



Pipe Size vs Pressure Over Distance

A 3/4 in copper line easily supplies 12 GPM at 100 feet. Stretch the same demand to 300 feet and 3/4 in loses too much pressure to fittings and friction, forcing a full size upgrade to 1 in copper.

A pipe that supplies plenty of pressure right next to the water heater can arrive at a fixture across the house running weak. The demand did not change. The distance did, and every foot of pipe eats a small amount of pressure to friction, whether or not a single fitting is in the way.

Friction loss scales with distance, not with the fixture

Water moving through a pipe rubs against the pipe wall, and that friction converts pressure into heat, a small, continuous loss that adds up over distance. At 3/4 in copper carrying enough flow for a 12 GPM demand, a 100 ft straight run at 6.6 ft/s loses about 11.2 psi to friction. Stretch that same pipe, same flow, to 300 ft and the loss triples to about 33.5 psi, because friction loss is close to proportional to length at a fixed flow rate.

A worked example: 12 GPM at 100 ft vs 300 ft

Run a 12 GPM demand through the pipe sizing engine at 100 ft of developed length and 3/4 in copper is the answer: friction loss 15.7 psi, pressure at the outlet 44.3 psi, comfortably above the 15 psi minimum. The sensitivity note on this result: 3/4 in copper holds 15 psi at the outlet out to about 287 ft of developed length at 12 GPM. Past that, it needs to step up.

Run the same 12 GPM demand at 300 ft, just past that 287 ft threshold, and 3/4 in copper no longer clears the 15 psi minimum. The recommended size becomes 1 in copper: friction loss 12.8 psi, pressure at the outlet 47.2 psi. Same demand, same fixture count, one size larger purely because the run got longer.

Developed length, not straight-line distance

"Developed length" is not the straight-line distance from the water heater to the fixture, it is the actual length of pipe run once every turn, rise, and fitting is accounted for. A run that looks short on a floor plan can have a developed length well past the straight-line distance once it climbs a wall, crosses a joist bay, and turns twice to reach the fixture. Sizing off the floor-plan distance instead of the true developed length is a common way this crossover gets missed.

Velocity matters alongside pressure

The bigger pipe does not just recover pressure, it also drops velocity, from 7.9 ft/s at 3/4 in down to 4.7 ft/s at 1 in in the 300 ft case. Lower velocity means less noise at the fixture and less wear on the pipe over time from erosion at fittings, a second reason the upsized answer at long runs is not just about clearing the pressure minimum.

Key takeaway. The same demand needs a bigger pipe as developed length grows, because friction loss scales with distance, not with the fixture at the end of the run. Always size off the true developed length, not the straight-line distance on a floor plan.

Assumptions

- Copper pipe, no fittings beyond straight run, 60 psi available at the source, 15 psi minimum required at the outlet, typical residential targets.

Sources

- Hazen-Williams friction loss equation (standard water-supply pipe sizing method)

Frequently asked questions

Why not just oversize every run to be safe?

A bigger pipe costs more in material and fittings, and past a certain point velocity drops low enough that flow can feel sluggish for high-demand fixtures. The right answer is the smallest pipe that clears both the pressure and velocity targets for the actual developed length, not the biggest pipe available.

Do fittings matter as much as straight length?

Yes. Each elbow, tee, or valve adds an "equivalent length" to the developed length, extra friction loss as if the pipe were physically longer. A run with several fittings can lose meaningfully more pressure than the same straight-line distance with a clean, direct path.

What happens if a pipe is undersized for its actual developed length?

Pressure at the fixture drops below a comfortable minimum, showing up as weak flow, especially when multiple fixtures run at once and compete for the same limited pressure budget. It is rarely a safety issue, but it is a real comfort and functionality problem that is expensive to fix after the walls are closed.

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