The Down & Dirty on DWV

It usually begins something like this: You call a plumber in to look at a job; you just want to confirm the specs and discuss faucet styles and fixture colors…Then your plumber says, "Of course, this will need a vent running up through that wall to the roof." Your eyes go wide. You've already given a price to the customer and now you have to cover additional plumbing, carpentry, and finish work. At this point, you don't want to ask why; you don't especially want to hear the answer.

The purpose of this article is to help you avoid such surprises. First I'll explain how drains, traps, and vents are laid out by a plumber. Then I'll discuss some common venting problems and their solutions.

Basic DWV

Vents and traps are the least understood elements of a house's DWV (drain/waste/vent) system, but to explain how they work, it's useful to examine what they serve: namely, drains.

Drains. Drains carry waterborne waste from the various fixtures (sinks, toilets, floor drains, etc.) to the sewer or septic system outside the building.

Horizontal drains should have a 2% slope, equivalent to 1/4-inch drop per foot of length. This allows the contents to develop a velocity (approximately 2 feet per second) which is not so slow that things bog down and not so fast that the water flows ahead of solid and semi-solid wastes.

Vertical drains should be plumb to allow the water and waste to fall as a unit (called a slug). On a horizontal run that drops to vertical, the turn can be abrupt. But a vertical drop that turns to horizontal, or a turn on a horizontal run, should have room to make a wide sweep and should have a cleanout, if practical.

If the drainpipe is plastic, it should be supported every 4 feet and nail guards should be installed to protect plastic drains if they are near the surface of studs or joists.

For sizing a drain, fixtures are rated in *drainage fixture units* (dfu). One dfu equals one cubic foot of water per minute. The specified dfu of a fixture determines the trap size and the individual drain which leads from it. Combined drains from several fixtures are sized based on the total dfu minus a factor based on the low probability that all the fixtures will discharge at the same time.

It pays to know the whys and wherefores of drains, vents, and traps — and to stay friends with your plumber

by Lanny Watts

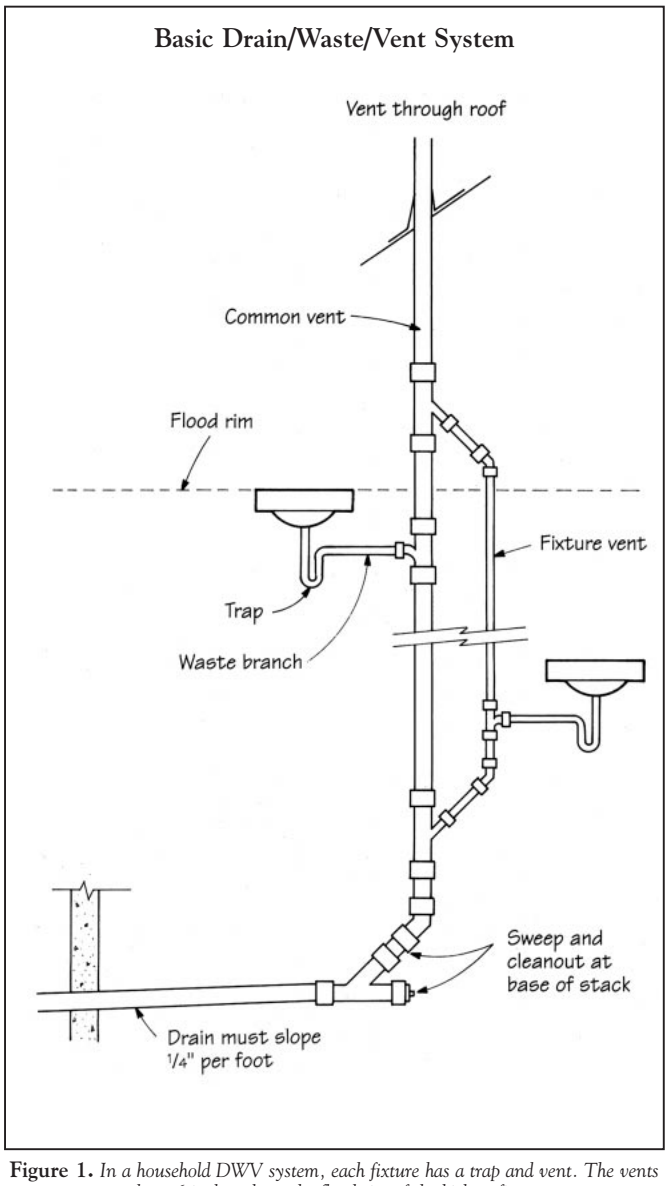

Figure 1. *In a household DWV system, each fixture has a trap and vent. The vents must connect at least 6 inches above the flood rim of the highest fixture.*

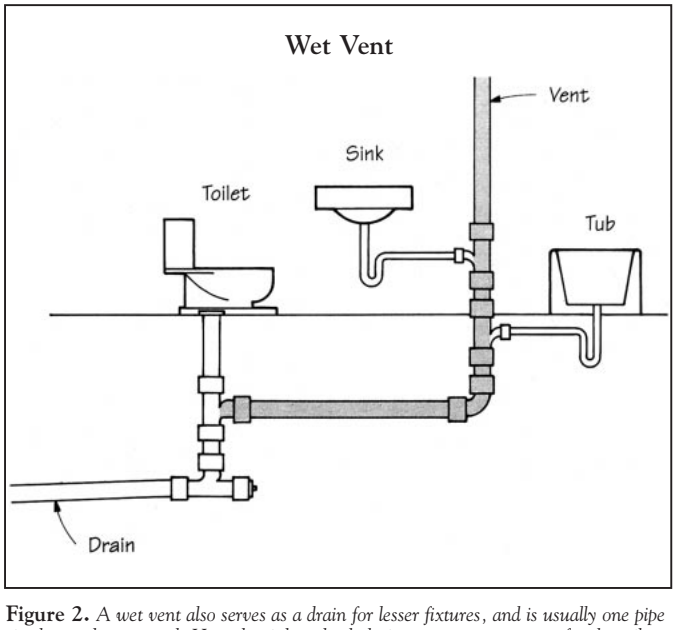

Figure 2. *A wet vent also serves as a drain for lesser fixtures, and is usually one pipe size larger than normal. Here the sink and tub drain serves as a wet vent for the toilet.*

Traps. As materials decompose in a drainage and sewer system, gases and odors are produced. The trap at each fixture holds a pocket of water, which is a highly effective seal for keeping the gases and odors out of the living space. As long as water remains in the trap and there is no undue pressure from the sewer gas, the occupants of the building are protected. (For a discussion of trap maintenance, see "Save the Seals," next page.)

Vents. The vent system is a continuation of the drainage system and penetrates the roof in one or more places. Its purpose is to maintain neutral pressure within the system by relieving positive pressure caused by the creation of sewer gases, and both positive and negative pressures caused by discharges traveling through the system. This keeps water draining smoothly and quietly, and keeps traps functioning properly.

Unlike drains, vents don't need to be sloped to maintain a smooth flow of waste. Horizontal runs simply need to be routed without any low spots where condensation could collect — 1% pitch is plenty. High points, which cause parts of the vent to drain in different directions, are not a problem.

Each fixture in a plumbing system must have a trap, and each trap must be protected by a vent. As a general rule, vents need to be at least half the diameter of the trap and drain they serve, but never less than 1¼ inches in diameter. Vents, like drains and supply lines, can be combined in a manifold. In this case, the pipe is sized to meet the combined dfu requirements.

A vent should rise vertically from the drain it serves until it is at least 6 inches above the highest flood rim (the top of a lavatory, for instance) of the fixture group it serves (see Figure 1). Plumbed this way, if a drain becomes plugged, the contents will overflow into the room before filling a horizontal vent. This eliminates the risks of leaving waste material behind to clog the vent, or of allowing the vent stack to act as a part-time drain.

Vents should only extend one foot above the roof and, in cold climates, they should be increased to at least 3- or 4-inches in diameter before going through the roof. This will eliminate frozen condensation in the pipe from closing the vent.

Vent terminations should be 8 feet above or 10 feet away from windows, roof decks, or ventilation inlets.

Wet vent. A wet vent is a vent pipe which also serves as a drain for a lesser fixture or fixtures (see Figure 2). It is usually sized one pipe size larger than normal. Because the vent is washed by the upper fixture, the vent can safely come off the drain horizontally. For health reasons a food preparation sink cannot wet vent a toilet.

Venting Problems

Sometimes just moving the location of a kitchen sink can cause venting problems. Some common problem layouts are:

- a sink on an outside wall with a window above it;
- a sink in a room with a low shed roof;
- a sink on a solid wall (log or concrete);
- an island sink in the middle of a room;
- or a sink over an unheated crawlspace.

Similar problems occur with other fixtures such as tubs and toilets. Generally the venting solutions are the same, but, of course, the drains, traps, and vents must be sized according to the dfu of each fixture.

Window sinks and low shed roofs. The drain and vent for a sink placed on a outside wall can be safely tucked just behind the drywall on the outside wall. All the insulation should be behind the piping, to keep condensation from freezing in the pipe. If the sink is in front of a window, the vent should rise to just below the rough opening and then bend around and up. Once at ceiling height, the vent should come across the ceiling into the main part of the house to minimize its exposure along an outside wall. This is true for a shed roof also. Doing this keeps the vent from penetrating along the edge of the roof. Unless absolutely necessary, the vent should also be reconnected with the main vent system and brought out through an upper roof to reduce the number of penetrations.

Island sinks and solid walls. A sink which is placed on a solid wall, or away from walls (island sink) needs either a *bow vent* or what I call a "*Nolan*" *vent*, named after the inspector who introduced it to me.

With a bow vent, the vent starts upward as a normal vent does, but then hangs a U-turn just below the countertop and drops down to run parallel with the drain (see Figure 3).

Once the vent is at the level of the horizontal drain it can do one of two things: 1) The vent can continue horizontally to the nearest available wall which will allow it to rise like a normal vent; or 2) the vent can connect back into the drain and a second vent is taken off at a location where it can rise normally.

The second layout would allow the vent to function as a drain should the actual drain become plugged in its vertical drop. Both setups require a cleanout, since, in either case, a bow vent will become fouled before a stopped sink overflows because it's below the flood

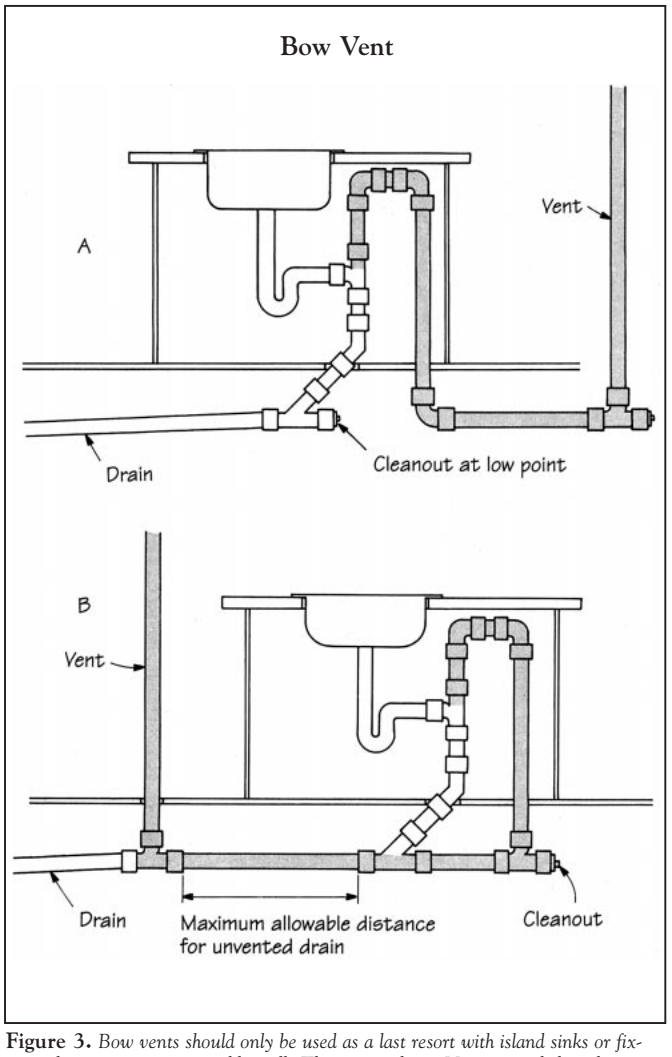

Figure 3. *Bow vents should only be used as a last resort with island sinks or fixtures that are not near a usable wall. The vent makes a U-turn just below the countertop, and drops to the level of the drain. From there, it either runs horizontally until it can rise like a normal vent (A), or connects back into the drain (B), which is vented as soon as possible.*

rim. For this reason, every bow vent must be preapproved by a plumbing inspector for a specific application. I try to avoid bow vents altogether.

A slightly bulkier, but mechanically simpler, solution is a "Nolan" vent (see Figure 4). This is basically a double-sized, single-fixture wet vent. From the 1 1/2-inch trap outlet, the drain runs horizontally to the corner of the sink base cabinet and discharges into a 3x1 1/2-inch tee. The top of the tee is capped with a cleanout and the 3-inch drain drops to below the floor. The drain remains oversized for its entire run, and a regular 1 1/2-inch vent is taken off at the first opportunity. This setup involves increased materials cost — especially if there is a long run to a full-sized stack — but it won't fail.

For fixtures over an unheated space. An unheated crawlspace creates a problem for the water supply more than for the drain. If the drain is pitched properly and protected from cold drafts and from small or continuous discharge, such as a drippy faucet, it will do fine.

Plumbing Problems Wanted

I'm interested in any plumbing problems builders out there might have, and tricks of the trade builders, plumbers, and other professionals have used to get around difficult plumbing problems. Please send your responses to JLC Plumbing Problems, RR #2, Box 146, Richmond, VT 05477, and I will respond to them in later issues. ■

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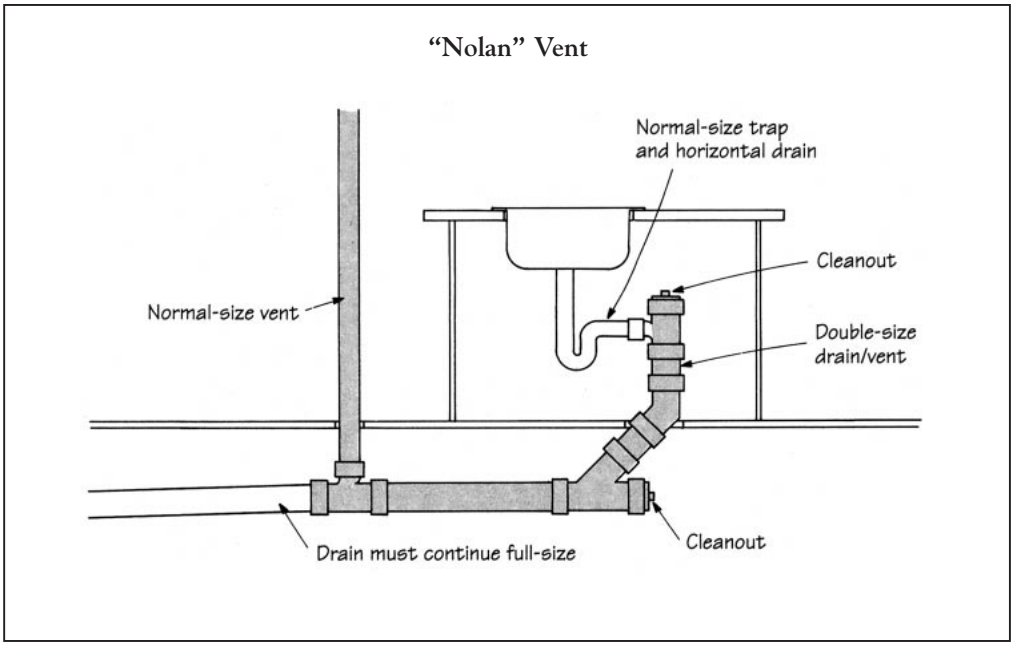
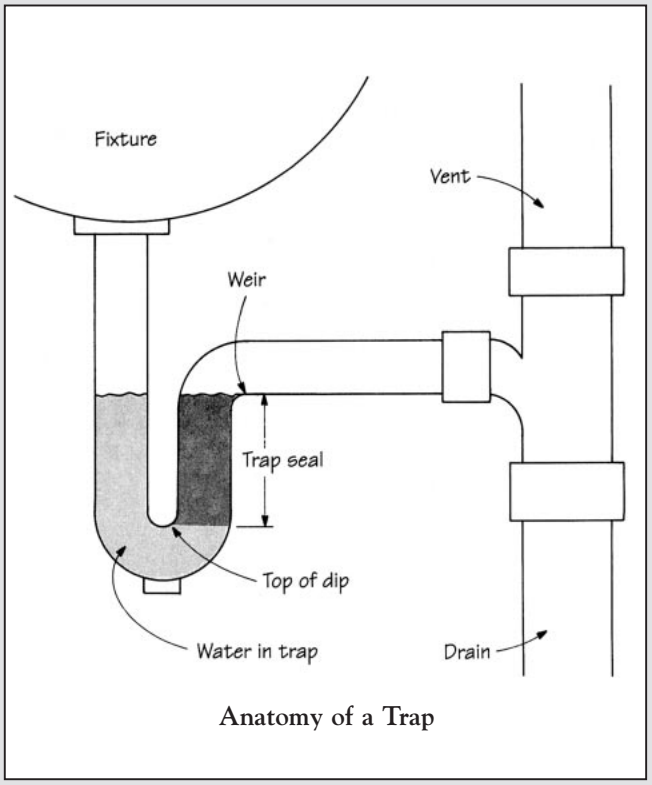


Figure 4. *A "Nolan" vent is a single-fixture wet vent, which must be double the size of the horizontal drain. This setup costs more in materials, but is more reliable than a bow vent for island sinks.*

Save the Seals



Anatomy of a Trap

When waste water leaves the sink, most of it flows out the horizontal drain. A small portion of the water stays behind in the trap, creating a seal to block gases.

Sewer gases may be unpleasant to smell, poisonous, explosive, or a combination of these. Traps prevent these gases from coming out of the drain pipes into the living space. Each plumbing fixture (toilet, shower, sink, etc.) in a building has to have some variation of a simple water seal trap.

Types of Traps

The standard trap is called a *P-trap*. Turned on its side, a P-trap resembles the letter p (see illustration). When wastewater leaves the sink, it goes down the vertical leg, around the U, and then most of it flows out the horizontal drain. A small portion of the water will be left behind in the trap and is known as the *water seal* or *trap seal*. The spillway where the water overflows from the U into the horizontal drain is called the *weir*. The top side of the lowest section of the U is called the *top of the dip*. The water located between the top of the dip and the weir forms the effective trap seal. Sewer gases forming and collecting in the drainage system will not normally pass through this barrier of water. The water in the inlet half of a trap, however, is not an effective seal because gases can bubble upward through it.

There are three common variations of the P-trap. A toilet has what is called an *integral trap*. The trap is actually a part of the toilet. The water we see in the bowl is matched by a trap seal of equal depth on the far side of the dip.

In some situations, where it would be hard to reach a P-trap to clean it, or where greater protection for the trap is required, a *drum trap* is used. A drum trap is typically the size and shape of a coffee can, and either the top or the bottom of the trap has a large threaded cover for cleaning. The depth of the water seal in a drum trap (about 4 inches) is greater than in a P-trap (about 2 inches), but drum traps are not accepted by every code.

The third common exception to the P-trap is called an *S-trap*. Instead of the outlet drain heading off horizontally, the trap bends and discharges vertically. S-traps are not accepted in any modern plumbing codes because they can fail easily.

When Traps Fail

Traps fail to function as gas traps when they lose their water seal. There are eight common ways this can happen: siphonage, oscillation, momentum, back pressure, evaporation, capillary attraction, aspiration, and mechanical failure. (In trade school, apprentice plumbers learn the word SOMBECA to remember every way except mechanical failure, which is presumably the most obvious.) Some of these problems can be reduced or eliminated through proper plumbing design. Others require that the trap be periodically inspected and maintained.

Siphonage. Anyone who has had to borrow a little gasoline from a friend's car is familiar with the effect of a siphon. When a siphon hose is filled, it will draw liquid from a high place to a lower place until the upper end of the hose is exposed to air. Water can siphon out of a trap if there is no air in the intervening pipe.

An S-trap will siphon at least some of its seal every time a large amount of water is drained. Siphonage is prevented by draining the water away from a trap horizontally, and by installing a vent pipe in the top of this horizontal drain.

A toilet trap also discharges downward and tends to siphon its contents. This, however, serves the function of a toilet well since it is required to carry away solid waste. The trap seal of a toilet is replenished by shunting a portion of the water that refills the tank into the bowl.

Oscillation. Oscillation is caused by pressure variations in the plumbing vents, especially those that penetrate the roof. On a gusty day, the air pressure in the drainage and vent system will fluctuate rapidly. This will cause the water in the traps to slosh back and forth. Every time the water sloshes, a little bit is lost over the weir. If enough water sloshes away, the seal is lost. Traps are designed to be deep enough to prevent this.

Momentum. The surface tension of water holds it together, so water tends to form into blobs, or *slugs*. If a slug has enough momentum, it can overcome gravity and travel up out of a trap. Placing the trap close to the fixture drain stops the slug from gaining enough momentum to overcome gravity.

Back pressure. When a fixture such as a toilet discharges a large volume of water, the resulting slug pushes air in front of it and sucks air behind it. Without proper venting, the air in front of the slug will push the water of other traps back into their respective fixtures. The trap seal will be temporarily lost and sewer gas will belch into the room.

Evaporation. In a seldom used trap, such as in a flood drain, the seal can simply evaporate away. The usual way of preventing this is to provide a regular source of water for the trap, either by periodically discharging water onto the floor surrounding the drain or by bleeding a small amount of water from a water supply line directly into the trap. This latter method is called a *trap primer*. If it is used, make sure your plumber takes precautions to prevent contaminated water from siphoning back into the supply system.

Capillary attraction. Capillary attraction is a form of absorption which can occur when a mass of hair or a piece of string is caught in a trap and extends down the drain. The strands will soak up water until saturated. Water can then drip off the lower end of the strands as a siphon. Smoothly constructed traps, sufficient volume of discharge water, and periodic maintenance are required to prevent this problem.

Aspiration. After a slug of water has passed a drainage branch that leads to another fixture, it will pull a vacuum on that line. Unless the trap is protected by a vent, the vacuum will suck the water seal from the trap.

Mechanical failure. If there is a crack in the trap, a broken gasket, or a crossed thread on a cleanout plug, the water will simply drip out.

So, the next time you go fishing in a trap for some matted hair, an earring, a chopstick, or perhaps a contact lens, think about all the horrid sewer gas it's been keeping out of the house… and of all the problems that were overcome to accomplish this.

— L.W.