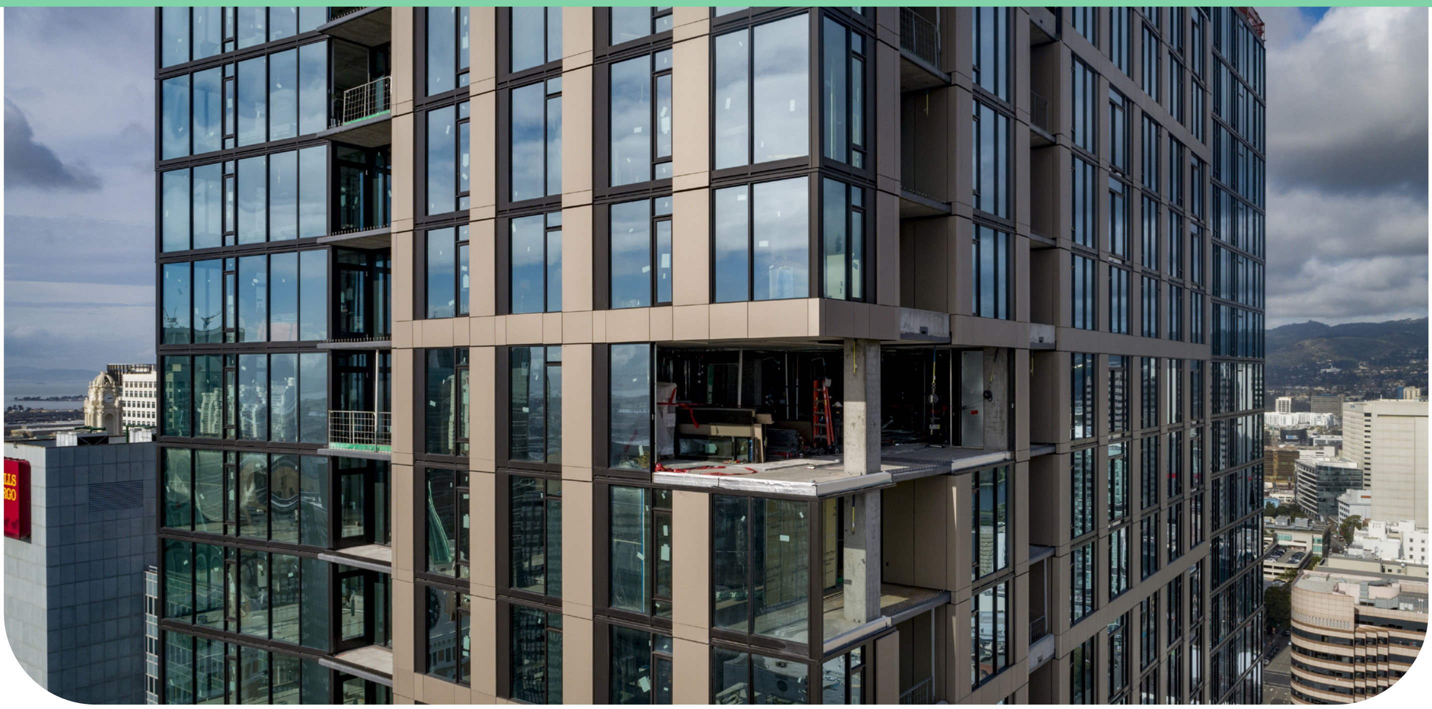
EBMUD Commercial Guidebook: Water Conservation Essentials

EBMUD

Introduction

INTRODUCTION



This guidebook was developed to help Commercial, Industrial and Institutional (CII) water users be more water efficient. It provides information on water-saving technologies and best management practices applicable to these sectors and will include an appendix section which provides seasonal water use benchmarks for numerous business types. These benchmarks provide readers with a comparison to their own water usage patterns and consumption levels. The guidebook is intended for use as a resource by:

- Existing and new businesses
- Developers, consultants, and designers
- Planning agencies, for benchmarking purposes
- Water providers, for reviewing and estimating water use at existing businesses

In this guide, readers will find eight broad categories of water-using or monitoring technologies:

- Data Collectors
- Metering of Individual Units
- Indoor Plumbing
- Restrooms
- Water Treatment
- Process Water
- Alternate On-site Water Sources
- Landscapes

Readers can also explore six business categories commonly represented in the CII sectors:

- Food Service
- Laundries & Dry Cleaning
- Medical Facilities & Laboratories
- Pools & Spas
- Vehicle Washes
- Cannabis Operations

Many of the technologies discussed in this guidebook can also be applied to other business types not specifically addressed herein. For example, restroom fixtures, process water and landscape technologies can also apply to many business types, and some of this information can also be applied to the residential sector. Each chapter has an introduction that includes a discussion of the end uses of water, as well as references on where to find technical data for such information as the estimated life-cycle water savings, costs, and payback (cost-effectiveness) of the technology where applicable.

For Water Providers and Utilities

Though this water efficiency guidebook was written to assist EBMUD customers, it also includes additional resource savings recommendations where applicable. Note that some of the recommendations may be specific to Northern California, but as a whole, many of the technologies can be applied to improved water efficiency world-wide. While it is left to each agency to decide what water-saving technologies might be appropriate for their service area, this guidebook includes examples of proven water conservation practices.

The business community can capture the benefits of reduced costs for water, energy, chemicals, wastewater, and onsite water- and wastewater- treatment facilities. For example, system-capacity charges imposed by water providers (i.e., water-provider connection fees) may be reduced due to either smaller meter sizes or reduced water use resulting from the water-saving technology. Thus, planning for and incorporating water- (and energy-) efficient technology during the design and construction phase of a project can represent a win-win scenario for all stakeholders, including the environment. Lastly, using this guidebook for new projects adopting water-efficiency standards can be considerably more cost-effective for both water utilities and businesses than retrofitting businesses with water-efficient technology after construction.

How to Use This Guide

The chapters "The True Cost of Water," "Data-logging Devices," "Plumbing," and "Restrooms" are broadly applicable to most business and facility types. They lay a foundation for understanding the interplay of water and energy costs, the utility of tracking and analyzing water use data, the basics of plumbing, and the considerations for restrooms, respectively.

In addition to these chapters, business and facility types will also want to focus on chapters directly relevant to their industry.

Example 1: Car Wash

This type of business will benefit from the following chapters, covering important aspects of water usage involved in washing cars, as well as the filtration, disposal, and potential reuse of wash water.

- → Vehicle Washes
- → Water Treatment
- → Process Water
- → Alternate On-Site Water Sources

Example 2: Hospital

Hospitals and medical facilities will want to focus both on the chapters concerning public-facing water fixtures, in addition to the specific specialized facilities often present on a medical campus.

- → Metering of Individual Units
- → Water Treatment
- → Process Water
- → Alternate On-Site Water Sources
- → Landscape Water Use Efficiency
- → Food Service Operations
- → Laundries & Dry-Cleaning Operations
- → Medical Facilities & Laboratories

Example 3: Restaurant

Restaurant operators will want to choose sections that reflect the building type that they are housed in. Stand-alone restaurant buildings with surrounding landscaping will have a few more considerations than restaurants operating in a mixed-use development setting.

- → Metering of Individual Units
- → Food Service Operations
- → Landscape Water Use Efficiency

Since technology changes over time, this guidebook will be reviewed every 5 years and updated accordingly.

Reader feedback is appreciated from those who gain experience with the use of this guidebook. Please provide comments to waterconservation@ebmud.com or write to:

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The True Cost of Water

THE TRUE COST OF WATER

The full, true cost of water used in a commercial or industrial establishment is more than just the money paid to the local water utility. Wastewater, water treatment, pretreatment and energy costs to heat water for a commercial facility are important factors in calculating the cost of water for a property. Presenting these costs to the average worker in units they can understand is also important so that all staff can appreciate the interrelated impacts of water and energy use. This chapter examines these cost relationships.

Water Rates in East Bay Municipal Utility District

Water rates for EBMUD are expressed in dollars per 100 cubic feet (CCF). One CCF is equal to 748 gallons.

Commercial and industrial rates include non-potable water and multifamily customers. Multifamily is included since these are businesses whose function is housing people. In addition to these water rates, the utility charges a fixed monthly fee based on the size of the water meter and pressure zone.

Check with your local water service provider for information on water rates and other billing information.

Wastewater Rates in East Bay Municipal Utility District

Wastewater rates can vary significantly by the wastewater utility in the area. Although EBMUD provides treatment facilities, each wastewater utility has specific rates by type of commercial or institutional user.

Much of the variation in volume charge is based on waste strength (Chemical Oxygen Demand – COD, and Total Suspended Solis – TSS) and other factors. EBMUD requires that users whose wastewater exceeds the assigned strengths obtain wastewater discharge permits under EBMUD's permit program. Each utility handles these charges in a different manner.

Putting Water and Wastewater Charges Together

Some account types such as irrigation-only are not assigned wastewater charges since wastewater is not generated from their consumption. In a similar fashion, commercial customers that do not discharge a significant amount of their incoming water to the sewer can apply for a permit that estimates the wastewater volume, which would otherwise be based on the incoming water volume and calculates the treatment charge. This "Estimation of Wastewater Charges" permit can result in significant savings for the customer. Buildings with cooling towers, for example, can be given evaporation credits by many utilities for the water that is evaporated and not returned to the sanitary sewer. However, almost all commercial and institutional indoor uses are not separable. Therefore, the cost to use water should include both water and wastewater volumetric charges.

Energy for Heating Water

The associated energy necessary to heat water is an often-overlooked water cost. Hot water use in restaurants is primarily in the kitchen for dishwashing and other activities. High temperature dishwashers must have 180°F water while other operations can use water in the 130°F to 140°F range. Hot water is used in lavatories, sinks, and for showers and on-site laundry. Hotels and hospitals have significant water costs for showering and medical equipment. Many other uses of hot water can be found in the commercial and institutional sectors.

The cost to heat water can add significantly to the cost of the water that is being used. The amount of energy needed depends on the tap water temperature; the colder the incoming water, the more energy needed to raise the water to the desired temperature.

Electricity and natural gas are the two main ways of heating water in commercial and institutional operations . This is also generally true in industrial operations, although other fuels are sometimes used.

Electricity rates can vary by time of use. The price of natural gas and propane also generally increases annually and can adjust seasonally or even daily.

Businesses should be aware of their current electric and natural gas rates. Pacific gas and

Electric (PG&E) is the main energy provider to EBMUD. Rates vary by total use and season.

The energy cost of heating water per gallon can be higher than the combined water and wastewater cost of that water per gallon. **Tables 1-1 and 1-2** show how much it costs to heat water at 100 percent water heater efficiency.

Cost to heat one gallon of water:

- The cost of natural gas or electricity
- The temperature of the water supplying the water heater
- The final temperature of the hot water
- The efficiency of the water heating system

Currently, electric water heaters operate in the range of 98% to 99% efficiency, and as of October 2015, commercial gas water heaters are required to achieve 80% efficiency[1]. Older water heaters were generally 70% to 75% energy efficient when brand new. New natural gas condensing heaters have efficiencies in the 90% to 95% range. However, the efficiency of hot water delivered to the point of use includes heat loss in the pipes. As water heaters age, their efficiency also tends to decline.

When energy costs are added, the cost of water increases dramatically.

The following examples illustrate how to use the sample tables.

Example 1: A new electric water heater operating at 80 percent efficiency heats water from 60°F to 140°F, an increase of 80°F. If the cost of electricity is 30 cents per kWh, the cost at 100% efficiency is 5.86 cents per gallon. At 80 percent efficiency, the actual cost is 5.86/0.80 = 7.33 cents per gallon. When added to the total water and wastewater cost, the hot water costs are 8.58 cents per gallon = $85.80 per thousand gallons ($64.18 per CCF).

Example 2: The 140°F hot water is then used to feed a high temperature dishwasher operating at 180°F using an electric booster heater. The water must be heated an additional 40°F with electricity at 30 cents per kWh. The rise in temperature from 140°F to 180°F cost would be 2.93 cents a gallon. Adding the water and wastewater cost of 1.26 cents and the gas heater cost to raise the water to 140°F 3.56 cents, the total cost = 4.78 cents per gallon = $47.80 per thousand gallons.

Typical Percentages of Hot Water Use for Commercial and Institutional Users

The cost of water used will depend on what percent of the water used in the application is heated.

For example, the percentage of water used in a shower depends on the temperature of the cold water and the preference of the person taking the shower. Cold water (water and wastewater combined) may cost 1.25 cents a gallon and hot water may cost approximately 2.60 cents a gallon. Therefore, if 60% percent of the water used in the shower is heated water, the cost of water would be calculated as follows: (1.25 X 0.40) + (2.6 X 0.60) = 2.06 cents per gallon. **Table 1-3** shows the range of hot water use for various types of hot water use in commercial and institutional establishments.

Treatment Costs

While many industries, such as restaurants, will generally not need to further treat their municipal water, certain commercial and industrial operations such as refineries require a specific chemical composition of water. In these cases, further treating municipal water could be necessary, adding to the cost. The two most common commercial treatment options are softening and reverse osmosis.

Softening is done with a softener that uses either sodium or lithium chloride to recharge the softener. Commonly, commercial heating and cooling applications, such as in cooling towers, require "softer" water that removes naturally occurring minerals. Water from the East Bay Municipal Utility District has an average hardness of 140 ppm as calcium carbonate. This is equal to 7.9 grains of hardness. The State of California requires residential softeners remove at least 4,000 grains of hardness per pound of salt. Commercial systems can generally operate at this efficiency or even higher.

1 *https://appliance-standards.org/product/commercial-water-heaters*

If the softener is operating at 4,000 grains per pound of salt and the hardness is 7.9 grains per gallon, one pound of salt will treat 506 gallons of water. The average cost of softening salt is in the range of 4.5 cents to 5.5 cents per pound. In this example, salt cost for softening to treat 500 gallons is 10 cents per thousand gallons - a relatively small amount.

Reverse Osmosis systems remove dissolved solids (salts and minerals) from water with a molecular level filtration type system. "Industries like mechanical, chemical, pharmaceutical, and lumber/pulp industries, utilize reverse osmosis systems for pre-boiling water treatment/conditioning."[2] Feed water to reverse osmosis (RO) systems is also often softened before RO is used. In some commercial operations such as car washes and in medical and laboratory systems, feed water to the RO unit is pressurized with a pump. For small RO applications in kitchens and point of use treatment, line pressure is used. Although, energy costs for systems using a pump are real, for most RO systems, they are small if only fresh water is the source. The main factor is how much water is discharged to waste for every gallon produced. Some older inefficient systems dumped five gallons of water into the sewer for each gallon provided for use. For car washes and kidney dialysis systems, typically, one gallon is dumped for every gallon produced. These two examples are used because for car washes with recirculation systems, dumped water is not wasted. It is caught and used for the first wash cycles. For the kidney dialysis systems, that water is lost. Modern under the sink RO systems typically dump two gallons per gallon produced, while much larger systems for laboratories can dump as little as a quarter of a gallon per gallon produced.

The following are examples of calculations.

Example 1: A small under the counter RO unit that discharges four gallons for each gallon produced by the RO system. In this case, for every one gallon produced, five gallons are used. The cost for water and wastewater is 1.246 cents per gallon. Therefore the total cost = 5 x 1.246 cents per gallon = 6.23 cents per gallon which equals $46.60 per CCF!

Example 2: A kidney dialysis clinic with an RO system that produces one gallon and discharges one gallon. In this case, two gallons are used for each usable gallon produced. At 1.246 cents a gallon, each usable gallon cost 2.49 cents a gallon ($18.64 per CCF).

The Impact of Inflation on Future Water Costs

Since 2000, water and wastewater rates have had an inflation rate between 5.5% and 5.6%[3]. Using historical rates means that rates for water and wastewater in 2021 were some 2.96 times more than in 2001. If this inflation rate prevails, current water and wastewater rates will double in 14 years. Table 1-4 shows this impact on the cost to flush a toilet.

Energy rates, such as for natural, also continue to increase. Figure 1-1 shows average natural gas prices for commercial establishments in California since 2010.

2 Intec America *https://www.intec-america.com/blog/reverse-osmosis-ro-industrial-applications*

3 Black & Veatch. (2021). 2021 50 Largest Cities Water and Wastewater Report. *https://bv.com/resources/2021-50-largest-cities-water-and-wastewater-report*

Table 1-1: The Cost of Heating Water with Natural Gas at 100% Efficiency

DOLLARS PER MCF	DEGREES F° OF INCREASE IN TEMPERATURE										
	40°	50°	60°	70°	80°	90°	100°	120°	130°	140°	150°
$6	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.65	0.70	0.75
$8	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.80	0.87	0.93	1.00
$10	0.33	0.42	0.50	0.58	0.67	0.75	0.83	1.00	1.08	1.17	1.25
$12	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.30	1.40	1.50
$14	0.47	0.58	0.70	0.82	0.93	1.05	1.17	1.40	1.52	1.63	1.75
$16	0.53	0.67	0.80	0.93	1.07	1.20	1.33	1.60	1.73	1.87	2.00
$18	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	1.95	2.10	2.25
$20	0.67	0.83	1.00	1.17	1.33	1.50	1.67	2.00	2.17	2.34	2.50

Table 1-2: The Cost of Heating Water with Electricity at 100% Efficiency

CENTS PER KWH	DEGREES F° OF INCREASE IN TEMPERATURE										
	40°	50°	60°	70°	80°	90°	100°	120°	130°	140°	150°
8	0.78	0.98	1.17	1.37	1.56	1.78	1.96	2.35	2.54	2.74	2.93
10	0.98	1.22	1.47	1.71	1.96	2.22	2.44	2.93	3.18	3.42	3.67
12	1.17	1.47	1.76	2.05	2.35	2.67	2.93	3.52	3.81	4.11	4.40
14	1.37	1.71	2.05	2.40	2.74	3.11	3.42	4.11	4.45	4.79	5.13
16	1.56	1.96	2.35	2.74	3.13	3.56	3.91	4.69	5.08	5.48	5.87
18	1.76	2.20	2.64	3.08	3.52	4.00	4.40	5.28	5.72	6.16	6.60
20	1.96	2.44	2.93	3.42	3.91	4.45	4.89	5.87	6.36	6.84	7.33
22	2.15	2.69	3.23	3.76	4.30	4.89	5.38	6.45	6.99	7.53	8.07
24	2.35	2.93	3.52	4.11	4.69	5.34	5.87	7.04	7.63	8.21	8.80
26	2.54	3.18	3.81	4.45	5.08	5.78	6.36	7.63	8.26	8.90	9.53
28	2.74	3.42	4.11	4.79	5.48	6.23	6.84	8.21	8.90	9.58	10.27
30	2.93	3.67	4.40	5.13	5.87	6.67	7.33	8.80	9.53	10.27	11.00
32	3.13	3.91	4.69	5.48	6.26	7.12	7.82	9.39	10.17	10.95	11.73

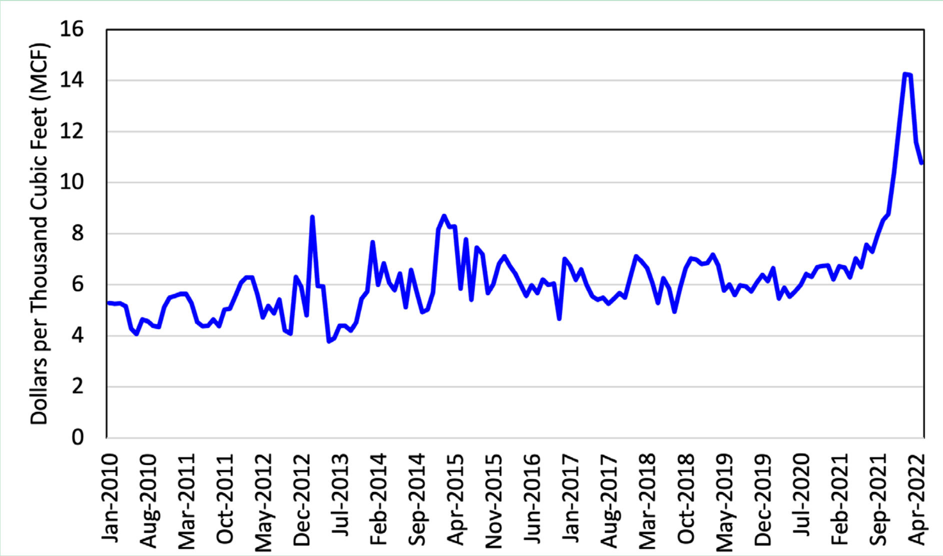
Table 1-3: Typical Percentages of Hot Water Use for CII Users

TYPE OF USE	PERCENT RANGE OF TYPICAL HOT WATER USE
Lavatory Faucets	10% to 30%
Showers	40% to 80%
Hotel Laundry Operations	5% to 35%
Coin Laundry Operations	20% to 35%
Commercial Dishwashers	100%
Pre-Rinse Spray Valves	0% to 100%

Table 1-4: Cost to Flush a Toilet Now and in 10 and 20 Years

GALLONS PER FLUSH	CENTS PER FLUSH		
	2022	10 YEARS	20 YEARS
5.0	6.2	10.1	16.7
3.5	4.4	7.1	11.7
1.6	2.0	3.2	5.4
1.28	1.6	2.6	4.3
1.0	1.2	2.0	3.3
0.8	1.0	1.6	2.7

Figure 1-1: California Commercial Gas Prices Since 2010



Source: Energy Information Administration

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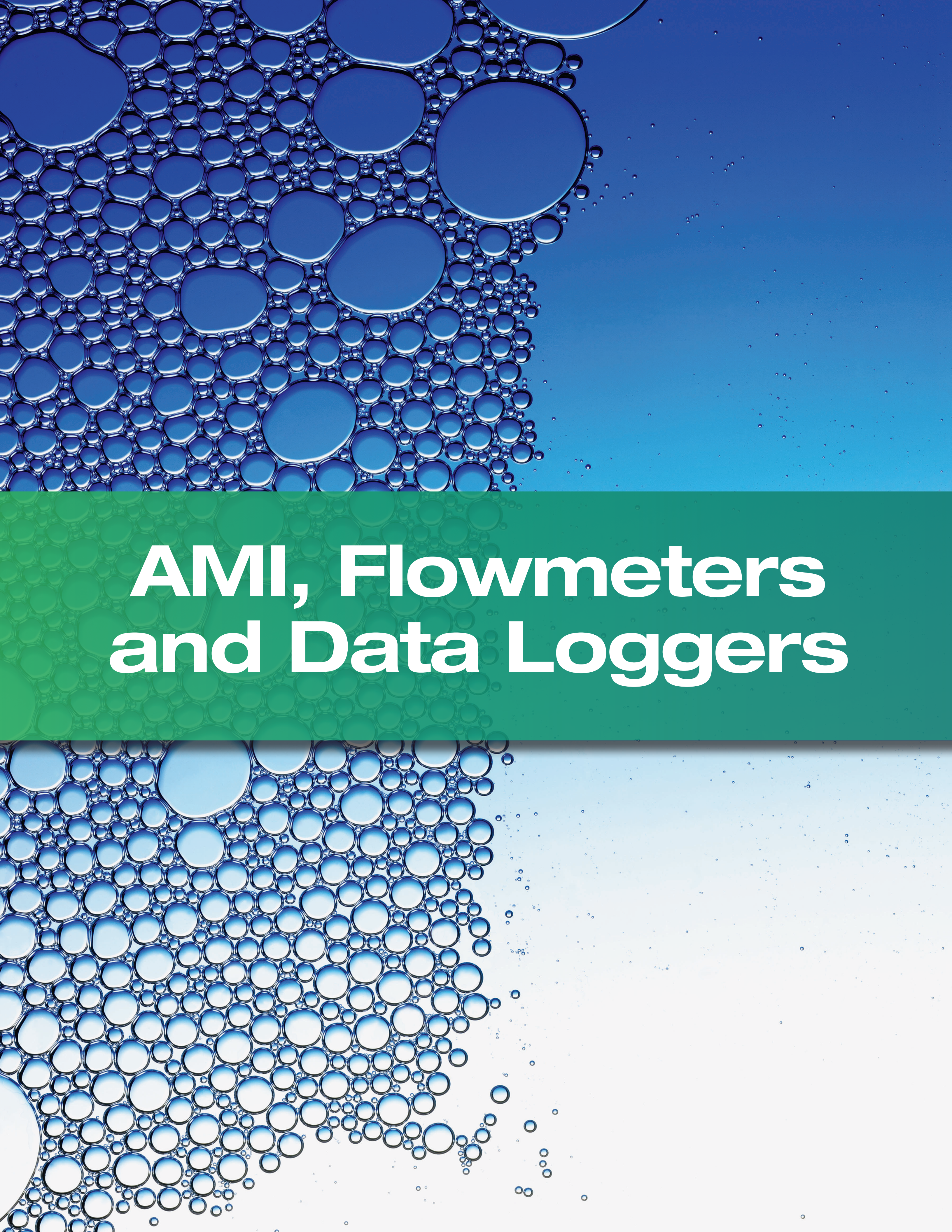


AMI, Flowmeters and Data Loggers

TECHNOLOGIES FOR REAL-TIME WATER USE: AMI, FLOWMETERS AND DATA LOGGERS

Thanks to advances in data monitoring technology, water use data is now frequently available at high volumetric resolutions and measurement frequencies that can be readily used to identify and implement water saving opportunities.

There are several technological options for capturing high-resolution water use data, including Advanced Metering Infrastructure (AMI) meters installed by utilities as well as flowmeters and data loggers installed by water users, or plumbers acting on the water users' behalf. This section provides a brief overview of each technology, followed by general recommendations and a table listing the efficiency, benefits, and drawbacks for the different technologies.

Advanced Metering Infrastructure (AMI)

AMI is a combination of utility-installed meters and associated devices or systems used to capture, transmit, and store high resolution water use data. Traditional metering systems record water use at monthly, bi-monthly, or quarterly intervals whereas AMI metering systems record data at daily, hourly, or sub-hourly intervals. In addition to more frequent measurements, AMI meters may capture, and report water use at gallon or even fractional gallon (or cubic foot) volumes, compared to traditional systems which often report in thousand-gallon (kgal) or hundred cubic foot (hcf) volumes.

While the systems are owned and operated by the utility, AMI systems also frequently include a customer-facing data portal and are sometimes integrated alongside utility billing systems. This gives the user access to nearly real-time water use data.

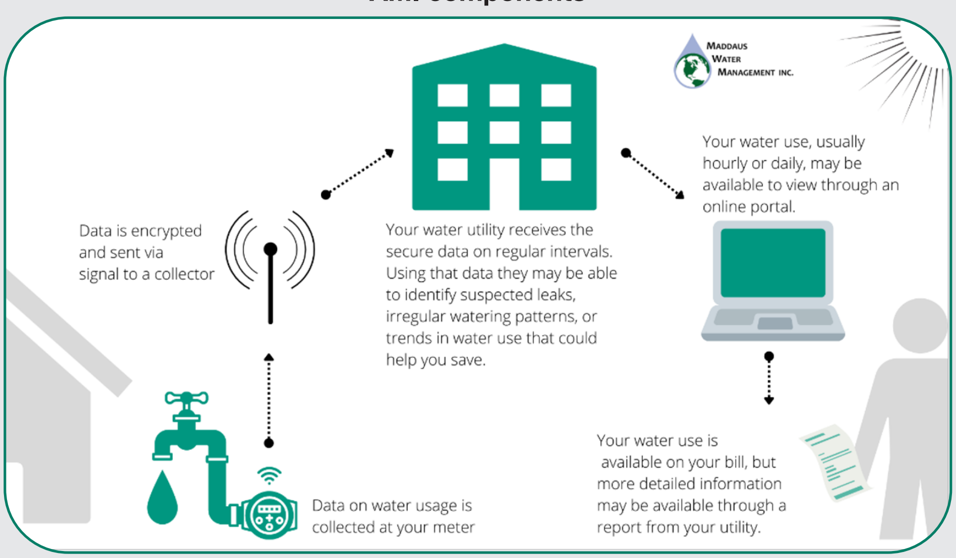
AMI technology represents a substantial improvement over many aspects of traditional metering systems but also requires a substantial capital investment by the utility. Not all utilities have made the switch to AMI, and those that have switched sometimes target specific customers, areas, or meter types for systematic replacement over time. As of 2023, EBMUD has not yet made the transition to AMI meters for the majority of its service area.

Opportunities to save include:

- Leak identification (including verification of leak repair)
- Increased operational efficiencies through benchmarking and other means
- Identification and replacement of inefficient equipment and fixtures

Although the data captured by AMI systems can seem overwhelming, tools are available to assist both water users and utilities in extracting meaningful and actionable information. Data collected by AMI systems can be processed in various ways, including automated methods implemented by utility staff or through processing handled

AMI components



Source: US EPA, https://www.epa.gov/system/files/documents/2022-09/ws-commercial-ami-guide-facilitymanagers.pdf

TABLE 2-1: METHOD/TECHNOLOGY TABLE

METHOD/ TECHNOLOGY	BENEFITS	DRAWBACKS
AMI Customer Portals	• With access to data in near-real-time, portals inherently encourage water use efficiency as you can actively monitor use to keep use/bills low • The Portal can identify some end uses such as irrigation or potential leaks and bursts.	• Customers must actively use and engage with the portal
AMI Leak Notification Programs	• Alerts customers of leaks quickly, preventing high bills and associated water damage. • Can automatically enroll customers so they are notified even if they have not proactively engaged with the customer portal.	• Requires advanced algorithms to detect CII leaks • False positives or multiple small leaks can be viewed as nuisances
AMI Threshold-Based Notifications (incl. water budgets)	• Allows customers to identify and address potential issues before a high bill is received. • Helps customers to reduce water to meet budget by showing actual versus desired usage • Can support operational efficiency by displaying accurate real-time water usage information	• Thresholds vary greatly across use types and individual users, so can be difficult to establish
Flowmeter / Data Logger Equipment	• Add bullet before this one: Allows customers to see real-time usage even without utility-installed AMI • Allows precise water use monitoring for specific equipment/systems and associated benefits (leak detection, efficiency improvements, etc.) • Customer can often easily self-install externally attached models • May help meet green building certifications and other sustainability goals	• Initial install as well as calibration, testing, or repair may require system drain-down and plumbing expertise • Isolation of individual uses may not be possible for all customers • Equipment replacement and upgrades can be costly • Not all models offer real-time notifications via app • Some models require Wi-Fi, cellular subscriptions, and/or external power sources

by AMI data portals.

Meaningful Utilization of AMI Data:

- Setting threshold-based notifications (e.g., notifying the utility and/or customer if water usage is greater than the user-specified number of gallons per hour/day/week)
- Projected bill amounts based on current usage to date
- Continuous usage (also known as suspected leak) notifications
- Advanced systems may also identify distinct large water usages such as irrigation or potential bursts possibly indicative of pipe breaks

Notifications regarding high usage, suspected leaks, or frequent irrigation are often part of a customer portal service, used by utilities, that can help water users address their own high usage and suspected leak issues before they escalate.

In addition to notification-driven savings, Commercial, Industrial & Institutional (CII) users can achieve even greater savings using AMI by actively monitoring their water use during operational events (E.g.: equipment that runs overnight).

This data can be used to form a baseline operational assessment. This assessment includes conducting a comprehensive review of typical water use and documenting water use for specific equipment and processes, or for the entire facility over various time periods. By comparing the actual water consumption for a piece of equipment or process to the manufacturer's description of expected use, it becomes easier to identify inefficiencies or potentially failing equipment. This information can be used to target efficiency projects and upgrades.

Flowmeters & Data Loggers

Flowmeters and dataloggers offer even higher resolution data than AMI meters and can provide data at fractions of a gallon every second. Sometimes, this more granular data makes identifying the cause of leaks and high usage easier than with AMI alone. Flowmeters are often in-line equipment that require system drain-down or wet tap and plumbing expertise to install, although clamp on models are also available. There are many types of flowmeters with varying suitability considerations, including pipe diameter, water properties, and desired accuracy. For additional information about flowmeter and data loggers, see the EPA's publication, [WaterSense at Work: Metering and Sub Metering].

Data loggers on two water meter dials

Image source: HW (Bill) Hoffman & Associates, LLC

Flowmeters can be connected upstream of specific equipment, such as cooling towers or irrigation systems, to provide high resolution data associated with specific equipment and end uses. Some flowmeters can also measure additional water parameters, such as pressure and temperature.

Dataloggers collect similarly high-resolution data but must be attached externally to existing metering equipment. Dataloggers can be attached to city-owned meters in some situations or can be attached to user-owned submeters or flowmeters.

Note that flowmeters and dataloggers are often referred to interchangeably. Both flowmeters and dataloggers require calibration and testing during initial setup and at recommended intervals, which vary by device. Both devices can either store data locally for manual retrieval or transmit data through a network method such as Wi-Fi or cellular. Platforms for accessing water use data are specific to each manufacturer, but most offer the ability to export data to a common platform like Microsoft Excel.

Recommendations

- Leverage capabilities of AMI system and data portals, if available
- Set up contact details and other parameters (ex: thresholds) for AMI notifications
- Familiarize key staff with AMI data access, monitoring, and other system features
- Install flowmeters or dataloggers upstream of high usage equipment and systems
- Actively monitor water usage during specific time periods and operational phases using AMI and/or flowmeters/dataloggers; compare over time or to available expected usage data (e.g., benchmarking studies) to identify opportunities for efficiency improvements.

Resources

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Plumbing Fixtures

PLUMBING FIXTURES

Plumbing fixtures are a ubiquitous part of our daily lives, and every building with a water supply uses plumbing to convey and control the water. Because of the large variety of plumbing fixtures and the enormous amounts of water they collectively use, federal and California statues set water-use standards for some fixtures and appliances.

Backflow preventers and vacuum breakers are required by state or local code so water supplies will not be contaminated by sources at the point of use.

Manufacturers and water utilities have continued to examine opportunities for water efficiency and associated energy efficiency. Ongoing plumbing fixture performance testing results in updated water flow specifications. Plumbing fixtures are also prime targets for replacement or retrofit with high-efficiency technologies. This chapter highlights ways that fixture leaks and inefficiencies can be mitigated in:

- Backflow Preventers
- Fire Protection Systems
- Floor Drain Trap Primers
- Janitorial Mop Sinks
- Outdoor Faucets
- Pumps
- Surge Tanks & Other Forms of Potable Water Storage
- Valves & Other Devices

Backflow Preventers

Backflow preventers stop water from flowing in the wrong direction through cross connections. Backflow preventers and vacuum breakers are required by state or local code so water supplies are not contaminated by sources at the point of use.

If one end of a hose, pipe, drain-trap primer, submersible pump, or other device is in non-potable water, and if the back pressure of the non-potable water exceeds the supply pressure, without a backflow preventer this potentially bacteria-laden or contaminated water could be sucked back into the potable-water supply line. Such cases are possible if a potable water system is connected to a boiler, cooling tower, booster or recirculating pump, or encounters any substance that could cause a health hazard or affect the aesthetic quality of the water supply. If any of these conditions exist at your site, you will be required to install an appropriate backflow preventer.

By health regulation, backflow devices between public-water supplies and private facilities should be inspected and tested on a regular schedule. For example, the California Code of Regulations, Title 17, mandates water purveyors such as EBMUD[1], which helps to keep potable water from contaminant and pollution exposure. Check with your local water supplier for details specific to your service area.

Brass Backflow Preventer

1 *https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/dw_regulations_2019_03_28.pdf*

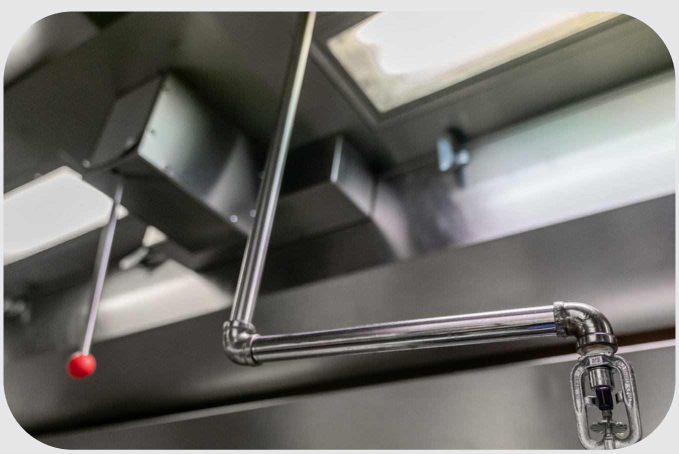
To avoid any cross connections between fire-protection and water supply plumbing, **mark fire-protection plumbing conspicuously**.

Recommendations

- Install backflow preventers and vacuum breakers as required by code and utilities
- Regularly test and maintain all backflow prevention devices installed at the service connection per local regulations
- Locate devices in easy-to-observe locations, and provide easy access for inspection and testing
- In non-freezing climates, mount exterior backflow preventers above ground so any leaks may be easily observed
- For interior devices, place small wells to collect any leak water where it may be observed

Fire Protection Systems

Fire Sprinkler in a Commercial Kitchen Facility



On the customer premises, a fire protection system is typically served by a dedicated plumbing system. No flow should occur except in the case of a fire emergency or testing. Connections to such a system by the customer for other purposes are prohibited.

Utilities meter and bill fire protection water supply lines separately from potable water supplies. Flow detection meters should be installed on fire service flows to indicate cross connections and improper use of fire water. To have an effective program, these meters need to be read when other meter readings are taken.

Install flow indicators to show the presence of leaks. Utilities may also require flow check meters capable of detecting small flows (less than 1 gallons per minute) on the fire supply line.

All fire meters require periodic pressure testing which can use 20 to 50 gallons per check. Most public utilities charge in units of water (1 unit = 1 CCF = 748 gallons). However, by the time one unit of water registers from normal use a year or longer could have elapsed. Thus, if the fire meter registers water use on consecutive billing periods, that is a sign that a leak may be occurring on the system.

Recommendations

- Allow no connections to fire-protection system except for fire protection
- Install flow-detection meters on fire services
- Conspicuously mark fire-protection-system plumbing
- Check billing for water usage to ensure there are no consecutive billing periods with water usage; this is a sign of water leak in the system.

Floor Drain Trap Primer

Floor drains often exist in spaces where regular water use may spill or where floors may be washed frequently. Plumbing codes require traps to prevent gases and odors from seeping from sanitary sewers into the room through the drains. Gas is blocked by water trapped below the drain in an "S" shaped pipe called a "P trap." In some rooms the trapped water evaporates when the floor is seldom washed, damp-mop floor-cleaning methods are used, or little water reaches the drain. This condition may allow the sewer gasses, other odors, and/or vermin to enter the room.

To sustain water in the trap, additional water must be added with a device called a trap primer. A trap primer is a valve or other connection from a water source that allows a small amount of water to flow through pipes to recharge traps of one or more drains.

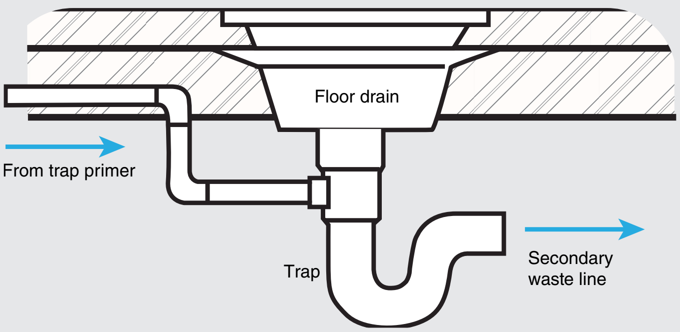
TABLE 3-1: Sample Water Use of Trap Primers

PRIMER TYPE	NUMBER OF ACTUATIONS PER DAY	DAILY WATER USE PER DRAIN SERVED	ANNUAL WATER USE IN GALLONS
Continuous	Continuous	0.25 gallons per minute (gpm), 360 gallons per day (gpd)	360 gpd X 365 = 131,400
Flush-activated	Depends upon flush valve use	For 10 flushes: 0 X 1 oz = 0.08 gallons	28
Pressure-sensitive	Depends upon fixture use	For 10 flushes: 0 X 1 oz = 0.08 gallons	28
Electronic	1 (one)	0.08 gallons	28
Waterless	0 (zero)	0 (zero)	0 (zero)

The common types of trap primers include:

- Continuous flow
- Pressure-drop activated
- Flush-valve activated
- Electronically timed

Schematic of a Floor Drain



Water sources for trap primers include cold-water pipes, the discharge side of flush valves, or washbasin drainpipes, depending upon the distance to the drain and the frequency that the supply device provides water. A seldom-used valve might provide inadequate water to maintain the trap function. The most efficient floor-trap primer will have a connection size and discharge frequency that provides a volume of water only slightly greater than the evaporation from the trap. Most pressure-sensitive, flush-activated or electronic trap primers discharge only a few ounces of water for each outlet during each operating cycle. Comparatively, a continuous flow trap primer can use over 300 gallons per day. Primers connected to sink drains use wastewater. However, the debris screens to these inlets need to be cleaned periodically. Where drains are used as sanitary sewers, such as in animal pens, additional water may be applied to the drain rim to flush debris from the surface of the drain.

Waterless floor drain trap primers, or barrier-type seal protection devices, can aid in saving water because they don't use water to maintain a seal. Waterless trap primers feature a one-way membrane that acts in the same way a check valve does.

Recommendations

- Ensure that selected trap primer(s) meet current state and/or national plumbing codes
- Select pressure-activated or electronic trap primers, each serving several drains
- For the largest water savings, select waterless trap primers
- Avoid continuous-flow trap primers
- Physically inspect traps at least once a year

Janitorial Mop Sinks

Mop sinks, also known as service sinks, are large wash basins or set tubs used for janitorial purposes in commercial settings. Mandatory in many jurisdictions, their installation and use are required to support proper sanitation and are thus regulated by building and health codes.[2]

Janitorial Mop Sink

Recommendations

- → Install check valves overhead on the mop sink faucet supply lines to help prevent back feed between hot or cold water supply lines
- → Do not let the faucet run, especially if a hose is attached, to clean dirty items

Outdoor Faucets

Outdoor faucets, often known as hose bibs, water spigots, sill cocks, or hose hydrants, are valves which are often threaded to allow easy connection to hoses, pressure washers, and other equipment. Not generally subject to specific flow limitation, flows through hose bibs are determined by the equipment being used.

For hose bibs where vandalism and unauthorized use is a concern, use a "loose key" or attach a hose bib lock. Instead of an attached handle, there is a slot for a removable square key to be used to operate the hose bib. Alternatively, provide a locked box over the hose bib or eliminate hose bibs.

Hose Bib Outside of a Commercial Business

Recommendations

- → Faucet flow should not exceed 5 gallons per minute
- → Install self-closing nozzles and valves on equipment connected to hose bibs
- → Install a hose bib lock or "loose key" where water theft or vandalism may be an issue
- → Prevent water waste in freezing conditions:
  - Install outdoor pipes and fixtures so they can be drained before freezing weather
  - Use freeze-proof bibs that extend through the wall into a warm environment
  - Insulate pipes and plumbing attachments and add heat tape for seasonal use

Pumps

Pumps can be present in a variety of commercial and institutional processes. Our focus is leakage that may occur from pumps used to move water and to increase water pressure. Pumps with packing glands have a reputation for leaks and frequent need for replacing the packing. Mechanical seals are superior to packing glands in that they are far less likely to fail and leak.

2 CA Retail Food Code, Page 124, Article 3. Janitorial Facilities, 114279. Curbed cleaning facility. *https://ochealthinfo.com/sites/healthcare/files/2024-01/CalCode%20effective%20January%202024%20Digital.pdf*

Recommendations

- Choose pumps with mechanical seals rather than packing to reduce chance of seal failure
- Choose newer vacuum pumps that do not use water seals
- Choose pumps that are air-cooled
- Carefully test pumps upon installation to ensure leak-free operation

Surge Tanks and Other Forms of Potable-water Storage

A surge tank is a water storage device used as a pressure neutralizer in a hydropower water conveyance system to resist excess pressure rise and pressure drop conditions.

Surge tanks absorb the pressure transients, also known as water hammers, of fast-acting valves to reduce plumbing system damage. A water hammer is a pressure surge or wave caused when a fluid in motion is forced to stop or change direction suddenly[3]. Expansion tanks and pressure-relief tanks are safety devices to store expanded heated water and relieve pressure on the plumbing system. A water hammer can occur in a building when the overall pressure of the water main entering a building is too high. A normal water pressure at the municipal water meter is 40 to 60 pounds per square inch (PSI) and when the pressure gets above this range it can increase the changes of a water hammer. Water pressure more than 100 psi can damage pipes and water using fixtures. Storage tanks may be placed atop high-rise buildings to maintain pressure in the building.

Tanks and their fittings sometimes leak only intermittently when water pressure is higher. An observation well or collection basin can collect the leakage and provide visible evidence of the leak so that repairs can be taken.

Altitude-control valves are supposed to sense the level of water in the tank and stop inflow if the storage level exceeds a specified elevation. If the altitude-control valve fails, the tank may overflow with great loss of water and sometimes property damage. The overflow is usually channeled through a pipe to a drain. Install a signal device to show that overflow has occurred.

Recommendations

- Provide visible and audible monitoring signals for tank overflow
- Provide monitoring wells to capture and make visible any leakage
- Inspect and verify all tanks every 12 months
- Inspect tanks and verify operability in accordance with the manufacturer's instruction, and/or any municipality having jurisdiction

Valves and Other Devices

Devices listed in this section are used to limit water losses during pipe ruptures, equipment failures, and other emergencies. Unlike much of the other equipment and processes described in this guide, these devices do not readily lend themselves to cost effectiveness analysis. These controls may be inactive for many months or even years, when suddenly their function becomes immediate. In the meantime, small leaks or overflows may occur. Install these devices in easily visible locations, so leaks may be noted, and corrective repairs performed.

Emergency Shutoff Valves and Isolation Valves

Emergency shutoff valves can be used to stop water flow when pipes rupture, connections leak, or equipment fails. During repairs, isolation valves can stop flows to individual pieces of equipment, while avoiding shutting down water to major portions of a building. Shutoff valves are relatively cheap compared with the potential damage they can minimize. Their usefulness relates to how well they are marked and their accessibility. Never block access to shutoff valves, and plainly mark the location of emergency shutoff valves near the valve site and in the area where the water is used.

Recommendations

- Add isolation valves to all pieces of water-using equipment, if not provided by the manufacturer
- Place additional emergency shutoff valves near critical water-use areas
- Plainly mark the location of emergency shut-off valves
- Attach information on the valve, stating which portions of the facility are supplied by the valve
- Meet plumbing codes for your state and county
- Consult the American Society for Mechanical Engineers and the National Board Inspection Code for more details relevant to your specific valves

3 *https://en.wikipedia.org/wiki/Water_hammer*

Water Heater Temperature Pressure Relief Valves (TPRVs) and Relief Valves

Located on the upper portion of a tank-style water heater, this valve prevents the build-up of hazardous pressure by releasing water to an overflow pipe. Water-supply pressure should be within the range recommended by appliance and equipment manufacturers — usually 40 to 60 psi. Flows from the valve discharge pipe should be easy to observe. Place visible indictors to show when the valves are actuated, and operations need to be corrected.

Recommendations

- Insert visible indicators that will show if the valve has activated
- Test valves roughly every six months
- Meet plumbing codes for your state and county
- Make the outlets to valve-discharge pipes easy to inspect for flow
- If no date is specified, a pressure relief valve shall be replaced no later than five years following the date of its manufacture

References/Resources

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2. American Backflow Prevention Association, Backflow Prevention - What Does it Mean to You?
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3. California Plumbing Code Chapter 4
   https://up.codes/viewer/california/ca-plumbing-code-2016/chapter/4/plumbing-fixtures-and-fixture-fittings#418.0
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   https://dialecticeng.com/wp-content/uploads/2019/06/Dialectic_Plumbing-Trap-Paper_October-2018.pdf
5. East Bay Municipal Utility District, Backflow Prevention
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6. Jay R. Smith Mfg. Co., Inc., Trap Primers
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7. Whole Building Design Guide, Water Conservation
   https://www.wbdg.org/resources/water-conservation

Restrooms

RESTROOMS

Since restrooms often account for a majority of the water used in commercial buildings, they are an important area of focus for commercial water efficiency. Because of the large numbers of plumbing fixtures and the volume of water they some restroom fixtures and appliances.[1] In addition, performance testing has resulted in targets pecifications, such as the EPA WaterSense specifications for high-efficiency toilets (HETs)[2], showerheads and faucets. Restroom fixtures are prime targets for new design or retrofit with high-efficiency technologies.

Two Flush Valve Toilets

The State of California requires all public and privately owned buildings have a bathroom.[3] Bathrooms must be equipped with enough toilets, sinks and drinking fountains to meet the needs of the public at peak hours.

Starting in 2019, the conservation standards that applied to single-family homes were extended to commercial and multifamily buildings. While previous regulations had applied specifically to new construction and renovation, provisions are unique in that they apply to any existing plumbing fixtures in buildings built before 1994.

Water efficient models are now the norm in the state of California and are getting more traction across the country. Legislation at both the state and federal level mandating efficient toilet fixtures has helped save trillions[4] of gallons of water annually.

The choice of plumbing fixtures for new structures should be driven not by the minimum standards, but rather by the lifecycle cost for the building operator.

In addition to fixtures that are more water-efficient, non-potable water supplies are being used to flush toilets. These water supplies include treated municipal wastewater and lavatory wash water. Using non-potable water may require more maintenance checks to ensure the mechanism is not clogged. Check with local and state codes for acceptance. See Chapter 7, Alternate Onsite Water Sources, for more information on non-potable water use.

Water-use standards for plumbing fixtures used in restrooms are set by both federal and California statute and are now included in the Uniform Building Codes. Codes have been noted in the table where applicable and are accurate as of 2023.[5] The California Energy Commission 2015 Title 20 standards apply to most restroom fixtures, if they are sold in California. Senate Bill 407 required that properties built prior to 1994 be fully retrofitted with water conserving fixtures by the year 2019 for commercial properties

Water Efficiency Measures for Restrooms Fixtures

Table 4-1, below, consolidates efficiency recommendations and California Plumbing Code requirements for a variety of restroom fixtures. Each efficiency intervention and/or code requirement has additional notes regarding either the relative impact of the intervention, or the designated fixture volumetric requirements.

1 California Plumbing Code Chapter 4 *https://up.codes/viewer/california/ca-plumbing-code-2016/chapter/4/plumbing-fixtures-and-fixture-fittings#4*
2 *https://19january2017snapshot.epa.gov/www3/watersense/products/toilets.html*
3 California Plumbing Code title 24, Part 5 Section 2901. *https://codes.iccsafe.org/content/CBC2019P4/chapter-29-plumbing-systems*
4 *https://www.allianceforwaterefficiency.org/news/20-years-energy-policy-act-18-trillion-gallons-saved-through-more-efficient-toilets*
5 *https://codes.iccsafe.org/content/CAGBC2022P1/chapter-5-nonresidential-mandatory-measures#CAGBC2022P1_Ch05_SubCh5.3_Sec5.303*

TABLE 4-1: Water Efficiency Measures for Restroom Fixtures

METHOD/ TECHNOLOGY	RECOMMENDATION/CODE	EFFICIENCY
TOILETS (AKA WATER CLOSETS) & URINALS	CODE: maximum 1.28 gallons per flush (gpf) (4.8 L)	Medium
	Use non-potable water (rain capture or recycled water) for flushing, where available and codes and health departments permit	High
	Flush should not exceed 3 to 7 seconds for flush valves fixtures.	
	Prohibit continuous water-flushing systems in urinals and toilets	Medium to high
	Prohibit automatic optical or motion-sensing flushing systems for toilets and urinals	Medium
URINALS	Install urinals using 0.5 gpf or less	High
	CODE: maximum 0.125 gallons/flush (0.47 L) for wall-mounted type and 0.5 gallons/flush (1.89 L) for floor-mounted or other type	High
SHOWERS & BATHS	CODE: 1.8 gallons per minute measured at 80 psi and must comply with Division 4.3 of the California Green Building Standards Code (CALGreen)(required by code). In showers with multiple heads, the combined rate of all showerheads controlled by a single valve may not exceed 1.8 gpm in total.	7 gallons per shower for a 10-minute shower and going from a 2.5 gpm to a 1.8 gpm showerhead
	Install only one shower head per personal shower stall (ensure that a properly selected mixing valve is used to reduce scalding hazards).	7 gallons per shower for a 10-minute shower and going from a 2.5 gpm to a 1.8 gpm showerhead
	For group showers, such as in school gyms and prisons, require individual valves for each shower head.	Medium & dependent on behavior
	Install metering showers valves and systems for public showers, detention facilities, or any shower where water usage needs to be controlled	High
	Specify recirculating hot-water systems for large buildings	High
	Select point-of-use hot-water heaters for small applications	Medium
	Substitute showers for bathtubs whenever possible	20 to 30 gallons/shower.
FAUCETS (AKA HAND WASHING LAVATORIES)	CODE: maximum 0.5 gallons (1.89 L) per minute at 60 psi for public lavatory faucets, self-closing faucets, and lavatory faucets installed in common and public use areas (outside of dwellings or sleeping units) in residential buildings	High
	CODE: maximum 0.20 gallons per cycle for metering faucets	Medium
	Businesses with high hand-washing demand should use self-closing faucets with foot-pedal actuators not to exceed 0.5 gpm	Medium to high
	CODE: maximum 1.2 gallons (4.54 L) per minute at 60 psi.	Medium
	Combine a self-closing faucet with low-flow aerator or laminar-flow restrictor	Medium
	CODE: maximum 1.28 gallons per flush (gpf) (4.8 L)	Medium

Toilets

California's AB 715 law requires that 100% of toilets and urinals (other than blow-out urinals) sold or installed in California be high efficiency.[6]

The consumer should be aware that **not all 1.28 gpf toilets are created equal**. A toilet must be able to remove solid waste in a single flush. Different models are designed and engineered to remove solid waste with a certain volume of water. **The most efficient toilets completely remove 600 to 1,000 grams of waste in a single flush**. Acceptable minimums are in the 250-to-350-gram range.

In addition, the law requires that waterless urinals be approved for sale and installation in California. The law also requires that any state agency adopting or proposing building standards for plumbing systems to consider developing building standards that would govern the use of waterless urinals for submission to the California Building Standards Commission. This law imposes a state-mandated local program, and violation of the State Housing Law is punishable as a misdemeanor. This law exclusively applies to toilets and urinals, and no other residential or commercial plumbing fixtures, fittings, appliances, or equipment.

When efficient toilets were first mandated in 1994, many manufacturers released models that had not been adequately engineered or tested for the proper water volume needed to achieve effective performance. Continued improvements are subjected to improved testing standards
for endorsement by water utilities and government agencies. Efficienct models were proven to perform better than older high-flush-volume toilets in 2006 by Veritec and Koeller through its MaP Toilet Testing program[7] which continues today. Some Ultra High Efficiency Toilets (UHETs) use as little as 0.8 gallons per flush (gpf), though the 1.28 gpf is now most common. The technology has proven so successful that California, Colorado, the District of Columbia, Georgia, Massachusetts, New York, Texas, Washington, and New York City have adopted toilet efficiency standards that require products to use no more than 1.28 gpf. One of the benefits in installing HETs, aside from the water saved, is less water going down the waste stream and therefore a savings on wastewater costs.

Flush Valve Toilet in a Commercial Bathroom

A toilet flush can be actuated by manual mechanical levers, push buttons, or electronic sensors. The hands-free sensors eliminate the need for human contact with the valve, but sometimes flush needlessly multiple times while the toilet is still in use.

Although the primary purpose of toilets is to remove human waste and initiate transportation to a wastewater treatment facility, toilets in public places are often used to dispose of other materials. Toilets for public locations should have a glazed trap of at least two inches diameter — the bigger the diameter, the better to prevent clogging.

Major requirements for minimizing water use in toilet operations include:

- Flush the toilet bowl clear
- Transport waste through pipelines to the sanitary sewer; operate reliably
- Have a leak-proof discharge valve

6 https://www.buildinggreen.com/newsbrief/california-law-raises-efficiency-toilets-and-urinals
7 https://map-testing.com/wp-content/uploads/2022/09/MaP-Testing-Specification-Version-7-revised-April-19-2018.pdf

Today's high-efficiency and ultra-high efficiency toilets (UHETs) offer a powerful flush without wasting water.

Gravity-Assist Toilets: these toilets work by moving water down into the bowl from the tank to easily move waste down the drain. They are popular because they are inexpensive and easy for plumbers and handy homeowners to fix. These toilets use rubber seals at the bottom of the tank called "flappers" that need to be replaced once every few years as water softens down the material and a proper seal cannot be maintained. Flapper leaks can be very quiet and very expensive if not detected. It is recommended that these toilets be checked 3 to 4 times a year for leaks by doing a toilet dye tab test. Also, water levels should be periodically checked, and the water level should be ½ to 1 inch below the top of the overflow tube.

Dual-Flush Toilets: these models offer users a choice based on whether you need to flush solid or liquid waste. For instance, a liquid waste 1st stageflush will only use about 0.8 to 1.1 gpf, while a "full-power" 2nd stage flush will use 1.28-1.6 gpf, depending on the toilet model's efficiency rating.

Image source: The Bathroom Blueprint

Pressure-Assisted Toilets: these toilets have a plastic tank within the ceramic porcelain tank. The inner tank is sealed and works by using mechanical air-pressure as the tank refills with water. When it is flushed, that pressurized air pushes out water with force and flushes it down bowl and the pipes. Some drawbacks are that these models are more expensive and harder to fix when they break. The PA toilet also tends to make some noise. When these toilets leak, they create a hissing noise which should be checked immediately.

Image source: Sloan

Commercial flush valve toilets: These toilets do not have a tank and use pressure to force water down the bowl. These toilets should flush between 3-7 seconds. If they flush for longer than that, it could indicate that the flushing mechanism called a "diaphragm" may need to be replaced. These toilets are the preferred model for businesses as they don't have a tank that needs to be checked. The flush time should be 7 seconds or less.

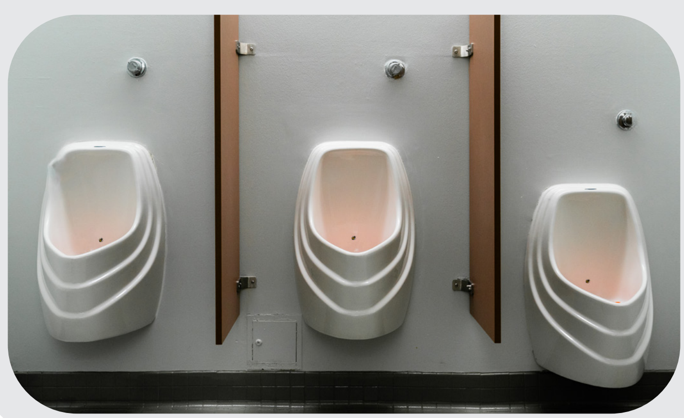
Urinals

Urinals are made to accept liquid waste, but not solid waste. They come in several configurations and combinations of features:

- Wall-mounted urinals for single-person use. These are flushed after each use, either manually by the user or by automatic actuator
- Wall-mounted troughs for simultaneous multiple-person use. Intended for high use areas such as sports venues, they are flushed continuously during the high use period and are controlled with a valve and timer, but not by the user
- Wall-mounted waterless urinals for single-person use that require neither flushing nor water supply plumbing

The potential for water savings depends upon the number of users at a given site. Urinals are used more often than toilets in buildings when both fixtures available. Based upon U.S. Green Building Council numbers, urinals are

Wall-Mounted Urinals



used two to three times a day. Addition energy savings can result from the reduced need to pump water to higher elevations in high rise buildings for water-efficient urinals.

Showers and Baths

The average bathtub is 60 inches long, 30 inches wide and 14 to 16 inches high. The capacity, in gallons, of an average bathtub is about 40 to 50 gallons when full and most people only fill it with 20 to 30 gallons as their mass will displace the water. 10-to-15-minute shower with a 2 gallon per minute showerhead. Where plumbing code and health officials allow, the wastewater from showers and baths may be captured, treated, and redirected for toilet flushing or other non-potable, non-contact uses.

The hospitality sector touts the relaxation and luxury of infinity and whirlpool baths (approximately 90 gallons per fill or equivalent to a 45-minute shower using a 2-gpm showerhead). In the hospitality sector, hot water is often circulated from a water heater, through a pipeline loop, to the guest rooms. Unused water returns to the water heater. This provides hot water quickly to the guest showers/baths and reduces the water wasted while waiting for warm water. The circulated hot water should be placed on a timer, as this may increase energy usage.

Installing a Water Efficient Showerhead

Manually Operated Faucet with a Water Efficient Aerator in Action

Tubs come in various sizes. Select shallower bathtubs that have smaller water capacity. The water level will cover the bather when immersed.

Shower heads are available with a variety of spray patterns, water-droplet sizes, and pulsations. Both shower and bathtub water are used and typically discharged to sanitary wastewater. In locker rooms and similar situations, several people may wash in a communal shower room with multiple shower heads. Showerhead shut-off valves can be added to maximize water savings. Installing a shower shut-off valve works by allowing the user to "turn-off" water while shampooing or lathering up and then turning the water back on to rise. Showerhead shut-off valves allow for a small amount of water to trickle through when fully in the "off" position in order to prevent hot water from accumulating at the front of the showerhead and scalding when turned back on. Installation of point-of-use hot water heaters will reduce the wait time, water and energy usage. However, do not use point-of-use hot water heaters on recirculating lines or at the far end of the water line.

Excluded from this discussion are shower heads required for emergency cleaning of personnel due to chemical and other contamination.

Faucets

A faucet is a device for delivering water from a plumbing system. It can consist of the following components: spout, handle(s), lift rod, cartridge, aerator, mixing chamber, and water inlets. When the handle is turned on, the valve opens and controls the water flow adjustment under any water or temperature condition. Outdoor hand-operated valves are known as hose bibs.

Hand-Washing Lavatories

Several types of faucets offer different flow durations and flow rates:

- Manually operated faucets require someone to open the valve and to close the valve
- Self-closing faucets run as long as the user holds the handle in the open position. Once released, the spring-loaded faucet closes itself
- Metering faucets are actuated manually or automatically. They deliver a preset amount of water (some models deliver 0.25 gallons during a 5- to 10-second cycle; other models have cycles that can be set to 45 seconds) before shutting off. Operating conditions, such as water pressure, temperature, and flow rate, may affect the timing cycle. Some manufacturers provide a 5-year warranty
- Automatic faucets sense the proximity of the user and start the flow of water, which is maintained while the user is within sensor range. Then the faucet shuts itself off
- Drinking-water bubblers operate with self-closing faucets

Aerators may be added to faucets to entrain air, reduce splash, and reduce the water flow. An aerator is a circular screen disk attached to the end of the faucet. Common aerator flow rates are:

- 0.5 gpm (for bathrooms)
- 1.0 gpm (for multi-purpose sinks)
- 1.5 gpm (for breakrooms)
- 2.0 gpm (for commercial kitchens)
- 2.2 gpm (for dish wash fill sinks)

Vandal- and tamper-proof aerators should be installed in non-residential buildings. Aerators with manual flow adjustment are available for kitchen faucets but the proper flow should be installed at each sink. We do not recommend aerators with manual flow adjustment. They require behavior modification which often is not followed, with the aerator often set at its maximum rate of flow.

An aerator separates a single flow of water into many tiny streams which introduces the air into the water flow. Because aerators entrain air which may contain pathogens into the water stream, and the pathogens may reside on the internal aerator screens, aerators should not be used in medical facilities. California regulations prohibit aerator use in hospitals, but laminar flow restrictors may be used to prevent splash and reduce flow without air entrainment. Other aerators should be replaced or at least cleaned every few years.

In high traffic areas (more than 100 uses per day) it is recommended aerators be replaced every 2 years.

Recommendations

Toilets and urinals

- Check flush diaphragms annually and replace flush diaphragms every 3-5 years, depending on traffic

Faucets

- Units with sensors should stop immediately after hands are removed from sensor area
- Units that use push valve activation should be calibrated to stop after 10 to 12 seconds run time
- For public faucets, anti-tampering or unremovable aerators are recommended. A special key is needed to install and remove them
- Medical facilities: Use laminar-flow faucets that use no more than 1.5 gpm

Bathtubs

- If there is a bathtub spigot present to regulate water temperature, once the shower is turned on there should be no water coming from the spigot. If water comes out, the diverter valve needs to be replaced
- Use low-volume tubs where possible

Resources

1. Appliance Standards Awareness Project 2021
   https://appliance-standards.org/product/faucets#:~:text=In%202015%2C%20the%20California%20Energy,maximum%20flow%20rate%20for%20private
2. California Building Standards Commission
   https://www.dgs.ca.gov/BSC/Codes
3. California Energy Commission, California Code of Regulations Title 20, Sections 1601 Through 1608, Toilets, Urinals, and Faucets Regulations Effective January 1, 2016.
4. California Energy Commission, Appliance Efficiency Regulations - Title 20
   https://www.energy.ca.gov/rules-and-regulations/appliance-efficiency-regulations-title-20
5. California Green Building Standards Code—Part 11, Title 24, California Code of Regulations—known as CALGreen
   https://www.dgs.ca.gov/BSC/CALGreen
6. California Green Building Standards Code Chapter 5, Division 5.3
   https://codes.iccsafe.org/content/CAGBC2022P1/chapter-5-nonresidential-mandatory-measures#CAGBC2022P1_Ch05_SubCh5.3_Sec5.303
7. CalGreen Plumbing Fixture Requirements
   https://calgreenenergyservices.com/2019/11/30/calgreen-plumbing-fixture-requirements/
8. California Plumbing Code 2019
   https://up.codes/viewer/california/ca-plumbing-code-2019/chapter/4/plumbing-fixtures-and-fixture-fittings#411.0
9. John Koeller, P.E., Koeller & Company, Bill Gauley, P.Eng., Gauley Associates, Ltd., MaP Testing, Commercial Flushometers Toilet & Urinal List Downloads - May 4, 2021
   https://www.map-testing.com/downloads.html
10. National Conference of State Legislatures, Water-Efficient Plumbing Fixtures
    https://www.ncsl.org/research/environment-and-natural-resources/water-efficient-plumbing-fixtures635433474.aspx
11. Plumbing Supply.com, Showeroff® Metering Shower Systems
    https://www.plumbingsupply.com/metering-shower-systems.html
12. US EPA, WaterSense Commercial Toilets Specifications
    https://www.epa.gov/watersense/commercial-toilets#:~:text=WaterSense%20labeled%20flushometer%2Dvalve%20toilets,adequate%20flow%20to%20function%20effectively
13. US EPA, WaterSense, Case Studies for Commercial Buildings
    https://www.epa.gov/watersense/case-studies
14. US Department of Energy, Energy Cost Calculator for Urinals
    https://www.energy.gov/eere/femp/energy-cost-calculator-urinals#output

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