When you turn on a hot-water tap, it can take a long time before hot water actually arrives at the faucet. That’s not surprising, considering all the cold water that has to flow out first. For example, a typical bungalow in the San Francisco Bay area — where we work — might have a 60-foot-long ¾-inch-diameter hot-water supply pipe with an additional 10-foot-long ½-inch branch connection to the sink. That much pipe can contain more than 1 ¾ gallons of cold water. Assuming a flow rate of 2.2 gpm, it would take at least 47 seconds before hot water flowed out of the faucet. If the homeowners have a green conscience and have installed a 1.5-gpm reduced-flow aerator on the faucet to save water, they’ll have to wait even longer — 70 seconds — for the hot water to arrive. They’re wasting both water and time.

According to Gary Klein, an expert on water distribution systems, a typical family of four wastes about 10,000 gallons of water per year waiting for hot water. “Average hot-water usage is about 20 gallons per person per day, with a very large variation,” Klein says. “About a third of that, or 7 gallons, is water that runs down the drain while waiting for the hot water to arrive at the tap.” With water and sewer costs averaging about $0.006 per gallon nationwide, 10,000 wasted gallons adds up to about $60 worth of water annually.
Whole-House Circulation

To help solve this problem, my partner, Jim Lunt, and I have installed hundreds of hot-water circulation systems over the past 30 years. When we began, we took the traditional approach: We’d run a dedicated hot-water return leg from the farthest fixture on a home’s plumbing system back to its hot-water heater. These hot-water loops — which are sometimes designed to operate by gravity but more often use a circulating pump — bring heated water directly from the heater to the end of the branch close to each fixture, then return “cooled” hot water back to the heater, where it is reheated. By recirculating water through the loop, the pipes act as an extension of the water heater’s reservoir. Because there is not much cold water to purge from the system, it doesn’t take long for hot water to arrive at the faucet.

On-Demand Circulation

These days we primarily install on-demand hot-water systems. We like them because they deliver the hot water rapidly to all the taps on the branch, cutting
Hot-Water Circulation

way down on the amount of cold water wasted down the drain. They offer the same convenience as a whole-house system but without the energy penalty. We install both Metlund (800/638-5863, gothotwater.com) and Taco D’Mand (401/942-8000, taco-hvac.com) systems. Taco makes the circulating pump for both.

On-demand systems feature a high-head pump capable of quickly moving the slug of cold water standing in the hot-water supply pipe toward the farthest faucet on the branch, along with the fully heated water from the water heater behind it. This is in contrast to most whole-house circulation pumps, which are low-head and therefore move the water at much slower flow rates.

**How on-demand pumps work.** When the on-demand pump comes on, any cool water in the hot supply pipe is pushed into either a dedicated recirculation line toward the water heater (closed-loop configuration) or back into the cold-water supply pipe (open-loop configuration). As soon as the temperature sensor installed in the hot supply detects a 3°F to 5°F rise in the incoming water, the system’s electronic controller shuts the pump off.

**Open- vs. Closed-Loop Systems**

On-demand pumps are small enough to fit in a bathroom vanity cabinet or below the kitchen sink (**Figure 2**). We usually place the pump under the faucet that’s farthest from the hot-water heater, especially in a retrofit project. In a simple open-loop — or non-recirculating — installation, the pump module connects to the hot- and cold-water supplies with tee fittings located just before the angle stops. The pump can simply be plugged into the nearest 110-volt outlet. If the electrical circuit is already in place, it usually takes less than two hours to retrofit a house with on-demand hot water.

**Hot water return.** However, with new construction or during a large renovation, when extensive plumbing work is being done, we prefer to install a dedicated hot-water return leg from the farthest fixture on the branch line back to the water heater, creating a closed loop (**Figure 3, facing page**). This extra plumbing adds cost and isn’t absolutely necessary, but it allows us to place the on-demand pump at the water heater rather than in a bathroom, which eliminates a potentially

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**Figure 2.** On-demand hot-water kits are small enough to fit in a bathroom vanity cabinet (A,B). The kit shown in (A) includes a wireless switch for mounting on the counter and a remote receiver for installation in the cabinet. When retrofitted to existing plumbing, the pump is located at the fixture farthest from the hot-water heater. A pair of tees installed behind the angle stops (C) create an open loop between the hot- and cold-water lines. When the pump is activated, the slug of cool water in the hot line is pushed back to the water heater via the cold-water line. The pump runs only a few seconds, until a sensor detects a rise in the temperature in the hot line.
bothersome source of vibration and noise.

The dedicated leg also eliminates the possibility that small slugs of warmed water will be pushed into the cold-water supply line, which, in our experience, can happen with certain open-loop systems. For example, we’ve found that the temperature-sensitive cartridges in the Grundfos Comfort system, an open-loop whole-house circulation system, often fail, allowing hot water to come out of the cold-water tap. With a hot-water return pipe, this can never happen.

**Controls**

On-demand pumps are activated by the user — either manually or via motion sensors. As a result, hot water is delivered only when it is actually needed. Eliminating the timer significantly reduces the actual runtime of the pump compared with a whole-house circulation system. It also minimizes standby heat loss from the hot-water pipes and keeps the water heater from firing unnecessarily.

*Manual switches.* The typical manual system uses

**Figure 3.** When possible, the author prefers to install the on-demand circulating pump at the water heater in a closed-loop configuration. The pump can be activated by any number of manual switches or motion detectors located near fixtures on the hot-water line.
a hard-wired low-voltage push button — just like a doorbell switch — to trigger the pump (Figure 4, facing page). After pushing the button, which is generally located on the countertop or cabinet face, the user waits 10 to 20 seconds (or until the low whirring sound of the pump stops) before turning on the hot tap. If the wall framing is reasonably accessible, we can hard-wire several low-voltage switches together — one at each tap on the branch — to control the pump. If the framing isn’t particularly accessible, we’ll use wireless remote-control switches along with a small receiver connected to the master controller.

Motion-detector switches. Some of our customers prefer that the system be triggered automatically, by motion detectors. Like on/off switches, these wireless motion sensors can be placed in several bathrooms and configured to communicate with a single pump, which, depending on the system, is located either downstream at the farthest fixture or back at the water heater. When the motion detector in any bathroom is activated, hot water moves along the main line supplying all the branches. The pump runs for only about 20 seconds at a time, so if it is activated but the faucet isn’t turned on, the energy penalty is minimal.

We typically install any necessary low-voltage wiring but leave the AC work to the electrician. Because even the largest on-demand pump draws a mere 1 or 2 amps, the only electrical requirement is an outlet located near the water heater or in the vanity cabinet. In some code jurisdictions, these outlets may need to be GFI-protected.

Sizing the Pump
The single-speed pumps used in on-demand systems are sized according to the length and diameter of the pipe in the branch and the flow resistance through
the piping and the water heater, known as “head loss.” The higher the head capacity of the pump, the more resistance it can overcome. For example, the smallest of the three Taco pumps used in Metlund and Taco systems produces 1/40 hp at 3,250 rpm, is rated at 8 gallons per minute, and has a total head of 10 feet. The largest pump produces 1/8 hp, is rated at 28 gallons per minute, and has a total head of 30 feet. Matching the pump to the system is important. If we oversize the pump, we risk pipe corrosion, which happens when water pumped too rapidly erodes the copper pipe wall. (This is more of a problem with whole-house recirculation pumps, especially ones that operate almost continuously.) On the other hand, if the pump has a lower head than the piping system, it won’t circulate any water at all.

On-demand pumps can be used with tankless water heaters, but because these heaters require a minimum flow of water before they activate, we always spec the largest pump size (Figure 5). The pump also has to overcome friction loss, caused by the turbulence of water moving through the piping within the heater itself.

Cost
Prices for on-demand systems vary depending on the size of the pump and the type and number of controllers, but we typically charge between $750 and $1,250 per installation. Prices for the least-expensive hard-wired undersink kits start at about $400 and range up to about $900; plumbing a dedicated return leg or wiring a new outlet can add significantly to the installed cost. In homes where hot-water supply pipes travel in more than one direction — for instance, to two separate wings of the house — more than one pump may be required.

Payback. On-demand systems will always cut down on wasted water, but payback depends on such factors as the owners’ usage habits; the size and design of the piping; annual runtime of the pump and local utility rates; and local water and sewage fees, which can be high in areas subject to water shortages. In our area it may take a few years, but these systems do pay for themselves.

Leigh Marymor is a plumbing contractor in Emeryville, Calif.
## Qualifications & Affiliations

**CA State Contractors Licenses**
- C4 (boiler)
- C16 (fire sprinkler)
- C36 (plumbing)

**Green Plumbers USA**

**Plumbing, Heating, Cooling Contractors of California**

**Diamond Certified**

**EPA**
- Certified

**U.S. Green Building Council**
- Certified professional

**Radiant Panel Association**
- Certified designer
- Certified installer

**Net Zero Energy**
- Member

**Good Service Guide**
- Referred

**International Association of Plumbing and Mechanical Officials**

**The Splinter Group**

**Viessman Boilers & Controls**
- Trained & certified

**Rinnai**
- Trained

**Munchkin Boiler & Vision Control**
- Trained & certified

**As seen on Boiler-Companies.com**

**TracPipe**
- Flexible gas piping certified

**Tekmar**
- Certified control designer

**Plexco**
- Heat welded underground gas piping certified

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John Boe
Matarozzi/Pelsinger Builders

We use Lunt Marymor when we want to guarantee the right outcome. Excellent people, excellent work, excellent service. The people who run our jobs ask for Lunt Marymor time and time again. From complex to simple, Lunt Marymor handles our plumbing work. When you’ve been in business as long as we have, you come to rely on good subs - and that's Lunt Marymor. When you want it done right, call these guys - they're one of the best, reliable, service oriented folks - highly recommended!

Steve Nicholls
MuellerNicholls

Why would anyone want to use L/M for their plumbing contractor? I would only recommend them if you want your p.c. to provide you with a thorough analysis of the plumbing aspects of your project; if you want your p.c. to field a knowledgeable, competent team of plumbers that will work with you and/or your foreperson as a team; if you want a fair price for the work and if you want the assurance that the work will not come back to haunt you. Otherwise, I can’t think of a single reason to use them!

Larry Hayden
Federal Building Co.

Ms. Angie McLane
Service Manager
The Lunt Marymor Company, Inc.

I wanted to let you know how happy my wife and I were with the work your company did in installing our new lateral and in correcting the numerous deficiencies on the underside of our house. I am in charge of almost 40 million square feet of real estate across the country and have dealt with hundreds of contractors over the 30 years that I’ve been in business. It is rare for them to appear at a job site on time, to come prepared with the necessary parts and tools, to do what they say they're going to do, and to finish the project on time and on budget. Lunt Marymor, on the other hand, met each and every one of these objectives. To top it off, Antonio and his helpers were courteous, conscientious, and honest. I told you previously that we thought Antonio walked on water and that statement is hardly and embellishment. I meant every word of it and am still surprised that people of his caliber still exist in this world.

What surprised me the most was the work you did on a time and material basis. In the real world, a T&M job is like writing someone a blank check. You gave an estimate of what the work would cost and said you rarely exceeded estimates even though there was no stipulated fee. I am aware of the many obstacles your guys ran into (boulders, City of Walnut Creek, tight working conditions, etc.) and really expected you to exceed your estimates. However, you came in right where you said you would and even ate some of the costs to ensure that you didn’t exceed budget. When the City Inspector did his final last week, he made it a point to tell us what a professional job your guys did. That's a first as far as I am concerned.

I’d better stop with the compliments before this sounds too good to be true. After all, this is supposed to be a thank you letter and not a commercial. However, before I close, I want to thank you and your company for doing such a great job and, second, thank you for restoring my faith in commercial contractors!

John L. Rossi
Senior Vice President, Director of Operations
AMB Property Corporation