothes washer. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

storage tank water heater

A water heater that continuously stores and heats a supply of water in a cylindrical tank. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

structural drawings

Plans that indicate load-bearing elements of a building, ensuring that plumbing modifications do not weaken the structure. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

tankless water heater

(Also called on-demand water heaters); A water heating system that heats water on demand without storing it in a tank. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

thermal expansion

A small tank installed in a water heating system to absorb excess pressure caused by thermal expansion of water. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

thermostat

A device that controls the temperature of a water heater by regulating the activation of heating elements. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

threaded flange

A type of drain flange with threads that allow for a secure connection to plumbing fittings. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

trapway

The curved pipe at the bottom of a toilet or sink that helps carry away water and waste. It also keeps a little bit of water inside to stop bad smells from coming back up. (Section C-1.1 (#chapter-chapter-1))

tub-filler valve

A valve used to blend hot and cold water, controlling the flow to a bathtub or shower. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

ultraviolet (UV) sterilizers

A water purification device that uses UV light to kill bacteria and viruses. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

vacuum relief valve

A valve that prevents a water heater tank from collapsing due to negative pressure caused by backsiphonage. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

vacuum-assist

A system in some toilets that helps the flush work more powerfully. It uses air pressure to help pull the waste and water down the drain quickly, using less water. (Section C-1.1 (#chapter-chapter-1))

vitriified porcelain

Also known as vitreous china; a type of very strong and smooth ceramic material made by heating special clay at a very high temperature. This process makes it hard, waterproof, and glass-like, so it doesn't absorb water and is very durable. It is often used for making sinks, toilets, and tiles. (Section C-1.1 (#chapter-chapter-1))

waste and overflow fittings

Plumbing components that connect the bathtub drain to the trap, preventing overflow. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

waste condensate

Water that forms when warm air touches a cold surface, like the water droplets on a cold drink. In buildings, this water comes from air conditioners, refrigerators, or pipes and is usually drained away as waste. (Section C-1.1 (#chapter-chapter-1))

water closets

Another name for toilets, which are used for flushing away waste. (Section C-1.1 (#chapter-chapter-1))

water-hammer arrestor

A device installed on water supply lines to absorb shock and prevent noise caused by the sudden closing of valves. (Section C-2.2 (#chapter-c-2-2-plumbing-appliance-installation))

weir

The top edge of the water inside a toilet or sink drain trap (the trapway's highest point). It helps control the flow of water and keeps some water in the trap to block bad smells from coming back up. (Section C-1.1 (#chapter-chapter-1))

whirlpool tub

A bathtub equipped with jets that mix air and water to create a massaging effect. (Section C-2.1 (#chapter-c-2-1-types-of-plumbing-appliances))

wing back elbow

A pipe fitting with mounting wings that allows secure attachment to a backing board, commonly used for shower and tub spouts. (Section C-1.2 (#chapter-c-1-2-fixtures-and-trim-installation))

Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship** (<https://skilledtradesbc.ca/plumber>) – Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber** (<https://www.red-seal.ca/eng/trades/plumbers/overview.shtml>) – National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards** (<https://www.bccodes.ca/>) – Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC** (<https://www.worksafebc.com/en>) – Essential safety resources for plumbers, including:
 - Health & Safety – WorkSafeBC (<https://www.worksafebc.com/en/health-safety>)
 - Report Unsafe Working Conditions (<https://www.worksafebc.com/en/contact-us/departments-and-services/health-safety-prevention>)
 - Report a Workplace Injury or Disease (<https://www.worksafebc.com/en/claims/report-workplace-injury-illness>)
 - Submit a Notice of Project Form (<https://www.worksafebc.com/en/for-employers/just-for-you/submit-notice-project>)
 - Get Health and Safety Resources (Videos, Posters, Publications, and More) (<https://www.worksafebc.com/en/resources-health-safety>)
 - Search the OHS Regulations (and Related Materials) (<https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation>)
 - Conduct an Incident Investigation (<https://www.worksafebc.com/en/health-safety/create-manage/incident-investigations/conducting-employer-investigation>)
- **CCOHS: OHS Answers Fact Sheets – Plumber** (https://www.ccohs.ca/oshanswers/occup_workplace/plumber.html) – Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** (<https://skilledtradesbc.ca/financial-support>) – Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training

(ISET) program.

- **StudentAidBC** (<https://studentaidbc.ca/>) – Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** (<https://www.workbc.ca/find-loans-and-grants/students-and-adult-learners/services-apprentices-and-employers>) – Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** (<https://www.healthlinkbc.ca/mental-health-and-substance-use>) – HealthLink BC resources for mental health and wellness support.
- **Here2Talk** (<https://here2talk.ca/>) – Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** (<https://helpstartshere.gov.bc.ca/>) – A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** (<https://www.hopeforwellness.ca/>) – 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
 - First Nations Health Authority Mental Health Supports Info Sheet [PDF] (<https://www.fnha.ca/Documents/FNHA-mental-health-and-wellness-supports-for-indigenous-people.pdf>) by First Nations health Authority – List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** (<https://www.heretohelp.bc.ca/>) – Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** (<https://www.constructionrehabplan.com/>) – Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** (<https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports>) – Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** – Call 1-888-353-2273 (tel:+1-888-353-2273) for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** (<https://talksuicide.ca/>) – An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** – Call 250-310-6789 (tel:+1-250-310-6789) for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** – Call 1-800-784-2433 (tel:+1-800-784-2433) if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** – Call 1-833-804-8111 (tel:+1-833-804-8111) between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** – Call 1-800-588-8717 (tel:+1-800-588-8717) for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** – Call 1-800-663-1441 (tel:+1-800-663-1441) to find resources and support.



Emergency Services – For life-threatening situations, call 911 or visit your nearest emergency department.

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 2, Block C (<https://c-plumbfixappliance-bcplumbingapprl2.pressbooks.tru.ca/>). Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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Version	Date	Change	Details
1.0	September, 2025	Plumbing Apprenticeship Level 2 Block C learning resource from STBC content converted to open and freely accessible digital platform and published at TRU.	
