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Sanitary Fixtures and Equipment

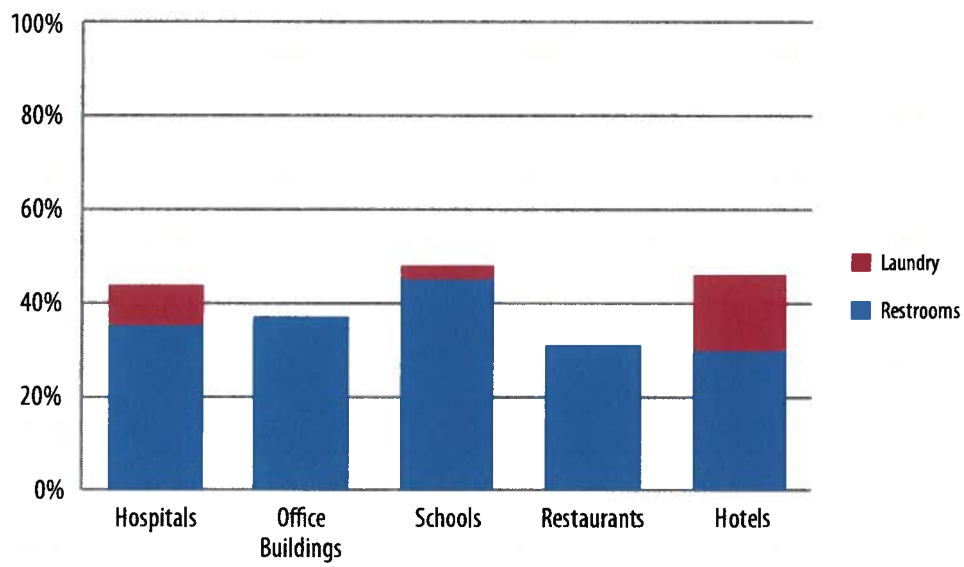
EPA WaterSense

3.1 Introduction to Sanitary Fixtures and Equipment

EPA WaterSense

Sanitary fixtures and equipment in restrooms and laundries can account for nearly 50 percent of total water use within a facility. Figure 3-1 shows this water use for various commercial facility types.[1] Depending on the type of facility and number of occupants and visitors, sanitary fixtures and equipment can provide significant opportunities for water and energy savings, particularly in older buildings with inefficient fixtures and equipment.

Figure 3-1. Water Use Attributed to Sanitary Fixtures and Equipment



Nearly every type of commercial and institutional facility has at least some sanitary fixtures or equipment, including toilets, urinals, faucets, showerheads, and laundry equipment.

Toilets, faucets, and to some extent, urinals are found in all commercial and institutional facility restrooms. Showerheads are likely to be found in healthcare facilities, hotels, schools, universities, and gyms, as well as in office buildings and other areas of employment providing showers for employee use. Laundry equipment, though less common, is generally found in dedicated laundromats and within hotels and healthcare facilities.

Over the past 20 years, there has been an increased focus on developing more efficient and better performing sanitary fixtures and equipment. For example, high-efficiency toilets, faucets, showerheads, and urinals are at least 20 percent more efficient than standard products on the market. Those that are labeled through the

[1] Created from analyzing data in: Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Water Users*. Prepared for the New Mexico Office of the State Engineer. www.ose.state.nm.us/wucp_ici.html; Dziegielewski, Benedykt, et al. American Water Works Association (AWWA) and AWWA Research Foundation. 2000. *Commercial and Institutional End Uses of Water*; East Bay Municipal Utility District. 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook; AWWA. *Helping Businesses Manage Water Use—A Guide for Water Utilities*.

U.S. Environmental Protection Agency's (EPA's) WaterSense® program are tested and certified for performance as well. EPA and the U.S. Energy Department's ENERGY STAR® qualified commercial coin- or card-operated washers are 37 percent more energy- and water-efficient than standard washers. In addition, the advent of ozone and wash water recycling systems provides significant water and energy savings opportunities for larger, more industrial types of laundry equipment.

Section 3: Sanitary Fixtures and Equipment of WaterSense at Work provides an overview of and guidance for effectively reducing the water use of:

- Toilets
- Urinals
- Faucets
- Showerheads
- Laundry equipment

Sanitary Fixtures Case Study

To learn how the Holiday Inn near the San Antonio Airport in Texas saved 7 million gallons of water and an estimated 330,000 kilowatt-hours of energy per year by installing high-efficiency toilets, faucet aerators, and showerheads, read the case study in Appendix A.

3.2 Toilets

Overview

Toilets, or water closets, can be found in nearly every commercial and institutional facility. Several types of toilet technologies are installed in commercial and institutional settings, including tank-type toilets, flushometer-valve toilets, and less commonly, composting toilets. Toilets currently on the market can perform well (i.e., adequately clear waste) while using less water than older models installed before the Energy Policy Act (EPAct) of 1992 maximum flush volume requirements were established.

Tank-type toilets are designed with tanks that store and dispense water to the toilet bowl to flush waste. Varieties of tank-type toilets include the standard gravity type (found in most homes), pressure-assist (or flushometer-tank toilets), and electromechanical hydraulic toilets. Tank-type toilets are available as single, constant-volume flushing models or as dual-flush models, which include a full flush for solids and a reduced flush for liquids. Tank-type toilets are commonly found in residential and light commercial settings.

Flushometer-valve toilet

Flushometer-valve toilets are tankless fixtures with either wall- or floor-mounted bowls attached to a lever- or sensor-activated flushometer valve that releases a specific volume of water at a high flow rate directly from the water supply line to the bowl to remove (i.e., flush) waste. Unlike tank-type toilets, which store water in the tank to provide the necessary pressure and flow to remove waste from the bowl, flushometer-valve toilets rely on larger diameter water supply piping and high water supply line pressures to remove waste. These fixtures are also available as single, constant-volume flushing models, or as dual-flush models. Flushometer-valve toilets are used predominantly in public-use facilities and high-use commercial settings. Flushometer-valve toilets include blowout and rear discharge toilets, which have bowls that remove waste slightly differently than standard siphonic bowls.

Flushometer-valve toilets can be equipped with electronic sensors, which trigger the flushing mechanism when a user has finished using the fixture. Sensors themselves provide no additional water-efficiency benefits; however, they provide health and sanitation benefits in public-use facilities since they offer a hands-free option. If not properly programmed, operated, and maintained, automatic flush sensors can cause double or phantom flushing, which increases the water used at a facility.

EPAct 1992 established the maximum allowable flush volume for gravity tank-type, flushometer tank (or pressure-assist), electromechanical hydraulic, and flushometer-valve toilets sold in the United States at 1.6 gallons per flush (gpf). The maximum flush volume for blowout toilets, which are used primarily in locations subject to high traffic or heavy use such as prisons, was set at 3.5 gpf. Due to the long, useful life of toilets, many toilets in use today are older and have flush volumes of 3.5 gpf and up to 5.0 gpf.

To further address efficiency and advances in tank-type toilet technology, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program published a specification to label water-efficient, high-performing tank-type toilets. WaterSense labeled tank-type toilets[2] are independently certified to use 1.28 gpf or less and remove at least 350 grams of solid waste per flush. The WaterSense tank-type toilet specification does not include flushometer-valve toilets in its scope, but it does include pressure-assist toilets and tank-type electromechanical hydraulic toilets.


WaterSense labeled tank-type toilet

Composting toilets are a less common alternative to typical water-using toilets. They are toilets that include an anaerobic processing system that can treat waste using little to no flush water. These toilets do not send the waste through the sanitary sewer for treatment at a wastewater treatment plant, although some applications treat the toilet waste in an onsite septic system.

Operation, Maintenance, and User Education

Facility managers can reduce water use by taking simple steps to educate users on proper toilet use and maintenance. In addition, consider the following:

- Train users to report continuously flushing, leaking, or otherwise improperly operating toilets to the appropriate personnel.
- Educate and inform users with restroom signage and other means to avoid flushing inappropriate objects, such as feminine products, wrappers, trash, or compact disc cases. Train custodial staff on how to handle the inappropriate disposal of such objects.

In addition, consider the operation and maintenance tips specific to tank-type toilets and flushometer-valve toilets below.

Tank-Type Toilets

- Periodically check to ensure fill valves are working properly and the water level is set correctly. Remove the toilet tank and check to see if water is flowing over the top of the overflow tube inside of the tank. Ensure that the refill water level is set below the top of the overflow tube. Adjust the float lower if the water level is too high. If the toilet continues to run after the float is adjusted, replace the fill valve. In order to prevent changes in tank water levels due to line water pressure fluctuations, only replace existing fill valves with pilot-type fill valves.

[2] U.S. Environmental Protection Agency's (EPA's) WaterSense program. WaterSense Labeled Toilets. www.epa.gov/WaterSense/products/toilets.html.

3.2 Toilets

- Annually test toilets to ensure the flappers are not worn or allowing water to seep from the tank into the bowl and down the sewer. Drop a dye tablet or several drops of diluted food coloring in the tank. After 10 minutes, see if the dye has leaked into the bowl. Flush the toilet immediately after conducting this test to ensure the dye does not stain the tank or bowl. If there is a leak, check for a tangled chain in the tank or replace a worn flapper valve. If leaking does not subside after a flapper valve is replaced, consider replacing the flapper seat and overflow tub assembly, which could also be worn.
- Learn more by watching leak detection and repair videos[3] posted on the Southern Nevada Water Authority website.

Flushometer-Valve Toilets

- At least annually, inspect diaphragm or piston valves and replace any worn parts. To determine if the valve is in need of replacement, determine the time it takes to complete a flush cycle. A properly functioning 1.6 gpf flush valve should not have a flush cycle longer than four seconds.
- If replacing valve inserts, make sure the replacements are consistent with the valve manufacturer's specifications, including the rated flush volume. If replacing the entire valve, make sure it has a rated flush volume consistent with manufacturer specifications for the existing bowl.
- Periodically check to ensure the control stop (which regulates the flow of water from the inlet pipe to the flushometer valve and is necessary for shutting off the flow of water during maintenance and replacement of the bowl or valve) is set to fully open during normal operation.
- Upon installation of a flushometer-valve toilet, adjust the flush volume following manufacturer's instructions to ensure optimum operation for the facility's specific conditions. Periodically inspect the flush volume adjustment screw to ensure the flush volume setting has not been modified from the original settings; if it has, it could change the water use and performance of the product.
- Ensure that the line pressure serving the flushometer-valve toilet meets the minimum requirements specified by the fixture manufacturer.
- If installed, check and adjust automatic sensors to ensure proper settings and operation to avoid double or phantom flushing.

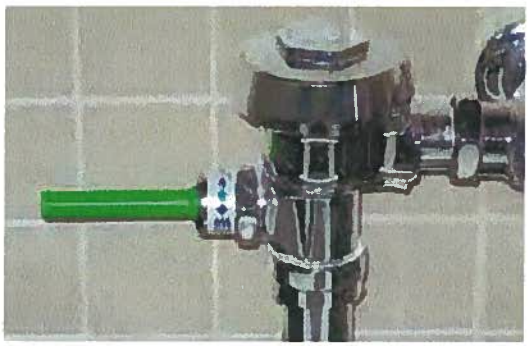
Retrofit Options

To retrofit an existing toilet to increase water efficiency, consider the following options for tank-type and flushometer-valve toilets.

[3] Southern Nevada Water Authority. How to Find a Leak. www.snwa.com/3party/find_leak/main.html.

Tank-Type Toilets

In general, avoid retrofitting existing tank-type toilets with displacement dams or bags, early-closing toilet flappers, or valves with different flush volumes, as these devices could impede overall performance and require increased operation and maintenance. In addition, the use of these devices and other retrofit products could void manufacturer warranties.



Dual-flush toilet handle

Flushometer-Valve Toilets

In general, it is best to avoid retrofit options, such as valve inserts, that reduce the flush volume of flushometer-valve toilets. These products might not provide the expected performance if the original bowl is not designed to handle a reduced flush volume. In addition, the use of these devices could void manufacturer warranties.

Dual-flush conversion devices are available for flushometer-valve toilets. These devices usually replace the existing flush valve handle with a handle that provides a reduced flush volume for liquids and a standard flush for solids. When considering this type of retrofit, verify that the product has been certified to either American Society of Mechanical Engineers (ASME) A112.19.10, *Dual-Flush Devices for Water Closets*, or International Association of Plumbing and Mechanical Officials (IAPMO) PS 50-2008, *Flush Valves With Dual-Flush Device for Water Closets or Water Closet Tanks with Integral Flush Valves with a Dual-Flush Device*. In addition, before initiating a full-scale retrofit, test the product on a select number of toilets to verify it achieves and maintains the desired performance.

Replacement Options

If installing a new toilet or replacing an older, inefficient toilet, consider the following replacement options.

Tank-Type Toilets

When installing new tank-type toilets or replacing older, inefficient tank-type toilets, choose WaterSense labeled models.[4] WaterSense labeled tank-type toilets are independently certified to have an effective flush volume of 1.28 gpf or less and pass a performance test to remove at least 350 grams or more of solid waste per flush.

Flushometer-Valve Toilets

When installing new or replacing older, inefficient flushometer-valve toilets, choose models that are designed to use 1.6 gpf or less. If considering 1.28 gpf or less flushometer-valve toilets, including dual-flush models, carefully evaluate the physical conditions of existing drainlines and the availability of supplemental water flow

[4] EPA's WaterSense program, *op. cit.*

upstream from the toilet fixtures to make sure that the conditions are appropriate for effective waste transport.

For maximum water savings and performance, purchase the flushometer valve and bowl in hydraulically matched combinations that are compatible in terms of their designed flush volume.

Composting Toilets

Consider installing composting toilets in facilities where connecting to a plumbing system is cost-prohibitive or unavailable.

Savings Potential

Water savings can be achieved by replacing existing tank-type and flushometer-valve toilets. To estimate facility-specific water savings and payback, use the following information.

Tank-Type Toilet Replacement

Current Water Use

To estimate the current water use of an existing tank-type toilet, identify the following information and use Equation 3-1:

- Flush volume of the existing tank-type toilet. Toilets installed starting in the mid-1970s typically have standard flush volumes of 3.5 gpf or 5.0 gpf.[5] Toilets installed in 1994 or later have standard flush volumes of 1.6 gpf.
- Average number of times the toilet is flushed per day, which will be dependent on the facility's male-to-female ratio. Female building occupants use the toilet three times per day on average, while male building occupants use the toilet once per day on average.[6]
- Days of facility operation per year.

Equation 3-1. Water Use of Toilet (gallons per year)

= Toilet Flush Volume x Number of Flushes x Days of Facility Operation

Where:

- Toilet Flush Volume (gallons per flush)
- Number of Flushes (flushes per day)
- Days of Facility Operation (days per year)

[5] North Carolina Department of Environment and Natural Resources, et al. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. Page 28. savewaternc.org/bushome.php.
[6] Vickers, Amy. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.

Water Use After Replacement

To estimate the water use of a WaterSense labeled replacement tank-type toilet, use Equation 3-1, substituting the flush volume of the replacement tank-type toilet. WaterSense labeled toilets use no more than 1.28 gpf on average.

Water Savings

To calculate the water savings that can be achieved from replacing an existing tank-type toilet, identify the following information and use Equation 3-2:

- Current water use as calculated using Equation 3-1.
- Water use after replacement as calculated using Equation 3-1.

Equation 3-2. Water Savings From Toilet Replacement (gallons per year)

= Current Water Use of Toilet – Water Use of Toilet After Replacement

Where:

- Current Water Use of Toilet (gallons per year)
- Water Use of Toilet After Replacement (gallons per year)

Payback

To calculate the simple payback from the water savings associated with replacing an existing tank-type toilet, consider the equipment and installation cost of the replacement tank-type toilet, the water savings as calculated using Equation 3-2, and the facility-specific cost of water and wastewater.

Flushometer-Valve Toilet Replacement

Current Water Use

To estimate the current water use of an existing flushometer-valve toilet, use Equation 3-1, substituting the flush volume of the existing flushometer-valve toilet. Toilets installed starting in the mid-1970s typically have standard flush volumes of 3.5 gpf or 5.0 gpf.[7] Toilets installed in 1994 or later have standard flush volumes of 1.6 gpf.

Water Use After Replacement

To estimate the water use of a replacement flushometer-valve toilet, use Equation 3-1, substituting the flush volume of the replacement flushometer-valve toilet.

[7] North Carolina Department of Environment and Natural Resources, et al., *op. cit.*

Water Savings

To calculate water savings that can be achieved from replacing an existing flushometer-valve toilet, use Equation 3-2.

Payback

To calculate the simple payback from the water savings associated with replacing an existing flushometer-valve toilet, consider the equipment and installation cost of the replacement flushometer-valve toilet, the water savings as calculated using Equation 3-2, and the facility-specific cost of water and wastewater.

Additional Resources

Alliance for Water Efficiency. Toilet Fixtures Introduction. www.allianceforwaterefficiency.org/toilet_fixtures.aspx.

EPA's WaterSense program. WaterSense Labeled Toilets. www.epa.gov/watersense/products/toilets.html.

North Carolina Department of Environment and Natural Resources, et al. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. Pages 27–33. savewaternc.org/bushome.php.

Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Users*. Prepared for the New Mexico Office of the State Engineer. Pages 33–36. www.ose.state.nm.us/wucp_ici.html.

Southern Nevada Water Authority. How to Find a Leak in Your Toilet. www.snwa.com/3party/find_leak/section4.html.

3.3 Urinals

EPA WaterSense

Overview

A urinal is defined in the applicable national standard for urinals as "a plumbing fixture that receives only liquid waste and conveys the waste through a trap seal into a gravity drainage system."[8] Flushing urinals use water to remove (i.e., flush) the liquid waste from the fixture. Flushing urinals use a variety of different technologies. Washdown or washout urinals require the activation of a flushometer valve. Gravity tank-type urinals, which are less common, rely on the release of water stored in an in-wall cistern to provide the necessary water pressure and flow to remove waste from the urinal, similar to the operation of a gravity tank-type toilet. Siphonic jet urinals have an elevated flush tank and operate by using a siphon device to automatically discharge the tank's contents when the water level in the tank reaches a certain height. This type of urinal requires no user activation.

Flushing urinal

Flushing urinals can be equipped with electronic sensors that activate the flushing mechanism when a user has finished using the fixture. Automatic flush sensors provide no additional water-efficiency benefits. They do, however, provide health and sanitation benefits in public-use facilities because they offer a hands-free option. Although, if not properly operated, automatic flush sensors can cause double or phantom flushing, actually increasing the water used at a facility.

Flushing urinals come in two basic types—standard, single-user fixtures and trough-type, multi-user fixtures. Trough-type urinals are large fixtures designed for multiple users in high-traffic places, such as stadiums and sports arenas. Trough urinals are sold in 36-, 48-, 60-, and 72-inch lengths. Some older models were designed to run continuously and, consequently, consumed large amounts of water. New trough urinals either use flushometer valves on preset timers or are equipped with electronic sensors.

Some urinals do not use water to flush the liquid waste from the fixture. A non-water urinal is "a plumbing fixture that is designed to receive and convey only liquid waste through a trap seal into the gravity drainage system without the use of water for such function."[9]

Non-water urinals use a specially designed trap that allows liquid waste to drain out of the fixture, through a trap seal, and into the drainage system. Many non-water

[8] American Society of Mechanical Engineers (ASME), Canadian Standards Association (CSA). August 2008. ASME A112.19.2-2008/CSA B45.1-08, *Ceramic Plumbing Fixtures.*

[9] International Association of Plumbing and Mechanical Officials (IAPMO). February 19, 2004. IAPMO Z124.9-2004, *American National Standard for Plastic Urinal Fixtures.*

urinals on the market today use a cartridge that contains a liquid barrier seal to prevent the escape of odors and sewer gases. Other models feature cartridge-less designs that use a liquid barrier seal in the urinal's trap. A third type uses a self-sealing mechanical waste valve trap that does not require a liquid barrier seal. U.S. plumbing codes currently prohibit these self-sealing mechanical trap designs.

The Energy Policy Act (EPAct) of 1992 established the maximum allowable flush volume for all urinals sold in the United States starting in 1994 as 1.0 gallons per flush (gpf). Many urinals in facilities nationwide were installed prior to 1994, and thus flush higher than the 1.0 gpf standard, often between 1.5 and 3.5 gpf.

To address efficiency and advances in flushing urinal technology, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program published a specification to label water-efficient, high-performing flushing urinals. WaterSense labeled flushing urinals[10] are independently certified to use 0.5 gpf or less, while still achieving equal or superior performance in removing liquid waste.

Operation, Maintenance, and User Education

For optimum urinal efficiency, consider the following tips specific to flushing urinals and non-water urinals.

Flushing Urinals

- At least annually, inspect diaphragm or piston valves and replace any worn parts. If replacing valve inserts, make sure the replacements are consistent with the valve manufacturer's specifications, including the rated flush volume. If replacing the entire valve, make sure it has a rated flush volume consistent with manufacturer specifications for the existing urinal fixture.
- Annually check and adjust automatic sensors, if installed, to ensure they are operating properly to avoid double or phantom flushing.
- Flushing urinals equipped with automatic flush sensors often will have an override switch, allowing maintenance personnel to manually activate the flush. Activating the override switch may release a larger volume of water than is typical for the standard flush. Train cleaning and maintenance personnel on how to effectively clean and maintain urinals with automatic flush sensors to ensure that the urinal is returned to its intended flush volume after maintenance operations are completed.
- Train users to report continuously flushing, leaking, or otherwise improperly operating urinals to the appropriate personnel.

Non-Water Urinals

If non-water urinals are selected for the facility, regularly clean and replace the seal cartridges or other materials as specified by the manufacturer and follow all other

[10] U.S. Environmental Protection Agency's (EPA's) WaterSense program. WaterSense Labeled Urinals. www.epa.gov/watersense/products/urinals.html.

manufacturer-provided guidance. Proper maintenance is vital to the long-term performance of non-water urinals.

Retrofit Options

In general, avoid retrofit options to reduce the flush volume of valves, including valve inserts that have a lower flush volume, unless the inserts are rated to provide a flush volume that is compatible with the existing urinal fixture. Confirm compatibility with the urinal fixture manufacturer, as many new urinal fixture models are designed to function at several different flush volumes. If the flush volume of the valve insert is not compatible with the urinal fixture, it may not provide the expected performance, especially if the original equipment is not designed to handle a reduced flush volume.

Replacement Options

When installing new flushing urinals or replacing older, inefficient flushing urinals, choose WaterSense labeled models.[11] WaterSense labeled flushing urinals have been independently certified to use no more than 0.5 gpf, which is at least 50 percent more water-efficient than standard flushing urinals on the market. In addition, WaterSense labeled flushing urinals must meet specific criteria for flush performance and drain trap functionality and are designed to be non-adjustable above their rated flush volume. These features provide for the longevity of water savings. The specification is applicable to the following devices:

- Urinal fixtures that receive liquid waste and use water to convey the waste through a trap seal into a gravity drainage system.
- Pressurized flushing devices that deliver water to urinal fixtures.
- Flush tank (gravity type) flushing devices that deliver water to urinal fixtures.

To ensure high performance and water savings, choose a valve and fixture combination with matching rated flush volumes.

Non-water urinals can also be considered during urinal installation or replacement. When looking to install non-water urinals and very low volume flushing urinals (e.g., 1.0 pint per flush urinals), consider the condition and design of the existing plumbing system and the expected usage patterns in order to ensure that these products will provide the anticipated performance. As a good rule of practice, adhere to the guidelines outlined in the International Association of Plumbing and Mechanical Officials (IAPMO) *Green Plumbing and Mechanical Code Supplement*,[12] which requires at least one water supply fixture unit (i.e., a faucet) to be installed on the drainline upstream of the fixtures to facilitate drainline flow and rinsing. Supplemental water or even periodic manual flushing of the drainlines is important because these products have little to no water going through the drain to flush out any solids that may build

[11] *Ibid.*

[12] IAPMO. February 2010. *Green Plumbing & Mechanical Code Supplement*. Page 9. www.iapmo.org/pages/iapmo_green.aspx.

up over time. It is also important to carefully adhere to manufacturer-recommended cleaning and maintenance requirements to ensure products continue to perform as expected.

Savings Potential

Water savings can be achieved by replacing existing flushing urinals with WaterSense labeled flushing urinals, which use no more than 0.5 gpf. To estimate facility-specific water savings and payback, use the following information.

Current Water Use

To estimate the current water use of an existing flushing urinal, identify the following information and use Equation 3-3:

- Flush volume of the existing urinal. Urinals installed prior to 1994 have flush volumes that typically range between 1.5 and 3.5 gpf. Urinals installed in 1994 or later have flush volumes of 1.0 gpf.
- Average number of times the urinal is flushed per day, which will be dependent on the number of male building occupants. Male building occupants use the urinal two times per day on average.[13]
- Days of facility operation per year.

Equation 3-3. Water Use of Urinal (gallons per year)

= Urinal Flush Volume x Number of Flushes x Days of Facility Operation

Where:

- Urinal Flush Volume (gallons per flush)
- Number of Flushes (flushes per day)
- Days of Facility Operation (days per year)

Water Use After Replacement

To estimate the water use of a replacement WaterSense labeled flushing urinal, use Equation 3-3, substituting the flow rate of the replacement WaterSense labeled flushing urinal. WaterSense labeled flushing urinals use no more than 0.5 gpf.

Water Savings

To calculate water savings that can be achieved from replacing an existing flushing urinal, identify the following information and use Equation 3-4:

[13] Vickers, Amy. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.

- Current water use as calculated using Equation 3-3.
- Water use after replacement as calculated using Equation 3-3.

Equation 3-4. Water Savings From Urinal Replacement (gallons per year)

= Current Water Use of Urinal – Water Use of Urinal After Replacement

Where:

- Current Water Use of Urinal (gallons per year)
- Water Use of Urinal After Replacement (gallons per year)

Payback

To calculate the simple payback from the water savings associated with replacing an existing flushing urinal, consider the equipment and installation cost of the replacement flushing urinal, the water savings as calculated in Equation 3-4, and the facility-specific cost of water and wastewater.

Additional Resources

Alliance for Water Efficiency. Urinal Fixtures Introduction. www.allianceforwaterefficiency.org/Urinal_Fixtures_Introduction.aspx.

EPA's WaterSense program. WaterSense Labeled Urinals. www.epa.gov/watersense/products/urinals.html.

North Carolina Department of Environment and Natural Resources, et al. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. Pages 31–34. savewaternc.org/bushome.php.

Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Users*. Prepared for the New Mexico Office of the State Engineer. Pages 33–36. www.ose.state.nm.us/wucp_ici.html.

3.4 Faucets

EPA WaterSense

Overview

Faucets can be found in restrooms, kitchens, break rooms, and service areas in all commercial and institutional buildings. Lavatory (i.e., restroom) faucets are designed for either private or public use. Private-use faucets are generally found in homes, hotel guest rooms, dorms, barracks, and hospital rooms. Public-use lavatory faucets are those intended for unrestricted use by more than one individual (i.e., employees, visitors, other building occupants) in facilities, such as public restrooms in offices, malls, schools, restaurants, or other commercial, industrial, and institutional buildings.

When it comes to improving faucet water efficiency in these lavatories, there are two different ways to apply technology: optimizing faucets and using faucet accessories. A faucet accessory is defined as a component that can be added, removed, or replaced easily and, when removed, does not prevent the faucet from functioning properly.[14] Faucet accessories include flow restrictors, flow regulators, aerators, and laminar flow devices. While faucet accessories can be incorporated into new faucet design to control the flow rate, most often, accessories are external components that screw onto an existing faucet's end spout.


Faucet accessory (aerator)

In addition to typical, hand-operated components, lavatory faucets can also be equipped with automatic sensors to trigger the on/off mechanism when users place their hands under and remove them from the fixture. Depending on use patterns before installation, appropriately programmed automatic sensors may or may not provide additional water savings.[15] In most cases, automatic sensors open the faucet valve completely when in use, whereas users of manually controlled faucets typically do not turn the tap fully on. Some jurisdictions might mandate the use of automatic sensors by code in certain applications. Automatic sensors can provide health and sanitation benefits in public-use facilities, since they are a hands-free option. However, recent research suggests that automatic sensor faucets might be more likely to be contaminated with *Legionella*, compared to old-style fixtures with separate handles for hot and cold water. This might be because the electronic faucet technology has more surfaces for the bacteria to become trapped and grow, or it might be because of the low flow rate of the faucets tested.[16] The American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) is currently developing a standard to protect users.

[14] American Society of Mechanical Engineers (ASME), Canadian Standards Association (CSA). June 2011. ASME A112.18.1/CSA B125.1 *Plumbing Supply Fittings*.
[15] Gauley, Bill and Koeller, John. March 2010. *Sensor-Operated Plumbing Fixtures: Do They Save Water?* www.map-testing.com/assets/files/hillsborough~study.pdf.
[16] Johns Hopkins Medicine. March 31, 2011. "Latest Hands-Free Electronic Water Faucets Found to Be Hindrance, Not Help, in Hospital Infection Control." www.hopkinsmedicine.org/news/media/releases/latest_hands_free_electronic_water_faucets_found_to_be_hindrance_not_help_in_hospital_infection_control.

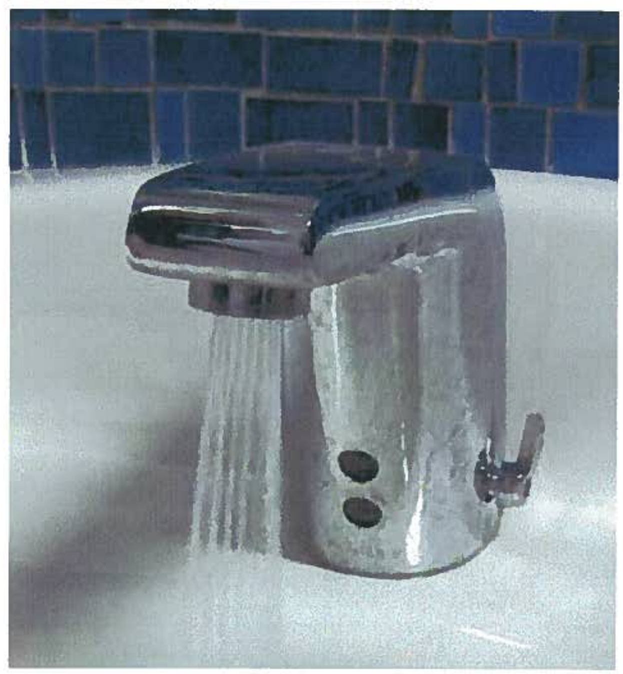
Once finalized, the *Proposed New Standard 188, Prevention of Legionellosis Associated with Building Water Systems* can assist building owners and managers in reducing the risk of legionellosis by specifying a practice to identify the conditions in a building water system that can be made less favorable to the growth and transmission of *Legionella*.[17] In addition, medical facilities should consider facility-specific health and safety needs before installing low-flow faucets or faucets with automatic sensors. For example, medical facilities might want to install laminar flow devices instead of faucet aerators. Since laminar flow faucets do not inject air into the water, there might be a lower risk of bacterial contamination.

Some restrooms can also be equipped with metered or self-closing faucets. Metered faucets, when activated by the user, dispense a preset amount of water before shutting off. Self-closing faucets, operated with a spring-loaded knob, automatically shut the water off when the user releases the knob.

The standard flow rate of a faucet is dictated by its intended end use, as described below.

Private-Use Lavatory Faucets

To promote and enhance the market for water-efficient, private-use lavatory faucets, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program has published a specification to label water-efficient, high-performing residential lavatory faucets and faucet accessories. WaterSense labeled lavatory faucets and faucet accessories[18] are independently certified to use between 0.8 gallons per minute (gpm) at 20.0 pounds per square inch (psi) and 1.5 gpm at 60.0 psi, which is 20 percent less than the federal standard.



Faucet aerator, 0.5 gpm

Public-Use Lavatory Faucets

The Energy Policy Act (EPAct) of 1992 addresses metered faucets found in public restrooms and sets a maximum water use of 0.25 gallons per cycle (gpc).

The American Society of Mechanical Engineers (ASME) A112.18.1/Canadian Standards Association (CSA) B125.1 specifies a maximum flow rate of 0.5 gpm at 60.0 psi for non-metered public-use lavatory faucets. Although not

[17] American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). June 2011. *Proposed Standard P188, Prevention of Legionellosis Associated with Building Water Systems.*

[18] U.S. Environmental Protection Agency's (EPA's) WaterSense program. WaterSense Labeled Sink Faucets & Accessories. www.epa.gov/watersense/products/bathroom_sink_faucets.html.

a federal regulation, the ASME/CSA standard has been incorporated into both the International Plumbing Code (IPC) and the Uniform Plumbing Code (UPC), two of the major plumbing codes adopted in many states and jurisdictions across the United States. Despite code requirements, many public-use faucets still have higher flow rates, typically between 2.0 and 2.5 gpm.

Kitchen Faucets

The U.S. Energy Department (DOE) adopted a 2.2 gpm at 60.0 psi maximum flow rate standard for all faucets, including kitchen faucets, in 1998 (see 63 FR 13307; March 18, 1998). This national standard is codified in the U.S. Code of Federal Regulations at 10 CFR Part 430.32. Thus far, codes and voluntary standards have not attempted to further address the efficiency of kitchen sink faucets because their uses may be volume-dependent.

Service Sinks

Sinks present in some facilities have purposes other than traditional kitchen or lavatory uses. These sinks can be found in janitorial closets, laundries, laboratories, classrooms, or other areas. There are no federal regulations limiting the flow rate of these faucets, but flow rate should be carefully considered with the intended end use, expected performance, and water efficiency in mind.

Operation, Maintenance, and User Education

For optimum faucet efficiency, test the system's water pressure to make sure that it is between 20 and 80 psi. This level ensures the faucet delivers the expected flow and performance. In addition, consider the following:

- Periodically inspect faucet aerators for scale buildup to ensure flow is not being restricted. Clean or replace the aerator or other spout end device, if necessary.
- If installed, check and adjust automatic sensors to ensure they are operating properly to avoid faucets from running longer than necessary.
- Post materials in restrooms and kitchens to ensure user awareness of the facility's water-efficiency goals. Remind users to turn off the tap when they are done and to consider turning the tap off during sanitation activities when it is not being used (i.e., when brushing teeth or washing dishes).
- Train users to report continuously running, leaking, or otherwise malfunctioning faucets to the appropriate personnel.

Retrofit Options

If looking to retrofit an existing faucet fixture to increase water efficiency, consider the following:

- For lavatory faucet retrofits in public restrooms, install faucet aerators or laminar flow devices that achieve 0.5 gpm.
- For lavatory faucet retrofits in private restrooms, look for WaterSense labeled sink faucets and accessories[19] (aerators or laminar flow devices), which have flow rates of 1.5 gpm or less at 60.0 psi and no less than 0.8 gpm at 20.0 psi.
- For kitchen faucet retrofits, install aerators or laminar flow devices that achieve a flow rate of 2.2 gpm.
- Install temporary shut-off or foot-operated valves for kitchen faucets in commercial facilities. These valves stop water flow during intermittent activities, such as scrubbing or dishwashing. The water can be reactivated at the previous temperature without the need to remix hot and cold water.
- Medical facilities should consider facility-specific health and safety needs before installing low-flow faucets or faucets with automatic sensors. For example, medical facilities may want to install laminar flow devices instead of faucet aerators; since laminar flow faucets do not inject air into the water, there is a lower risk of bacterial contamination.[20]
- For service sinks, install retrofit devices that reduce the water flow as much as possible without inhibiting the use of the sink (i.e., if the sink's function is volume-dependent, do not reduce faucet flow rate to the point that it has to be used significantly longer).

Replacement Options

If installing a new faucet fixture, consider the following:

- In public restrooms, install lavatory faucet fixtures that flow at 0.5 gpm (with or without the self-closing feature) or metered faucets that use no more than 0.25 gpc.
- In private restrooms, select WaterSense labeled sink faucets and accessories,[21] which have flow rates or 1.5 gpm or less at 60.0 psi and no less than 0.8 gpm at 20.0 psi.
- In kitchens, install faucet fixtures that flow at 2.2 gpm. Consider installing temporary shut-off or foot-operated valves for kitchen faucets in commercial facilities.
- Medical facilities should consider facility-specific health and safety needs before installing low-flow faucets or faucets with automatic sensors. For example, medical facilities may want to install laminar flow devices instead of faucet aerators; since laminar flow faucets do not inject air into the water, there is a lower risk of bacterial contamination.[22]

[19] *Ibid.*
[20] U.S. Energy Department (DOE), Energy Efficiency & Renewable Energy (EERE), Federal Energy Management Program (FEMP). Water Management Training, Faucets and Showerheads.
[21] EPA's WaterSense program, *op. cit.*
[22] DOE, EERE, FEMP, *op. cit.*

- For service sinks, install faucets that flow as low as possible without inhibiting the use of the sink (i.e., if the sink's function is volume-dependent, do not reduce faucet flow rate to the point that it has to be used significantly longer).

Savings Potential

Water savings for both private- and public-use lavatory faucets can be achieved by retrofitting existing faucets with aerators or replacing existing faucets. The same amount of water savings can be expected for a retrofit or replacement, however, retrofitting existing faucets with aerators will yield the shortest payback period due to minimal equipment costs.

To estimate facility-specific water savings and payback, use the following information:

Current Water Use

To estimate the current water use of an existing faucet, identify the following information and use Equation 3-5:

- Flow rate of the existing faucet. Private- and public-use lavatory faucets installed in 1996 or later have flow rates of 2.2 gpm or less. Some public-use lavatory faucets installed in more recent years may flow at 0.5 gpm. Faucet flow rate is typically inscribed directly on the fixture itself.
- Average daily use time. The average private-use lavatory faucet use is approximately 8.1 minutes per person per day.[23] Public-use faucets can be used between 15 seconds and one minute per use, and used three or four times per occupant per day.
- Number of building occupants.
- Days of facility operation per year.

Equation 3-5. Water Use of Faucet (gallons per year)

= Faucet Flow Rate x Daily Use Time x Number of Building Occupants x Days of Facility Operation

Where:

- Faucet Flow Rate (gallons per minute)
- Daily Use Time (minutes per person per day)
- Number of Building Occupants (persons)
- Days of Facility Operation (days per year)

[23] Mayer, Peter W., and DeOreo, William B. American Water Works Association (AWWA) and AWWA Research Foundation. 1998. *Residential End Uses of Water*. Page 95.

Water Use After Retrofit or Replacement

To estimate the water use after retrofitting or replacing an existing faucet with a water-efficient model or aerator, use Equation 3-5, substituting the flow rate of the retrofit or replacement. WaterSense labeled aerators installed in private-use settings use no more than 1.5 gpm. Public-use lavatory faucets can be retrofitted with 0.5 gpm aerators.

Water Savings

To calculate water savings that can be achieved from retrofitting or replacing an existing faucet, identify the following information and use Equation 3-6:

- Current water use as calculated using Equation 3-5.
- Water use after retrofit or replacement as calculated using Equation 3-5.

Equation 3-6. Water Savings From Faucet Retrofit or Replacement (gallons per year)

= Current Water Use of Faucet – Water Use of Faucet After Retrofit or Replacement

Where:

- Current Water Use of Faucet (gallons per year)
- Water Use of Faucet After Retrofit or Replacement (gallons per year)

Payback

To calculate the simple payback from the water savings associated with the lavatory faucet retrofit or replacement, consider the equipment and installation cost of the retrofit or replacement faucet or aerator, the water savings as calculated using Equation 3-6, and the facility-specific cost of water and wastewater. Aerators typically cost $10 and require no installation cost.

Because faucets use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness.

Additional Resources

Alliance for Water Efficiency. Faucet Fixtures Introduction. www.allianceforwaterefficiency.org/Faucet_Fixtures_Introduction.aspx.

EPA's WaterSense program. WaterSense Labeled Sink Faucets & Accessories. www.epa.gov/watersense/products/bathroom_sink_faucets.html.

3.4 Faucets

North Carolina Department of Environment and Natural Resources, et al. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. Pages 36–37. savewaternc.org/bushome.php.

Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Users*. Prepared for the New Mexico Office of the State Engineer. Pages 33–37. www.ose.state.nm.us/wucp_ici.html.

3.5 Showerheads

EPA WaterSense

Overview

Showerheads come in a variety of shapes, sizes, and configurations, including: fixed showerheads, which are affixed overhead and permanently attached to the wall; handheld showerheads, which have a flexible hose that can be detached from the wall and moved freely by the user; and body sprays (e.g., spas, jets), which spray water onto the user from a direction other than overhead, usually from a vertical column on the shower wall. Each type is uniquely suited to perform a specific function. In order to reduce overall water use, the Energy Policy Act (EPAct) of 1992 established the maximum allowable flow rate for all showerheads sold in the United States as 2.5 gallons per minute (gpm).

Handheld showerhead

Since this standard was enacted, many showerheads have been designed to use even less water. While these fixtures save water with a lower flow rate, the duration of the shower sometimes increases, resulting in an overall increase water usage. Recent consumer market research identified three key performance attributes that are necessary to ensure user satisfaction under a variety of household conditions: flow rate across a range of pressures, spray force, and spray coverage. Each of these criteria can be tested using a specific protocol that measures accuracy and reliability. All three criteria must be met to produce a "satisfactory" shower without using more water.

To address efficiency and advances in showerhead technology, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program has published a specification to label water-efficient, high-performing showerheads. WaterSense labeled showerheads[24] are independently certified to use 2.0 gpm or less, while also meeting or exceeding performance criteria for force and coverage.

Operation, Maintenance, and User Education

For optimum showerhead efficiency, the system pressure should be tested to make sure that it is between 20 and 80 pounds per square inch (psi). This will ensure that the showerhead will deliver the expected flow and performance. In addition, consider the following:

- Verify that the hot and cold water plumbing lines to the showerhead are routed through a shower valve that meets the temperature control performance requirements of the American Society of Sanitary Engineers (ASSE) 1016 or American Society of Mechanical Engineers (ASME) A112.18.1/Canadian Standards Association (CSA) B125.1 standards when tested at the flow rate of the showerhead installed. This valve will prevent against significant fluctuations in water pressure

[24] U.S. Environmental Protection Agency's (EPA's) WaterSense program. WaterSense Labeled Showerheads. www.epa.gov/watersense/products/showerheads.html.

and temperature and can reduce risks of thermal shock and scalding. A plumber can check the compatibility of the showerhead and shower valve and, if necessary, install a valve that meets the recommended standards for the flow rate of the showerhead.

- Periodically inspect showerheads for scale buildup to ensure flow is not being restricted. Certain cleaning products are designed to dissolve scale from showerheads with buildup. Do not attempt to bore holes in the showerhead or manually remove scale buildup, as this can lead to increased water use or cause performance problems.
- Provide a way for users to track showering time and encourage users to take shorter showers by placing clocks or timers in or near the showers.
- Train users to report leaking or malfunctioning showerheads to the appropriate personnel.

Retrofit Options

Because showerheads are relatively inexpensive, replacement is often more economical and practical than a retrofit. In general, avoid retrofitting existing inefficient showerheads with flow control inserts (which restrict water flow) or flow control valves (which can be activated to temporarily shut off water flow) to reduce the flow rate and save water. These devices may not provide adequate performance in some facilities and can lead to user dissatisfaction.

In certain circumstances, single shower stalls may be outfitted with multiple showerheads that can be activated simultaneously or individually by the user. In some cases, when these showerheads are turned on simultaneously, they use more water than the federal maximum flow rate of 2.5 gpm for an individual showerhead (e.g., two 2.5 gpm showerheads can use 5.0 gpm). In these instances, stalls can be retrofitted so that the showerheads can only be operated individually rather than all at the same time, or so the total volume of water flowing from all showerheads is equal to or less than 2.0 gpm. The latter may require replacing the existing showerheads with more efficient ones. The retrofit suggestions for single shower stalls provided here do not apply to communal showers used in prisons, locker rooms, and barracks. Communal showers might have multiple showerheads that each flow at equal to or less than 2.0 gpm, since the showerheads are designed to be used by different users at once, as opposed to multiple showerheads being used by one user, as described above.

WaterSense labeled showerhead

Replacement Options

When installing new showerheads or replacing older, inefficient showerheads, choose WaterSense labeled models. WaterSense labeled showerheads[25] are designed to use 2.0 gpm or

[25] *Ibid.*

less and thus are 20 percent more water-efficient than standard showerheads on the market. In addition, WaterSense labeled showerheads are independently certified to meet or exceed minimum performance requirements for spray coverage and force.

Except for communal settings in prisons, locker rooms, and barracks, avoid purchasing and installing multiple showerheads when remodeling, particularly if they can be operated simultaneously or so that the total volume of water flowing from all showerheads is greater than the 2.0 gpm WaterSense specification maximum. These multiple showerhead systems can waste a significant amount of water and energy.

Savings Potential

Water savings can be achieved by replacing existing showerheads. To estimate facility-specific water savings and payback, use the following information.

Current Water Use

To estimate the current water use of an existing showerhead, identify the following information and use Equation 3-7:

- Flow rate of the existing showerhead. Showerheads installed in 1994 or later will have a flow rate of 2.5 gpm or less. Older showerheads may flow as high as 3.0 to 5.0 gpm.
- Average duration of each shower. The average shower duration is approximately eight minutes.[26]
- Average use rate of showers in terms of number of showers each person takes per day.
- Number of building occupants.
- Days of facility operation per year.

Equation 3-7. Water Use of Showerhead (gallons per year)

= Showerhead Flow Rate x Duration of Use x Use Rate x Number of Building Occupants x Days of Facility Operation

Where:

- Showerhead Flow Rate (gallons per minute)
- Duration of Use (minutes per shower)
- Use Rate (showers per person per day)
- Number of Building Occupants (persons)
- Days of Facility Operation (days per year)

[26] Mayer, Peter W. and DeOreo, William B. American Water Works Association (AWWA) and AWWA Research Foundation. 1998. *Residential End Uses of Water*. Page 102.

Water Use After Replacement

To estimate the water use of a replacement WaterSense labeled showerhead, use Equation 3-7, substituting the flow rate of the replacement showerhead. WaterSense labeled showerheads use no more than 2.0 gpm.

Water Savings

To calculate water savings that can be achieved from replacing an existing showerhead, identify the following information and use Equation 3-8:

- Current water use as calculated using Equation 3-7.
- Water use after replacement as calculated using Equation 3-7.

Equation 3-8. Water Savings From Showerhead Replacement (gallons per year)

= Current Water Use of Showerhead – Water Use of Showerhead After Replacement

Where:

- Current Water Use of Showerhead (gallons per year)
- Water Use of Showerhead After Replacement (gallons per year)

Payback

To calculate the simple payback from the water savings associated with replacing an existing showerhead, consider the equipment and installation cost of the replacement showerhead, the water savings as calculated in Equation 3-8, and the facility-specific cost of water and wastewater. The average showerhead costs approximately $30 retail.[27]

Because showerheads use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness.

Additional Resources

Alliance for Water Efficiency. Residential Shower and Bath Introduction. www.allianceforwaterefficiency.org/Residential_Shower_Introduction.aspx.

EPA's WaterSense program. WaterSense Labeled Showerheads. www.epa.gov/watersense/products/showerheads.html.

Vickers, Amy. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.

[27] EPA's WaterSense program. March 4, 2010. *WaterSense Specification for Showerheads Supporting Statement*. Page 6. www.epa.gov/WaterSense/partners/showerhead_spec.html.

3.6 Laundry Equipment

EPA WaterSense

Overview

The type of laundry equipment used in commercial laundry operations depends on the type of laundry facility, the total quantity and type of laundry to be cleaned, and the frequency that cleaning is needed. Self-service laundromats provide a centralized location where individuals can bring their personal laundry. These types of laundry facilities typically use commercial coin- or card-operated, single-load, residential-style washers. On-premises laundries are onsite facilities dedicated to washing fabrics used at the location and are typically found in facilities such as hotels, hospitals, nursing homes, prisons, and universities. Industrial laundries are typically centralized contract laundries that launder fabrics from other businesses. Industrial laundries and on-premises laundries tend to use large, multi-load washers and washer extractors. Very large on-premises laundries may use tunnel washers. The specific types of commercial laundry equipment are discussed in more detail below.

Recent advances in commercial laundry equipment, including the availability of more efficient equipment, water recycling, and ozone technologies, have provided options for reducing water use in nearly all commercial laundry operations.

Commercial Coin- or Card-Operated Washers

Commercial coin- or card-operated washers are similar to conventional, residential-style washing machines. Top-loading machines have dominated this market, although they are being phased out and replaced by more efficient, front-loading machines.

The Energy Policy Act (EPAct) of 2005 previously set requirements for commercial coin- or card-operated single-load, soft-mount (i.e., not bolted to the floor), residential-style laundry equipment, but the U.S. Energy Department (DOE) recently revised those energy conservation standards. Commercial coin- or card-operated single-load laundry equipment must now meet a water factor of 8.5 gallons per cubic foot for top-loading washers and 5.5 gallons per cubic foot for front-loading washers.[28]

To address efficiency and advances in commercial clothes washers, the U.S. Environmental Protection Agency (EPA) and DOE's ENERGY STAR® has developed voluntary criteria to qualify high-efficiency clothes washers to earn the ENERGY STAR label. ENERGY STAR qualified washers[29] are 37 percent more efficient than standard models, saving energy, water, and detergent.[30]

[28] U.S. Energy Department (DOE), Energy Efficiency & Renewable Energy, Building Technologies Program. Commercial Clothes Washers. www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html.
[29] U.S. Environmental Protection Agency (EPA) and DOE's ENERGY STAR. Commercial Clothes Washers. www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW.
[30] EPA and DOE's ENERGY STAR. Commercial Clothes Washers. www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW.

3.6 Laundry Equipment

Multi-Load Washers

Multi-load washers

Some commercial laundromats have coin- or card-operated multi-load-capacity washers. These types of machines are not regulated for water use by EPAct 2005. Multi-load machines may be top- or front-loading, hard-mount (bolted to the floor) or conventional soft-mount machines with capacities often exceeding 80 pounds of laundry per load, compared to less than 20 pounds per load for a conventional commercial washing machine. Unlike conventional washing machines, multi-load machines can allow a feature with programmable control settings (e.g., number of cycles, water levels per cycle). These settings can dictate the amount of water used by the machine and can be adjusted to improve efficiency.

Washer Extractors

Washer extractors are similar to multi-load washers, but can be larger, with capacities ranging from 30 to 800 pounds of per load. Washer extractors remove water and detergent from clothes using high-speed, centrifugal force spin cycles and are only configured with a horizontal front-loading axis, which makes them more efficient. Washer extractor efficiency is usually measured in gallons of water per pound of fabric, as opposed to gallons per cubic foot for commercial coin- or card-operated washers.

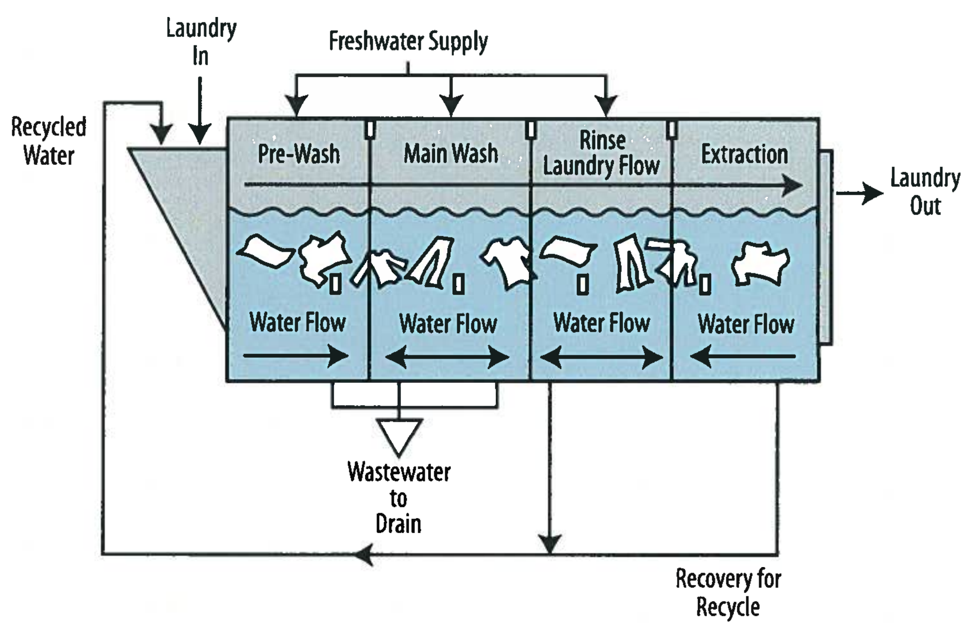
Washer extractors

One significant difference between a washer extractor and a coin- or card-operated commercial washer is the ability to significantly vary the number of wash cycles. For example, washing lightly soiled sheets at a hotel may only require a three-cycle operation consisting of wash (detergent), bleach, and rinse cycles. More heavily soiled laundry may require additional cycles, including a first flush, an alkali cycle to adjust the pH, a wash cycle, a bleach cycle, several rinse cycles, another pH adjustment to return the pH to neutral, and a final rinse cycle. With each cycle, some machines even have the ability to adjust water levels and the amount of hot or cold water used. This flexibility illustrates the importance of separating laundry by its level of soil, as doing so will determine the amount of water used for the total wash operation. Most washer extractors require two to four gallons of water per pound of fabric cleaned, depending upon the machine, the number of wash cycles used, and the water level settings.

Tunnel Washers

Tunnel washers are large-volume, continuous-batch washers with long chambers and a series of compartments through which the laundry is pulled for soaking, washing, and rinsing. Tunnel washers are used in very large laundry operations serving institutional users, such as hospitals, prisons, hotels, motels, and restaurants. They are capable of handling up to 2,000 pounds of laundry per hour. Tunnel washers are more water-efficient, because the water moves in a counter-flow direction to the laundry starting with the last rinse, so that the water is used through several cycles of the wash before being sent to the drain (see Figure 3-2). Tunnel washers are costly to install, but they are capable of saving more water than washer extractors and require less operation and maintenance labor. Tunnel washers typically use two gallons of water or less per pound of fabric.

Figure 3-2. Tunnel Washer



Operation, Maintenance, and User Education

Facility managers can reduce water use by taking simple steps to educate users on proper laundry equipment use and maintenance. In addition, consider the following:

- Encourage users to wash only full loads. Consider using a laundry scale to weigh loads to ensure the machine is filled to capacity.
- Consider separating and washing laundry based on the number of wash cycles needed (e.g., more soiled articles will require more wash cycles).

- Ensure multi-load washers are preset to meet a water factor of 8.0 gallons per cycle per cubic foot of capacity or less.[31]
- Work with the equipment supplier to provide an ongoing service and maintenance program.
- Consult the laundry chemical supplier for laundry methods that require fewer wash and rinse steps.
- Use detergents formulated for high-efficiency clothes washers. Normal detergents may suds too much and can leave laundry that is not completely washed or rinsed.

Retrofit Options

There are two main retrofit options to reduce water use associated with existing laundry equipment: water reuse/recycling and ozone systems.

Water Reuse/Recycling

Simple or complex recycling systems can be added to coin- or card-operated washers, multi-load washers, and washer extractors to recycle a portion or all of the water for reuse in the next wash. Simple recycling systems recover discharge from the final rinse in a multi-cycle operation for use in the first rinse of the next cycle. The water from these systems rarely needs treatment prior to reuse, so potential water savings is 10 to 35 percent. Complex recycling systems treat the reclaimed water from wash and rinse cycles for use in all cycles of the next load and can save more than 85 percent of water used. Complex recycle systems usually require water treatment before reuse.

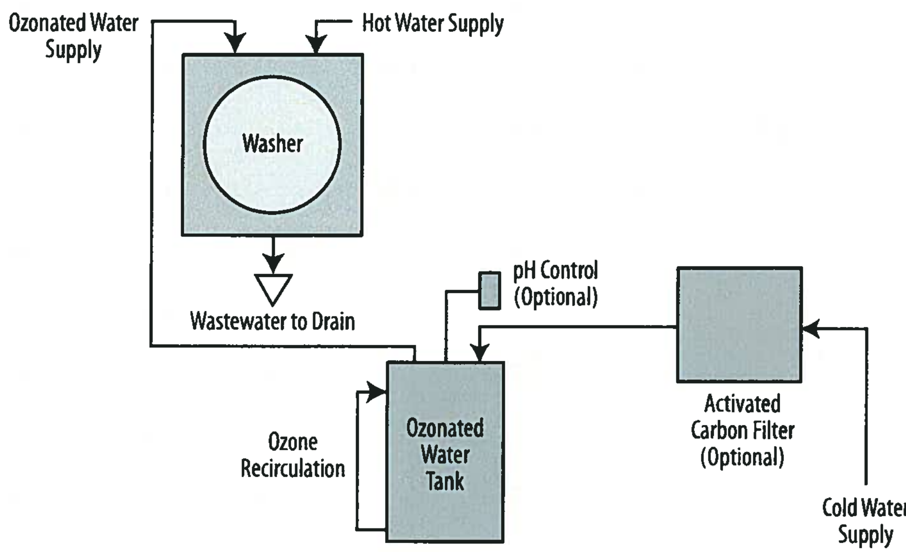
Be sure to evaluate space constraints when considering water reuse/recycling options. Space may not be available to accommodate additional recycling equipment or storage tanks. Because recycling may also require adjustments in chemicals and detergents, contact the chemical supply vendor in any retrofit planning.

Ozone Systems

Ozone systems can be installed on all types of existing commercial laundry machines as retrofits, although they are not as common as a retrofit for tunnel washers. Ozone systems generate ozone, which is injected into the wash as a powerful oxidant that reacts with dirt and organic materials. It also provides disinfection and whitening properties. Ozone can allow for reduced water temperatures, typically to 80°F, which saves energy. It also can reduce the amount of detergents and other chemicals needed, lessening the amount of rinsing required. Ozone systems work well on lightly soiled laundry, but they are not recommended for heavily soiled laundry. For heavily soiled laundry, conventional washing, detergents, and hot water work best. See Figure 3-3 for an example of the configuration of a laundry ozone system.

[31] East Bay Municipal Utility District (EBMUD). 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. Page 31. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

Figure 3-3. Laundry Ozone System



Replacement Options

When installing new laundry equipment or replacing existing equipment, consider the following replacement options:

- For coin- or card-operated, single-load clothes washers, choose models that are ENERGY STAR qualified.[32] ENERGY STAR qualified washers use significantly less energy, water, and detergent compared to standard models.
- For multi-load washers, choose models that use no more than 8.0 gallons per cycle per cubic foot of capacity.
- For washer extractors, choose machines with built-in water recycling capabilities that can store the rinse water from the previous load for use in the next load. These types of washer extractors can use less than 2.5 gallons of water per pound of fabric.
- For large industrial or commercial laundries, consider replacing old washer extractors or multi-load washers with tunnel washers if large volumes of laundry will be processed.
- Choose new machines that support remote diagnosis by the manufacturer to minimize maintenance cost and time associated with troubleshooting equipment problems.

[32] EPA and DOE's ENERGY STAR. ENERGY STAR Qualified Products, *op. cit.*

Savings Potential

Water savings can be achieved through retrofitting existing laundry equipment to recycle wash water or reduce the amount of water required for rinsing, or by replacing existing laundry equipment with more efficient equipment. To estimate facility-specific water savings and payback, use the following information.

Coin- or Card-Operated Washer or Multi-Load Washer Retrofit

Use the following information to estimate water savings and payback potential that may be achieved with recycling or ozone retrofits. Water savings can vary based upon the water use and use patterns of the existing laundry equipment and the type of retrofit selected.

Current Water Use

To estimate the current water use from a commercial coin- or card-operated washer or multi-load washer, identify the following information and use Equation 3-9:

- Washer's water factor in gallons per cycle per cubic foot of capacity. Coin- or card-operated washers installed since the early 1990s will have a water factor of 9.5 gallons per cycle per cubic foot of capacity or less.
- Capacity of the washer.
- Average number of cycles per load. The number of cycles refers to the number of times the washer is filled with water. There may be one or two wash cycles and one or two rinse cycles in typical coin- or card-operated washers or multi-load washers.
- Average number of loads per year.

Equation 3-9. Water Use of Commercial Coin- or Card-Operated Washer or Multi-Load Washer (gallons per year)

= Water Factor x Washer Capacity x Number of Cycles x Number of Loads

Where:

- Water Factor (gallons per cycle per cubic foot capacity)
- Washer Capacity (cubic feet of capacity)
- Number of Cycles (cycles per load)
- Number of Loads (loads per year)

Water Savings

Studies have documented water savings for retrofits with a simple recycling system, retrofits with a complex recycling system, and ozone system retrofits. To estimate water savings that can be achieved from retrofitting existing laundry equipment, multiply the water use of the existing laundry equipment (Equation 3-9) by the savings potential for the appropriate retrofit option indicated in Table 3-1 below (see Equation 3-10).[33]

Table 3-1. Potential Water Savings From Commercial Laundry Retrofit Options

Retrofit Option	Water Savings Potential
Retrofit With Simple Recycling System	10% to 35%
Retrofit With Complex Recycling System	85% to 90%
Retrofit With Ozone System	10% to 25%

Equation 3-10. Water Savings From Commercial Laundry Equipment Retrofit (gallons per year)

= Current Water Use of Laundry Equipment x Water Savings Potential

Where:

- Current Water Use of Laundry Equipment (gallons per year)
- Water Savings Potential (percent, from Table 3-1)

Payback

To calculate the simple payback from the water savings associated with retrofitting existing laundry equipment, consider the equipment and installation cost of the retrofit option, the water savings as calculated using Equation 3-10, and the facility-specific cost of water and wastewater.

Because washers use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness. More efficient washers may also require less detergent. If the facility is paying for the detergent used, this may reduce overall operating costs and reduce the payback period.

Washer Extractor or Tunnel Washer Retrofit

Existing washer extractors or tunnel washers can also be retrofitted to recycle and reuse a portion of the rinse water or retrofitted with an ozone system.

Current Water Use

To estimate the current water use from a washer extractor or tunnel washer, identify the following information and use Equation 3-11:

[33] EBMUD, *op. cit.*, Pages LAUND 4–6.

- Washer's water-efficiency factor in gallons per pound of fabric.
- Average number of pounds of fabric per load.
- Average number of loads per year.

Equation 3-11. Water Use of Washer Extractor or Tunnel Washer (gallons per year)

= Water-Efficiency Factor x Pounds of Fabric x Number of Loads

Where:

- Water-Efficiency Factor (gallons per pound of fabric)
- Pounds of Fabric (pounds of fabric per load)
- Number of Loads (loads per year)

Water Savings

To calculate water savings that can be achieved from retrofitting an existing washer extractor or tunnel washer, multiply the water use of the existing laundry equipment as calculated using Equation 3-11 by the savings potential for the appropriate retrofit option indicated in the Table 3-1 above (Equation 3-10).

Payback

To calculate the simple payback from the water savings associated with retrofitting an existing washer extractor or tunnel washer, consider the equipment and installation cost of the retrofit option, the water savings as calculated using Equation 3-10, and the facility-specific cost of water and wastewater.

Because washers use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness. More efficient washers may also require less detergent, which may reduce overall operating costs and reduce the payback period.

Coin- or Card-Operated Washer or Multi-Load Washer Replacement

Coin- or card-operated washer or multi-load washers can be replaced with more efficient laundry equipment. Look for washers with the ENERGY STAR label.

Current Water Use

To estimate the current water use of a coin- or card-operated washer or multi-load washer, use Equation 3-9.

Water Use After Replacement

To estimate the water use of a more efficient replacement commercial coin- or card-operated washer or multi-load washer, use Equation 3-9, substituting the water factor and washer capacity of the replacement equipment. ENERGY STAR qualified coin- or card-operated washers will have a water factor of 6.0 gallons per cycle per cubic foot of capacity or less. An efficient multi-load washer will have a water factor of 8.0 gallons per cycle per cubic foot or less.

Water Savings

To calculate water savings that can be achieved from replacing an existing coin- or card-operated washer or multi-load washer, identify the following information and use Equation 3-12:

- Current water use as calculated using Equation 3-9.
- Water use after replacement as calculated using Equation 3-9.

Equation 3-12. Water Savings From Commercial Laundry Equipment Replacement

= Current Laundry Equipment Water Use – Water Use of Laundry Equipment After Replacement

Where:

- Current Laundry Equipment Water Use (gallons per year)
- Water Use of Laundry Equipment After Replacement (gallons per year)

Payback

To calculate the simple payback from the water savings associated with replacing an existing coin- or card-operated washer or multi-load washer with an ENERGY STAR qualified model, consider the equipment and installation cost of the new equipment, the water savings as calculated using Equation 3-12, and the facility-specific cost of water and wastewater.

Because washers use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness. More efficient washers may also require less detergent. If the facility is paying for the detergent used, this may reduce overall operating costs and reduce the payback period.

Washer Extractor or Tunnel Washer Replacement

Existing washer extractors or tunnel washers can be replaced with more efficient laundry equipment.

Current Water Use

To estimate the current water use from a washer extractor or tunnel washer, use Equation 3-11.

Water Use After Replacement

To estimate the water use of a more efficient, replacement washer extractor or tunnel washer, use Equation 3-11, substituting the new washer's water efficiency. Existing washer extractors can be replaced with machines with built-in water recycling capabilities that use less than 2.5 gallons of water per pound of fabric. Efficient tunnel washers typically use two gallons of water or less per pound of fabric.

Water Savings

To calculate water savings that can be achieved from replacing an existing washer extractor or tunnel washer, use Equation 3-12.

Payback

To calculate the simple payback from the water savings associated with replacing an existing washer extractor or tunnel washer, consider the equipment and installation cost of new equipment, the water savings as calculated using Equation 3-12, and the facility-specific cost of water and wastewater.

Because washers use hot water, a reduction in water use will also result in energy savings, further reducing the payback period and increasing replacement cost-effectiveness. More efficient washers may also require less detergent, which may reduce overall operating costs and reduce the payback period.

Additional Resources

Alliance for Water Efficiency. Commercial Laundry Facilities Introduction. www.allianceforwaterefficiency.org/commercial_laundry.aspx.

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages 31, LAUND4-6. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

EPA and DOE's ENERGY STAR. Commercial Clothes Washers. www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW.

Koeller, John, et al. Koeller and Company. January 2006. *A Report on Potential Best Management Practices, Annual Report—Year Two*. Prepared for The California Urban Water Conservation Council. www.cuwcc.org/products/pbmp-reports.aspx.

Pacific Gas and Electric. 2009. *Hospitality Fact Sheet: Ozonated Laundry Systems in Hospital Facilities*. www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hospitality/Ozonated_Laundry_FS_Final.pdf.

Schultz Communications. July 1999. *A Water Conservation Guide for Commercial, Institutional and Industrial Users*. Prepared for the New Mexico Office of the State Engineer. Page 41. www.ose.state.nm.us/wucp_ici.html.

Sullivan, G.P., et al. January 2008. *Cal-UCONS Commercial Laundry Program Measurement and Evaluation, Southern California Gas Company and San Diego Gas and Electric Company, Final Report*. eere.pnnl.gov/building-technologies/pdf/sempra_final.pdf.

Water Management, Inc., et al. 2006. *Report on the Monitoring and Assessment of Water Savings from the Coin-Operated Multi-Load Clothes Washer Voucher Initiative Program*. Prepared for the San Diego Water Authority. www.allianceforwaterefficiency.org/commercial_laundry.aspx.