BuildingGreen

BuildingGreen's Guide to

# GREEN PLUMBING PRODUCTS

*Simple, clear criteria for selecting efficient fixtures and healthier materials*

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## About BuildingGreen

BuildingGreen combines insight with information, creating knowledge that informs practice. We provide design and construction professionals with practical insights, engagement opportunities, and software resources to exceed clients' energy and environmental performance expectations.

Readers of this guide are eligible for continuing education credits from the AIA, ILFI, and GBCI. To claim your credits, take the quiz at BuildingGreen.com/PlumbingGuide.

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## What Makes Plumbing Green?

*People like a clean flush and a long shower, but water is getting scarcer. Selecting the right building products can meet both needs.*

People want a hot, luxurious shower or bath. They want a toilet that doesn't make them think. People want to use the urinal, not smell it. They want the faucet water to wet their hands—not bounce off them.

And most people don't want to think about water scarcity, especially when they're enjoying that shower.

The good news is that plumbing fixtures and accessories have come a long way in the last 20 years. Even as some project teams continue to install ultra-luxurious, ultra-wasteful baths, it's more common to see efficient, easy choices that satisfy first-world sensibilities *and* sustainability objectives.

In this guide, we'll connect you to those options and also put water conservation choices in context with human comfort, energy use, material use, and other issues that affect sustainability and budget.

### About Water Scarcity

Since you're probably not reading this in the shower, let's take a moment to look at the water problem.

The U.S. Forest Service said it would spend more than half of its budget in 2015 on fighting wildfires due to severe drought in the West. In Brazil, rolling power outages resulted from a lack of water in hydroelectric dams. Central and southern Africa are joining eastern African nations in massive food shortages due to historic lack of rain.

While those all might seem like someone else's problem (unless you happen to live there), even water-rich regions are not immune to water issues. Severe weather, sea-level rise, flooding, overdevelopment, poor farming practices, and toxic spills make clean, fresh water—already a scarce resource—even more rare (see Warm Globally, Flood Locally: Water Crises Loom for U.S. Cities).

### Green Products and Our Mission

Part of BuildingGreen's mission since 1992 has been to look for the greenest building products available and to share that knowledge to build more liveable, more effcient, healthier buildings.

Once housed in three-ring binders and then in a database focused only on green products, our green building products expertise is now embedded in BuildingGreen.com.

We rely on third-party testing and other criteria when vetting products (see What Makes a Product Green?). To give you an even better idea of why we feature the products we do, we have created a series of product guides that explain the problems with the industry norms and how we identify building products that mitigate those problems.

Even in locations with plenty of water, like New York City, sewage overflow from overloaded infrastructure can create unsafe, polluted waterways.

Climate change and population growth are global problems requiring large-scale solutions. But when it comes to water conservation, a big solution requires a lot of small, individual choices in order to be successful.

## How this guide can help

In this guide, we look at plumbing products, covering everything from faucet aerators to heat-pump water heaters.

As you read through the guide, you will see that plumbing products can affect the environment in ways that go far beyond water consumption. These guides are living documents, so expect them to evolve along with the industry (remember when CFLs were green?).

Following are the primary Green Attributes that BuildingGreen uses to select plumbing products, and what to look for in each area.

## Conserves water

Low-flow fixtures are nothing new, but BuildingGreen picks the most water-efficient products that still meet or exceed handpicked performance standards.

Toilets and commercial flush valves should save the most water possible while still removing solids, and we include explanations of our required standards. While dual-flush and high-efficiency toilet (HET) models are still great choices, we also highlight new ultra-high-efficiency toilets technologies that redefine how toilets operate—as found in Niagara's Stealth toilet, a BuildingGreen Top-10 product selection.

Also look for ultra-high-efficiency urinals, showerheads, faucets, aerators, pre-rinse spray valves, and other products. We also list products that use no water, such as non-water urinals and composting toilets.

## Energy-conserving equipment

When we associate energy and plumbing, we normally think of products that consume energy, such as water heaters.

Unfortunately, people often overlook the most important part of the water–energy connection: it takes a lot of energy to treat, pump, and deliver potable water and then more to remove it as waste. Always select the lowest-flow fixture that will meet performance standards, in addition to using as little heated water as possible.

This plumbing guide provides a discussion of our efficiency requirements for these products and for innovative heat-pump models that are far more efficient.

Replacing old showerheads or retrofitting low-flow aerators in commercial faucets, for instance, will save a significant amount of water and the energy required to heat it, with a relatively small investment. These savings are magnified in high-use fixtures that demand a lot of hot water, such as pre-rinse spray valves used in commercial kitchens.

But even if the water spirals down the drain, all is not lost. You can also read about heat exchangers that recapture this waste heat.

## Avoids hazardous ingredients

Materials really do matter in plumbing products, especially when those materials carry your drinking water.

BuildingGreen selects the most environmentally responsible products available, in terms of both materials and installation. That can be a challenge for categories such as domestic water piping and drain, waste, and vent piping.

PVC is by far the most-used pipe material and is a challenge to replace in a budget-conscious building project because it is inexpensive, light, and familiar to trades. But PVC has significant impacts throughout its life-cycle (see The PVC Debate: A Fresh Look).

In these sections, you will find information on PVC alternatives, including a discussion of vitreous clay, an ancient, natural building material that still works in the right application.

## Reduces operational pollution or waste

This plumbing guide also lists a variety of products that capture, store, treat, and filter water (gray and potable). Capturing, storing, and treating rainwater and graywater is a much needed, developing industry.

Building codes—along with the low cost of fresh water—have limited the adoption of such products in the U.S., but prolonged droughts are changing that. BuildingGreen looks at a number of rainwater catchment systems and graywater products that balance storage and safety. Many of these come from drought-stricken Australia, where they are more common.

After all the water is used, it has to be returned to the Earth in an environmentally responsible way. Our plumbing guide also provides an overview of wastewater systems that mimic natural processes and reduce the demands on our overstressed treatment facilities.

# COMMERCIAL PRE-RINSE SPRAY VALVES

*Some older pre-rinse spray valves found in large commercial kitchens can use as much as five gallons per minute (gpm) of water for up to four hours a day.*

## BuildingGreen-Approved Spray Valves

Pre-rinse spray valves listed by BuildingGreen:

- use a maximum of 1.15 gpm at 60 psi
- and can clean a test plate in 22 seconds or less, as measured by Pacific Gas & Electric's Food Service Technology Center or other third-party testing using ASTM F2324-03

For sprayers that demonstrate exceptional water savings below 1.00 gpm, BuildingGreen allows a cleaning time of up to 26 seconds. Similarly, valves that have a slightly higher gpm are approved if cleaning time is below 18 seconds.

## Performance and Environmental Considerations

About one-third of all water used in restaurants is consumed by pre-rinse sprayers to remove food from dishes before being loaded into the dishwasher. They are a colossal waste of water and the energy used to heat it, and they also increase the demands on wastewater treatment.

Today's spray valves use high pressure and improved spray patterns to remove food from dishes, and though federal standards for pre-rinse spray valves are now 1.25 gpm with a cleanability of 26 seconds, there are many models that exceed these criteria.

Photo: Artaxerxes. License: CC BY SA 3.0.

*Pre-rinsing dishes can use a significant amount of water; spray valves can minimize this waste by using higher pressure.*

## Read more online:

» Faucets That Combat Infection Without Wasting Water

» Water: Doing More With Less

» Innovations in Water Conservation Products

# COMPOSTING TOILET SYSTEMS

*Conventional wastewater treatment requires huge amounts of energy and clean water. There are other problems as well: overloaded sewers contaminate waterways with raw sewage, and that "waste" we flush down the toilet is loaded with nonrenewable agricultural nutrients that harm downstream ecosystems.*

## BuildingGreen-Approved Toilets

BuildingGreen approves composting toilets that are designed either for interior installation or as standalone systems for nature centers and other settings.

## Why Composting Toilets?

Composting toilets convert human waste into nutrient-rich fertilizer for nonfood plants, rather than mixing the waste with potable water and flushing it down the drain.

They're not for every project, but they do warrant consideration. Composting toilets use very little or no water, depending on the model, thus avoiding pollution of potable water for the sole purpose of moving human waste around.

Although the humus and liquids generated by composting toilets cannot legally be used to amend soil in some places, composting toilets have the potential to help us recover valuable nitrogen, phosphorus, and other nutrients in the future if these regulations change.

Energy use from pumping wastewater over long distances also represents a significant portion of the overall impacts of centralized wastewater treatment, according to a Cascadia Green Building Council life-cycle analysis, detailed in its report Clean Water, Healthy Sound. Composting toilets use relatively little energy and do not pollute water, making them the most sustainable choice, according to the analysis.

More high-profile projects are questioning our assumptions about where composting toilets make sense. The six-story Bullitt Center, a downtown office building in Seattle, reports great success with its composting toilet system.

*(continued)*

Photo: Alex Wilson

*Composting toilets at the Bullitt Center drop waste into these basement composters. Both leachate and compost are taken monthly to amend soil in a nearby forest.*

## Read more online:

- Waste Water, Want Water
- Alternative Water Sources: Supply-Side Solutions for Green Buildings
- Phoenix Composting Toilet Sets New Standard
- World Trade Center Construction Uses Onsite Composting
- Urine Collection Beats Composting Toilets for Nutrient Recycling
- Take Control of Your Materials: Four Empowering Lessons from Teams That Beat the Red List
- How to Succeed with the Living Building Challenge: 12 Teams Share Tips

Advantages of composting toilets include dramatic reductions in water use, reduced groundwater pollution or sewage-treatment impacts, resilience (ability to operate during water shortages), and recycling of nutrients.

Some composting chambers can be used with microflush and foam-flush toilets, though most use no water. Proper sizing is critical for effective composting; a model with undersized capacity won't function appropriately. If composting toilets are used, graywater treatment and disposal still need to be addressed.

## Watch for energy use and PVC

Project teams pursuing net-zero water, net-zero energy, or PVC avoidance—such as Living Building Challenge projects—should be aware that:

- most composting toilets require low-wattage ventilation fans running continuously; factor these into energy calculations
- some models use small amounts of water for every flush
- some toilets include PVC components, so vet materials before specifying

# DOMESTIC WATER PIPING

*Pipe that delivers domestic water in North America is made from copper, chlorinated polyvinyl chloride (CPVC), cross-linked polyethylene (PEX), and sometimes polypropylene (PP), all of which present environmental challenges.*

## BuildingGreen-Approved Domestic Water Piping

BuildingGreen approves polypropylene piping, which is made of nonhalogenated plastic and contains no heavy metals or brominated flame retardants.

## Health and Environmental Considerations for Domestic Water Piping

The raw materials used for some domestic water piping can have a significant negative impact on the environment, and sometimes on the end user. Below are some of the most common materials and their impacts:

- CPVC has toxic manufacturing intermediaries, requires the use of hazardous solvents for welding the joints, and can generate highly toxic dioxins in the case of accidental fire or improper incineration.
- Copper's environmentally intensive extraction and manufacturing process make it a poor performer in terms of life-cycle environmental and human health impacts, according to recent studies.
- PEX piping is flexible and easy to install and does not require solvents or flames for installation, but it can't be recycled, and in most cases is oxygen permeable so chemicals can penetrate the tubing, such as when in contact with contaminated soil. PEX has also been linked to chemical leaching in recent studies. We do not approve any PEX, but if it is chosen for drinking water, PEX-c is generally preferable since past studies as well as recently released research suggest it is more chemically stable than PEX-a and PEX-b.
- Polypropylene (PP) piping is made from petrochemicals, but this rigid piping can be recycled into other products, is low in toxicity, and is typically heat-fused together without the use of solvents or flames.

Photo: Aquatherm Piping Systems, LLC

*Fusiotherm polypropylene pipe connections are heat-fused, resulting in joints that become monolithic (the pipe and fitting become one piece of plastic).*

### Read more online:

- » A PEX-like Pipe Without the Cross-Linking Chemicals
- » New Polypropylene Pipe Aims at PVC, Copper, and Steel Replacement
- » Harmful Chemicals May Leach from PEX into Drinking Water
- » Scorecard Shows Some Plastics Are "Cleaner" Than Others
- » Fusiotherm Polypropylene Piping from Aquatherm

# DRAIN, WASTE AND VENT PIPING

*Piping used for drains, waste stems, and vents is typically made from materials such as PVC or cast iron, which are durable but have significant manufacturing and other life-cycle impacts.*

## BuildingGreen-Approved Drain, Waste and Vent Piping

BuildingGreen lists polypropylene and polyethylene piping products, which are made of nonhalogenated plastic and contain no heavy metals or brominated flame retardants.

BuildingGreen also lists vitrified clay pipe for its long service life and chemical resistance, but clay should be used exclusively for gravity sewers as these pipes often do not have high-pressure ratings.

## Health and Environmental Considerations

Drain-waste-vent systems remove sewage and graywater from a building through a system of pipes that usually rely on gravity. However, in some cases, sewage ejector pumps are used, in which case piping must be able to handle pressure loads.

Most DWV piping used today is made from PVC or ABS plastic. Both of these have toxic manufacturing intermediaries and require the use of hazardous solvents for welding the joints. PVC can also generate highly toxic dioxins in the case of accidental fire or improper incineration. Polypropylene (PP) piping is made from petrochemicals, but this rigid piping can be recycled into other products, is low in toxicity, and is typically heat-fused without the use of solvents or flames.

Though it doesn't carry the pressure ratings required for some applications and it is labor-intensive to handle, vitrified clay is used in some projects as a drainage pipe. It is most commonly used for larger-diameter sewage applications (where it competes with concrete and PVC), and although heavy and labor-intensive, vitrified clay is chemical and corrosion resistant and is estimated to have a life cycle of 100 years.

## Graywater and Purple Pipes

Most graywater recovery sytems require seperate plumbing, in which case purple colored pipes are sometimes used (or required by code) to distinquish from pipes carrying blackwater. Purple pipes should be held to the same material and performance standards as other dmv piping.

*Vitrified clay is an ultra-low-impact piping solution for certain applications.*

## Read more online:

- » New Polypropylene Pipe Aims at PVC, Copper, and Steel Replacement
- » Piping in Perspective: Selecting Pipe for Plumbing in Buildings
- » Scorecard Shows Some Plastics Are "Cleaner" Than Others

# FAUCETS

*Faucets with high flow rates can waste water—not to mention the energy used to treat and deliver it to our buildings—and the additional water stresses our wastewater treatment systems.*

## BuildingGreen-Approved Faucets

BuildingGreen approves the following products:

- commercial and residential bathroom faucets with a flow rate of 1.0 gallons per minute or less
- aerators, including adjustable-flow models, and flow limiters with a flow rate of 1.0 gallons per minute or less
- foot controls or other controls that temporarily shut off the flow during washing to minimize water loss
- recirculation equipment that minimizes water loss through plumbing

## Environmental Considerations for Faucets

Our potable water requires significant amounts of chemicals and energy to process and deliver to homes and other buildings and, once used, requires wastewater treatment. High-flow-rate bathroom faucets waste water during every handwashing, and for commercial properties, this waste adds up and can be significant.

The U.S. Environmental Protection Agency's WaterSense program specification for bathroom sink faucets allows a maximum flow rate of no more than 1.5 gpm for bathroom faucets, 32% below the industry standard of 2.2 gpm. There is no specification for kitchen sink faucets, since kitchen sinks are often used to fill pots, and a lower flow rate is not always optimal. Several manufacturers offer kitchen faucets with a flow rate of 1.5 gpm, but foot or knee controls can reduce water waste while still providing convenience.

Faucets can be retrofitted with aerators and flow limiters to cost-effectively reduce the flow rate as well; some are adjustable and can be good choices for kitchen sinks in particular.

Other water-saving devices, such as recirculators, can prevent wasting water while waiting for hot water.

Image: Rada

*Digital thermostatic faucets and showers from Rada are specially engineered to conserve water while preventing healthcare-associated infections like Legionella.*

### Read more online:

- » How Low-Flow Can You Go with Plumbing Fixtures?
- » A Foot-Control Faucet for Convenience and Savings
- » Faucets That Combat Infection Without Wasting Water
- » 6 Ways Our Household is Saving Water—And Energy
- » Innovations in Water Conservation Products
- » On-Demand Hot-Water Recirculation System from Taco
- » An Efficient Retrofit for Commercial Hot Water on Demand
- » The Water-Energy Connection
- » Emerging Technologies Address the Water-Energy Nexus

# GRAYWATER SYSTEMS

*Graywater can be treated and used for irrigation or toilet flushing, reducing significant burdens on municipal drinking water and wastewater treatment systems.*

## BuildingGreen-Approved Graywater Products

BuildingGreen approves products that are used in graywater systems for collection, treatment, and reuse.

## Environmental Considerations with Graywater

Graywater is wastewater that has been used in clothes washers, showers, bathtubs, and lavatory sinks.

In some parts of the country, graywater may be collected using separate drainage pipes—typically colored purple—then filtered and temporarily stored (without treatment) before being distributed in subsurface outdoor irrigation.

There are also systems that direct lavatory washwater to an adjacent toilet tank to be used (after limited treatment with disinfectant) for toilet flushing.

Graywater systems are worth considering in areas where droughts have resulted in restrictions on potable water use outdoors or in projects where either water use reduction or wastewater reduction is a high priority.

Whole-building graywater systems are most practical for buildings that have outside landscape area where subsurface irrigation is feasible.

Photo: Water Wise Group, Inc.

*The Aqua2use graywater system collects water from the shower, laundry, and bath and channels it through a four-stage filtration system.*

### Read more online:

- » Modular, Onsite Graywater Systems
- » Graywater Collection and Use
- » Using Graywater for Landscape Irrigation
- » Net-Zero Water and More: Moving Beyond "Low Flow"
- » Waste Water, Want Water
- » Alternative Water Sources: Supply-Side Solutions for Green Buildings

# HEAT-PUMP WATER HEATERS

*Conventional water heaters use fossil fuels or electrical resistance and have serious efficiency limitations.*

## BuildingGreen-Approved Water Heaters

BuildingGreen approves heat-pump water heaters certified by Energy Star, which certifies heat pump water heaters with an Energy Factor of 2.0 or greater and a "first-hour rating" of 50 gallons per hour or greater.

First-hour rating is the amount of hot water a storage water heater can supply per hour.

## Energy Savings from Heat Pumps

Electric heat-pump water heaters use compressors to evaporate and condense refrigerant in a closed loop, pulling heat from the air—similar to an air conditioner—and transferring that heat into water stored in an insulated tank.

They are available as retrofits that connect to standard storage-type water heaters, or as standalone products with integral tanks.

A heat-pump water heater can achieve an energy factor of 2.0 or higher, while a storage-type electric water heater relying on electric-resistance heating elements has a theoretical maximum energy factor of 1.0.

The performance of some of these products is measured using "coefficient of performance" or COP, but there is no standard for COP, so manufacturer claims may not be comparable.

## Heat pumps in winter

Heat-pump water heaters dehumidify and cool the air where installed, so when located in conditioned space, they help reduce summertime air-conditioning costs and improve comfort.

But in the winter, such a heat-pump water heater increases heating loads by cooling the surrounding air. Depending on the climate and the building, heat-pump water heaters may be installed in the living space, garage, basement, or attic.

They should not be installed in a space that will fall below 40°F (4°C). Be aware that heat-pump water heaters contain fans and compressors, so they produce noise similar to that of a refrigerator.

Photo: GE Appliances


*The GE GeoSpring heat-pump water heater is a quiet model made in America.*

## Read more online:

- » Heat-Pump Water Heaters: A Primer
- » Heat Pump Water Heaters in Cold Climates: Pros and Cons
- » Picking a Water Heater: Solar vs. Electric or Gas Is Just the Beginning
- » A Look at Heat Pump Water Heaters
- » An Affordable Heat-Pump Water-Heater Retrofit
- » Heat-Pump Water Heaters Ready for Prime Time

# PLUMBING ACCESSORIES

*Water leaks waste water and damage buildings, while uninsulated pipes waste energy.*

## BuildingGreen-Approved Plumbing Accessories

BuildingGreen approves a variety of plumbing accessories:

- Leak detectors: According to the U.S. EPA, a leaking toilet can waste up to 200 gallons of water per month.
- Insulated plumbing: Low-emitting insulation options that fit various end uses. Approved products avoid common toxic ingredients.
- Drinking fountains: Pressure water coolers are made from durable materials, are well insulated, and contain energy-efficient compressors and low-flow bubblers. We prefer products with a bottle filler and a replaceable water filter certified to ANSI 42 and 53.
- Maintenance equipment: Products listed have a low environmental impact and focus on healthy cleaning practices, including energy efficiency and water conservation.
- Water pumps: Manually operated pumps that can be installed on standard shallow and deep wells

## Energy, Water, and Health Considerations

Along with reducing heat loss or heat gain in residential and commercial plumbing, insulation serves a number of other important roles:

- It protects occupants from burning hot pipes and noise.
- It can speed the delivery of hot water in residential and commercial buildings.
- It can extend the life of heating and industrial process equipment by improving system efficiency and reducing cycling.
- It can eliminate condensation on cold-water supply lines, chiller pipes, roof drains, and toilet tanks, thus preventing water damage and mold growth.
- It can reduce unwanted heat gain into conditioned spaces, thus reducing cooling loads.

*(continued)*

Photo: FloLogic, Inc.


*A FloLogic whole-house water sensor is installed on a home's incoming water line, where it can detect leaks as small as 0.5 ounces per minute; once the leak is detected, the unit shuts off the water supply, reducing waste and preventing property damage.*

### Read more online:

» Piping in Perspective: Selecting Pipe for Plumbing in Buildings

» Detect Leaks Before They Ruin Your House

» Mineral Wool Insulation Entering the Mainstream

Plumbing insulation is available in a variety of materials, including foamed polyethylene, AB/PVC flexible foam, fiberglass, polyisocyanurate, cellular glass, calcium silicate, and mineral wool.

It is available unjacketed or with an all-service jacket (ASJ) exterior. ASJ exteriors come with varying degrees of durability, moisture permeability, and flammability. Factors determining which insulation material to choose include:

- pipe temperature
- ambient temperature
- potential exposure to weather, moisture, chemicals, or abuse
- environmental characteristics of the insulation material and jacket, which may include halogenated flame retardants

For hydronic heating pipes that experience high temperature (over 150°F), inexpensive foam-plastic pipe insulation sleeves may not be adequate; high-temperature pipe insulation is required, such as products made from mineral wool for cellular glass.

## Drinking water

Municipal water quality in the U.S. is considered to be among the best in the world. Regulated by the EPA, tap water is delivered to millions of Americans at a very low cost, and it is generally considered very safe, though it may contain residual chlorine from the water treatment as well as other contaminants, such as lead and arsenic (in some areas). Drinking fountains and water coolers, typically required in commercial and institutional buildings, usually deliver drinking water in fountains (bubblers), but they may also provide convenient dispensers for filling bottles, thus helping to reduce the need for purchase of water in throw-away plastic bottles.

BuildingGreen considers tap water fountains and dispensers superior to another option for drinking water delivery: bottled-water dispensers, most of which use polycarbonate plastic carboys that are delivered by truck, that contain bisphenol-A in the polycarbonate, and that may use significant energy for chilling and (in some cases) heating.

BuildingGreen does not approve these bottled-water dispensers; however, Energy Star does certify relatively energy-efficient models of this type.

## Manual pumps

Standard water pumps used for domestic wells are are vulnerable to power outages, leaving households without water. We approve modern, manually operated pumps that can be installed on standard shallow and deep wells. Some models may be able to be easily switched to solar-powered operation.

These hand pumps can provide clean, potable water, even during power outages or other service interruptions, help make homes and communities more resilient and less reliant on emergency supplies that may involve fuel-powered generators or truck delivery.

# RAINWATER CATCHMENT AND STORAGE

*Rainwater capture is increasingly important as shortages put pressure on our water systems.*

## BuildingGreen-Approved Rainwater Harvesting

We approve a wide range of rainwater catchment and storage systems and components, with an emphasis on unique performance features.

We prefer low toxicity and high recycled content.

## Environmental and Health Considerations

Rainwater harvesting is the practice of collecting and using rainwater, most commonly from roofs.

Use of collected rainwater can provide building owners with high-quality soft water for irrigation and potable uses, reduce pressure on water-treatment plants, and reduce stormwater runoff and flooding. To use captured rainwater as potable water, filtration and purification are necessary. In addition to looking for products that meet your functional requirements, consider other environmental features such as recycled content, recyclability, and other material-related benefits.

Image: Water Fence

*Created by a 14-year-old student for a science fair, Water Fence provides an innovative solution for storing large volumes of water.*

## Read more online:

- » Rainwater Harvesting: Standout Products in a Rising Market
- » Alternative Water Sources: Supply-Side Solutions for Green Buildings
- » A New Place to Store Rainwater: The Fence
- » Resilient Design: Water in a Drought-Prone Era
- » Net-Zero Water and More: Moving Beyond "Low Flow"

# SHOWERHEADS

*Showers account for about 17% of all indoor residential water use, and inefficient showerheads increase both water and energy use.*

## BuildingGreen-Approved Showerheads

BuildingGreen approves showerheads that use no more than 1.75 gallons per minute (gpm)—below WaterSense's limit of 2 gpm—and are WaterSense labeled to address spray force and coverage.

## Balancing Performance with Water Conservation

Everyone wants to save water, but low-flow shower units have been faulted for delivering poor performance—leading people to spend more time in the shower or to remove the showerhead and replace it with an older, higher-flow showerhead.

WaterSense has developed a specification that includes water efficiency, spray force, and spray coverage criteria.

The first criterion is designed to reduce water use; the last two are aimed at maintaining a standard for superior shower performance, even as less water is being used. After doing field research in 2008, WaterSense developed tests that measure performance in spray force and spray coverage.

Not directly included in the WaterSense criteria is "wetting performance" (though spray coverage could be a proxy for that) and "heat retention," which is a function of droplet size. Showerheads that atomize water into very small droplets cool off very quickly, though atomizing showerheads may or may not satisfy the "spray force" requirement in WaterSense.

To go beyond WaterSense, consider other aspects that are more relevant in public and commercial settings. As these showerheads might see more abuse and adjusting than a residential showerhead, be sure to consider durability. There is no commonly adopted standard for durability in showerheads, but BuildingGreen notes a product's durability when there is evidence that a product is engineered with that in mind.

Solid brass showerheads are among the more durable options available on the market. Some models cannot be adjusted and are designed to be installed such that nothing can hang from them.

Further, select vandal-resistant models and coatings, and look for showerheads that can be repaired before they need to be replaced.

Photos: Rada

*Digital thermostatic faucets and showers from Rada are specially engineered to conserve water while preventing healthcare-associated infections like Legionella.*

### Read more online:

- » Faucets That Combat Infection Without Wasting Water
- » The DOE Showerhead Rule: Someone is All Wet
- » Delta Showerhead Advances State of the Art
- » Innovations in Water Conservation Products

# TOILETS

*Toilet flushing is the single largest water use in both commercial and residential buildings.*

## BuildingGreen-Approved Flush Toilets

BuildingGreen approves the most efficient single-flush toilets available, including ultra-efficient models and those meeting the EPA WaterSense High Efficiency Toilet (HET) specification:

- Flush volume – no more than 1.28 gallons per flush (for dual flush, 1.6 for full flush and 1.1 for reduced flush)
- Flushing performance – minimum 350 grams per the Maximum Performance (MaP) test

We also approve toilet flushometers meet the above standard and can evacuate 500 grams.

## Balancing Water Conservation with Performance

The opportunity for water savings from installing efficient toilets, and from toilet replacement, is significant.

In addition to improvements to the traditional gravity system, pressure- and vacuum-assisted flushing systems have been developed that offer superior performance—albeit often with some increase in flushing noise.

Not into flushing? Check out composting toilets.

## Commercial toilets

Toilets represent a significant portion of the potable water consumption in most commercial buildings, so the possibilities for savings in both new installations and replacements are huge.

There have been improvements to the tank-type gravity system, and commercial water-pressure-based blow-out toilets as well as pressure- and vacuum-assisted flushing systems have been developed that offer superior performance in commercial applications.

*(continued)*

Photo: Niagara Conservation

*The ultra-high-efficiency Stealth toilet combines high pressure with low noise.*

### Read more online:

- » Niagara's Innovative Ultra-High-Efficiency "Stealth" Toilet
- » Urine Collection Beats Composting Toilets for Nutrient Recycling
- » Power Flushing With Pressure-Assist Toilets
- » Men Should Pee Sitting Down
- » Exploding Low-Flow Toilets
- » Waste Water, Want Water
- » Design Strategies for Occupant Engagement—and Why They Boost Performance
- » All About Toilets

## Commercial flushometers

While appropriate pairing of flushometer to toilet bowl is necessary for effective flushing performance, retrofitting existing commercial toilets with low water use and dual-flush flushometers can yield significant water savings.

Flushometer retrofits are also available for urinals.

Although flushometers can be installed in residential buildings, they are primarily used in commercial buildings.

Note that commercial toilets may have different flushometer options. Dual-flush flushometer valves offer similar performance for standard commercial blow-out toilets, and many flushometers include sensors that improve sanitation by triggering the flush.

Flushometer and toilet pairings should be able to evacuate 500 grams, according to Maximum Performance (MaP) testing. The MaP testing website offers a database of tested pairings, and BuildingGreen recommends that this database be consulted before deciding on a retrofit flushometer.

Dual-flush flushometers are measured by averaging two reduced flushes and one full flush.

## Dual-flush toilets

Dual-flush toilets comply with WaterSense by making two flushes available: one for solid wastes and a lower-volume flush for liquids and paper.

For dual-flush toilets, WaterSense factors water savings by averaging the high- and low-volume flush levels. Two reduced flushes and one full flush cannot average more than 1.28 gallons per flush.

Be aware of the limitations of the WaterSense criteria. MaP Test results many times higher than the 350 g minimum may come at the expense of other aspects of performance, such as:

- Floating or dissolved media clearance
- Rim clearing
- Water spot
- Back wall clearance

To the extent possible, BuildingGreen considers these other aspects of performance qualitatively because no other publicly available standards are available.

Also, be aware that in certain buildings—especially existing buildings—long horizontal drainline runs or low slopes may result in clogging with the lowest-flow toilets, due to inability to carry wastes.

# URINALS

*A single non-water-using urinal can save more than 10,000 gallons of water per year compared with the U.S. EPA standard of 1 gallon per flush (gpf).*

*When older 3 gpf urinals are replaced, the savings can be as great as 50,000 gallons per year.*

## BuildingGreen-Approved Urinals

BuildingGreen approves:

- high-efficiency urinals that use 0.125 gpf or less
- low-water-use flush valves that use 0.5 gpf or less
- non-water urinals that meet ANSI/ASME A112.19.19
- low- or non-water-use residential urinals

## Balancing Water Conservation with Performance

Urinals do no require a lot of water to remove urine, but they need to balance water efficiency with hygiene.

Poor maintenance of non-water urinals can result in a buildup of salts and bacteria, leading to clogging and odor, and sometimes removal of the units.

Proper training of maintenance crews will minimize these problems, but manufacturers have come up with alternate products that use small amounts of water yet are less vulnerable to maintenance problems. High-efficiency urinals that use 0.125 gpf are now readily available, as are innovative hybrid models that do not flush but introduce small amounts of water intermittently to help keep pipes clear.

Note that installing a standard high-efficiency urinal at the beginning of a piping run can help keep non-water urine lines clean but will not clean the cartridge or pipes leading from the urinal.

Photo: Mark Hillary. License: CC BY 2.0.

*In a line of waterless or low-flush urinals, having one or two with a higher flush can help clear the piping. The Zurn Omni-Flow and the Steward Hybrid are designed for this purpose.*

## Read more online:


» How Low-Flow Can You Go with Plumbing Fixtures?

» The Great Eight: High-Impact Material Choices for Green Building

» Why Non-Flushing Urinals Fail (And How to Prevent Those Failures)

» Is America Ready for a Home Urinal?

» New Type of Waterless Urinal Cartridge Focus of Lawsuit

» Innovative Products and Technology from the Greenbuild Expo

» Men Should Pee Sitting Down

# WASTEWATER TREATMENT

*Constructed wetlands and other natural filtration systems close the nutrient and water loop, permitting safe and sustainable wastewater treatment and reuse right on the site.*

## BuildingGreen-Approved Systems

We look for components of low-impact constructed wetlands and living machines, as well as more compact systems like membrane bioreactors.

## Environmental Impacts of Wastewater Treatment

Whether onsite wastewater treatment is a good choice for your next project will depend on a lot of different factors, from local codes to annual rainfall to the age of municipal infrastructure.

If your project team does choose to treat and reuse wastewater on the site, different types of systems can have broad implications for energy consumption and other aspects of the project—but decentralized treatment and reuse can also contribute to improvements in centralized infrastructure.

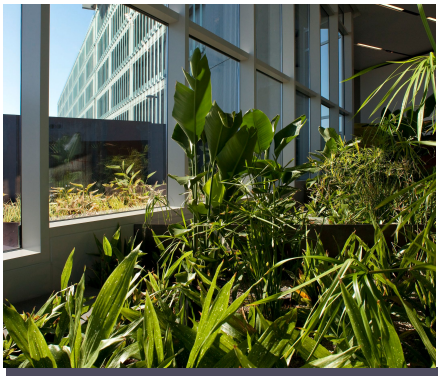
There's not a sharp difference between the simplest natural systems and the more intensive ones: it's more of a spectrum from the most basic constructed wetland to an energy—and space—intensive indoor natural filtration system. This is partly because, in general, the industry has moved away from tropical plantings (at least in temperate climates) that require greenhouse conditions and lots of water aeration.

Most onsite "natural" systems cycle water relatively slowly through a variety of filtration media, relying on plant roots to create ideal conditions for bacterial growth. Parts of these systems may include lagoons, indoor or outdoor constructed wetlands, and a variety of gravel or sand filtration beds (along with less-attractive pumps and polishing and disinfection tanks).

One of the advancements since the days of tropical greenhouse Living Machines is that not every "natural" treatment method needs plants. But the plants have aesthetic and educational value, and they are far less energy-intensive than enclosed mechanical treatment systems.

*(continued)*

Photo: Eckert



*This Living Machine at the ZGF-designed Port of Portland headquarters treats all the wastewater for the building.*

## Read more online:

- Waste Water, Want Water
- 5 Reasons to Consider Onsite Wastewater Treatment for Your Next Project
- Public Distaste an Obstacle to Direct Wastewater Recycling
- EPA Ignoring Hundreds of Toxic Chemicals in Wastewater
- Failing Water Infrastructure Drains Economy, Report Warns
- BioBarrier Offers New Approach to Treating Wastewater Onsite
- Constructed Wetlands for Wastewater
- Net-Zero Water and More: Moving Beyond "Low Flow"

Other onsite systems enclose the bacteria in a tank and cycle water relatively quickly; the bacteria are doing all the heavy lifting here, too, so in a sense these systems are just as "natural" as the kind that involve showy plantings and water features.

In general, the more compact the system, the more energy it will require.

- The most common enclosed systems, membrane bioreactors, are very compact and work relatively quickly compared with natural filtration systems, but they require very high energy inputs.
- Biofilm-based systems like trickling filters also push water through fine membranes, though they tend to use less energy per gallon (and also work at a slower rate).

## Regulatory issues

Treating blackwater—and sometimes even graywater—on the project site can meet with regulatory issues, but there can be other barriers as well, such as ongoing water testing and system maintenance. Depending on the situation, some project teams question the sustainability of onsite wastewater treatment at a small scale.

# WATER HEAT EXCHANGERS

*Excess heat generated by air conditioners, refrigerators, boilers, and water flowing through pipes typically goes unused.*

## BuildingGreen-Approved Water Heat Exchangers

BuildingGreen lists desuperheating technologies and domestic water heat reclaimers whose effectiveness is supported by performance data.

## Health and Energy Considerations for Water Heat Exchangers

There are a variety of ways that waste heat can be used to heat domestic water (i.e., potable water in residential or commercial buildings).

## Desuperheaters

With refrigeration and air-conditioning equipment, waste heat is typically captured via heat exchangers called desuperheaters.

To be cost effective, a significant cooling load must support desuperheating operation. In homes, this means air conditioning running for long hours in semi-tropical or tropical climates. Relevant examples in commercial buildings include supermarkets that have large, year-round cooling and refrigeration loads.

Waste heat from fuel-fired boilers can also be recovered for water heating.

## Domestic water heat reclaimers

Heat from domestic wastewater—including residential and commercial washing machines, showers, dishwashers, and other appliances—can be recovered using a variety of heat exchangers.

The most common, a gravity film heat exchanger (GFX), takes advantage of water's surface tension. In these units, warm drainwater clings to the interior of a copper center pipe, around which a smaller-diameter copper pipe is coiled. Where the pipes meet, heat from the drainline warms the incoming water before it flows to the water heater.

These units can recover a significant amount of energy from homes but are particularly effective in commercial laundromats, restaurants, and other businesses that use a lot of hot water, as well as institutional facilities with concentrated showers.

Credit: International Wastewater Systems


*The Sewage Sharc can cut water-heating costs for multi-unit residential and commercial building owners up to 75%, the manufacturer claims.*

## Read more online:

- » Drainline Heat Exchangers
- » Capturing and Distributing Waste Heat From Power Generation
- » Sewage-Source Heat Pumps Turn Wastewater to Warmth
- » In the Pipeline: District Energy and Green Building

# WATER HEATERS – FUEL-FIRED COMMERCIAL

*Water heating is typically the fourth largest energy expenditure in commercial buildings (behind lighting, heating, and cooling).*

## BuildingGreen-Approved Water Heaters

The most efficient fuel-fired water heaters include electronic-ignition gas-fired tankless (on-demand) models, direct-contact commercial water heaters, and advanced combination space- and water-heating systems.

Commercial-sized water heaters approved by BuildingGreen have:

- thermal efficiency ratings of at least 96% for gas and 87% for oil
- or a high thermal efficiency along with additional environmental features such as sealed combustion

To date, neither CEE nor Energy Star has a commercial water heater standard.

## Energy Issues with Tankless vs. Storage

Besides the promise of never running out of hot water, tankless water heaters have no standby losses or storage tank insulation concerns, and some models have sealed combustion and no pilot lights.

However, tankless water heaters are most efficient during long, continuous draws of hot water, from which real-world conditions often diverge. They also have much larger burners that may require a larger gas-supply line—often an expensive retrofit—and may require increased maintenance, including using freeze-protection systems, installing a water softener, and flushing the heat-exchanger coils. Because they reduce standby losses, tankless models may be perfect for a commercial building in which hot water demand is very low. However, storage water heaters often make more sense for whole-building applications with higher hot water demands.

## Combined systems

In combined, or integrated, systems, efficiencies are boosted by uniting space heating or cooling into a single system that includes water heating. Some boilers also provide domestic hot water, and some electronic-ignition on-demand water heaters can be used as boilers for heating, particularly in very-low-energy buildings. Including a tankless coil in a regular boiler, however, is less efficient than storage-tank type water heaters.

*(continued)*

Photo: A.O. Smith


*In terms of greenhouse gas emissions, a standard electric water heater is equivalent to nearly half the carbon dioxide emissions of an average passenger car.*

## Read more online:

» Water Heating: A Look at the Options

» A Look at Heat Pump Water Heaters

## Other Factors to Consider

Beyond energy, other factors to consider in product selection include:

- rate of use
- climate
- maintenance
- indoor air quality, particularly whether the system has sealed combustion with direct venting to the outdoors or enhanced combustion emissions controls
- whether it is capable of continued operation in the event of a power outage

# WATER HEATERS – FUEL-FIRED RESIDENTIAL

*All electric-resistance water heaters have the inefficiencies and fuel-source pollution concerns inherent to electric power generation. Tankless electric water heaters require very large current feeds—often 40 or even 60 amps—which necessitates heavy wiring and can create capacity challenges for utility companies.*

## BuildingGreen-Approved Water Heaters

The most efficient fuel-fired residential water heaters include gas-fired storage and on-demand models, heat-pump water heaters, and advanced combination space- and water-heating systems.

BuildingGreen approves the following types of residential systems.

- Fuel-fired storage water heaters have Energy Factors (EF) of at least 0.67 reflecting Energy Star criteria for 2010 and CEE's Tier I standard.
- Storage models with inputs greater than 75,000 Btu are not required to have energy factors, so for those units we require thermal efficiency over 90%.
- Tankless water heaters have Energy Factors (EF) of at least 0.82, reflecting Energy Star criteria, or have a high EF along with additional environmental features, such as sealed combustion.
- Heat-pump water heaters have at least double the efficiency of electric-resistance water heaters.

## Energy Issues: Tankless vs. Storage

Besides the promise of never running out of hot water, tankless water heaters have no standby losses or storage tank insulation concerns, and some models have sealed combustion and no pilot lights.

However, tankless water heaters are most efficient during long, continuous draws of hot water, from which real-world conditions often diverge. They also have much larger burners which may require a larger gas-supply line—often an expensive retrofit—and may require increased maintenance, including using freeze-protection systems, installing a water softener, and flushing the heat-exchanger coils.

Because they reduce standby losses, tankless models may be perfect for a vacation home that is only used for an occasional weekend. However, storage water heaters often make more sense for whole-house applications.

*(continued)*

*Smart Series indirect-fired water heaters, from Triangle Tube, are available in residential and commercial models and work in conjunction with a boiler to provide domestic hot water.*

### Read more online:

» Tankless Water Heaters Don't Use Less Energy

» The Difference Between Storage and Tankless Water Heaters

## Combined systems

In combined or integrated systems, efficiencies are boosted by uniting space heating and/or cooling into a single system that includes water heating.

Some boilers also provide domestic hot water, and some electronic-ignition on-demand water heaters can be used as boilers for heating, particularly in very-low-energy buildings. Including a tankless coil in a regular boiler, however, is less efficient than storage-tank type water heaters.

## Other Factors to Consider

Other factors to consider include:

- rate of use
- climate
- maintenance needs
- indoor air quality, particularly whether the system has sealed combustion with direct venting to the outdoors or enhanced combustion emissions controls
- the ozone-depletion impacts associated with refrigerants for heat pumps and blowing agents for storage tank insulation
- whether the system is capable of continued operation in the event of a power outage

# WATER TREATMENT

*Water filtration is necessary in many areas to achieve clean, palatable drinking water. In some places, water conditioning may be needed to protect mechanical equipment.*

## BuildingGreen-Approved Water Filtration Systems

BuildingGreen approves water treatment systems for domestic water as well as process water:

- Plumbed-in domestic water filters certified to NSF/ANSI 53 and capable of removing multiple contaminants, including heavy metals, organic chemicals, and Cryptosporidium
- Plumbed-in and whole-building UV disinfection systems certified under NSF/ANSI 55
- Solar-powered water purification and distillation systems
- Water softeners using template-assisted crystallization

## Environmental and Health Impacts of Water Filters

The need for water treatment—and the type of filtration, purification, or conditioning required—varies widely based on the water source and the end use.

## Drinking water filtration and disinfection

Project teams as well as individual consumers in the U.S. can find out what type of drinking water filtration they may need by reading the Consumer Confidence Report released annually by their local water system. The U.S. Environmental Protection Agency (EPA) maintains a database of these CCRs.

NSF International has a suite of standards relating to water treatment, including some focused on taste and odor. Although aesthetics are an important sustainability measure—water that tastes or smells bad drives people to purchase bottled water—BuildingGreen does not include any filtration systems that focus exclusively on taste and odor because there are hundreds on the market and little to distinguish products from one another.

NSF/ANSI 53 is a safety standard concerning health-related contaminants that can be filtered out of drinking water, with testing covering a multitude of potential contaminants. We approve multipurpose systems capable of removing several different contaminants.

*(continued)*

Photo: Next Filtration Systems


*Next Filtration offers a broad range of system sizes. Single-unit systems range in capacity from 1 to 75 gallons per minute (gpm), and commercial systems can handle up to 900 gpm.*

### Read more online:

- » The Water We Drink: Softeners, Filters, and Other Treatment Options
- » Waste Water, Want Water
- » Net-Zero Water and More: Moving Beyond "Low Flow"
- » Template-Assisted Crystallization: Scale Prevention Without Salt

To find a system specialized for a single contaminant, such as Cryptosporidium or lead, search the NSF International website.

NSF/ANSI 55 focuses on UV disinfection, with Class A intended for well water or surface water collected on the site and Class B intended for supplemental disinfection of treated drinking water.

BuildingGreen does not approve any treatment system using reverse osmosis, which wastes large quantities of both water and energy.

## Water treatment off the grid

Many areas have no connection to centralized potable water distribution—and since this distribution uses large quantities of energy, it's important even for grid-connected communities to have a way to disinfect water in the event of a natural disaster.

We approve packaged systems designed to purify water using solar power.

## Protecting plumbing and HVAC from scale

Water hardness refers to the concentration of calcium and magnesium cations. These positively charged ions dissolve in water as it percolates through alkaline soils or bedrock. Hard water is closely linked with scale, in which calcium or magnesium carbonate crystallizes on the interior surface of pipes. Scale reduces the efficiency of heat-transfer equipment such as water heaters and is expensive and time-consuming to remove.

Water softeners typically work by replacing calcium and magnesium ions with sodium ions, which don't form scale. Ion-exchange water softeners operate with a slight, though continuous, electric draw and require significant backwashing of sodium ions into the waste stream.

An alternative to water softening is scale prevention without ion replacement. Template-assisted crystallization (TAC) does not replace the positively charged ions with salt, as is common in other products.

Although the water treatment market is filled with unproven and questionable technologies, TAC systems have been shown to reduce scale buildup without environmental drawbacks such as electricity use or sodium backwashing.

BuildingGreen's Guide to

# GREEN PLUMBING PRODUCTS

*Simple, clear criteria for selecting efficient fixtures and healthier materials*

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