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CALIFORNIA ENERGY COMMISSION

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California Energy Commission

**DRAFT STAFF REPORT**

# Analysis of Proposed Efficiency Standards for Water Closets (Toilets)

## 2022 Appliance Efficiency Rulemaking Docket Number 22-AAER-05

**November 2024 | CEC-400-2024-001-SD**

# California Energy Commission


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# PREFACE

On October 12, 2022, the California Energy Commission (CEC) adopted an order instituting rulemaking for water closets to consider modifying existing efficiency standards, test procedures, marking requirements, and other efficiency measures found in the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601–1609).

On December 14, 2022, the CEC released a notice for a request for information to seek information and a notice of invitation to submit proposals to seek information and provide interested parties an opportunity to submit proposals for standards and other measures to improve the efficiency of water closets.

The CEC reviewed all information submitted in writing to the CEC's docket for this rulemaking. This staff report proposes standards for water closets and describes the basis for such standards.

# ABSTRACT

This report discusses proposed updates to the water closet standards in the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 to 1609). These proposed updates are part of the 2022 Appliance Efficiency Pre-Rulemaking (Docket 22-AAER-05). California Energy Commission staff analyzed the cost-effectiveness and technical feasibility of proposed efficiency standards for water closets. Statewide energy use and savings and related environmental impacts and benefits are also included.

The proposed efficiency standards for water closets would take effect December 1, 2026. The specific water closets in the scope of this proposal are residential type water closets. The scope does not include blowout water closets, flushometer valve water closets, and prison-type water closets. Staff also proposes to update terms and definitions, performance criteria, test lab report requirements, and certification requirements to support the proposed efficiency standards. The proposal would save 643 million of gallons (Mgal) of water and 4 GWh of embedded electricity the first year the standards is in effect. By 2050, the year that stock turns over, the proposed standards would have an annual savings of 15,902 Mgal of water and 86 GWh of embedded electricity, which equates to about $191 million in annual savings.

Staff analyzed available market data and concluded that the updates to the efficiency standards for water closets would significantly reduce water and energy consumption and are technically feasible and cost effective.

**Keywords**: appliance efficiency regulations, water savings, energy efficiency, water closets, gravity tank-type water closets, dual-flush, toilets

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# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

Page

# EXECUTIVE SUMMARY

The California Energy Commission has exclusive authority to adopt appliance efficiency standards to promote the efficient use of both energy and water. The CEC adopted California's first water appliance efficiency standard in 1977 and has adopted numerous standards since then. These water appliance efficiency standards benefit California by eliminating wasteful water use, and hence making more water available for uses Californians value. Reducing water use, in turn, reduces the amount of energy used to transport and treat water.

This report presents staff's analysis of proposed efficiency standards, test procedure requirements, and reporting requirements for water closets. The term water closet is interchangeable with the term toilet and is primarily used to align with existing standards such as the industry standard American Society of Mechanical Engineers (ASME) A112.19.2/Canadian Standards Association (CSA) B45.1 *Ceramic Plumbing Fixtures*. Water closets are sanitation fixtures used to dispose of human waste. A water closet typically consists of a bowl connected to a tank and a flushing device.

Staff is proposing to update standards for water closets. The scope covers all water closets (single-flush water closets and dual-flush water closets) except commercial and institutional water closets such as blowout water closets, flushometer valve water closets, and prison-type water closets. Staff proposes to update the water efficiency standard from 1.28 gallons per flush (gpf) to 1.1 gpf for single-flush water closets and update the effective flush volume of 1.28 to a full flush volume of 1.28 gpf and a reduced flush volume of 0.8 gpf for dual-flush water closets.

The proposal also includes updating the performance criteria for water closets used in ASME A112.19.2/CSA B45.1 *Ceramic Plumbing Fixtures* to align with U.S EPA WaterSense® specifications for tank-type water closets and flushometer valve-type water closets. Staff also recommends test lab report requirements to ensure compliance with the proposed standards. Lastly, staff recommends updating reporting requirements to California's Modern Appliance Efficiency Database System (MAEDbS) to improve the categorization of water closets in the database and to provide the public with more accessible and accurate data. Data from U.S EPA WaterSense, MAEDbS, and other voluntary programs demonstrate minimum performance requirements for water closets make this proposal technically feasible. The proposed water efficiency standards would take effect December 1, 2026.

The estimated savings for single-flush water closets after complete stock turnover in 2050 is 12,157 million gallons (Mgal) of water per year and 66 gigawatt-hours (GWh) per year of embedded electricity (electricity savings associated with reduction of water pumping, water treatment, and water delivery), equivalent to $146 million in annual savings. The estimated savings for dual-flush water closets after complete stock turnover in 2050 is 3,745 Mgal of water per year and 20 GWh per year of embedded electricity, equivalent to $45 million in annual savings.

The total savings from the proposed standards for the specified water closets, previously mentioned, are 15,902 Mgal per year after stock turnover and 86 GWh per year of embedded electricity, equivalent to $191 million in annual savings. The savings over the lifetime of product ranges from $103 to $183 per unit, with an estimated incremental cost of zero. Therefore, lifecycle benefit per unit exceeds the incremental costs, indicating this proposal is cost-effective.

# CHAPTER 1:
# Efficiency Policy

The Warren-Alquist Act[1] establishes the California Energy Commission (CEC) as California's primary energy policy and planning agency. Section 25402(c)(1) of the California Public Resources Code directs that the CEC reduce the inefficient consumption of energy and water by prescribing efficiency standards and other cost-effective measures for appliances that require a significant amount of energy and water to operate on a statewide basis.

For nearly five decades, California has regularly increased the energy efficiency requirements for new appliances sold and new buildings constructed in the state. Through the Appliance Efficiency Program,[2] appliance efficiency standards have shifted the marketplace toward more efficient products and practices, reaping large benefits for California's consumers. The state's Title 20 appliance efficiency regulations, along with federal appliance standards encompassing a variety of appliance types, saved an estimated 34,707 gigawatt-hours (GWh) of electricity in 2017 alone, resulting in about $8.26 billion in savings to California consumers.[3]

Included in these totals is energy use associated with water-using appliances, and specifically with purifying, transporting, and treating potable water. The embodied energy in delivered potable water creates a water-energy nexus, meaning that improvements to the water efficiency of an end-use appliance are improvements to its energy efficiency. Following this policy has led the CEC to adopt water efficiency standards for several water fittings and fixtures, including prior standards for water efficiency in water closets, and said standards have delivered significant statewide benefits in avoided energy and water costs.

## Improving California's Resiliency to Future Drought

On January 17, 2014, with California facing water shortfalls in the driest year in recorded state history, former Governor Edmund G. Brown Jr. proclaimed a state of emergency and directed state officials to take all necessary actions to prepare for and respond to drought conditions. On September 13, 2016, former Governor Brown signed the Water Efficiency: Landscape Irrigation Equipment Act (Assembly Bill 1928, Campos, Chapter 326, Statutes of 2016) requiring the CEC to adopt by January 1, 2019, performance standards and labeling

1 The Warren-Alquist State Energy Resources Conservation and Development Act, Division 15 of the Public Resources Code, sections 25000-25996.1

2 California Energy Commission. 2023. "Appliance Efficiency Program: Outreach and Education." https://www.energy.ca.gov/programs-and-topics/programs/appliance-efficiency-program-outreach-and-education.

3 Kavalec, Chris, Nick Fugate, Cary Garcia, Asish Gautam, and Mehrzad Soltani Nia. 2016. *California Energy Demand 2016-2026, Revised Electricity Forecast: Volume 1 - Statewide Electricity Demand and Energy Efficiency*. Sacramento: California Energy Commission. https://efiling.energy.ca.gov/GetDocument.aspx?tn=207439&DocumentContentId=21362.

requirements for landscape irrigation equipment, including, but not limited to, irrigation controllers, moisture sensors, emission devices, and valves.[4] In response, the CEC began rulemakings prioritized water efficiency measures for landscape irrigation equipment, faucets, toilets, and urinals implementing Governor Brown's call for all Californians to conserve water in every way possible. Between 2020 and 2023[5], California once again experienced severe to exceptional drought statewide, and January, February, and March 2022 were the driest on record dating back over 100 years, confirming the need to ensure that water conservation remains a California way of life.[6]

## Water-Energy Nexus

Significant energy is used to move and treat water. A 2005 CEC study estimated 7,500 GWh per year or roughly 3 percent of California state electrical energy is consumed to supply and treat water intended for urban consumption.[7] A more recent study by the Codes and Standards Enhancement (CASE) Team using data provided by the CPUC estimated the energy to supply water as 3,565 kilowatt-hours (kWh) per million gallons.[8] Appliance standards leading to the efficient use of water will lead to significant energy savings for California.

## Reducing Electrical Energy Consumption to Address Climate Change

Appliance energy efficiency is identified as a key to achieving the greenhouse gas emission (GHG) reduction goals of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)[9] and Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016),[10] as well as the recommendations contained in the California Air Resources Board's 2022 Scoping Plan for Achieving Carbon Neutrality.[11] Energy efficiency regulations are also identified as key components in reducing electrical

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4 Assembly Bill 1928, Water efficiency: landscape irrigation equipment, available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB1928.

5 National Integrated Drought Information System. 2024. *California - Historical Drought Conditions in California*. https://www.drought.gov/states/california.

6 State of California Drought Action. 2022. *California Drought Update May 31, 2022*. Sacramento: State of California Drought Action. https://drought.ca.gov/media/2022/06/Weekly-CA-Drought-Update-05312022.pdf.

7 Navigant Consulting, Inc. 2006. *Refining Estimates of Water-Related Energy Use in California*, CEC-500-2006-118. California Energy Commission, PIER Industrial/Agricultural/Water End Use Energy Efficiency Program. http://s3-us-west-2.amazonaws.com/ucldc-nuxeo-ref-media/16ff231a-63cd-4750-8820-c0420116936f.

8 Pike, Ed, and Daniela Urigwe. 2017. *Spray Sprinklers Bodies Response to Invitation to Submit Proposals Irrigation Spray Sprinklers Bodies Docket #17-AAER-08*. California Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=221224&DocumentContentId=26740.

9 Assembly Bill 32, California Global Warming Solutions Act of 2006, available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32.

10 Senate Bill 32, California Global Warming Solutions Act of 2006, available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB32.

11 California Air Resources Board. 2022. *2022 Scoping Plan for Achieving Carbon Neutrality*. Sacramento: California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf.

energy consumption in the 2021 Integrated Energy Policy Report (IEPR)[12] and the 2021 California Building Decarbonization Assessment.[13]

On October 7, 2015, former Governor Brown signed the Clean Energy and Pollution Reduction Act of 2015 or Senate Bill 350 (De León, Chapter 547, Statutes of 2015).[14] This law requires the CEC to establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a doubling of energy savings from buildings and retail end uses by 2030. Appliance efficiency standards will be critical in meeting this goal. In addition, the CEC adopted the *Existing Buildings Energy Efficiency Action Plan*[15] in September 2015 and updated it in December 2016 to transform existing residential, commercial, and public buildings into energy-efficient buildings. Water end-use efficiency is one of the several strategies identified to increase efficiency in existing buildings.

## Expanding Energy Efficiency in Low-Income and Disadvantaged Communities

California is working to ensure that clean energy transformation benefits are realized by all Californians, especially those in low-income, disadvantaged, or rural communities. In the SB 350 Low-Income Barriers Study, Part A (Barriers Study),[16] the CEC studied the barriers to energy efficiency and weatherization investments for low-income customers, including those in disadvantaged communities, and made recommendations on how to increase access. The CEC and its partner agencies have since taken steps to implement the recommendations in the Barriers Study, including convening the Disadvantaged Communities Advisory Group (DACAG) in 2018, adopting a Clean Energy in Low-Income Multifamily Buildings (CLIMB) Action Plan,[17] and tracking and updating key metrics to better understand energy barriers. The CEC developed an online interactive map to display energy equity indicators and highlight key

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12 Bailey, Stephanie, Jane Berner, David Erne, Noemí Gallardo, Quentin Gee, Akruti Gupta, Heidi Javanbakht, Hilary Poore, John Reid, and Kristen Widdifield. 2023. *Final 2022 Integrated Energy Policy Report - Publication Number: CEC-100-2022-001-CMD*. Sacramento: California Energy Commission. https://efiling.energy.ca.gov/GetDocument.aspx?tn=248735&DocumentContentId=83252.

13 Kenney, Michael, Nicholas Janusch, Ingrid Neumann, and Mike Jaske. 2021. *California Building Decarbonization Assessment CEC-400-2021-006-CMF*. Sacramento: California Energy Commission. https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment.

14 Senate Bill 350, Clean Energy and Pollution Reduction Act of 2015, available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350.

15 California Energy Commission. 2015. *Existing Buildings Energy Efficiency Action Plan.* California Energy Commission. https://efiling.energy.ca.gov/getdocument.aspx?tn=206015.

16 Scavo, Jordan, Suzanne Korosec, Esteban Guerrero, Bill Pennington, and Pamela Doughman. 2016. *Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities, CEC-300-2016-009-CMF.* California Energy Commission. https://assets.ctfassets.net/ntcn17ss1ow9/3SqKkJoNIvts2nYVPAOmGH/fe590149c3e39e51593231dc60eeeeff/TN214830_20161215T184655_SB_350_LowIncome_Barriers_Study_Part_A__Commission_Final_Report.pdf.

17 Haramati, Mikhail, Eugene Lee, Tiffany Mateo, Brian McCollough, Shaun Ransom, Robert Ridgley, and Joseph Sit. 2018. *Clean Energy in Low-Income Multifamily Buildings Action Plan.* California Energy Commission. https://www.energy.ca.gov/filebrowser/download/1295.

opportunities to advance clean energy in low-income and disadvantaged communities. More work is needed to remove financing barriers, and to develop the local workforce needed to implement clean energy solutions.

# CHAPTER 2:
# Statutory Criteria for Efficiency Standards

Section 25402(c)(1) of the California Public Resources Code[18] mandates that the California Energy Commission (CEC) reduce the inefficient consumption of energy and water statewide. The CEC must accomplish the mandate prescribing efficiency standards and other cost-effective[19] measures for appliances that require a significant amount of energy or water to operate. Such standards must be feasible and attainable and not result in any added total cost to the consumer over the designed life of the appliance. Technical feasibility is discussed in **Chapter 7**.

In determining cost-effectiveness, the CEC is directed to consider the value of the water or energy saved, the effect on product efficacy for the consumer, and the life-cycle cost to the consumer of complying with the standard. The CEC is also directed to consider other relevant factors, including the effect on housing costs, the statewide costs and benefits of the standard over the lifetime of the standard, the economic impact on California businesses, and alternative approaches and the associated costs. Cost effectiveness is discussed in **Chapter 8**.

Actions taken by state agencies to adopt or amend regulation are subject to the Administrative Procedures Act, which requires, in part, a consideration of alternatives. Staff's consideration of alternatives is discussed in **Chapter 5**. Actions taken by state agencies to adopt or amend regulation are also potentially subject to the California Environmental Quality Act. Environmental impacts are discussed in **Chapter 9**.

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18 California Public Resources Code, Division 15, Chapter 5, section 25402.

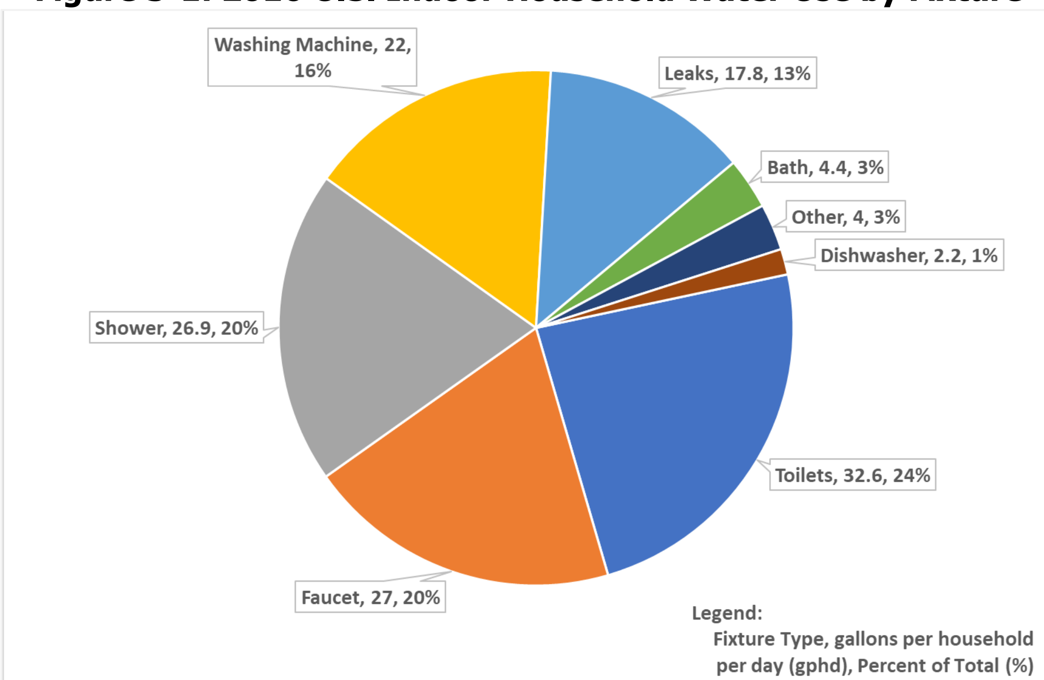
19 These include energy and water consumption labeling, fleet averaging, incentive programs, and consumer education programs.

# CHAPTER 3: Product Description

## Background

In 1994, the national standard for toilets was set to a maximum of 1.6 gallons per flush (gpf), which is still the standard today. In 1999, the average flush volume for existing installed toilets was 3.65 gpf and by 2016 the average was determined to be to 2.6 gpf. This accounted for as much as 24 percent of indoor water use or 32.6 gallons per household per day (gphd) (**Figure 3-1**).[20] These numbers show the continued impact the standard in 1994 has had from the continued efficiency and advancement of technology. Yet, in 2021, roughly 59 percent of toilets in the United States had a flush volume greater than 1.6 gpf, with an average of 2.0 gpf. [21]

**Figure 3-1: 2016 U.S. Indoor Household Water Use by Fixture**




Source: Residential End Uses of Water Version 2, Water Research Foundation (2016); Note: The average household size for this study is 2.65 people.

Despite these efforts, water usage for toilets is still a significant component of urban indoor water use. **Figure 3-2** shows that toilets accounted for about 25 percent (38 gphd) of indoor

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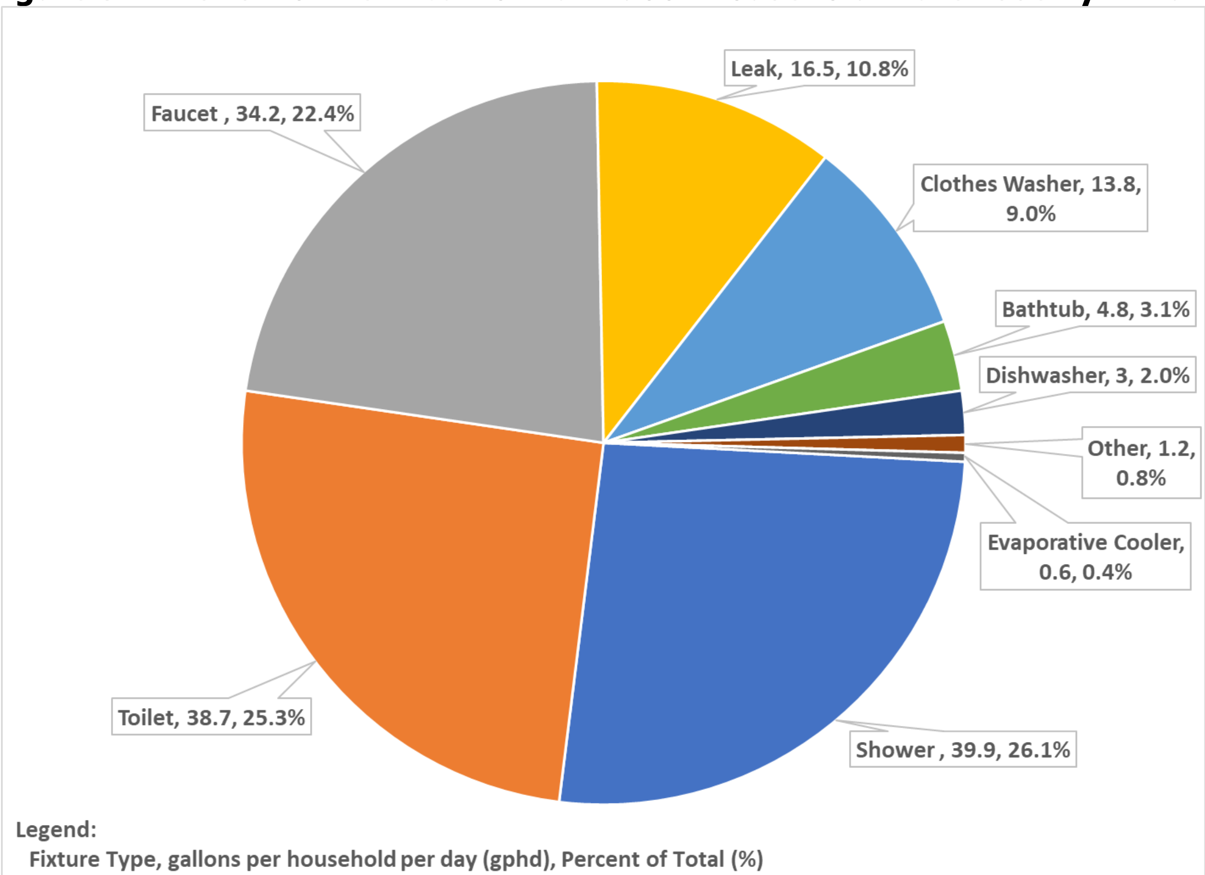
20 DeOreo, William B., Peter Mayer, Benedykt Dziegielewski, and Jack Kiefer. 2016. *Residential End Uses of Water Version 2 Executive Report*. Denver: Water Research Foundation. https://www.waterrf.org/research/projects/residential-end-uses-water-version-2.

21 Mayer, Peter, and Flume. 2022. *Flume Data Analysis Methodology*. San Luis Obispo: Flume Inc. https://flumewater.com/water-index/.

water use in Northern California in 2020.[22] Indoor water use averaged 152.7 gphd or 50.8 gallons per capita per day (gpcd) during this time as well, (**Figure 3-2**).[23] Statewide residential water use (indoor and outdoor) averaged 93 gpcd in 2020. Although the indoor water usage for this data was collected during the COVID-19 pandemic when most California residents were quarantined at home, this data provides insight to the effects on water usage of large portions of the workforce working from home.

**Figure 3-2: 2020 Northern California Indoor Household Water Use by Fixture**




Source: Appendices for the Residential Water Use Study, California Department of Water Resources (2020); Note: Study performed during the COVID-19 pandemic and summer conditions. The average household size for this study is 3.0 with an average of 8.5 flushes per person per day and an average flush volume of 1.5 gpf.

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22 The California Department of Water Resources (DWR) conducted a pilot study as part of its research into residential water demands following Section 10609.4(b) of the California Water Code. The study evaluated 20 homes in Folsom, California, during June and August 2020, using Flume water monitoring devices. This study was performed during the COVID-19 pandemic and summer conditions. The homes had an average of 3 residents per household, an average of 8.5 flushes per person per day, and an average flush volume of 1.5 gpf.

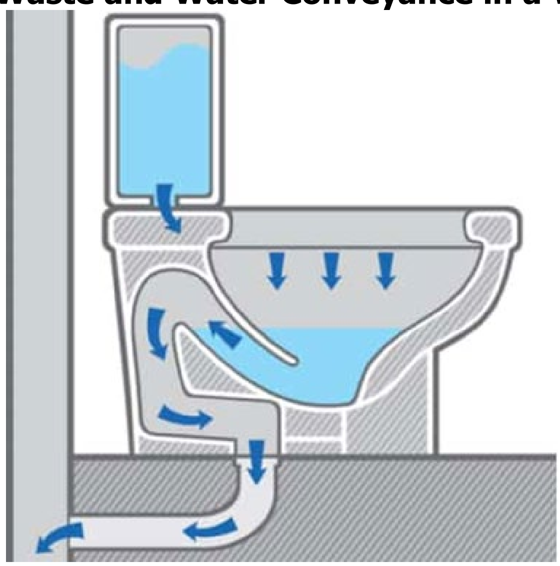
23 California Department of Water Resources. 2020. *Appendices for the Residential Water Use Study*. California Department of Water Resources. https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/regs/water_efficiency_legislation.html#reg-docs.

Today, the average California monthly residential water use (indoor and outdoor) is 72 gpcd.[24] Staff estimates the average toilet flush volume in California is 1.5 gpf, which equates to about 20.7 gallons per household per day.[25] Given the significant water use of toilets and the availability of high efficiency toilets, reducing the water consumption by continuing to establish minimum efficiency conditions standards for water closets is a key component of California's overall water and embedded energy use strategy.

## Water Closets

Water closets (also known as toilets) are sanitation fixtures used to dispose of human waste. More specifically, a water closet is a fixture with a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a drainage system (**Figure 3-3**).[26]

**Figure 3-3: Waste and Water Conveyance in a Water Closet**



Source: PunctualPlumberDallas.com

Water closets can be categorized in several ways based on design and application. See **Figure 3-4** for general categorization of water closets. For example, commercial water closets are more likely to be flushometer valve-type water closets, and residential water closets are more likely to be gravity tank-type water closets.

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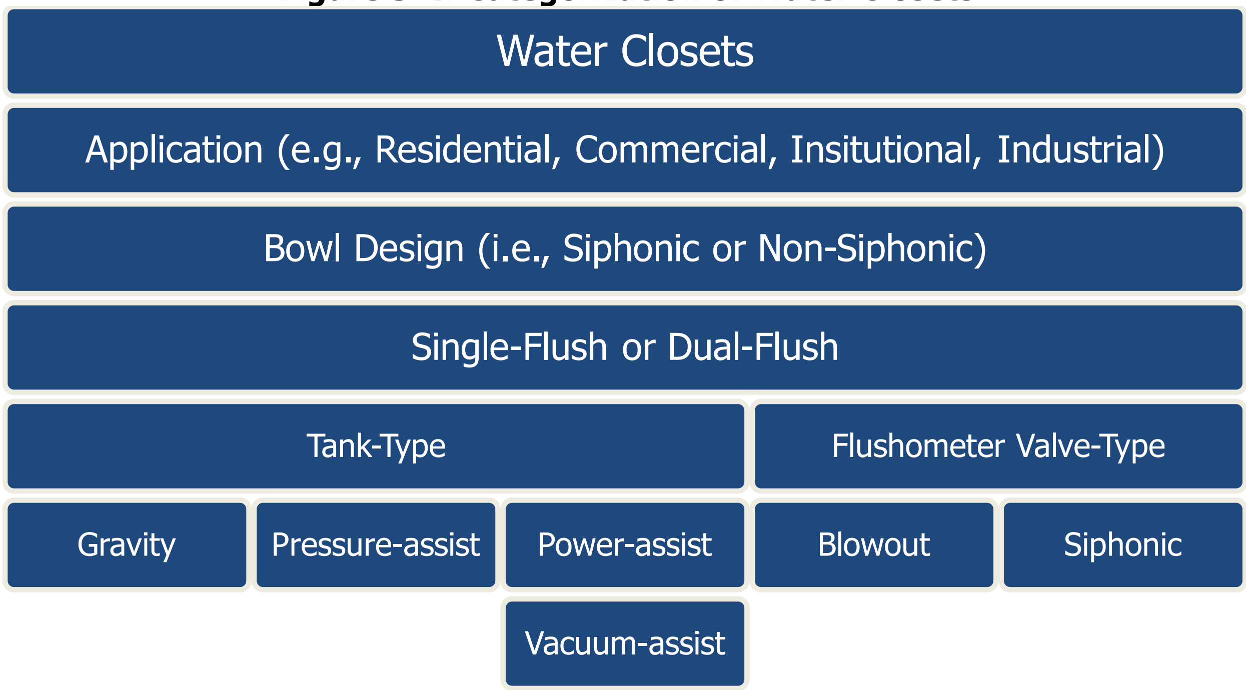
24 California State Water Resources Control Board. 2024. *Water Conservation and Production Reports*. https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html; Note. The statewide average yearly residential water use is as of October 6, 2024.

25 Multiplying 1.5 gpf by 13.79 flushes per day per household. See Appendix A.

26 American Society of Mechanical Engineers & Canadian Standards Association. 2018. *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures*. Toronto: CSA Group. https://www.asme.org/codes-standards/find-codes-standards/a112-19-2-csa-b45-1-ceramic-plumbing-fixtures/2018/drm-enabled-pdf.

**Figure 3-4: Categorization of Water Closets**




Source: Staff Research, IOU Draft CASE Report for Water Closets, U.S. EPA WaterSense

Although there are various types of water closets, the main components of a water closet include the bowl, the flushing mechanism, and the refill mechanism. This chapter will cover various water closet types and the characteristics that differentiate them.

The life span of a water closet ranges from 25 to 30 years.[27] The life span can be affected if key maintenance is not performed on a regular schedule or if incompatible replacement parts, such as flapper valves, are installed. Another key issue affecting life span and efficiency is the use of chemical in-tank toilet cleaners. Although some toilets are marketed as chemical-resistant, chemical cleaners will still interfere with the performance of the toilet.[28]

## Bowl Design

The bowl design or evacuation method of water closets can be categorized into siphonic action or nonsiphonic action bowls.

A *siphonic bowl* is defined as a water closet bowl that has an integral flushing rim, a trap at the front or rear, and a floor or wall outlet. It operates with a siphonic action (with or without a jet) (**Figure 3-5**). A siphonic action means the movement of water through a flushing

27 Singh, Harinder, Ken Rider, Tuan Ngo, and Kristen Driskell. 2015. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets, CEC-400-2015-008.* Sacramento: California Energy Commission. https://www.energy.ca.gov/publications/2015/staff-analysis-water-efficiency-standards-toilets-urinals-and-faucetss-2015.

28 United States Environmental Protection Agency. 2000. *Wastewater Technology Fact Sheet: High-Efficiency Toilets.* Washington, D.C.: United States Environmental Protection Agency. https://www3.epa.gov/npdes/pubs/hi-eff_toilet.pdf.

fixture by creating a siphon to remove waste material.[29] That is, the bowl and the trapway (P-shape or S-shape) are carefully designed to create a siphon that pulls waste from the bowl when the toilet is flushed. Water then enters the bowl rapidly, displacing the air inside the trapway to form a vacuum. Water then flows over the weir in the trapway, triggering the siphoning effect. When all the water is evacuated from the bowl, air enters the trap, and the siphon action is halted (**Figure 3-3**.)[30]

**Figure 3-5: Types of Siphonic Bowls**


Source: SCG-SmartHome.com

A *blowout bowl* is defined as a nonsiphonic water closet bowl with an integral flushing rim, a trap at the rear of the bowl, and a visible or concealed jet that operates with a blowout action. A blowout action means a jet of water directed at the bowl outlet opening pushes the bowl contents into the upleg, over the weir, and into the gravity drainage system.[31] Blowout bowl toilets rely on high water pressure and high water volume to remove waste from the bowl. **Figure 3-6** compares a siphonic bowl water closet and a blowout bowl water closet.

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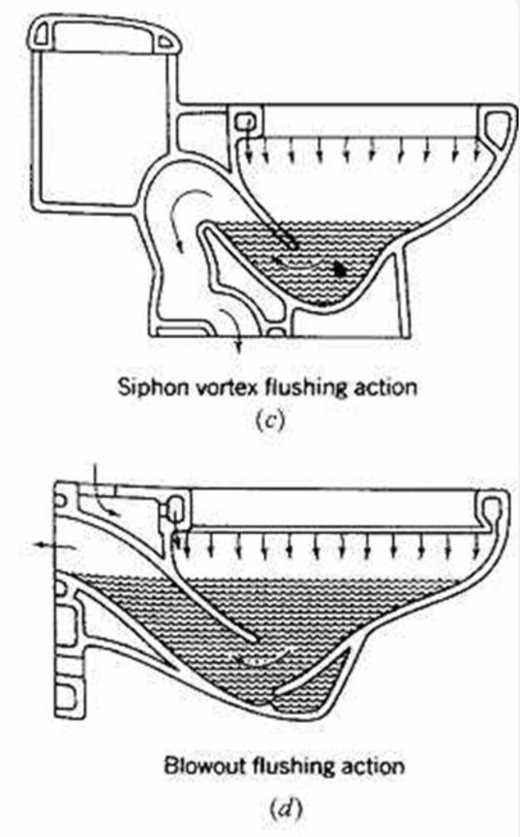
29 *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures.*

30 Hauenstein, Heidi, Ed Osann, and Tracy Quinn. 2013. *Analysis of Standards Proposal for Toilets & Urinals Water Efficiency*. California Investor-Owned Utilities Codes. https://efiling.energy.ca.gov/GetDocument.aspx?tn=71765&DocumentContentId=8087.

31 *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures.*

**Figure 3-6: Comparison of a Siphonic Bowl and Blowout Bowl**




Source: Industrial-Electronics.com

A *wash-down (or washout) bowl* is defined as a water closet bowl that has an integral flushing rim and a floor or wall outlet and primarily operates with a nonsiphonic action (**Figure 3-7**.)[32] That is, a washdown toilet uses the velocity of water to push waste from toilet bowl into the trapway. Because they have a short and wide trapway, waste can easily enter the trapway from the force of the water coming out of the tank.

32 Ibid.

**Figure 3-7: Siphonic and Nonsiphonic Washdown Bowls**


Source: SCG-SmartHome.com

The water level in siphonic toilets sits at a level above the outlet hole to form a seal that prevents odor coming into the bowl from the sewer drain line and sits at a higher level to minimize odor being emitted from the solid waste as they get submerged. Siphonic toilets are preferred in residential applications because have they a quieter and stronger flush. (A larger flush valve diameter and narrow trapway is ideal for removing heavy solid waste.) They also have a larger surface area than wash-down bowls to minimize solid waste residue remaining on the surface of the bowl (aka skid marks or scarring) (**Figures 3-5**, **3-7**, and **3-8)**. But they are prone to clogging because of the narrow shape of the trapway.

Washdown bowls have a shorter and wider trapway than siphonic toilets and are therefore less prone to clogging as more waste can be evacuated. But a shorter trapway results in a lower water level and a smaller water surface area than siphonic bowls (**Figures 3-5**, **3-7**, and **3-8)**. They also have a noisier flush than siphonic bowls. The disadvantage of having a smaller water surface area and a lower water level is wastes are not fully submerged causing odor and skid marks are more likely to form.

A quality glazed, hydrophilic coat reduces the likelihood of scarring on the surface of bowl and the number of clogs.[33]

33 Gardner, Matthew. 2023. "Siphonic Vs Washdown Toilet: Which Is Better?" February 24. https://www.bomisch.com/siphonic-vs-washdown-toilet/; Becking, Steffi, Bill Gauley, John Koeller, Mary Ann Dickinson, Helen Davis, and Kathleen Bryan. 2023. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*. California Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=249521&DocumentContentId=84153.

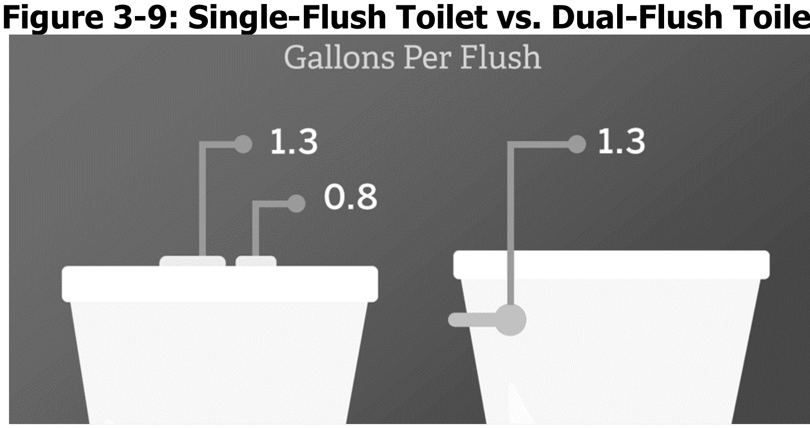
**Figure 3-8: Bowl Water Surface Comparison**


Source: ToiletFound.com

## Single-Flush vs. Dual-Flush

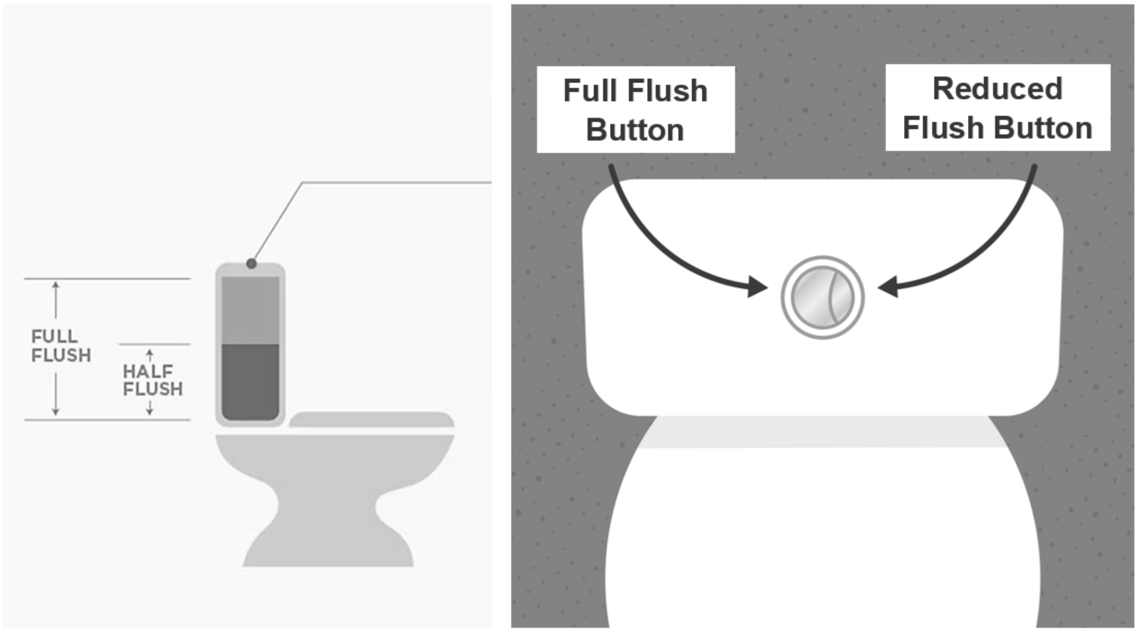
Most residential water closets have a single lever or button with one option of a flush volume called single-flush toilets (**Figure 3-9**). Flushing enough water to clear solid waste isn't necessary when there is only liquid waste in the bowl. Liquid waste flushes with half as much water that is required for solid waste. Therefore, dual-flush toilets, as the name implies, allow the user to flush the toilet with either a reduced flush or full flush volume of water depending upon bowl contents. These toilets also have the option of two flush volumes with a two-button system or a two-option lever, see **Figures 3-9** and **3-10**. The average of two reduced flushes and one full flush is called the *effective flush volume.* Also, many washdown toilets come with dual-flushing systems that allow water preservation.

**Figure 3-9: Single-Flush Toilet vs. Dual-Flush Toilet**




Source: PipeSpy.com

**Figure 3-10: Dual-Flush Toilet**




Source: Architizer.com, NWG.co.uk

## Water Consumption

Before 1992, most toilets had a flush volume of 3.5 gpf. Advancement in toilet technology has shifted from removing waste by using flush water volume to increasing flush water velocity to remove waste and continues to be refined to improve efficiency.[34]

A low-consumption water closet is considered a toilet with a maximum flush volume of 1.6 gpf or less.[35]

A high-efficiency toilet (HET) is considered a toilet with a maximum effective flush volume of 1.28 gpf.[36]

An ultra-high-efficiency toilet (UHET) is considered a toilet with a maximum flush volume between 0.8 gpf and 1.1 gpf.[37]

## Water Closet Types

Water closets can be categorized in several ways based on their design and application. Most residential water closets are tank-type water closets – more specifically gravity, pressure-assisted, vacuumed-assisted, and power-assisted, see **Figure 3-11**. And most commercial water closets are flushometer valve-type water closets or tankless water closets.

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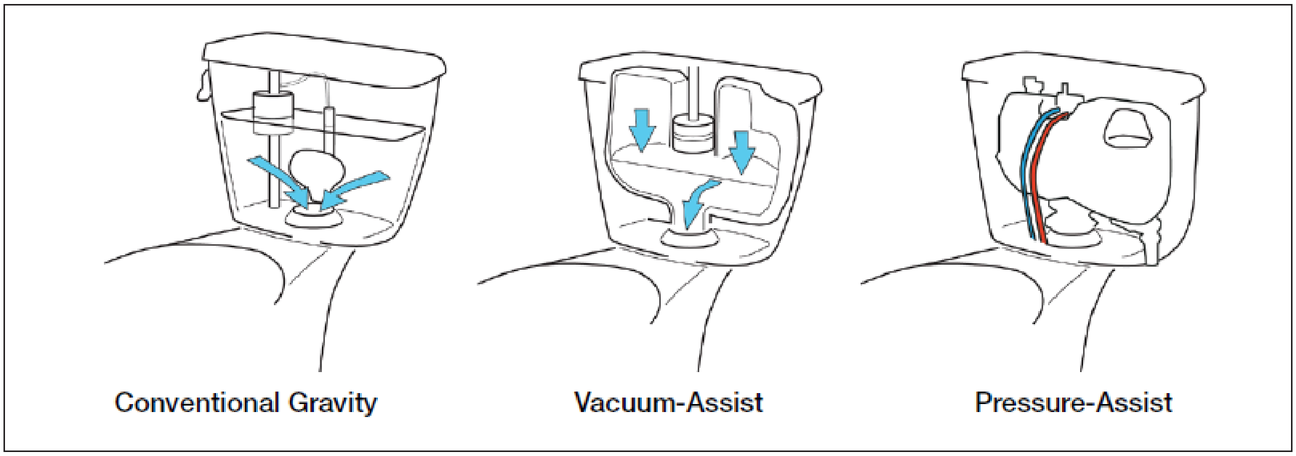
34 U.S EPA, *Wastewater Technology Fact Sheet: High-Efficiency Toilets.*

35 *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures*.

36 Ibid.

37 Maximum Performance. 2018. *Maximum Performance (MaP) Testing: Toilet Fixture Performance Testing Protocol Version 7*. Maximum Performance. https://map-testing.com/map-testing-protocol/.

**Figure 3-11: Diagram Comparison of a Gravity-Flush, Vacuum-Assisted, and Pressure-Assisted Toilet**




Source: MaP

**Tank-Type**

*Gravity-Flush*

Gravity flush tank-type toilets account for the majority of toilets, as well as a small percentage of commercial toilets. When toilets are flushed, a portion of the water flows to the toilet bowl rim to rinse the sides of the bowl, and a portion flows into a siphon hole to initiate siphoning. This siphon action pulls and pushes water and waste out of the toilet bowl to the sewer line. In the meantime, as the water in the tank empties, a flapper valve at the bottom of the tank falls back onto the drain tube, which stops the water to the toilet bowl. The water tank refills through a ballcock or fill valve, which closes when the water reaches the proper level, as controlled by a float ball. As the tank refills, a portion of the refill water is diverted through a tube to refill the toilet bowl.[38] **Figure 3-12** illustrates the internal parts of a gravity tank-type toilet and related functions.

38 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets*.

**Figure 3-12: Diagram of a Gravity Tank-Type Toilet**


Source: TheSpruce.com (2023)

*Pressure-Assisted*

In a pressure-assisted toilet or flushometer tank toilet, an airtight enclosure is inserted into the tank. Water fills from the bottom of the enclosure and pressurizes the air space above, providing additional pressure to the flushing water for proper flushing (**Figure 3-13**). Pressure-assisted toilets, although noisy, are less likely to clog and are therefore more likely to be used in light-commercial or heavy-duty commercial settings.[39]

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39 U.S EPA, *Wastewater Technology Fact Sheet: High-Efficiency Toilets.*

**Figure 3-13: Diagram Comparison of a Gravity-Flush and Pressure-Assisted Toilet**

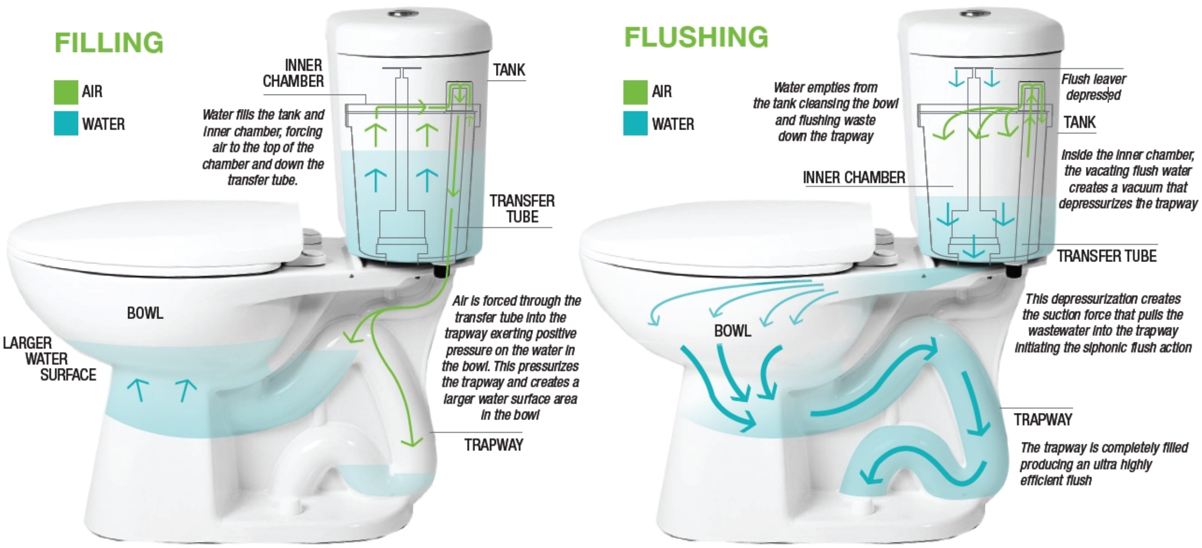

Source: Gerber-US.com

*Vacuum-Assisted*

To improve waste removal in toilets that consume less water, manufacturers have developed vacuum-assisted systems. Vacuum-assisted systems use specialized double-S trap toilet bowls connected to a built-in sealed chamber by a vacuum tube. When the toilet is flushed, the draining water seals the air vent in the trapway. At the same time, water draining from the vacuum-sealed chamber creates a vacuum that is transmitted to the airspace in the trapway. This modest vacuum force combines with the inherent siphonic action of the toilet bowl to enhance the "pull" on the toilet bowl contents for an effective boost in the flush (**Figure 3-14**.)[40]

40 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets.*

**Figure 3-14: Diagram of a Vacuum-Assisted Toilet**

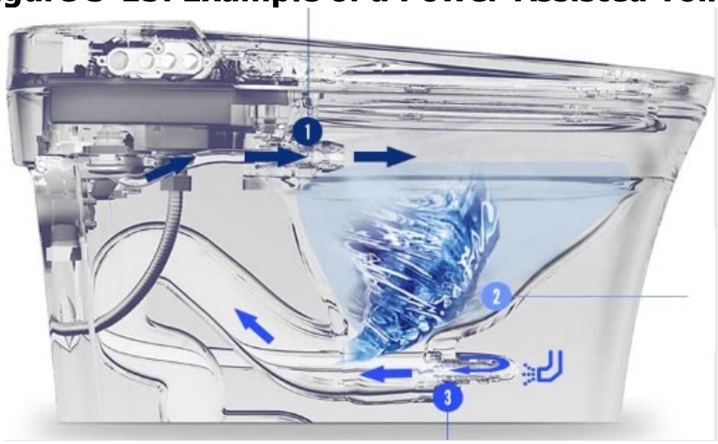



Source: Niagara Conservation

*Power-Assisted*

Power-assisted or electromechanical hydraulic toilets use electrically operated devices, such as air compressors, pumps, solenoids, motors, or macerators in place of or to aid gravity in evacuating waste from the toilet bowl. They require an electrical outlet to be installed near the toilet or a battery to power the main functions. Because of the electrical power source, power-assisted toilets are more inclined to have smart features.[41] **Figure 3-15** illustrates a cross-section of a tankless power-assisted toilet. Although this example is tankless, some do have a reservoir tank built into the bowl, near the trapway.

**Figure 3-15: Example of a Power-Assisted Toilet**




Source: EPLO Toilet via Amazon.com

41 Becking, S., et al. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*.

**Figure 3-16** illustrates an electrically powered macerator toilet or upflush toilet. A macerator toilet uses a grinder to breakdown solids after every flush before going down the drain line, with the goal of reducing clogging and promoting flow in longer drain lines. An upflush toilet uses a macerator to help move waste from lower building levels, such as a basement, to the sewer line.[42]

**Figure 3-16: Example of a Macerator Toilet**

Source: ManoMano.co.uk

### Flushometer Valve-Type

Valve-type toilets, also known as *flushometer valve toilets*, are common in medium- to high-usage commercial and industrial buildings. Flushometer valves are automatically timed, self-closing valves. Before pressing down on the handle or flushing, the water is at equal pressure in the lower and upper chambers, keeping the diaphragm closed tightly on the valve. After pressing down on the handle, the relief valve opens releasing water from the upper chamber, decreasing the pressure. High-pressure water from inlet now enters the system, lifting the valve up and travels down the flush pipe. During the flush, water enters the upper chamber through the small bypass hole into the diaphragm, equalizing the pressure until it pushes down onto the relief valve again (**Figure 3-17**).[43]

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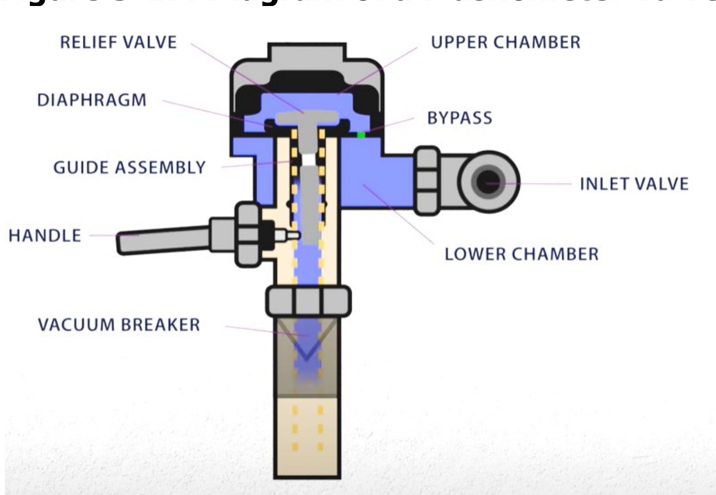
42 Harbison, Yvonne. 2023. "The Toilet Buying Guide." *Build.com.* https://www.build.com/toilet-buying-guide/a18064.

43 AMRE Supply. 2019. "How Do Flushometers Work?" *Youtube.com.* https://www.youtube.com/watch?app=desktop&v=FOw9W39C_Ts.

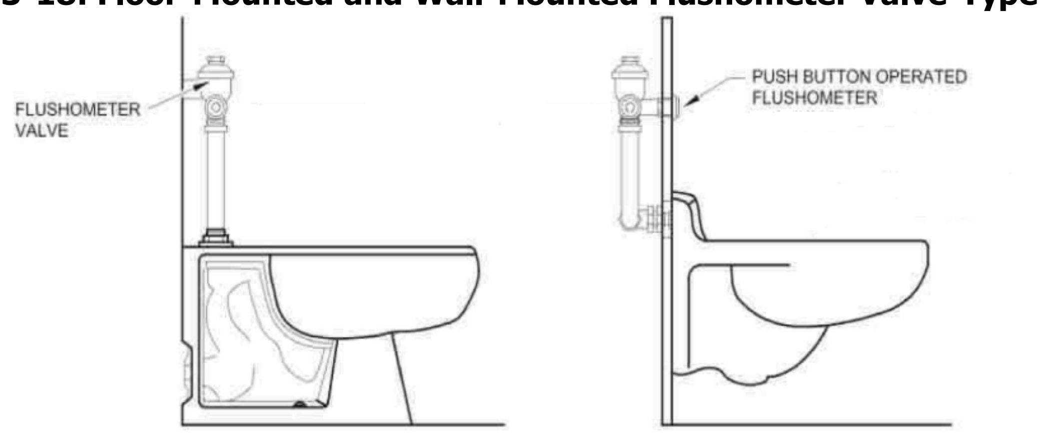
**Figure 3-17: Diagram of a Flushometer Valve**




Source: AMRE Supply via Youtube.com

The actual flush of a valve-type toilet is similar to a tank-type, except that the flushometer valve delivers the water and necessary flushing force using pipe pressure rather than using the flush force from a gravity tank-type toilet. Fairly high water pressure is required for this type of toilet, and it usually has to be supplied by a 1-inch plumbing line to provide sufficient force. It provides a quick flush and rapid recovery, but it is also noisy compared to other flush mechanisms.[44] The flushing mechanism can be automatic (via built-in sensor) or manual (via push-button or handle) (**Figures 3-17** and **3-18**). The toilet bowl can be floor-mounted or wall-mounted (**Figure 3-18**).

**Figure 3-18: Floor-Mounted and Wall-Mounted Flushometer Valve-Type Toilets**




Source: New Jersey Plumbing Code

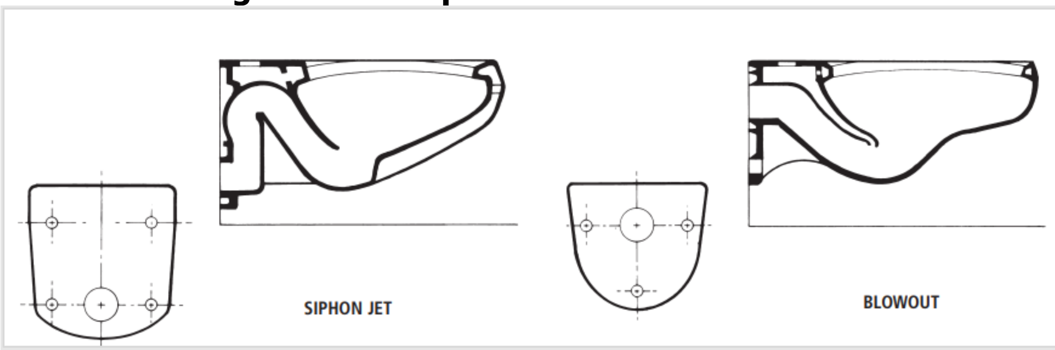
Flushometer valve-type toilets come in two flushing bowl categories: siphonic or blowout (**Figure 3-19**.)[45] As the name implies, a siphoning toilet uses a siphon action to remove the

44 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets*.

45 *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures.*

waste, and a blowout toilet uses high-pressure, high-volume water to flush the waste out of the bowl. See **Bowl Design** section in this chapter for details.

**Figure 3-19: Siphonic and Blowout Bowls**




Source: Josam.com

*Siphonic Type*

As the name implies, a siphoning toilet uses a siphon action to remove the waste. (See **Bowl Design** section in this chapter for details.) Flushometer valve-type siphoning toilets are used primarily in commercial, institutional, offices, and hotel facilities for the quieter, efficient flushing qualities. As described earlier, water is introduced into the bowl through the rim, filling the trapway and creating a siphonic action to evacuate the bowl. But unlike a gravity tank-type siphonic toilet, water is delivered through pipe pressure rather than a reservoir tank. The large water surface in the bowl ensures sanitation.

*Blowout Type*

A flushometer valve-type blowout toilet uses high-pressure, high-volume water to flush the waste out of the bowl. (See **Bowl Design** section in this chapter for details.) Blowout toilets are used primarily in locations subject to high use, such as airports, stadiums, and prisons, because of their durability. They are noisy, but more sanitary, due to the near-instant flush capability that leaves little to no residue behind. They are typically made of stainless steel and connected to the sewer system by bracketing through a wall to a sewer connection (usually about 10 to 12 inches above the floor) instead of through the floor. Blowout toilets rely exclusively on pipe pressure to deliver the necessary water volume to flush the waste.

There is a special type of blowout toilet that is designed for use in prisons or mental health facilities. These toilets are designed to withstand between 2,000 and 5,000 pounds of force and are typically bracketed to the wall to prevent vandalism or inappropriate use. They also feature components with round edges that cannot be removed from the primary device through normal means. These toilets have a large trapway diameter so that large pieces of debris can easily pass into the sewer to prevent intentional blockage. Because these types of toilets are used with special safety intention, they are exempt from regulatory standards.[46]

46 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets*.

## Design Features

Toilets come in various styles and several features to fit a specific need or aesthetic. The following sections discuss some features available in the market today.

### Toilet Profile

The outer design of a toilet below the rim of the bowl comes in different styles (**Figure 3-20**). The most common style found in homes is the visible trapway (left toilet in **Figure 3-20**). A concealed trap designs, hides the trapway for a smooth surface that provides a modern look, and is easier to clean (middle toilet in **Figure 3-20**). A skirted toilet also hides the trapway and eliminates the rounded outline of the bowl (right toilet in **Figure 3-20**).[47]

**Figure 3-20: Toilet Profiles**

Source: The Home Depot, 2023

### Two-Piece vs. One-Piece

Toilets either come in two pieces or one piece. Two-piece toilets have a separate tank and bowl (**Figure 3-21**), and one-piece toilets do not. A two-piece toilet is the most common type of toilet, is less expensive, and makes it easier to replace parts.[48] They also provide users the option to mix and match tanks and bowls to fit a specific height or bathroom space. A one-piece toilet is easier to clean since there are fewer crevices and are less complicated to install. But if one part of the toilet breaks, it's likely the whole toilet must be replaced.[49]

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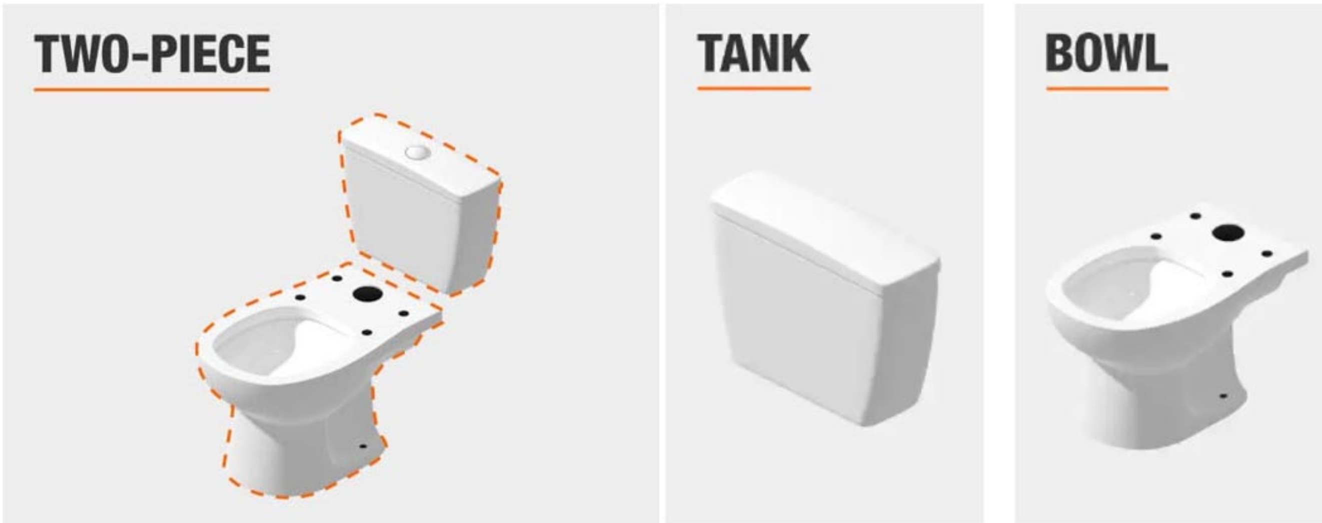
47 The Home Depot. 2023. "Toilet Buying Guide." *The Home Depot.* https://www.homedepot.com/c/ab/toilet-buying-guide/9ba683603be9fa5395fab903b4a0dc1.

48 Ibid.

49 Harbison, Y. "The Toilet Buying Guide."

**Figure 3-21: Two-Piece Toilet**




Source: The Home Depot, 2023

### Wall-Mounted Toilets

Most residential type toilets are floor-mounted, but wall-mounted toilets are also available. Wall-mounted toilets are either tankless, such as power-assisted toilets, or have a tank installed behind the wall called *in-wall tanks* or *concealed tanks* (**Figure 3-22**).

**Figure 3-22: Wall-Mounted Toilet With an In-Wall Tank**


Source: Geberit

### Smart Toilets

Smart toilets add an ancillary component to toilets for a better bathroom experience or convenience. Examples of smart technology features are slow-closing lids, bidet features, warm air drying, heated seats, lighting features, adjustable water temperature, auto cleaning, deodorizers, music, motion sensors for flushing, built-in air purifying systems, automation for opening and closing lids, remote control options, and Bluetooth or Wi-Fi connection. These types of toilets require an outlet connection or batteries to function.[50]

50 Harbison, Y. "The Toilet Buying Guide."

# CHAPTER 4: Regulatory Approaches

CEC staff examined and considered several approaches for improving the efficiency of water closets while achieving savings for California. Evaluated pathways included regulatory and voluntary ones at state, federal, and international levels.

## History of Toilets

Water closets have a long history:

- 1775, Alexander Cummings receives the first patent for a flushing toilet.
- 1880s, high-tank toilets appear in the market using 10 gallons per flush (gpf).
- 1906, William E. Sloan invents the flushometer valve.
- 1920s, tank-type toilets using 5 to 7 gpf appear in the market. [51]
- 1970s, 3.5 gpf and 4.0 gpf toilets appear in the market.
- 1980s, manufacturers began to introduce toilets using 1.6 gpf.[52]
- 1998, gravity-fed dual-flush toilets appear in the market.[53]
- 2000s, high-efficiency toilets (HETs) with flush volumes less than 1.28 gpf began appearing in the market.[54]

## California State Standards

### Appliance Efficiency Standards

On January 1, 1978, California adopted regulations making it mandatory that all toilets have a maximum flush volume of 3.5 gpf in new residential construction, effective January 1, 1980.[55] California later updated its efficiency standards for toilets, requiring a maximum flush volume

51 Plumbing Manufacturers International. 2022. *The History of Plumbing…so far!* McLean: Plumbing Manufacturers International. https://www.safeplumbing.org/about-pmi/timeline.

52 Osann, Edward R., and John E. Young. 1998. *Saving Water, Saving Dollars: Efficient Plumbing Products and Protection of America's Waters.* Potomac Resources, Inc.

53 Koeller, John. 2005. *Evaluation of Potential Best Management Practices: High-Efficiency Plumbing Fixtures - Toilets & Urinals*. Sacramento: California Urban Water Conservation Council. https://efiling.energy.ca.gov/GetDocument.aspx?tn=71102&DocumentContentId=7980.

54 DeMarco, Pete. 2017. "A Brief History of Plumbing Efficiency." March 7. https://www.phcppros.com/articles/3072-a-brief-history-of-plumbing-efficiency#:~:text=Reacting%20to%20these%20programs%2C%20by,as%20low%20as%200.8%20gpf.

55 Hauenstein, Heidi, Ed Osann, and Tracy Quinn. 2013. *Analysis of Standards Proposal for Toilets & Urinals Water Efficiency*. California Investor-Owned Utilities Codes. https://efiling.energy.ca.gov/GetDocument.aspx?tn=71765&DocumentContentId=8087.

of 1.6 gpf for all new buildings, additions, and renovations, effective January 1, 1992.[56] The U.S. Congress then approved the Energy Policy Act of 1992, which included efficiency standards for toilets. The act mandated that all toilets sold on or after January 1, 1994, have a maximum flush volume of 1.6 gpf. This federal regulation preempted California from updating its standards for water closets. Then on December 22, 2010, the U.S. Department of Energy (DOE) waived federal preemption for energy conservation standards with respect to any state regulation concerning the water use or water efficiency of faucets, showerheads, toilets, and urinals. This waiver allows states to set their own standards for the relevant plumbing products as long as the state standard is more stringent than the federal standard.[57]

On January 17, 2014, with California facing water shortfalls in the driest year in recorded state history, Governor Edmund G. Brown Jr. proclaimed a state of emergency and directed state officials to take all necessary actions to prepare for and respond to drought conditions.[58] This proclamation was followed by another state of emergency proclamation on April 25, 2014. One year later, on April 1, 2015, the Governor signed Executive Order B-29-15, authorizing the CEC to adopt emergency regulations establishing standards that improve the efficiency of water appliances for sale and installation in new and existing buildings.[59] These emergency regulations were exempted from the administrative requirements in the Administrative Procedure Act, the Warren-Alquist Act,[60] and the California Environmental Quality Act.[61]

In response to the Governor's executive order, the CEC adopted updated standards for toilets, faucets, and urinals in 2015. The updated standards for toilets set a maximum flush volume of 1.28 gpf for single-flush toilets and an effective flush volume[62] of 1.28 gpf for dual-flush toilets, applying to toilets sold on or after January 1, 2016. These standards are effective in California today. The update also included a waste extraction test using Section 7.10 of ASME A112.19.2/Canadian Standards Association (CSA) B45.1-2013. As of today, the test procedure

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56 United States General Accounting Office. 2000. *Water Infrastructure Water Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows*. Washington, D.C.: United States General Accounting Office. https://www.gao.gov/assets/rced-00-232.pdf; Becking, Steffi, Bill Gauley, John Koeller, Mary Ann Dickinson, Helen Davis, and Kathleen Bryan. 2023. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*. California Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=249521&DocumentContentId=84153.

57 Department of Energy — Energy Efficiency and Renewable Energy Office. 2023. "Water Closets." https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=43&action=viewlive.

58 Office of Governor Edmund G. Brown Jr. 2014. "Governor Brown Declares Drought State of Emergency." January 14. https://www.ca.gov/archive/gov39/2014/01/17/news18368/index.html.

59 State of California, Executive Order B-26-15. April 1, 2015.

60 Administrative Procedure Act of California, available at https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=GOV&division=3.&title=2.&part=1.&chapter=3.5.&article=.

61 California Environmental Quality Act, available at https://opr.ca.gov/ceqa/.

62 Effective flush volume means the average flush volume of two reduced flushes and one full flush.

for establishing water use for toilets is aligned with the federal test procedure referencing ASME A112.19.2/CSA B45.1-2018, *Ceramic Plumbing Fixtures.* [63]

Current marking and labeling requirements for water closets require the manufacturer's name, the model number, and the date of manufacture on each unit or on the packaging for each unit.

For state-regulated and federally regulated appliances to be sold or offered for sale in California, each manufacturer must certify information about each appliance demonstrating that it complies with federal and state standards.[64] This information is used to verify compliance through product determination, validating efficiency standards, and provides a limited ability to monitor the market.

Manufacturers certify appliance information to the CEC'S Modernized Appliance Efficiency Database System (MAEDbS). Manufacturers must report the criteria specified in the California Code of Regulations (CCR), Title 20, Section 1601 Table X. Current reporting requirements for water closets include specifying the type of water closet, water consumption (effective flush volume for dual-flush water closets), whether the model passes the waste extraction test, and the waste extraction value. The database lists more than 5,000 models of water closets consisting of eight types of water closets and more than 120 brands.[65]

## Legislative Actions

In the early 2000s, California legislators began to introduced bills to promote the use of water efficient toilets having a maximum flush volume of 1.6 gpf.[66] On October 11, 2007, the California Legislature enacted Assembly Bill 715 (Laird, Chapter 499), which set a schedule for manufacturers to meet water conservation standards for toilets and urinals sold or installed in the state such that after January 1, 2014, toilets cannot use more than 1.28 gpf, and urinals cannot use more than 0.5 gpf. AB 715 also required the California Building Standards Commission to incorporate these standards into the California Building Standards Code, which it did in the 2013 California Plumbing Code.[67]

On October 11, 2009, the California Legislature enacted Senate Bill 407 (Padilla, Chapter 587), which requires that:

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63 California Code of Regulations, Title 20, Section 1604(i). As of the publishing date of this report.

64 California Code of Regulations, Title 20, Section 1606(a).

65 California Energy Commission. 2023. "Modernized Appliance Efficiency Database System." https://cacertappliances.energy.ca.gov/Login.aspx.

66 AB 952 Income Taxes: exclusions (Kelley, 2001, approved), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200120020AB952; AB 2734 Conservation (Pavley, 2002, no further action), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200120020AB2734; AB 2496 Water Conservation: low-flush water closets (Laird, 2006, Vetoed), available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200520060AB2496.

67 AB 715 Water Conservation: low-flush water closets and urinals (Laird, 2007), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200720080AB715.

- Residential and commercial buildings built on or before January 1, 1994, be retrofitted with more efficient plumbing fittings and fixtures.
- On or after January 1, 2014, all building alterations or improvements to single-family residential real property replace non-compliant fixtures.
- On or before January 1, 2017, that all noncompliant plumbing fixtures in any single-family residential real property shall be replaced by the property owner with water-conserving plumbing fixtures.
- On or before January 1, 2019, that all noncompliant plumbing fixtures in multifamily residential real property and commercial real property, as defined, be replaced with water-conserving plumbing fixtures.

Specifically, SB 407 requires that, by the effective date, all noncompliant fixtures be replaced with toilets that use no more than 1.6 gpf, urinals that use no more than 1.0 gpf, and faucets that use no more than 2.2 gpm.[68] SB 407 is enforced only at the point of installation, when a permit is issued, and not at the point of sale.[69]

On May 31, 2018, the California Legislature enacted Senate Bill 606 (Hertzberg, Chapter 14), which establishes urban water use objectives and water use reporting requirements,[70] and Assembly Bill 1668 (Friedman, Chapter 15), which sets a schedule for urban retail water suppliers to meet indoor water use standards. The indoor water use standard will be 55 gallons per capita per day (GPCD) until January 2025; the standard will become stronger over time, decreasing to 50 GPCD in January 2030.[71] The California Department of Water Resources (DWR) and the State Water Resources Control Board (State Water Board) found that the median indoor residential water use in California was 48 GPCD,[72] below the standards specified in AB 1668. Therefore, DWR and the State Water Board recommended state lawmakers lower the standard to "help ensure resilient water supplies as climate change intensifies drought cycles."[73] On September 22, 2022, these objectives were updated in

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68 SB 407 Property Transfers: plumbing fixtures replacement (Padilla, 2009), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB407.

69 Singh, Harinder, Ken Rider, Tuan Ngo, and Kristen Driskell. 2015. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets, CEC-400-2015-008.* Sacramento: California Energy Commission. https://www.energy.ca.gov/publications/2015/staff-analysis-water-efficiency-standards-toilets-urinals-and-faucetss-2015.

70 SB 606 Water Management Planning (Hertzbery, 2018), available at https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB606.

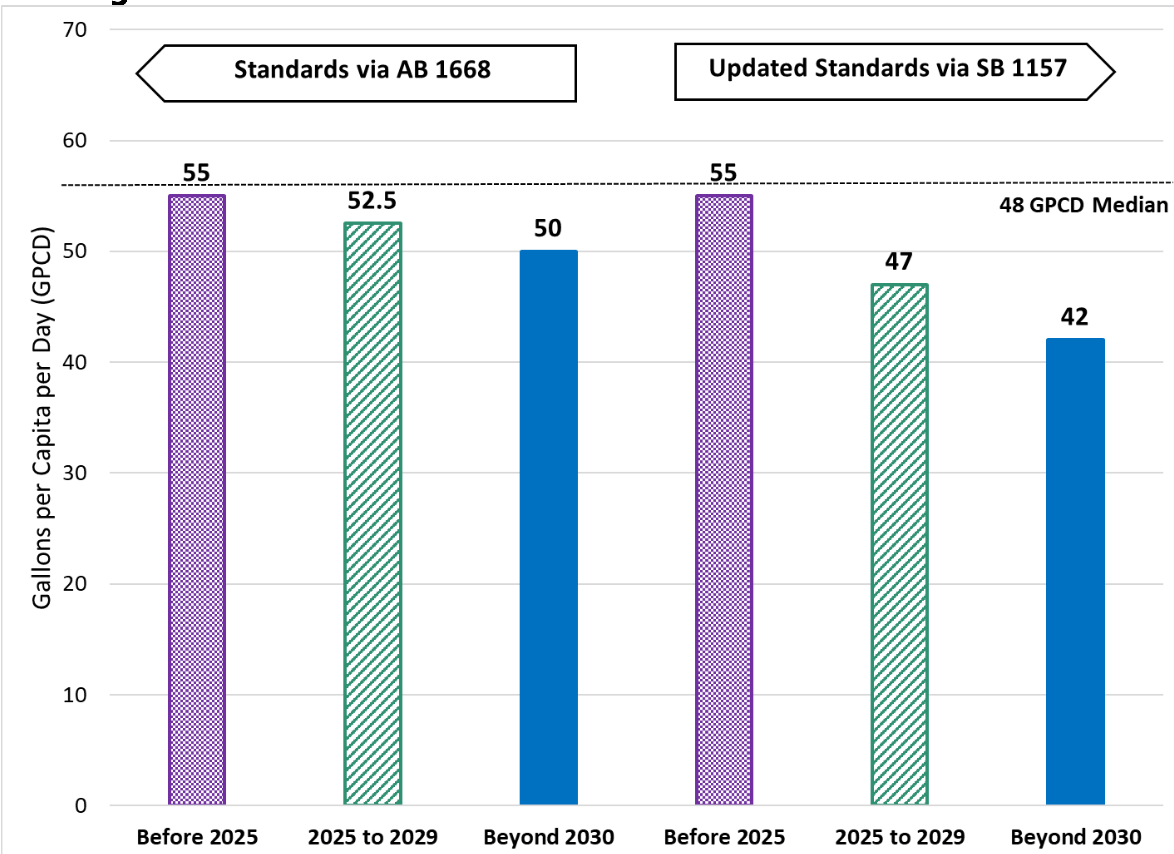
71 AB 1668 Water Management Planning (Friedman, 2018), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB1668.

72 California Department of Water Resources, Water Use Efficiency Branch. 2021. *Results of the Indoor Residential Water Use Study; A Report to the Legislature Prepared pursuant to Water Code Section 10609.4(b).* Sacramento: California Department of Water Resources. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/2018-Water-Conservation-Legislation/Performance-Measures/NEW_Results-of-the-Indoor-Residential-Water-Use-Study.pdf.

73 Beam, Adam. 21. "California Senate OKs lower standard for indoor water use." *KCRA 3.* April 2022. https://www.kcra.com/article/california-senate-oks-lower-standard-indoor-water-use/39791477#; California

Senate Bill 1157 (Hertzberg, Chapter 679). The indoor water use standard will still initiate with a 55 GPCD until January 2025, then decreasing to 42 GPCD in January 2030.[74] **Figure 4-1** summarizes the indoor residential water use standards specified in AB 1668 and SB 1157.

**Figure 4-1: California's Indoor Residential Water Use Standards**




Source: AB 1668; SB 1157

**Figure 4-2** shows the average monthly residential GPCD water use (indoor and outdoor) by hydrologic region and statewide from 2015 to 2023.[75] State agencies indicate that the indoor residential water used is expected to decline due to plumbing code requirements and more efficient appliances and fixtures being installed in homes, in the absence of legislative actions.[76]

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Department of Water Resources. 2021. "State Agencies Recommend Indoor Residential Water Use Standard to Legislature." *California Department of Water Resources.* November 30. https://water.ca.gov/News/News-Releases/2021/Nov-21/State-Agencies-Recommend-Indoor-Residential-Water-Use-Standard.

74 SB 1157 Urban Water Use Objectives (Hertzberg, 2022), available at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1157.

75 California State Water Resources Control Board. 2024. "Water Conservation and Production Reports." https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html.

76 CA DWR. "State Agencies Recommend Indoor Residential Water Use Standard to Legislature."

**Figure 4-2: California's Average Monthly Residential Gallons per Capita Daily**

| Region | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|
| Central Coast | 65 | 68 | 69 | 67 | 74 | 74 | 71 | 62 |
| Colorado River | 151 | 163 | 166 | 159 | 175 | 173 | 176 | 151 |
| North Coast | 65 | 64 | 66 | 67 | 73 | 66 | 61 | 58 |
| North Lahontan | 87 | 91 | 91 | 87 | 94 | 92 | 87 | 52 |
| Sacramento River | 114 | 122 | 119 | 112 | 130 | 123 | 116 | 103 |
| San Francisco Bay | 63 | 68 | 68 | 67 | 72 | 65 | 61 | 57 |
| San Joaquin River | 100 | 107 | 111 | 108 | 117 | 113 | 109 | 92 |
| South Coast | 81 | 85 | 85 | 80 | 87 | 86 | 82 | 75 |
| South Lahontan | 108 | 112 | 113 | 107 | 114 | 115 | 106 | 93 |
| Tulare Lake | 126 | 133 | 134 | 131 | 133 | 134 | 126 | 109 |
| Statewide | 85 | 90 | 90 | 85 | 93 | 91 | 86 | 78 |

Source: California State Water Resources Control Board (2024).

## California Building Standards Code

The 2022 California Building Standards Code (CCR, Title 24) consists of 12 parts and has an effective date of January 1, 2023. The California Plumbing Code and California Green Building Code (CALGreen) establish standards for products installed during new construction or alterations, but they do not regulate products sold or offered for sale in California.[77]

### California Plumbing Code

The 2022 California Plumbing Code is Part 5 of the California Building Standards Code (CCR, Title 24, Part 5). The requirements for water closets include an effective flush volume no greater than 1.28 gpf and must comply with ASME A112.19.2/CSA B45.1. Tank-type water closets shall be certified to the performance criteria of the U.S. EPA WaterSense specification for tank-type toilets.

### California Energy Code

The 2022 California Energy Code is Part 6 of the California Building Standards Code (CCR, Title 24, Part 6). The standards for water closets in this code must comply with California's Appliance Efficiency Regulations (CCR, Title 20).

### California Green Building Standards Code

The 2022 California Green Building Code (CALGreen) is Part 11 of the California Building Standards Code (CCR, Title 24, Part 11). The standards for water closets in this code is equivalent to the standards of the 2022 California Plumbing Code.

77 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets*.

### Local Jurisdictions

The City of West Hollywood adopted water efficiency standards that exceed CALGreen. For residential and nonresidential projects, the effective flush volume of all water closets shall not exceed 1.1 gpf.[78]

## Federal Regulations

The Appliance and Equipment Standards program was authorized in 1975 by the Energy Policy and Conservation Act (EPCA), a national standards program with nonbinding targets. Several amendments were made to EPCA establishing efficiency standards and increasing the number of covered products, one of the most significant amendments was the Energy Policy Act (EPAct) of 1992.[79] The EPAct of 1992 established water efficiency standards for plumbing fixtures such as toilets, urinals, faucets, and showerheads manufactured after January 1, 1994.[80] The water efficiency standards established for toilets in the EPAct 1992 are still the current national standards (**Table 4-1**.)[81] Manufacturers are required to certify their products to the Department of Energy's (DOE) online database – Compliance Certification Management System (CCMS).[82]

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78 City of West Hollywood. (2019). City of West Hollywood — 2019 Ordinance 19-1072. West Hollywood, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=229924-2&DocumentContentId=61390.

79 Offutt, Martin C. 2022. *The Department of Energy's Appliance and Equipment Standards Program.* Washington, D.C.: Congressional Research Service. https://crsreports.congress.gov/product/pdf/R/R47038.

80 U.S. GAO. *Water Infrastructure Water Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows.*

81 Code of Federal Regulations, Title 10, Part 430.32(q), available at https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#430.32.

82 United States Department of Energy. 2023. "Compliance Certification Management System." August. https://www.regulations.doe.gov/ccms/.

**Table 4-1: National Standards for Water Closets**

| Water Closet Type | Maximum Flush Rate (gpf)<br>Manufactured After January 1, 1994 | Maximum Flush Rate (gpf)<br>Manufactured After January 1, 1997 |
|---|---|---|
| Gravity flush tank water closet | 1.6 | 1.6 |
| Flushometer tank water closet | 1.6 | 1.6 |
| Electromechanical hydraulic water closet | 1.6 | 1.6 |
| Blowout bowl water closet | 3.5 | 3.5 |
| Flushometer valve water closets, other than those with blowout bowls | NA | 1.6 |

Source: 10 CFR 430.32(q)

On December 22, 2010, DOE waived federal preemption for energy conservation standards with respect to any state regulation concerning the water use or water efficiency of faucets, showerheads, toilets, and urinals. This waiver allows states to set their own standards for the relevant plumbing products as long as the state standard is more stringent than the federal standard.[83]

EPCA directed that the test method for water closets be American Society of Mechanical Engineers (ASME) A112.19.6-1990, *Hydraulic Requirements for Water Closets and Urinals,* and if it were to be revised, the Department of Energy (DOE) must amend federal test procedures to conform with the revised ASME standard. Therefore, on October 23, 2013, DOE amended its test procedure for water closets to specific sections of ASME A112.19.2-2008, *Ceramic Plumbing Fixtures*.[84] Then on March 23, 2022, DOE updated the test procedure to ASME A112.19.2-2018, *Ceramic Plumbing Fixtures*, specifically Sections 7.1.1–7.1.5, and 7.3.[85] These standards have remained unchanged since then, and DOE has not indicated any intent to amend these standards.

The DOE's database, CCMS, lists more than 2,700 water closet models by classifying them into five types of toilets. Reporting requirements include: brand name, toilet type, model number, and maximum water use.[86]

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83 U.S. DOE. "Water Closets."

84 United States Department of Energy - Energy Efficiency and Renewable Energy Office. 2021. *Energy Conservation Program: Test Procedures for Water Closets and Urinals; Notice of proposed rulemaking and request for comment.* Department of Energy. https://www.regulations.gov/document/EERE-2017-BT-TP-0028-0007.

85 U.S. DOE. "Water Closets."

86 U.S. DOE. "Compliance Certification Management System."

Marking and labeling requirements for water closets must include a permanent marking on the fixture and the unit's packaging indicating the flow rate in gpf and lpf, the water use in gpf and lpf, and the manufacturer's name. These requirements are in addition to California marking and labeling requirements.

## Other States

Just as California did, several states established water efficiency standards for toilets in the early 1990s (**Figure 4-3**). Congress used these state-level standards as the basis for the first federal standards for these appliances, passed in the EPAct of 1992. These standards took effect in 1994 and set the maximum flush volumes at 1.6 gpf for toilets.[87]

**Figure 4-3: State and Local Standards for Plumbing Fixtures Prior to EPAct of 1992**

| | | Water-efficiency standard | | | | |
|---|---|---|---|---|---|---|
| State/locality | Effective date[a] | Ultra-low-flow toilets (gal. per flush) | Low-flow showerhead (gal. per minute) | Kitchen faucets (gal. per min.) | Lavatory faucets (gal. per min.) | Urinals (gal. per flush) |
| National standard | Jan. 1, 1994 | 1.6 | 2.50 | 2.5 | 2.5 | 1.0 |
| States | | | | | | |
| Arizona | Jan. 1, 1993 | 1.6 | 2.50 | 2.5 | 2.0 | None |
| California | Jan. 1, 1992 | 1.6 | 2.50 | 2.5 | None | 1.0 |
| Connecticut[b] | Jan. 1, 1990 | 1.6 | 2.50 | 2.5 | 2.5 | 1.0 |
| Delaware | Apr. 1, 1992 | 1.6 | 2.50 | 2.5 | 2.0 | 1.0 |
| Georgia | Apr. 1, 1992 | 1.6 | 2.50 | 2.5 | 2.0 | 1.0 |
| Maryland | Apr. 1, 1992 | 1.6 | 2.50 | 2.5 | 2.0 | 1.0 |
| Massachusetts | Mar. 2, 1989 | 1.6 | 3.00 | None | None | 1.0 |
| Nevada | Mar. 1, 1993 | 1.6 | 2.50 | 2.5 | 2.5 | 1.0 |
| New Jersey[b] | July 1, 1991 | 1.6 | 3.00 | 3.0 | 3.0 | 1.5 |
| New York[b] | Jan. 1, 1992 | 1.6 | 3.00 | None | 2.0 | 1.0 |
| North Carolina[b] | Jan. 1, 1993 | 1.6 | 3.00 | 3.0 | 3.0 | 1.5 |
| Oregon | July 1, 1993 | 1.6 | 2.50 | 2.5 | 2.5 | 1.0 |
| Rhode Island[b] | Mar. 1, 1991 | 1.6 | 2.50 | 2.0 | 2.0 | 1.0 |
| Texas | Jan. 1, 1992 | 1.6 | 2.75 | 2.2 | 2.2 | 1.0 |
| Utah | July 1, 1992 | 1.6 | 2.50 | None | None | None |
| Washington | July 1, 1993 | 1.6 | 2.50 | 2.5 | 2.5 | 1.0 |
| Localities | | | | | | |
| Dade County, Fla. | Jan. 1, 1992 | 1.6 | 2.50 | 2.5 | 2.0 | 1.0 |
| Denver, Colo. | Mar. 1, 1992 | 1.6 | 2.50 | 2.2 | 2.2 | 1.0 |
| District of Columbia | Jan. 1, 1992 | 1.6 | 2.50 | 2.5 | 2.0 | 1.0 |
| Hillsborough County, Fla. | Mar. 26, 1992 | 1.6 | 2.50 | 2.2 | 2.2 | 1.0 |
| Palm Beach, Fla.[b] | Apr. 1, 1991 | 1.6 | 3.00 | None | None | 1.5 |
| Tampa, Fla.[b] | June 1, 1990 | 2.0 | 2.50 | 2.0 | 2.0 | 1.0 |

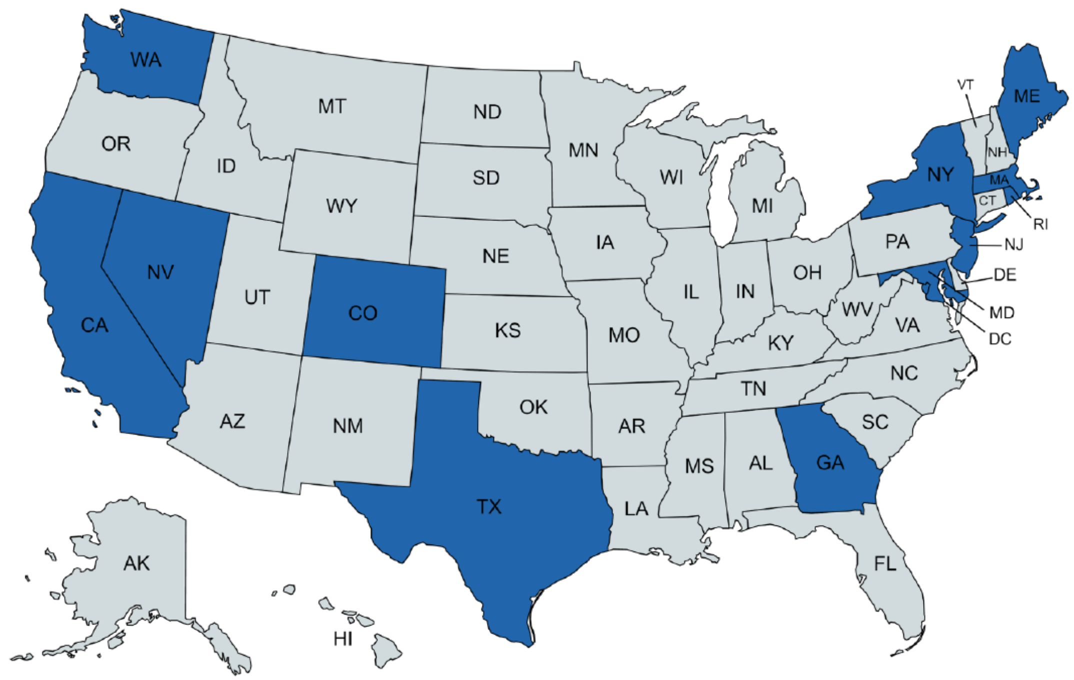
Source: United States General Accounting Office, 2000

Today, most states align with the federal regulations. But as other states begin to add appliance efficiency standards to their state, those standards tend to align with California's

87 U.S. GAO. *Water Infrastructure Water Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows.*

efficiency standards. Colorado, the District of Columbia, Georgia, Maine, Maryland, Massachusetts, Nevada, New Jersey, New York, Texas, Rhode Island, and Washington have adopted toilet efficiency standards that require products to use no more than 1.28 gpf (**Figure 4-4**.)[88]

**Figure 4-4: Map of States That Match California's Efficiency Requirements**




Source: U.S. EPA WaterSense, 2023

# Industry Standards

## ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures

The standard American Society of Mechanical Engineers (ASME) A112.19.2/Canadian Standards Association (CSA) B45.1 *Ceramic Plumbing Fixtures* initially started as ASME A112.19.6-1990 *Hydraulic Performance Requirements for Water Closets and Urinals*. It has gone through six revisions in 1995, 1998, 2004, 2008, 2013, and the latest in 2018.[89]

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88 Appliance Standards Awareness Project. 2023. "Toilets." https://appliance-standards.org/product/toilets.

89 American Society of Mechanical Engineers & Canadian Standards Association. 2018. *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures*. Toronto: CSA Group. https://www.asme.org/codes-standards/find-codes-standards/a112-19-2-csa-b45-1-ceramic-plumbing-fixtures/2018/drm-enabled-pdf.

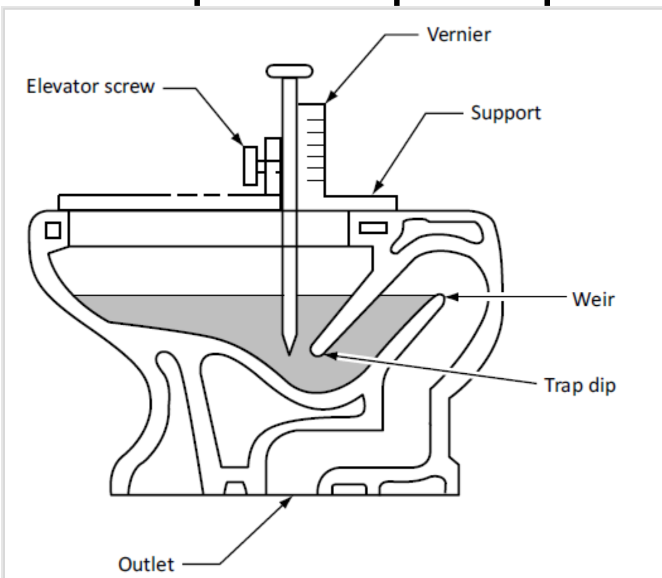
The 2018 version was reaffirmed in 2023[90] and is being assessed to be revised to incorporate ASME A112.19.14, *Six-Liter Water Closets Equipped with a Dual Flushing Device* into ASME A112.19.2/CSA B45.1. The revised version is planned to be published in 2024.[91]

Section 7 of ASME A112.19.2/CSA B45.1, Version 2018, pertains to water closets only. The following sections in this chapter will summarize each of the performance requirements set in Section 7 of ASME A112.19.2/CSA B45.1, Version 2018.

## Trap Seal Performance

Section 7.2 and Section 7.4 ensure the trap seal performs accordingly to the design. That is, the vertical distance from the trap dip to the weir, called the trap seal depth, is consistent after each flush (**Figure 4-5**). The trap seal depth must be at least 51 millimeters (mm) or 2 inches after 10 flushes.

**Figure 4-5: Apparatus Setup for the Trap Seal Depth Determination Test**




Source: ASME A112.19.2/CSA B45.1, Version 2018

## Water Consumption

Section 7.3 measures the performance of the flush volume at a specified pressure for three test runs. This industry standard requires the flush volume to not exceed 1.28 gpf for single-flush water closets, 1.6 gpf for the full flush volume mode of dual-flush water closets, and 1.6 gpf for low-consumption water closets.

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90 Canadian Standards Association Group. 2024. *ASME A112.19.2-2018/CSA B45.1-18 (R2023)*. https://www.csagroup.org/store/product/ASME%20A112.19.2-2018-CSA%20B45.1-18/.

91 United States Environmental Protection Agency WaterSense. 2023. *WaterSense® Notice of Intent to Revise the Specification for Tank-Type Toilets*. Washington, D.C.: United States Environmental Protection Agency WaterSense. https://www.epa.gov/system/files/documents/2023-06/ws-products-toilets-v2-noi.pdf.

### Granule and Ball Test

Section 7.5 measures the performance of how well the water closets flushes different media types. The test media consist of 2,500 cylindrical high-density polyethylene granules with a diameter of 4.0 mm and 100 nylon balls with a diameter of 6.35 mm. For each test run, for a total of three test runs, if more than 5 percent of each type of media remains in the bowl after each flush, it does not pass the test.

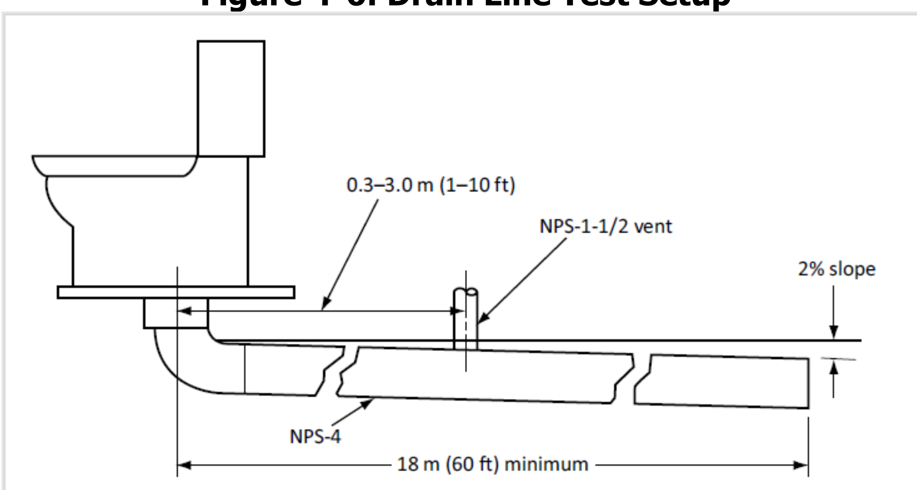
### Surface Wash Test

Section 7.6 measures the performance of how well the surface of the bowl is cleaned after each flush. The test medium for this test is a wet-erase fine-point transparency marker. A horizontal is line drawn around the circumference of the flushing surface. The total length of the ink line segments remaining on the flushing surface after each flush shall not exceed 51 mm when averaged over three test runs. No individual segment shall be longer than 13 mm.

### Drain Line Transport Characterization Test

Section 7.7 measures the performance of how well the water closet transports waste through a drain line. The test media for this test consists of 100 polypropylene balls with a diameter of 19 mm and a weight of 3 grams. The drain line connected to the water closet is at least 18 meters long with a slope of 2 percent, as shown in **Figure 4-6**. The test procedure is conducted by recording the location of the balls at various distances down the drain line. More balls further down the drain line signifies that the water closet is effective at transporting waste through a drain line.

**Figure 4-6: Drain Line Test Setup**




Source: ASME A112.19.2/CSA B45.1, Version 2018

### Overflow Test for Gravity Flush Tanks

Section 7.8 tests for leakage coming from the flush tank. The test procedure is conducted by opening the water supply valve and allowing the water to flow at a specified static pressure for a specified period.

### Waste Extraction Test

Section 7.9 measures the performance of how well the water closet clears waste from the bowl. The test media consists of seven (case or uncased) soybean paste cylinders for a combined mass of 350 grams and four loosely crumpled balls of six squares of single-ply toilet paper. The test procedure is conducted by dropping all the test media and flushing. If the any test media remains in the bowl or trap, then it did not pass. This procedure is repeated five times.

The 2018 version of the waste extraction test differs slightly from the 2013 version. First, the content mixture of the soybean paste cylinders has changed. The water and soybean percentage amount has decreased to allow the addition of ethyl alcohol into the mixture. The 2013 version does not include ethyl alcohol in the soybean paste mixture. The suggested supplier of the soybean paste has been updated in the 2018 version. The temperature of the soybean past cylinders during testing has changed from 15 ± 10 °C (59 ± 18°F) to 18 and 27°C (65 and 80 °F). Lastly, the 2018 version uses a coupling with a smaller diameter to perform the wet tensile strength for the toilet paper.

### Consistent Water Level Test and Fill Valve Shutoff Integrity Test With Increased Water Pressure

Sections 7.10 and 7.11 measure the performance of how well the fill valve shuts off at the same water level for water closets with nonpilot valves only. The test procedure is performed at the three inlet water pressures.

### Adjustability Test for Tank-Type Gravity Water Closets

Sections 7.12 and 7.13 measure the performance of the adjustment features in the tank that might increase the water closet flush volume. The test procedure is conducted by setting the adjustable tank components to the maximum water use setting, flushing the water closet, and measuring the total flush volume. The test is repeated five times at two static water supply pressures. The average total flush volume from the five test runs shall not exceed the following:

- For single-flush fixtures: 1.68 gpf.
- For dual-flush fixtures: reduced flush mode 1.40 gpf and full flush mode 2.00 gpf.[92]

## ASME A112.19.14 Six-Liter Water Closets Equipped with a Dual-Flushing Device

For water closets that have dual-flush capabilities, the standard American Society of Mechanical Engineers (ASME) A112.19.14 *Six-Liter Water Closets Equipped with a Dual Flushing Device* is applied. The standard establishes additional performance criteria other than those specified in A112.19.2-2018 *Ceramic Plumbing Fixtures* for 1.6-gallon (6-liter) dual-flush

92 ASME & CSA. 2018. *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures.*

water closets. This standard has had two updates since published in 2001 — once in 2006, in 2013, and the 2013 version being reaffirmed in 2018.[93]

The standard ASME A112.19.2-2018 requires dual-flush water closets comply with ASME A112.19.14 in Section 5.6 and Section 7.9.5.[94] The *WaterSense Specification for Tank-Type Toilets* also requires dual-flush water closets conform to the requirements of ASME A112.19.14 and, therefore, ASME A112.19.2.[95]

The following sections in this chapter will summarize each of the performance requirements set in ASME A112.19.14, Version 2013 (R2018).

### Water Consumption

This industry standard requires the reduced flush volume to not exceed 1.1 gpf. The full flush volume must meet the requirements of ASME A112.19.2, indicating the full flush volume to not exceed 1.6 gpf.

### Dye Test

The dye test ensures the bowl clears all its contents after flushing. The test requires one ounce of a dye mix solution to be added to the bowl, flushed, and then a sample of water in the bowl is taken to be compared with the controlled sample. For each test run, for a total of three test runs, if the average dilution ratio exceeds 17:1 from each flush, it does not pass the test.

### Waste Extraction Test

The waste extraction test measures the performance of how well the water closet clears waste from the bowl. The test media consists of four loosely crumpled balls of six sheets of untreated single-ply toilet paper. The test procedure is conducted by dropping all the test media and flushing. If the any test media remains in the bowl or trap, then it did not pass. This procedure is repeated three times.

### Durability Test

The durability test ensures the flushing mechanism operates accordingly. The test requires the full flush mode be flushed in 15,000 cycles and after each four full flushes, one reduced flush mode shall follow for a total of 60,000 cycles for the reduced flush mode. If the flushing mechanism, actuator, or levers/buttons show any sign of deterioration, then it does not pass the test.

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93 American Society of Mechanical Engineers. 2014. *ASME A112.19.14-2013 (R2018) Six-Liter Water Closets Equipped with a Dual Flushing Device*. New York: American Society of Mechanical Engineers. https://www.asme.org/codes-standards/find-codes-standards/a112-19-14-six-liter-water-closets-equipped-dual-flushing-device/2013/drm-enabled-pdf.

94 ASME & CSA. 2018. *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures.*

95 United States Environmental Protection Agency WaterSense. 2014. *WaterSense Specification for Tank-Type Toilets Version 1.2.* Washington, D.C.: United States Environmental Protection Agency WaterSense. https://www.epa.gov/sites/production/files/2017-01/documents/ws-products-spec-toilets.pdf.

## Voluntary Standards

### MaP Test Protocol

The Maximum Performance (MaP) test protocol is a voluntary testing program that ranks toilets based on flushing performance — the ability to flush solid waste — launched in 2003. Toilets are ranked from lowest to highest. A higher score means the toilet is more effective at removing larger amounts of solid waste in a single flush. The MaP score represents the number of grams of solid waste (soybean paste and toilet paper). Manufacturers send their models to a MaP-approved laboratory for independent testing and to have models listed in MaP's online database.[96]

The test media consist of one or more of cased soybean paste specimens with a weight of 50g, one or more uncased soybean paste specimens (**Figure 4-7**) with a weight of 50g, and four loosely crumpled balls of toilet paper. The test procedure requires the water closet successfully clear the test media in at least four of five attempts when cased media is used and in at least two of three attempts when uncased media is used. Additional test specimens are added as required to achieve desired mass loading: 350g, 400g, 500g, 600g, 800g, and 1000g.

**Figure 4-7: 350 grams of Extruded Soybean Paste**

Source: MaP Testing

The MaP Premium rating is for water closets that score at least 600g and up to 1,000 grams, have a rated flush volume of 1.1 gpf for single-flush water closets, have a maximum full flush volume of 1.28 gpf for dual-flush water closets, and have an effective flush volume of 1.1 gpf

96 Maximum Performance. 2023. "What is MaP?" https://map-testing.com/performance-toilets-testing/.

for dual-flush water closets.[97] The effective flush under the MaP Premium test protocol is calculated as the average volume of one reduced flush and one full flush.

The MaP database lists 5,737 tank-type toilet models from 210 brands and 409 MaP Premium toilet models from 41 brands.[98]

## U.S. EPA WaterSense®

WaterSense is a voluntary partnership program by the U.S. Environmental Protection Agency (EPA) that launched on June 12, 2006.[99] It is a labeling program for products that are at least 20 percent more water-efficient than standard models, is a resource for searching water-efficient products, provides tools for building and maintaining efficient homes, and provides resources for water efficiency best management practices for commercial and institutional facilities (**Figure 4-8**).[100]

**Figure 4-8: WaterSense Label**

Source: U.S. EPA WaterSense, 2023

The program collaborates with stakeholders — including manufacturers, certifying bodies, testing laboratories, standard development organizations, trade organizations, water and energy utilities, and other water efficiency experts — to develop performance criteria or voluntary specifications for high-efficiency water-consuming appliances, such as toilets, showerheads, faucets, and landscape irrigation equipment. Manufacturers certify and label their products according to standards developed by EPA-licensed laboratories.

The first WaterSense specification for tank-type toilets was released January 24, 2007. There have been three revisions since the first specification was released. The current specification

97 Maximum Performance. 2018. *Maximum Performance (MaP) Testing: Toilet Fixture Performance Testing Protocol Version 7*. Maximum Performance. https://map-testing.com/map-testing-protocol/.

98 Maximum Performance. 2023. "Toilet and Urinal List Downloads." Maximum Performance, August 2. https://map-testing.com/downloads/.

99 United States Environmental Protection Agency. 2023. "WaterSense: Accomplishments and History." June 29. https://www.epa.gov/watersense/accomplishments-and-history.

100 United States Environmental Protection Agency. 2023. "About WaterSense." June 6. https://www.epa.gov/watersense/about-watersense.

released June 2, 2014 (Version 1.2.) will remain in effect until June 30, 2025.[101] The scope covers:

- single-flush and dual-flush tank-type gravity toilets,
- tank-type flushometer tank (pressure-assist) toilets, and
- tank-type electrohydraulic toilets, and
- other technologies that meet the performance specifications.

The water efficiency criteria is set to an effective flush volume of 1.28 gpf as determined in accordance with ASME A112.19.2/CSA B45.1. Dual-flush toilets are required to conform with the requirements of ASME A112.19.14, *Six Liter Water Closets Equipped with a Dual Flushing Device*. **Table 4-2** summarizes additional performance requirements that are included in the specification, either directly or by reference to the applicable national standard, ASME A112.19.2/CSA B45.1. Additional details on each of these performance requirements can be found in the **Industry Standards** section of this chapter.[102]

**Table 4-2: WaterSense's Specification Performance Requirements**

| Performance Requirement | Purpose |
|---|---|
| Granule and Ball | Assesses the ability of a toilet to flush media of different sizes and density (i.e., floating versus sinking media). |
| Surface Wash | Evaluates the ability of a toilet to clean the surface of the bowl. |
| Drain Line Transport Characterization | Assesses the ability of a toilet to transport waste media through a drain line. |
| Overflow | Ensures toilet tank does not leak or permit water to otherwise escape. |
| Waste Extraction | Determines the ability of a toilet to clear soybean paste test media (meant to represent human waste) and toilet paper from the bowl. |
| Adjustability Tests | Limits the allowed adjustability of features in the toilet tank that might increase the flush volume |

Source: EPA WaterSense Performance Overview: Tank-Type Toilets (2022)

101 United States Environmental Protection Agency. 2024. "WaterSense: Residential Toilets." https://www.epa.gov/watersense/residential-toilets.

102 U.S. EPA. *WaterSense Specification for Tank-Type Toilets Version 1.2*.

In addition to the performance criteria listed in **Table 4-2**, specification Version 1.2 requires:

- That the average flush volume does not exceed 0.10 gallons more than the rated flush volume.
- That toilet tanks with adjustable water use settings that can be overridden by the user to exceed the rated flush volume do not qualify for the WaterSense label.
- That every combination of tank and bowl be tested and certified.[103]

An updated WaterSense specification was released in May 2024 (Version 2.0) and will take effect on July 1, 2025.[104] The scope remains the same but clarifies that "combination in-wall toilet carrier systems and wall hung bowls" are in-scope products, as well as prohibits toilet tanks with adjustable water use settings that can be overridden in the scope of the specification.[105] The coverage of in-wall toilets and wall hung bowls was implied in the reporting requirements and clarified in section 3.0 Clarifications of Appendix A in Version 1.2. The criteria that toilet tanks with adjustable water use settings that can be overridden by the user to exceed the rated flush volume do not qualify for the WaterSense label was also clarified in section 3.0 Clarifications of Appendix A in Version 1.2.[106] All toilets within the scope continue to conform to ASME A112.19.2/CSA B45.1-2018 and dual-flush toilets continue to conform to ASME A112.19.14 via ASME A112.19.2/CSA B45.1-2018.

The most substantial change in Version 2.0 is the elimination of the effective flush volume for dual-flush toilets and the establishment of a maximum flush volume of 1.28 gpf for both the full-flush and reduced-flush modes. WaterSense has not established a maximum flush volume for the reduced-flush mode but through ASME A112.19.14 via ASME A112.19.2/CSA B45.1-2018 the maximum rated flush volume for the reduced-flush mode remains at 1.1 gpf for dual-flush toilets. The performance criteria listed in **Table 4-2** from Version 1.2 remains the same. The additional clarifications in Version 1.2, such as product marking for toilet combinations, have been incorporated into Version 2.0. Reporting requirements also remain the same. The WaterSense database lists more than 4,700 tank-type toilets. Reporting requirements include: the brand name, model name, model number, bowl model number, tank model number, flush volume (reduced and full flush volumes for dual-flush toilets), flush type (single or dual), and flush mechanism (gravity, pressure-assist, or other).[107]

## LEED Certification

Leadership in Energy and Environmental Design (LEED) is the most widely used green building rating system that expresses how efficiently a building is designed and operated. To achieve

103 Ibid.

104 U.S. EPA. "WaterSense: Residential Toilets." https://www.epa.gov/watersense/residential-toilets

105 United States Environmental Protection Agency. 2024. *WaterSense Specification for Tank-Type Toilets Version 2.0*. Washington, D.C.: U.S. EPA WaterSense. https://www.epa.gov/system/files/documents/2024-05/ws-products-indoor-tank-type-toilets-v2-final-spec.pdf.

106 U.S. EPA. *WaterSense Specification for Tank-Type Toilets Version 1.2*.

107 United States Environmental Protection Agency. 2023. "WaterSense - Product Search." https://lookforwatersense.epa.gov/Product-Search-Results-Toilets.html.

LEED certification, a project, such as commercial and industrial properties or residential homes, must earn points by meeting various requirements that help reduce the environmental impact. The levels of LEED certification are as follows: Certified (40–49 points), Silver (50–59 points), Gold (60–79 points), and Platinum (80+ points).[108]

Residential multifamily homes and single-family homes must have a water closet with a flush volume no more than 1.28 gallons per flush. To gain additional points, multifamily homes must have a WaterSense labeled water closet and the average rated flush volume across all toilets must not exceed 1.28 gallons per flush (4.8 liters) for 1 point, or 1.1 gallons (4.1 liters) per flush for 2 points.[109] Single-family homes have an additional opportunity to gain points, and that is by having a WaterSense-labeled water closet with an average rated flush volume of 0.8 gallons per flush (3.0 liters) for 3 points.[110]

## International Standards

Climate change has worldwide impacts that differ by location. One of California's climate-driven challenges is severe droughts, which negatively impact the moving and storing of the state's water supply. Other countries have similar climate change challenges that impact their water resources. Promoting efficiency policies plays a major role in water resiliency.

**Table 4-3** lists countries that have instilled water efficiency requirements for water closets, and **Figure 4-9** illustrates countries that have mandatory or voluntary water efficiency labeling programs.

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108 United States Green Building Council. 2023. "LEED Rating System." https://www.usgbc.org/leed.

109 United States Green Building Council. 2021. *LEED v4.1 Residential BD+C Multifamily Homes*. Washington, D.C.: United States Green Building Council. https://www.usgbc.org/leed/v41#residential.

110 United States Green Building Council. 2020. *LEED v4.1 Residential Single Family Homes*. Washington, D.C.: United States Green Building Council. https://www.usgbc.org/leed/v41#residential.

**Table 4-3: Countries with Water Efficiency Requirements for Water Closets**

| Country | Water Efficiency Requirement | System Type |
|---|---|---|
| Australia[111] | 1 star: 2.51 gpf/1.19 gpf (Full/Reduced)<br>2 stars: 2.51 gpf/1.19 gpf<br>3 stars: 1.72 gpf/0.92 gpf<br>4 stars: 1.24 gpf/0.85 gpf<br>5 stars: 1.24 gpf/undefined<br>6 stars: 1.24 gpf/undefined | Rating |
| China[112] | Grade 1: Average 4 lpf (1.06 gpf)[113]<br>Grade 2: Average 4.8 lpf (1.27 gpf)<br>Grade 3: Average 6 lpf (1.58 gpf) | Rating |
| European Union[114] | Full Flush: 6 lpf (1.58 gpf)<br>Reduced Flush: 3 lpf (0.79 gpf)[115] | Maximum |
| India[116] | Full Flush: 10 lpf (2.64 gpf)<br>Reduced Flush: 6 lpf (1.58 gpf) | Maximum |
| Republic of Korea[117] | Full Flush: 6 lpf (1.58 gpf)<br>Reduced Flush: 4 lpf (1.06 gpf) | Maximum |
| Singapore[118] | Dual-Flush:<br>2-Ticks: 4 lpf (1.06 gpf)/3 lpf (0.79 gpf)<br>3-Ticks: 3.5 lpf (0.92 gpf)/3 lpf (0.79 gpf)<br>Single-Flush:<br>2-Ticks: 4 lpf (1.06 gpf)<br>3-Ticks: 3.5 lpf (0.92 gpf) | Rating |
| United Kingdom[119] | Single-Flush: 6 lpf (1.58 gpf)<br>Dual-Flush: 6 lpf (1.58 gpf)/ 4 lpf (1.06 gpf) | Maximum |
| United States | Full Flush: 1.6 gpf | Maximum |

Source: CEC research

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111 Becking, S., et al. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*.

112 Values are based on researching toilet model specification sheets. The minimum requirements can be found in the standard: GB 25502-2017 Minimum Allowable Values of Water Efficiency and Water Efficiency Grades For Water Closets.

113 Reduced flush: 3.5 lpf (.92 gpf); Full Flush: 5 lpf (1.32 gpf).

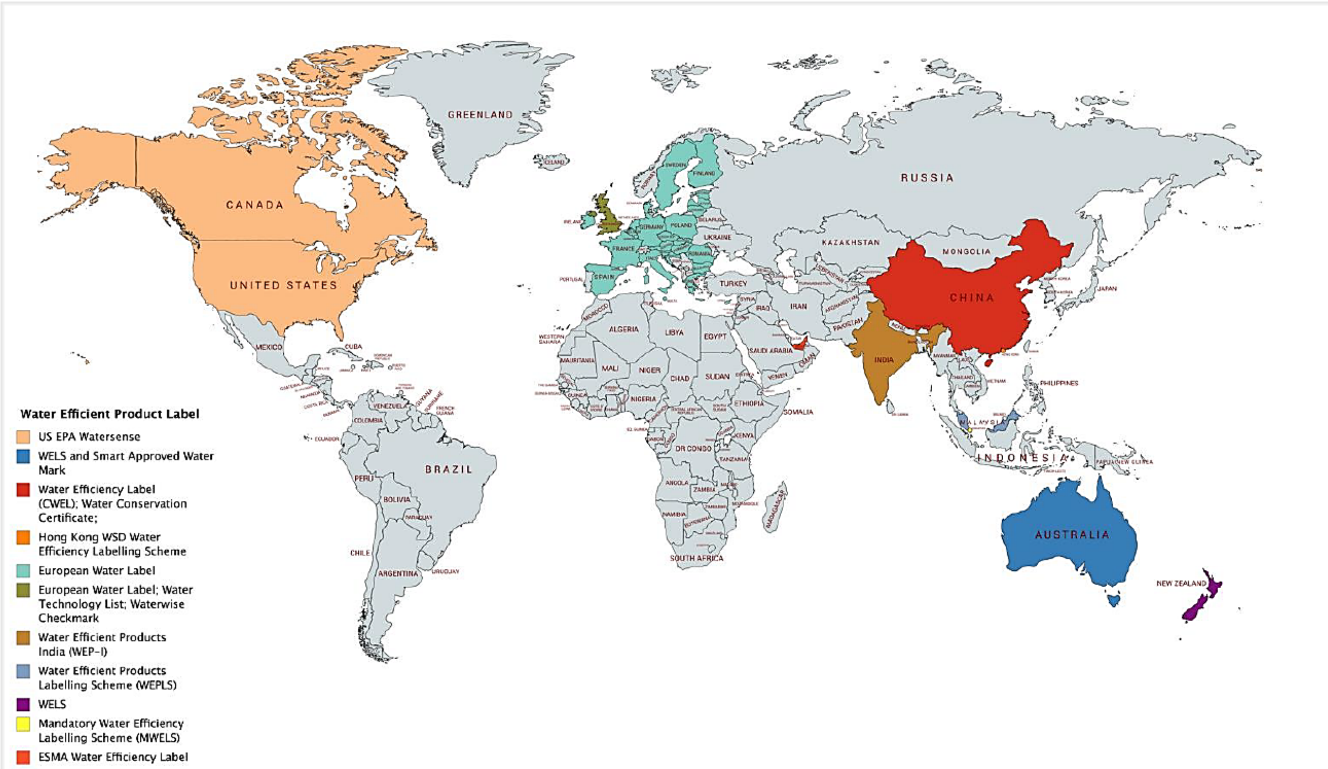
114 Commission Decision of November 7, 2013, establishing the ecological criteria for the award of the EU Ecolabel for flushing toilets and urinals.

115 Toilet suites delivering a full flush volume of more than 4.0 liters and toilet flushing systems shall be equipped with a water-saving device. When placed on the market, the reduced flush volume, independent of the water pressure, delivered when the water-saving device is operated shall not exceed 3.0 l/flush.

116 Indian Standard 774 of 2004 amended in 2006.

117 Demartini, Sara, Matt Malinowski, and Yang Yu. 2021. *Global Water Efficiency Scoping Study*. Washington, D.C.: CLASP. https://www.clasp.ngo/wp-content/uploads/2021/01/Global-Water-Efficiency-Report-1.pdf.

**Figure 4-9: International Map of Water Efficiency Labeling Coverage**




Source: International Waster Association (2019); see Figure C-1 in Appendix C for details.

118 Singapore's National Water Agency. 2021. *Water Efficiency Labelling Scheme (WELS) Guidebook*. Singapore's National Water Agency. https://www.pub.gov.sg/Documents/WELS_Guidebook.pdf.

119 Becking, S., et al. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*.

# CHAPTER 5: Alternative Considerations

The scope for each alternative covers all water closets (single-flush water closets and dual-flush water closets) except blowout water closets, flushometer valve water closets, and prison-type water closets. State standards for four scenarios were considered:

(1) maintaining existing standards,

(2) updating efficiency standards for dual-flush water closets only,

(3) updating efficiency standards for single-flush water closets and dual-flush water closets to moderately stringent standards, and

(4) updating efficiency standards for single-flush water closets and for dual-flush water closets to more stringent standards.

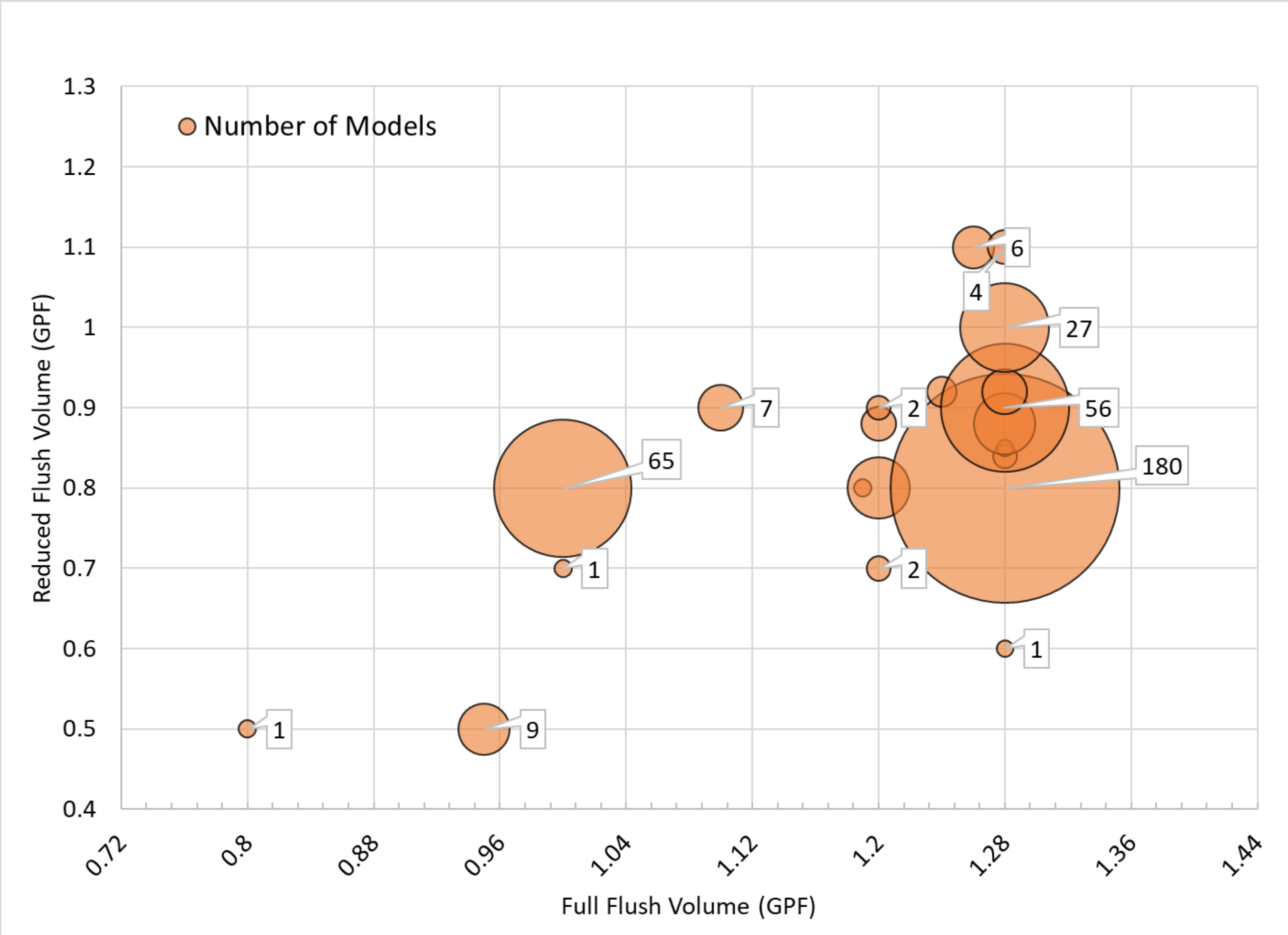
## Alternative 1: Maintaining Current Title 20 Standards

Title 20 currently requires single-flush water closets to have a maximum flush volume of 1.28 gpf and for dual-flush water closets to have a maximum effective flush volume of 1.28 gpf. CEC staff believes there is an opportunity to save significant water and energy given the availability of water closets in the market that perform satisfactorily at lower flush volumes. Staff additionally believes that doing nothing to pursue feasible and cost-effective savings would be contrary to established legislation and executive policy. For these reasons, staff believes the Title 20 water efficiency standards for water closets should be updated to achieve California's climate and energy efficiency goals.

## Alternative 2: Efficiency Standards for Dual-Flush Water Closets Only

Alternative 2 would remove the effective flush volume approach and put in a place a maximum full flush standard of 1.28 gpf and a maximum reduced flush volume of 0.8 gpf for dual-flush water closets while maintaining the existing standard for single-flush water closets. **Figure 5-1** demonstrates that the market offers several models of dual-flush water closets with a reduced flush volume of 0.8 gpf or below with a full flush volume of 1.28 gpf, indicating the technical feasibility of this alternative. This alternative, however, misses the opportunity to save significant water and energy by not updating the standards for single-flush toilets.

**Figure 5-1: Dual-Flush Toilets With a Full Flush Volume Below 1.28 Gpf**




Source: U.S EPA WaterSense

## Alternative 3: Moderate Efficiency Standards for Single-Flush and Dual-Flush Water Closets (Staff Proposal)

Alternative 3 would establish moderately stringent standards for dual-flush water closets as recommended by Alternative 2 and would update water efficiency standards for single-flush water closets. Specifically, this alternative recommends the following:

- Update the water efficiency standard from 1.28 gpf to 1.1 gpf for single-flush water closets.
- Update the effective flush volume of 1.28 gpf to a full flush volume of 1.28 gpf and a reduced flush volume of 0.8 gpf for dual-flush water closets.

This alternative is cost-effective, is technically feasible, and achieves a significant amount of water and energy savings.

## Alternative 4: Stringent Efficiency Standards for Single-Flush and Dual-Flush Water Closets

Staff considered another alternative of matching the maximum rated flush volume of single-flush water closets to the reduced flush volume of dual-flush water closets. This alternative is similar to Alternative 3 but is more stringent for single-flush water closets. Specifically, this alternative recommends the following:

- Update the water efficiency standard from 1.28 gpf to 0.8 gpf for single-flush water closets.
- Update the effective flush volume of 1.28 to a full flush volume of 1.28 gpf and a reduced flush volume of 0.8 gpf for dual-flush water closets.

This proposal presents a significant opportunity for water savings and energy savings. Although this alternative is attainable, staff believes this alternative would reduce consumer product availability of single-flush water closets that are more water-efficient than dual-flush water closets. For these reasons, staff believes this alternative is not a viable proposal at this time.

# CHAPTER 6: Staff Proposal

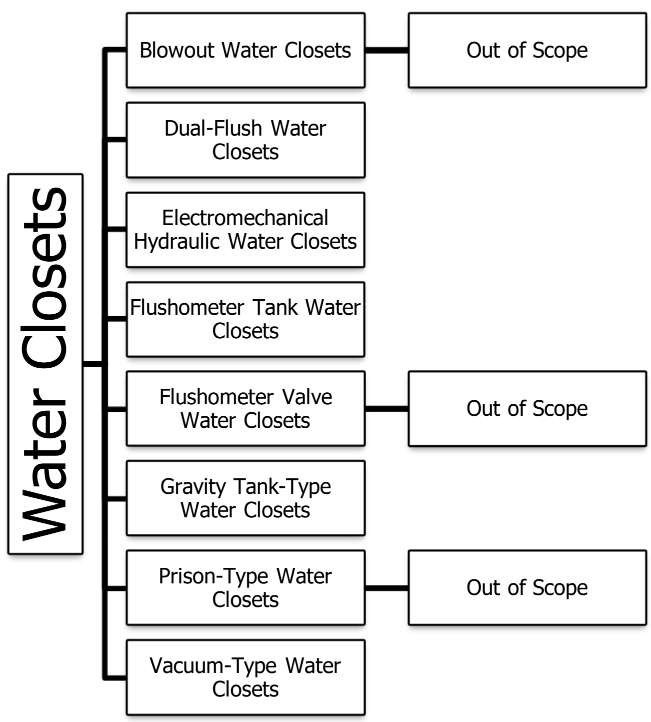
CEC staff analyzed the cost-effectiveness and technical feasibility of Alternative 3. Based on this information, staff proposes to update the efficiency standards for water closets manufactured on or after December 1, 2026, except for blowout water closets, flushometer valve water closets, and prison-type water closets. Staff also proposes other changes to the regulations related to water closets that are necessary to update the efficiency standards for water closets.

Based on independent analysis of the best available data, staff concludes that the proposed regulations are cost-effective, are technically feasible and will save a significant amount of water and energy statewide. Staff assumptions and calculation methods are provided in **Appendix A**.

## Scope

There are no proposed additions or exclusions to the existing scope of water closets set forth in the California Code of Regulations (CCR), Title 20, Section 1601. The proposed efficiency standard updates would apply to residential type water closets, except for blowout water closets, flushometer valve water closets, and prison-type water closets, which are considered commercial water closets (**Figure 6-1**).

**Figure 6-1: Scope of Water Closets Efficiency Standard Update**




Source: CEC

## Definitions

Staff is recommending changes to some definitions related to the scope of water closets to either further clarify or maintain consistency with the terminology used throughout California CCR, Title 20, Section 1601 through Section 1607.

The term "blowout toilet" will be replaced with "blowout water closet." This proposed change aligns with the existing terminology used in Title 20, Section 1606, Table X. The change is minor and does not affect the meaning of the term or definition.

The term "electromechanical hydraulic water closet" will be replaced with "power-assisted water closet." The definition will be modified to include the phrase "also known as electromechanical hydraulic water closet." Power-assisted water closets is the consumer-facing term for electromechanical hydraulic water closets; therefore, this proposed change adds another known name to this type of water closet. This change does not affect the meaning of the term or definition.

The definition for "flushometer tank" was modified to align with the definition of "flushometer tank" set forth in Code of Federal Regulations (CFR), Title 10, Subpart 430.2 — Definitions. This change does not affect the meaning of the term or definition but further clarifies the difference between a flushometer tank and a flushometer valve. Furthermore, the change avoids the misinterpretation that a flushometer tank water closet is equivalent to a flushometer valve water closet.

The term "flushometer tank water closet" will be replaced with "pressure-assisted water closet." The definition will be modified to include the phrase "also known as a flushometer tank water closet." Pressure-assisted water closets is the consumer-facing term for flushometer tank water closets; therefore, this proposed change adds another known name to this type of water closet. This change does not affect the meaning of the term or definition.

Staff proposes to add a definition for flushometer valve water closets. This term is an existing term in Table X, Section 1606, and is not currently defined. The definition helps distinguish between the terms flushometer tank water closets and flushometer valve water closets, as noted earlier. This addition is also necessary to maintain consistency with the existing regulatory language structure.

The term "vacuum-type water closet" will be replaced with "vacuum-assisted water closet." Vacuum-assisted water closets is the consumer-facing term for vacuum-type water closets; therefore, this proposed change adds another known name to this type of water closet. This change does not affect the meaning of the term or definition.

The definition for "water closet" will be modified to align closely with the definitions of "water closet" in CFR, Title 10, Subpart 430.2 — Definitions and in ASME 112.19.2/CSA B45.1 Version 2018. This change does not affect the meaning of the term or definition.

## Test Procedure

The existing test method for water closets is 10 CFR Section 430.23(u) — Appendix T to Subpart B of Part 430, which references Sections 7.1.1 (including Table 5), 7.1.2, 7.1.3, 7.1.4, and 7.1.5 of ASME A112.19.2/CSA B45.1 Version 2018. Existing performance requirements include only the waste extraction test, Section 7.10 of ASME A112.19.2/CSA B45.1 Version 2013.

Staff proposes to update the waste extraction test for water closets from the 2013 version to the 2018 version of ASME A112.19.2/CSA B45.1 (Section 7.9) to align with the latest version of the test method for water closets. This change does not affect the purpose of this test nor the outcome of the performance. See **Chapter 4** for details on the differences between the 2013 and the 2018 versions of the waste extraction test.

Staff is also proposing to include performance requirements in addition to the waste extraction test — more specifically, Section 7.5 *Granule and ball test*, Section 7.6 *Surface wash test*, Section 7.7 *Drain line transport characterization test*, 7.8 *Overflow test*, and Section 7.12 and 7.13 *Adjustability tests* of ASME A112.19.2/CSA B45.1-2018. See **Chapter 4** for details on each type of test. Each section would apply to all water closets, except Sections 7.8, 7.12, and 7.13 are not applicable to flushometer valve-type water closets (that is, blowout water closets, prison-type water closets, and flushometer valve water closets — see **Figure 6-1**). These performance requirements align with the specifications for tank-type toilets and flushometer valve-type water closets by U.S. EPA WaterSense. See **Table 6-1** for comparison.

**Table 6-1: U.S EPA WaterSense Performance Requirements for Tank-Type Toilets and Flushometer-Valve Water Closets**

| Performance Requirements<br>ASME A112.19.2 ASME A112.19.2/CSA B45.1 Version 2018 | WaterSense Specification for Tank-Type Toilets[120] | WaterSense Specification for Flushometer-Valve Water Closets[121] |
|---|---|---|
| Section 7.5 – Granule and Ball test | Yes | Yes |
| Section 7.6 – Surface Wash Test | Yes | Yes |
| Section 7.7 – Drain Line Transport Characterization Test | Yes | Yes |
| Section 7.8 – Overflow Test | Yes | Not Applicable |
| Section 7.9 – Waste Extraction Test | Yes | Yes |
| Section 7.12 – Adjustability Test for Tank-Type Gravity Water Closets with Original Equipment | Yes | Not Applicable |
| Section 7.13 – Adjustability Test for Tank-Type Gravity Water Closets with Aftermarket Closure Seals | Yes | Not Applicable |

Source: U.S. EPA WaterSense

## Efficiency Standard

The proposed update to the flush volume standard will be applied to all water closets, except blowout water closets, flushometer valve water closets, and prison-type water closets manufactured on or after December 1, 2026. Dual-flush water closets shall meet a maximum flush volume of 0.8 gpf for the reduced flush and 1.28 gpf for the full flush. Single-flush water

120 United States Environmental Protection Agency. 2022. *WaterSense Performance Overview: Tank-Type Toilets*. Washington, D.C.: United States Environmental Protection Agency. https://www.epa.gov/system/files/documents/2022-05/ws-products-perfomance-toilets.pdf.

121 United States Environmental Protection Agency. 2022. *WaterSense Performance Overview: Flushometer-Valve Water Closets*. Washington, D.C.: United States Environmental Protection Agency. https://www.epa.gov/system/files/documents/2022-05/ws-products-perfomance-commercial-toilets.pdf.

closets, except blowout and flushometer valve water closets, shall meet a maximum flush of 1.1 gpf. Blowout and flushometer valve water closets shall meet the current standard of 1.28 gpf. These updates are summarized in **Table 6-2**; updates are marked with underlining.

**Table 6-2: Proposed Water Efficiency Standards for Water Closets**

| **Appliance** | **Maximum Flush Volume (gallons per flush)** |
|---|---|
| Dual-Flush Water Closets | <u>Reduced Flush = 0.8 gpf</u><br><u>Full Flush = 1.28 gpf</u> |
| Blowout Water Closets and Flushometer Valve Water Closets | 1.28 gpf |
| All other water closets | <u>1.1 gpf</u> |

Source: CEC

## Marking Requirements

There are no proposed changes to the marking requirements for water closets set forth in the CCR, Title 20, Section 1607.

## Test Lab Report Requirements

Test lab reports are not required to be submitted with each appliance certification but can be requested at any time per CCR, Title 20, Section 1608(c). Staff has determined this recommendation is the best approach to verify compliance and is already practiced by the industry.

Staff proposes that test lab reports include the reporting requirements from CCR, Title 20, Section 1606 Table X and the reporting requirements specified in each section of *Section 7.5 Granule and ball test*, *Section 7.6 Surface wash test*, *Section 7.7 Drain line transport characterization test*, *Section 7.8 Overflow test (for gravity tank-type water closets only)*, *Section 7.9 Waste extraction test*, and *Section 7.12 or 7.13 Adjustability tests (for gravity tank-type water closets only)* of ASME A112.19.2/CSA B45.1-2018.

## Reporting Requirements

Reporting requirements are used to verify compliance through product determination and validation of efficiency standards. Reporting requirements also provide the ability to monitor the market. For state-regulated and federally regulated appliances to be sold or offered for sale in California, each manufacturer must certify each appliance.[122] Manufacturers certify to the CEC through the Modernized Appliance Efficiency Database System (MAEDbS).

122 CCR, Title 20, Section 1606(a).

Manufacturers must report specific criteria as specified in the California Code of Regulations, Title 20, Section 1601, Table X.

Staff is proposing several changes to the reporting requirements for water closets to reinforce that appliances must be sold as they were tested as required under CCR, Title 20, Section 1608(a)(3),[123] to distinguish one-piece and two-piece models and improve the categorization of water closets. These changes are summarized in **Table 6-3**.

**Table 6-3: Proposed Changes to the Reporting Requirements**

| Additions | Removed | Replacements |
|---|---|---|
| Water closet type (one-piece, two-piece) | Water Consumption (dual-flush effective volume for dual-flush water closet) | Electromechanical hydraulic water closet to power-assisted water closet |
| Flush type (single, dual) | Waste extraction value (grams) | Flushometer tank water closet to pressure-assisted water closet |
| Tank model number (two-piece water closets only)[124] | Passes waste extraction test (True, False) | Vacuum-type water closet to vacuum-assisted water closet |
| Bowl model number (two-piece water closets only) | | |
| Dual-flush effective flush volume | | |
| Reduced flush volume (for dual-flush water closets only) | | |
| Full flush volume (for all water closets) | | |
| Urinal flush volume | | |

Source: CEC

According to the waste extraction test, the soybean paste cylinders must have a combined mass of 350 grams (±10). Since the value is limited to a range of ±10 grams for this waste extraction test, the benefit of collecting this value is not effective in monitoring the flush performance.

The current reporting requirement for water consumption is used to collect the maximum flush volume for single-flush toilets, the effective flush for dual-flush toilets, and the flush volume

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123 Any unit of any appliance within the scope of Section 1601 of this article may be sold or offered for sale in California only if the unit has the same components, design characteristics, and all other features that affect energy or water consumption or energy or water efficiency, as applicable, as the units that were tested under Sections 1603 and 1604 of this article and for which information was submitted under Section 1606(a) of this article.

124 Includes tanks sold as in-wall tanks or concealed tanks.

for urinals. Separating the flush volumes for each type is recommended to improve the data collected for plumbing fixtures.

The terms *vacuum-assisted, pressure-assisted,* and *power-assisted* align with terms used by online retailers and manufacturers to categorize toilets. In addition, the U.S. EPA WaterSense database and MaP Test Protocol database use these terms to categorize toilets. Therefore, it is recommended to align with these categorical terms to ensure consistency with industry and other regulatory approaches and use terms with which the public is familiar with.

# CHAPTER 7: Technical Feasibility

The proposed standards for water closets are technically feasible based on the information available U.S. EPA WaterSense, U.S. DOE, industry, California IOUs, industry, trade associations, and information received in the docket for this pre-rulemaking.

## Market Availability

CEC staff used U.S EPA's WaterSense database[125] and California's Modern Appliance Efficiency Database System (MAEDbS)[126] to assess the California market for water closets. The data were collected as of August 2022.

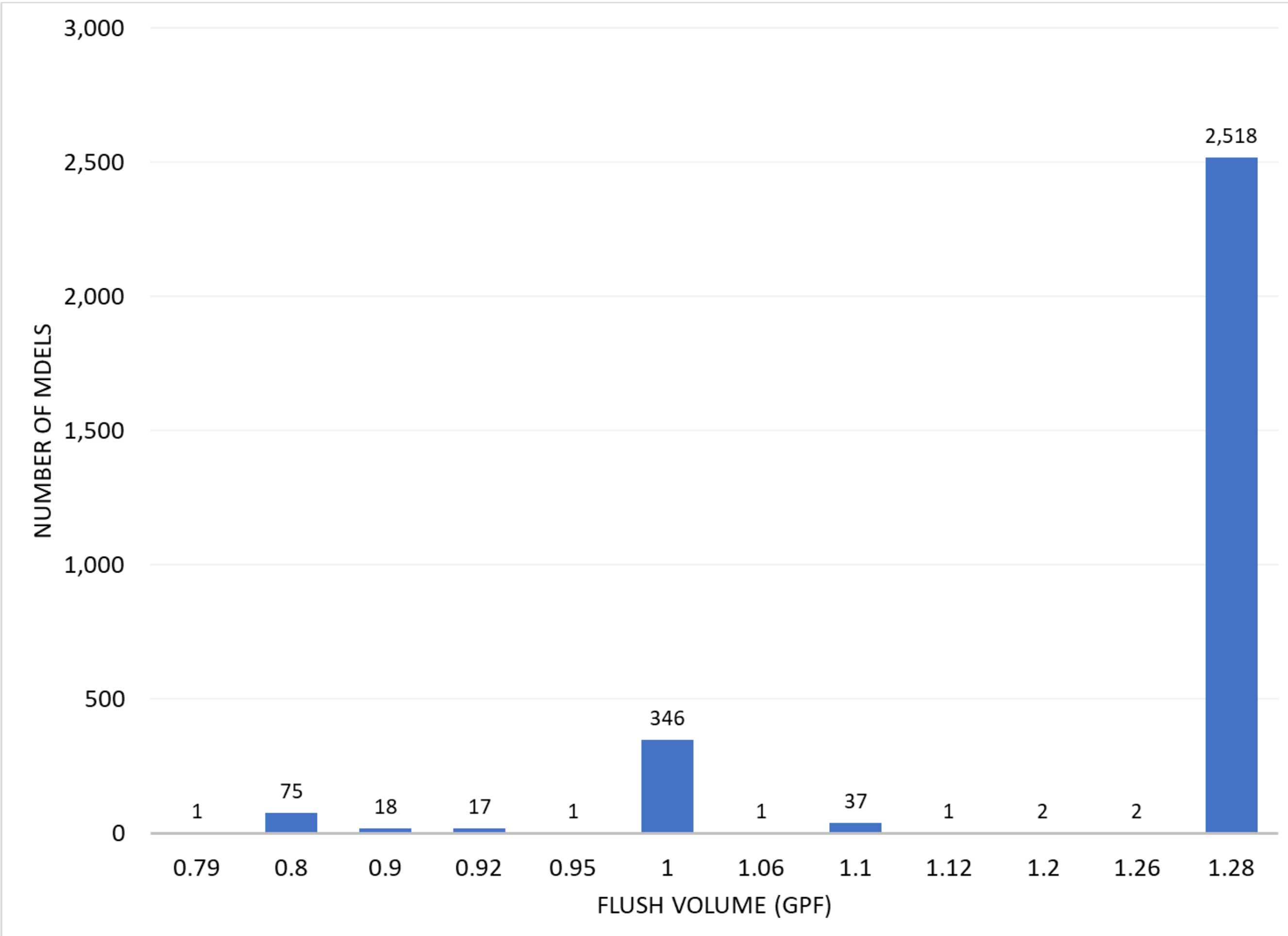
### Single-Flush Toilets

The U.S EPA WaterSense database lists more than 3,000 single-flush toilets, and MAEDbS lists more than 2,300 single-flush toilets. **Figure 7-1** illustrates the number of WaterSense-labeled single-flush toilets categorized by flush volume. **Figure 7-2** illustrates the number of single-flush toilets certified to MAEDbS by flush volume. Both graphs demonstrate that most single-flush toilets have a flush volume of 1.28 gpf. The second highest of number of single-flush toilets have a flush volume of 1 gpf.

125 United States Environmental Protection Agency. 2023. "WaterSense - Product Search." https://lookforwatersense.epa.gov/Product-Search-Results-Toilets.html.

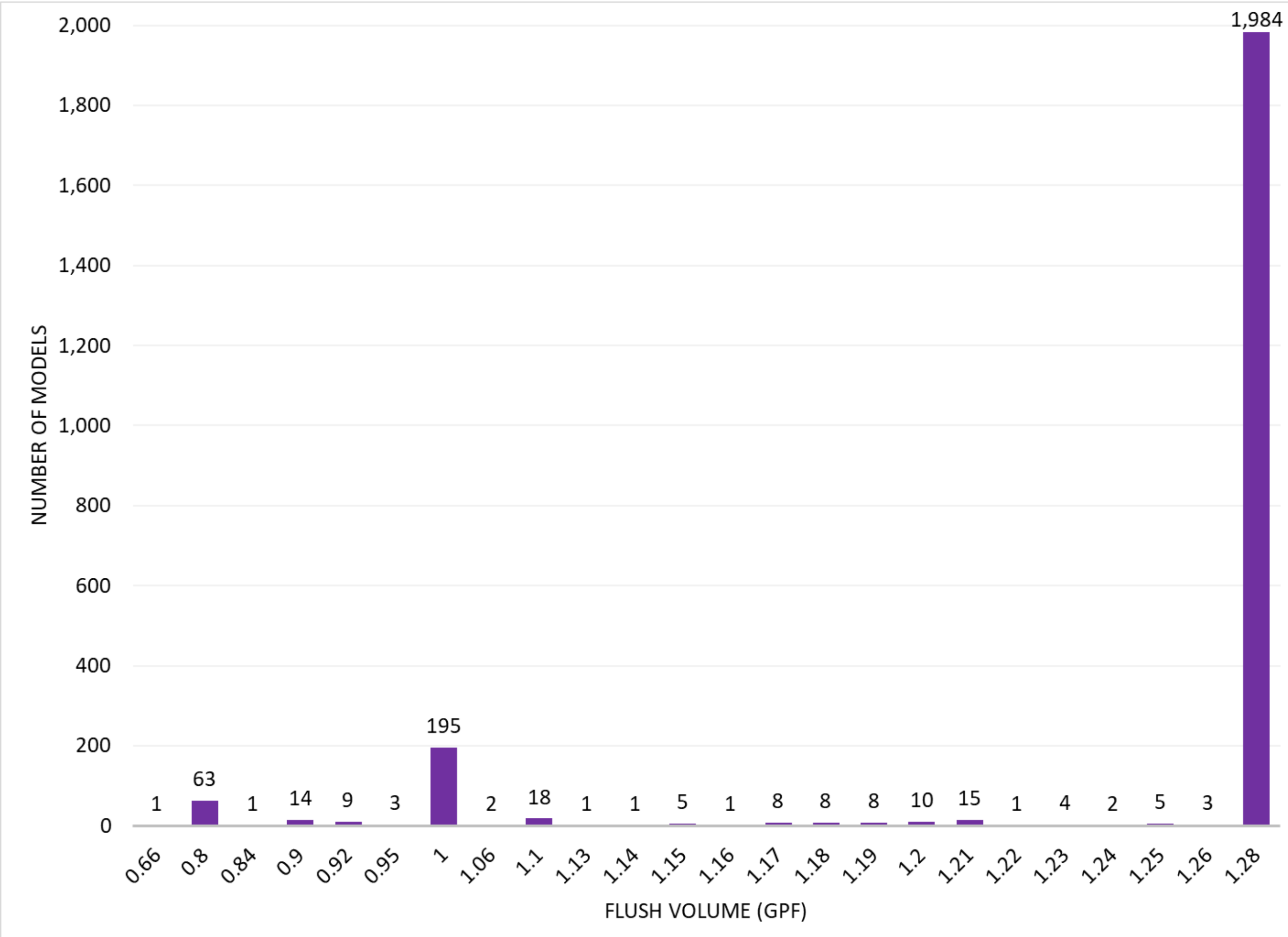
126 California Energy Commission. 2023. "Modernized Appliance Efficiency Database System." https://cacertappliances.energy.ca.gov/Login.aspx.

**Figure 7-1: Bar Graph of Single-Flush Toilets by Flush Volume Certified to U.S. EPA WaterSense**




Source: U.S. EPA WaterSense

**Figure 7-2: Bar Graph of Single-Flush Toilets by Flush Volume Certified to California's MAEDbS**




Source: California's MAEDbS

**Table 7-1** summarizes the compliance rates illustrated in **Figures 7-1** and **7-2**, demonstrating the proposed efficiency standard is technical feasible.

**Table 7-1: Summary of Compliance Rates for Single-Flush Toilets**

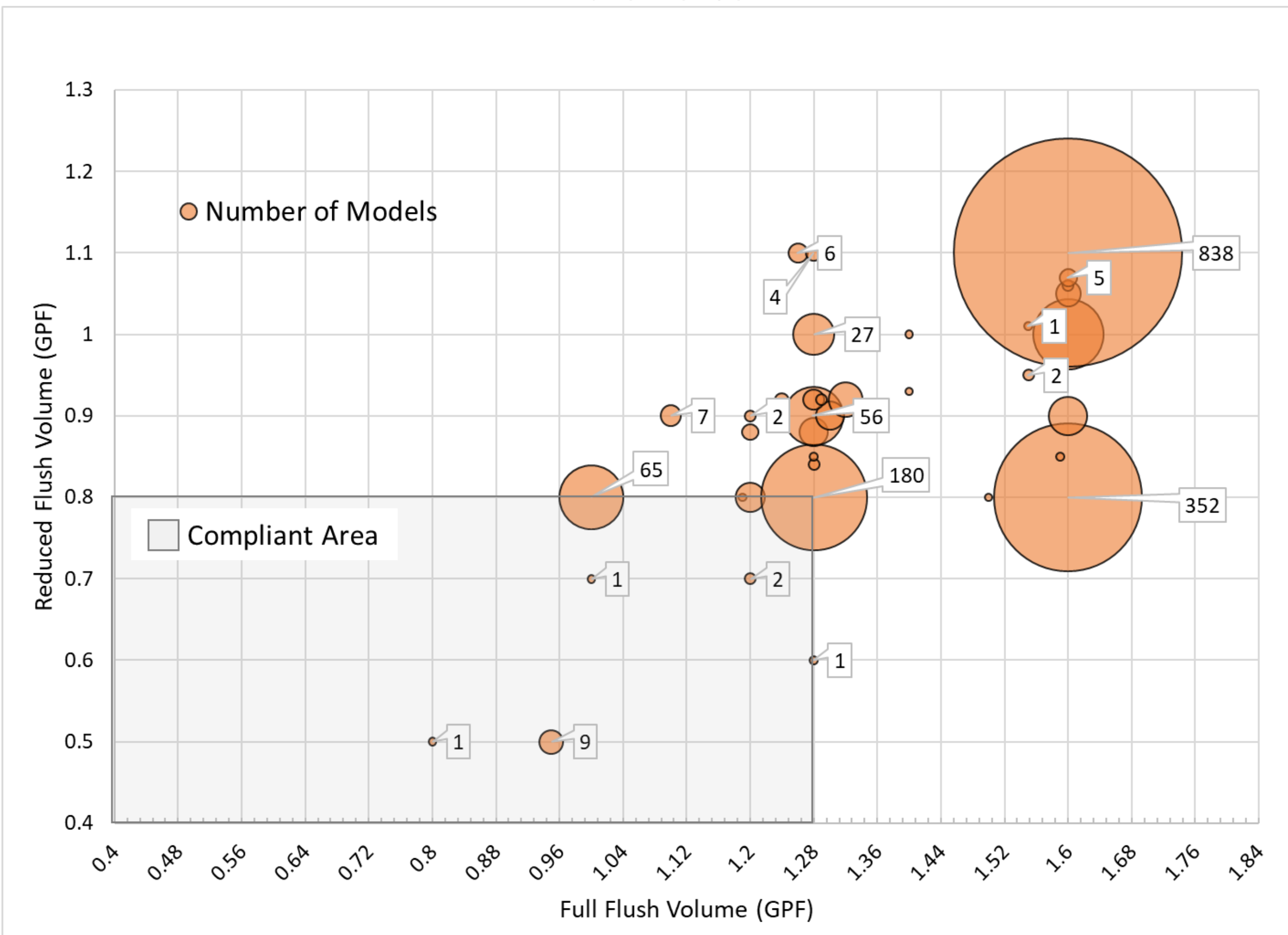
| Compliancy With Proposal (Flush Volume ≤ 1.1 gpf) | U.S. EPA WaterSense Models | California's MAEDbS Models | Average |
|---|---|---|---|
| Compliant | 16.4% | 13.0% | 14.7% |
| Non-compliant | 83.6% | 87.0% | 85.3% |

Source: U.S EPA WaterSense, California's MAEDbS

## Dual-Flush Toilets

The U.S EPA WaterSense database lists more than 1,700 dual-flush toilets, and MAEDbS lists more than 1,500 dual-flush toilets. **Figure 7-3** illustrates the number of WaterSense-labeled single-flush toilets categorized by flush volume with the full flush volume on the x-axis and the corresponding reduced flush volume on the y-axis. Each bubble represents the number of models that have the same full- and reduced-flush volume. Most dual-flush toilets have a full-flush volume of 1.6 gpf with a reduced-flush volume of 0.8 gpf or 1.1 gpf. Following this pattern, the second-highest number of dual-flush toilets is dual-flush toilets with a full-flush volume of 1.28 gpf with a reduced-flush volume of 0.8 gpf or 0.9 gpf. The shaded area demonstrates the number of models that would meet the proposed efficiency standard for dual-flush toilets — a full-flush volume of 1.28 gpf and a reduced-flush volume of 0.8 gpf. The complete dataset illustrated in this graph is available in **Appendix C**.

**Figure 7-3: Chart of Dual-Flush Toilets by Flush Volume Certified to U.S. EPA WaterSense**




Source: U.S. EPA WaterSense

**Table 7-2** summarizes the compliance rates illustrated in **Figure 7-3**, demonstrating the proposed efficiency standard is technical feasible.

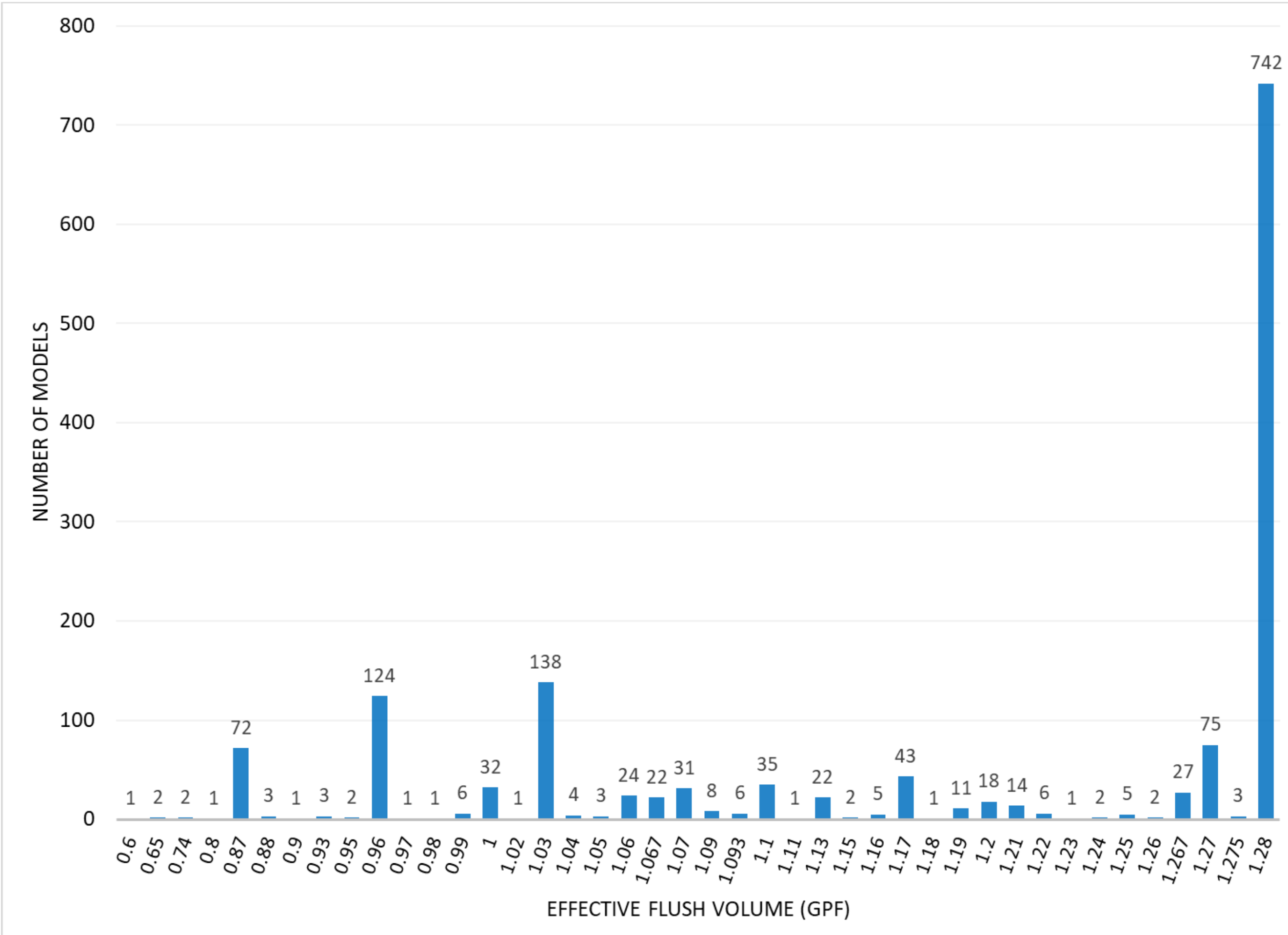
**Table 7-2: Compliance Rates of Dual-Flush Models Certified to U.S. EPA WaterSense**

| Flush Volume (gpf) Reduced/Full | Percentage of Models | Compliancy With Proposal (Reduced ≤ 0.8 gpf, Full ≤ 1.28 gpf) |
|---|---|---|
| 0.8/1.28 | 15.5% | Compliant |
| 0.9/1.28 | 4.8% | Non-Compliant |
| (>0.9)/1.28 | 2.7% | Non-Compliant |
| (Any)/(>1.28) | 77.0% | Non-Compliant |

Source: U.S. EPA WaterSense

**Figure 7-4** illustrates the number of dual-flush toilets certified to MAEDbS by effective flush volume. Most dual-flush toilets have an effective flush volume of 1.28 gpf, which is equivalent to a full-flush volume of 1.6 gpf and a reduced-flush volume of 1.1 gpf. The next highest number of dual-flush toilets are those with an effective flush volume of 1.03 gpf, which is roughly equivalent to a full-flush volume of 1.28 gpf and a reduced-flush volume of 0.9 gpf. These are followed by dual-flush toilets with an effective flush volume of 0.96 gpf, which is nearly equivalent to a full-flush volume of 1.28 gpf and reduced-flush volume of 0.8 gpf.

**Figure 7-4: Bar Graph of Dual-Flush Toilets by Flush Volume Certified to California's MAEDbS**




Source: California's MAEDbS

**Table 7-3** summarizes the compliance rates illustrated in **Figure 7-4**, demonstrating the proposed efficiency standard is technical feasible.

**Table 7-3: Compliance Rates of Dual-Flush Models Certified to California's MAEDbS**

| Effective Flush Volume Range (gpf) | Equivalent Separate Flush Volume (gpf) Reduced/Full | Percentage of Models | Compliancy With Proposal (Reduced ≤ 0.8 gpf, Full ≤ 1.28 gpf) |
|---|---|---|---|
| 0.6 to 0.96 | (0.5/0.8) to (0.8/1.28) | 14% | Compliant |
| 0.97 to 1.03 | (0.9/1.1) to (0.9/1.28) | 11.9% | Non-Compliant |
| >1.03 to ≤1.28 | (0.92/1.28) to (1.1/1.6) | 74.1 % | Non-Compliant |

Source: California's MAEDbS

## Performance Overview

**Table 7-4** summarizes regulatory approaches that require water closets to meet minimum performance requirements of ASME A112.19.2/CSA B45.1 that can attest to the cleanability, transportation of waste through a drainage system, and complete evacuation of solid waste in water closets, indicating the proposal for California is attainable. Each type of test is discussed in **Chapter 4**.

Although California's Appliance Efficiency Regulations mandate only the waste extraction test from ASME A112.19.2/CSA B45.1, it is presumable manufacturers complete all other performance criteria in ASME A112.19.2/CSA B45.1 to ensure their products can be registered to U.S. EPA WaterSense, receive a MaP score, can be installed in California residential and commercial applications, or market their products as ASME-certified.

**Table 7-4: Summary of Regulatory and Voluntary Performance Criteria for Water Closets**

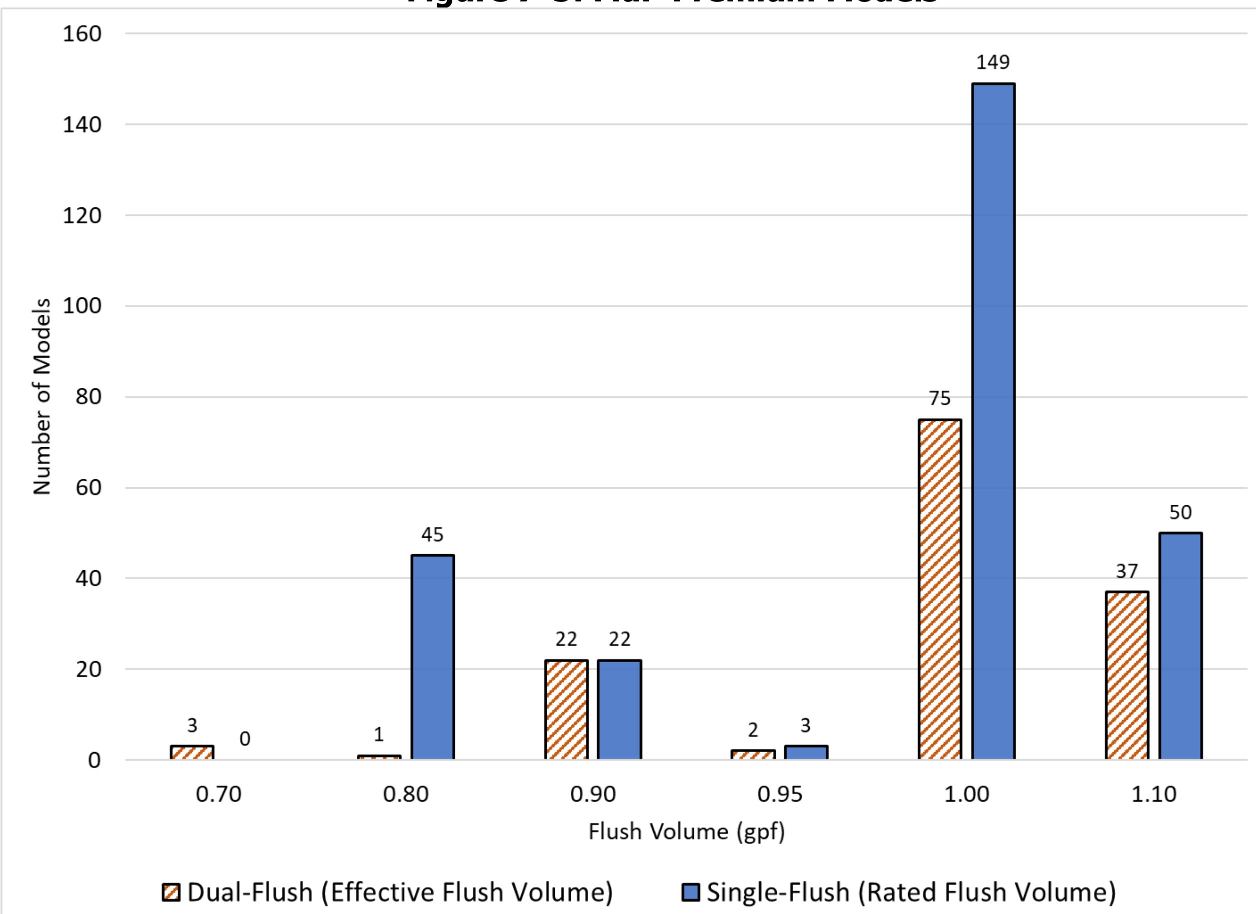
| ASME A112.19.2/CSA B45.1 Performance Criteria | Federal Regulations | California's Title 20 Appliance Efficiency Regulations | U.S. EPA WaterSense | MaP Test Protocol (By Reference) | CALGreen & California Plumbing Code (By Reference) |
|---|---|---|---|---|---|
| Water Consumption Test | Yes | Yes | Yes | Yes | Yes |
| Granule and Ball Test | No | No | Yes | Yes | Yes |
| Surface Wash Test | No | No | Yes | Yes | Yes |
| Drain Line Transport Characterization Test | No | No | Yes | Yes | Yes |
| Overflow Test | No | No | Yes | Yes | Yes |
| Waste Extraction Test | No | Yes | Yes | Yes | Yes |
| Adjustability Test | No | No | Yes | Yes | Yes |

Source: CEC staff

The test media in waste extraction test procedure referenced in ASME A112.19.2/CSA B45.1 Version 2018 consists of seven (case or uncased) soybean paste cylinders for a combined mass of 350 grams and four loosely crumpled balls of six squares of single-ply toilet paper.

The MaP premium test protocol requires a minimum 600 grams of soybean paste cylinders (cased and uncased) and four loosely crumpled balls of toilet paper. Only tank-type toilets that are certified to U.S. EPA WaterSense specification are eligible for this test at a specifically rated flush volume. Single-flush toilets must have a flush volume no greater than 1.1 gpf. And dual-flush toilets must have a maximum full flush volume no greater than 1.28 gpf with an effective flush (average of one full flush and one reduced flush) of 1.1 gpf. **Figure 7-5** demonstrates the 409 MaP premium models listed in MaP database, both single-flush toilets (269 models) and dual-flush toilets (140 models) by flush volume, that exceed the minimum waste extraction test in ASME A112.19.2/CSA B45.1 Version 2018.[127]

**Figure 7-5: MaP Premium Models**




Source: MaP Database

As water closets and other indoor water appliances become more water-efficient, questions arise whether existing pipe systems — such as the pipe diameter, length to the sewer line, slope — can successfully carry solid waste without clogging as water flow decreases, especially for residential-type toilets that may be in used light commercial settings. The industry standard

127 Dual-flush models with an effective flush volume (1:1 ratio) of 1.1 gpf, equates to a full flush volume of 1.28 gpf and a reduced flush volume of 0.9 gpf. These flush volumes would be considered non-compliant as they relate to the water efficiency standards being proposed in this report.

ASME A112.19.2/CSA B45.1 provides minimum performance requirements to test the transportation of solid waste through a drain line for water closets, indicating existing standards and the proposed standards meet minimum drain line requirements.[128]

Staff is aware of two major studies that examine the transportation of solid waste through a drain line system in commercial settings for water closets below 1.28 gpf. Commercial systems are of particular concern because they have long horizontal runs to the sewer line, typically over 60 feet in length. Both studies were conducted by the Plumbing Efficiency Research Coalition (PERC) — a group consisting of members from the Alliance for Water Efficiency (AWE), the International Association of Plumbing and Mechanical Officials (IAPMO), the International Code Council (ICC), the Plumbing-Heating-Cooling Contractors — National Association (PHCC), the Plumbing Manufacturers International (PMI), and the American Society of Plumbing Engineers (ASPE).

The first PERC study was published in November 2012.[129] The scope of the test plan examined three flush rates at 0.8 gpf, 1.28 gpf, or 1.6 gpf. Replicating flush rates consistent with "slow acting" toilets (such gravity-fed toilets that use standard 2-inch diameter flapper type flush valves), and "fast discharge" toilets (such as gravity-fed toilets employing 3-inch diameter flapper-type flush valves or pressure-assisted and flushometer-valve toilets) using a surge injector. The test apparatus was constructed of 4-inch diameter clear polyvinyl chloride (PVC) pipe, with a total length of 135 feet with two wide-sweep, 90-degree bends and was set for 1 percent slope test runs and 2 percent slope test runs. The test media consisted of cylinders of uncased soybean paste each weighing 50 grams each with loadings varying randomly and evenly between 300 grams, 200 grams, 100 grams, and 0 grams. And single-ply low tensile strength paper used eight balls of six sheets each, for a total of 48 sheets. The test procedure consisted of 40 test runs, each run consisting of 100 flushes from the surge injector.

The test results concluded that at flush volumes of 1.6 gpf and 1.28 gpf performed effectively at transporting solid waste and should pose no issues with drain line systems in new construction commercial applications. In retrofit commercial applications, defects in existing drain line systems should be identified and fixed to prevent clogging. Otherwise, there should also be no problems with solid waste transportation in existing commercial settings. Results at 0.8 gpf flush volumes may be "problematic in commercial installations that have long horizontal drains and little or no additional long-duration flows available to assist the toilet in providing drain line transport of solids."[130] Therefore, additional testing is recommended at 0.8 gpf.

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128 United States Environmental Protection Agency. 2000. *Wastewater Technology Fact Sheet: High-Efficiency Toilets*. Washington, D.C.: United States Environmental Protection Agency. https://www3.epa.gov/npdes/pubs/hi-eff_toilet.pdf.

129 Plumbing Efficiency Research Coalition. 2012. *The Drainline Transport of Solid Waste in Buildings*. https://www.plumbingefficiencyresearchcoalition.org/wp-content/uploads/2012/12/Drainline-Transport-Study-PhaseOne.pdf.

130 The test runs at 0.8 gpf created temporary plugs that resulted in chaotic and unpredictable data that were not useable in the statistical analysis.

The second PERC study was released in September 2015 and revised in March 2016.[131] The scope of this test plan is similar to the first study — examining commercial drain line systems under certain conditions for water closets at various flush volumes with little to no supplemental water flows. New conditions under this study examined two pipe diameter sizes versus just one: 4 inches (the variable in the first study) and 3 inches. Also, a flush volume of 1.0 gpf was examined in addition to 1.6 gpf, 1.28 gpf, 0.8 gpf to determine where between the 1.28 gpf and 0.8 gpf range does the drain line transport performance begins to decline based on the results of the previous study. The test apparatus, test media, and test runs were performed similarly to the first study.

The test results indicated that water closets with a flush volume of 1.0 gpf or less is not recommended in commercial applications that have long horizontal drains and that do not provide additional long-duration flows from other sources to assist with the drain line transport of solid waste. The results for 1.6 gpf, 1.28 gpf, and 0.8 gpf were similar to the first PERC study. The study notes that the recommendation is made for commercial applications under the conditions specified in this study and not residential applications. Furthermore, residential water closets with flush volumes less than or equal to 0.8 gpf are widely available in the market, and there have been no confirmed reports of clogging issues.

Both studies conclude that a high-tensile-strength toilet paper is more likely to cause poor drain line transport performance and clog in horizontal drains at all flush volumes with every variable.

The U.S EPA WaterSense also conducted a study to evaluate the transport of solid waste through a drain line system at flush volumes of 1.0 gpf (pressure-assist toilet), 1.2 gpf (gravity washdown), and 1.28 gpf (gravity siphonic) for residential applications for a total of 60 runs.[132] The drain line is shorter in residential applications versus commercial applications. The test conditions were a 4-inch diameter drain line at a 1 percent slope with a length of 13 feet, conditions more stringent than most building and plumbing codes (3-imch diameter drain line at a 2 percent slope) without supplemental flows. The test media consisted of a total of 350 grams of soybean paste cylinders and 4 crumpled balls of toilet paper. Each toilet tested met or exceeded at carrying solid waste through a drain line with a length of 13 ft.

Based on these studies, staff concludes the recommended proposal is technically feasible. The proposed flush volumes will transport solid waste effectively in residential applications and commercial applications. In particularly challenging commercial applications with long horizontal drains, users can minimize the chances of clogging by selecting dual-flush toilets,

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131 Plumbing Efficiency Research Coalition. 2016. *The Drainline Transport of Solid Waste in Buildings – Phase 2.0; Includes Supplemental Report on PERC Phase 2.1 - Revised – March 2016*. Plumbing Efficiency Research Coalition. https://www.plumbingefficiencyresearchcoalition.org/wp-content/uploads/2016/04/PERC-2-0_2-1-FINAL.pdf.

132 United States Environmental Protection Agency. 2006. *Response to Issues Raised During Public Comment on April 2006 Draft Specifications for WaterSense Labeling of Tank-Type High-Efficiency Toilets*. Washington, D.C.: United States Environmental Protection Agency. https://www.epa.gov/sites/production/files/2017-02/documents/ws-background-toilets-comment-response.pdf.

using low tensile strength toilet paper, and/or by periodically providing supplemental flow through the drain line. There is no concern for dual-flush toilets that have a reduced flush volume of 0.8 gpf since the reduced flush is dedicated for liquid waste only.

# CHAPTER 8: Savings and Cost Analysis

The proposed updated standards for the specified water closets in this proposal would significantly reduce water and energy consumption, are cost-effective, and are technically feasible. **Tables 8-3** summarize the potential water and embedded energy savings of the proposed standards for water closets. The embedded electricity savings is the electricity saved from the reduction in water pumping, water treatment, and water delivery. The water savings include the water saved from improving a noncompliant product to a compliant product. Savings are further separated into first-year savings and full stock turnover savings. First-year savings mean the annual energy reduction associated with annual sales one year after the standards take effect. Annual stock turnover savings mean the annual energy reduction achieved after all existing stock in use complies with the proposed standards. **Appendix A** provides staff's calculations and assumptions used to estimate the first-year savings and the full stock turnover savings.

## Incremental Costs

Incremental costs are additional costs the manufacturer imparts on the consumer for modifying a noncompliant product into a compliant product. Water closets have a wide range of prices based on the respective brand, design, dimensions, accessibility, application, style, material, and ancillary components. The price can range from less than a hundred dollars to thousands of dollars. The average cost to replace or install a water closet ranges from $185 to $533.[133]

**Table 8-1** lists the estimated incremental costs for the proposed water efficiency standard. Staff derived these estimates by collecting data from online retailers and manufacturer websites as of July 2023. Toilets with a price greater than $500 were excluded from this analysis to avoid skewed data and remove luxury products. **Appendix C** contains tables of the original dataset that includes prices greater than $500 and the final dataset used to estimate the incremental cost in **Table 8-1**. The average cost or retail price of non-compliant units is the average price of units that meet the current standard for water closets. The average price of complaint units is the average price of units that meet the proposed standards for water closets. **Figures 8-1** and **8-2** illustrates the range of prices of toilets in the market today and the resulting average price for dual-flush and single-flush toilets, respectively.

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133 The Home Depot. 2023. "Toilet Installation Cost Guide." https://www.homedepot.com/services/c/cost-install-toilet/55af3b94a; Angi. 2023. "How Much Does Toilet Installation Cost? [2023 Data]." https://www.angi.com/articles/how-much-does-toilet-installation-cost.htm.

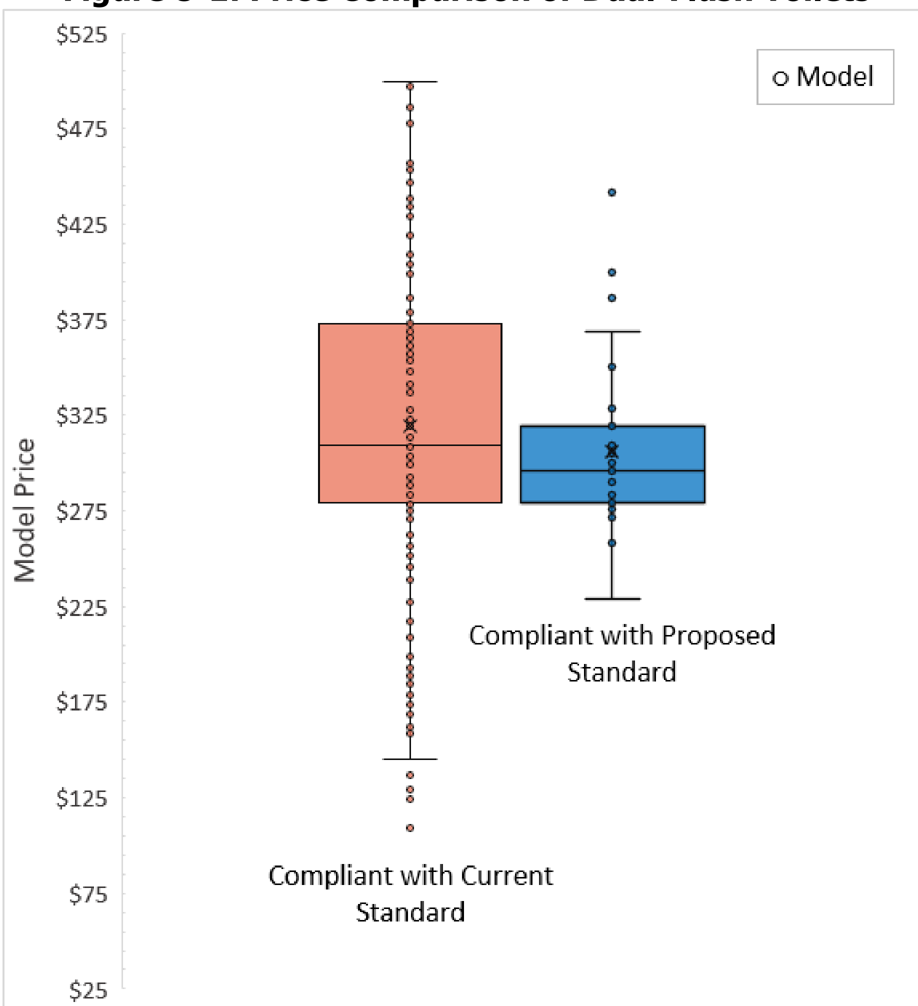
**Table 8-1: Incremental Costs by Toilet Type**

| Compliancy | Average Cost of Single-Flush Toilets ($/unit) | Average Cost of Dual-Flush Toilets ($/unit) |
|---|---|---|
| Non-compliant | $314 | $320 |
| Compliant | $312 | $306 |
| Incremental Cost | $0 | $0 |

Source: CEC research, HomeDepot.com, Lowes.com, Build.com

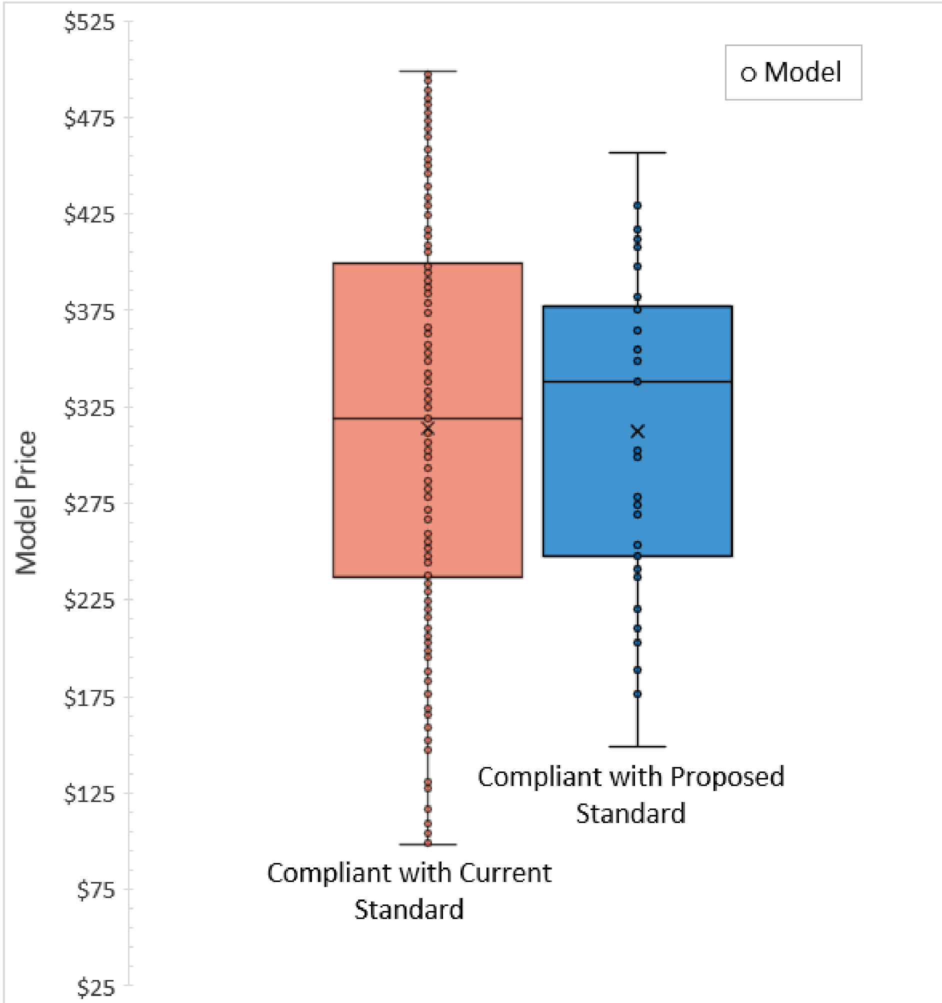
The average price stays relatively the same for dual-flush toilets and single-flush toilets for non-compliant and compliant models.

**Figure 8-1: Price Comparison of Dual-Flush Toilets**




Source: CEC

**Figure 8-2: Price Comparison of Single-Flush Toilets**




Source: CEC

The average cost of non-compliant models is greater than the average cost of compliant models. Therefore, staff assumes the incremental cost is zero, whether consumers decide to choose a compliant single-flush toilet over a non-compliant single-flush toilet or a non-compliant dual-flush toilet, and similarly for compliant dual-flush toilets. The IOU CASE Team reported similar results for dual-flush toilets and assumes an incremental cost of zero (**Figure 8-3**.)[134] Lastly, **Tables C-2** through **C-5** indicate there is no correlation that the price of single-flush toilets or dual-flush toilets increase with efficiency.

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134 Becking, Steffi, Bill Gauley, John Koeller, Mary Ann Dickinson, Helen Davis, and Kathleen Bryan. 2023. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*. California Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=249521&DocumentContentId=84153.

**Figure 8-3: Retail Prices of Water Closets Reported by the IOU CASE Team**

| Fixture Type | Number of Models | Average Price | Median Price | Range of Prices |
|---|---|---|---|---|
| Tank-type single-flush | 198 | $355 | $361 | $119 - $500 |
| Non-qualifying tank-type dual-flush | 91 | $346 | $354 | $99 - $486 |
| Qualifying tank-type dual-flush | 27 | $345 | $311 | $253 - $482 |

Source: IOU CASE Team, 2023

Sections of ASME A112.19.2/CSA B45.1 Version 2018 are required by U.S. EPA WaterSense specification for tank-type toilets and DOE. (See **Chapter 4** for details.) Therefore, staff assumes there are no incremental costs associated with updating the performance criteria test procedure reference from the 2013 version to the 2018 version.

## Statewide Savings

Staff considered two scenarios for analyzing the potential savings — a growth rate scenario and a flat rate scenario. See **Appendix A** for background and calculations for this analysis. The research found in the CASE Team report suggests that by the time the stock reaches full compliance, in this case 2050, the market share of dual-flush toilets will reach 19 percent in 2050 and remain at 19 percent for the foreseeable future.[135] The market share results for this scenario are presented in **Table 8-2**. The year 2026 signifies the proposed effective date, and 2050 signifies the year when the stock turns over or when stock is assumed to be fully in compliance with the proposed standard. The growth rate scenario will show an increase in the dual-flush toilet market share and a decrease in the single-flush toilet market share from 2026 to 2050.

**Table 8-2: Growth Rate Scenario — Market Share**

| Year | Dual-Flush Market Share | Single-Flush Market Share |
|---|---|---|
| 2026 | 7% | 93% |
| 2050 | 19% | 81% |

Source: CEC

Another scenario staff considered is a flat rate scenario where the dual-flush market share could remain steady. Staff assumed a flat rate of 13 percent for dual-flush toilets and the remaining 87 percent for single-flush toilets, the average market share between 2026 and 2050. The results of this scenario are presented in **Appendix A**. The total statewide savings are nearly the same because the stock conditions are the same except for the market share distribution for each toilet type. The growth rate scenario for dual-flush toilets will show a

135 Ibid.

lower first-year savings compared to the flat rate scenario, and higher full stock turnover savings compared to the flat rate scenario.

This chapter will present results of only the growth rate scenario. Staff believes the growth rate scenario is more representative of how the market potentially responds to the proposed standards.

The potential savings of single-flush and dual-flush toilets during the first year (FY) of implementation and after full stock turnover (FST) are listed in **Table 8-3**. California would save 15,902 million gallons of water per year after full stock turnover in 2050. Using a weighted average residential water rate of $6.13 per 1000 gallons of water[136] and a residential rate of $0.26 per kWh of electricity,[137] the proposed efficiency standard for the toilets would achieve an estimated $191 million a year in reduced utility costs after full stock turnover. The savings are based on the assumption that the duty cycle remains the same under the baseline and compliant scenarios for a controlled comparison. The proposed standards will also result in significant electricity attributed to reduction in water pumping, treatment, and delivery. Staff used the data provided by the California Investor-Owned Utilities (IOU), indicating that every million gallons of water uses 5,440 kilowatt-hours (kWh), to estimate embedded electricity savings.[138]

**Table 8-3: Total Statewide Savings by Toilet Type**

| Year | FY 2026 | FY 2026 | FY 2026 | FST 2050 | FST 2050 | FST 2050 |
|---|---|---|---|---|---|---|
| **Toilet Type** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** |
| Single-Flush | 567 | 3 | $7 | 12,157 | 66 | $146 |
| Dual-Flush | 76 | 1 | $1 | 3,745 | 20 | $45 |
| Total | 643 | 4 | $8 | 15,902 | 86 | $191 |

Source: CEC

136 California Department of Water Resources. 2023. "Water Audit Data Reports." https://wuedata.water.ca.gov/default.asp.

137 United States Energy Information Administration. 2023. "California State Profile and Energy Estimates." July 20. https://www.eia.gov/state/data.php?sid=CA.

138 Becking, S., et al. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*.

## Life-Cycle Costs and Benefits

The life-cycle costs and benefits of the proposed standards for single-flush and dual-flush toilets are shown in **Table 8-4**. Life-cycle costs are based on the estimated incremental costs for improving the proposed standards. The life-cycle benefit represents the savings the consumer should receive over the life of the appliance. Because of the long design life of these products (25 years), staff applied a 3 percent discount rate to calculate the net present value of the anticipated savings. The net life-cycle benefits are the differences between the net present value of the savings and the incremental cost of each compliant unit. Background calculation details are available in **Appendix A**. The benefits are greater than the costs, indicating the proposed standards are cost-effective.

**Table 8-4: Life-Cycle Costs and Benefits**

| Toilet Type | Life-cycle Cost ($/unit) | Lifetime Monetary Savings ($/unit) | NPV Lifetime Benefit ($/unit) | Net Lifetime Benefit ($/unit) |
|---|---|---|---|---|
| Single-Flush | $0 | 147 | $103 | $103 |
| Dual-Flush | $0 | 262 | $183 | $183 |

Source: CEC

# CHAPTER 9: Environmental Impact Assessment

## Impacts

Toilets are typically replaced at the end of their useful lives. This proposal does not require any toilet replacement before the end of its useful life, nor does it impact the amount or type of materials used in manufacturing toilets. Therefore, replacement of these appliances at the end of their useful life with more efficient appliances would present no additional impact to the environment compared to replacing them with less efficient appliances.

Stakeholders such as Inland Empire Utilities Agency (IEUA) and the California Association of Sanitation Agencies (CASA)[139] have raised concerns that efficiency improvement of toilets may cause additional stress to some sewer collection and treatment systems because of the reduced volume of water for carrying solid waste through the sewage pipes causing solid accumulation in pipes (blockages) and lower influent flow rates leading to high concentrations of constituents that changes the course of treatment. As part of the *Making Conservation a California Way of Life* [a regulatory framework implemented by the State Water Resources Control Board (State Water Board)][140] the State Water Board conducted a wastewater impact assessment as part of its analysis in the rulemaking process to identify potential effects of lower flows, model potential impacts, identify mitigation options, and estimate effects related to AB 1668 (Friedman) and SB 606 (Hertzberg).

In California there are 1,239 collection systems, 20.3% sewer miles were constructed before 1959, and 52.1% sewer miles were constructed before 1979. These outdated collection systems are generally oversized and not watertight, utilize unprotected concrete pipes, and were designed for an indoor water capacity of 100 gallons per capita day (gpcd). There are approximately 1,300 wastewater treatment facilities in California, with 65% having flow rates less than 1 million gallons per day (MGD).[141] The report estimates that 61% of wastewater treatment facilities and 62% wastewater collection facilities would potentially be affected by the reduction of the indoor water use standard [42 gpcd (gallons per capita day) by 2030] by experiencing lower flows or more concentrated flows. Most impacts would affect wastewater

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139 Inland Empire Utilities Agency. 2023. *IEUA Comments on Appliance Efficiency Regulations for Water Closets*. Docket 22-AAER-05 TN# 249415.
https://efiling.energy.ca.gov/GetDocument.aspx?tn=249415&DocumentContentId=84019.

140 In 2018, the California State Legislature passed Assembly Bill (AB) 1668 and Senate Bill (SB) 606, directing the State Water Board in coordination with DWR to adopt urban retail water use efficiency standards and establishes several reporting requirements to ensure water conservation objectives are being met.

141 California State Water Resources Control Board. 2022. *Summary of Environmental Effects: Evaluating effects of urban water use efficiency standards (AB 1668-SB 606) on urban retail water suppliers, wastewater management agencies, and urban landscapes (trees and urban parklands)*. Sacramento.
https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/regs/water_efficiency_legislation.html#reg-docs.

treatment facilities with a capacity of 0-5 MGD and wastewater collection facilities that serve a population of less than 50,000 people.[142]

The number of impacted wastewater treatment and collection facilities is based on an assumption that urban retail suppliers reduce water use by 15% from indoor water use efficiency such as reduced flow of appliances and fixtures, and new housing with water efficient codes. It does not account for age of existing infrastructure, rate structures, drought conditions, and other water use sectors. DWR suggests that half of California will be using 44 gpcd or less by 2030 through passive conservation and other studies suggest that California is already below the standard.[143] The State Water Board found that 44% of wastewater agencies have experienced flow volumes for three years or longer equivalent to the projected influent volume under AB 1668 and SB 606.[144] Therefore, these impacts are occurring now and will continue to occur, absent changes to the water efficiency standard for toilets. Additionally, toilets have a life span of 25 to 30 years, suggesting the immediate impact of reduced flow rates from toilets will be modest and only grow gradually until full stock turnover around year 2050.

Strategies to mitigate impacts include modernizing an aging infrastructure, coating pipes and replacing pipes to reduce corrosion, improve monitoring technology, adding pumping or distribution piping to improve process flexibility, changing ratings for wastewater treatment facilities to be based on mass loading rather than flow, and updating treatment processes to adapt to future influent flows and concentration changes. These options, plus several other mitigation and adaptation strategies are explained in the State Water Board report and in DWR's *Appendices for the Residential Water Use Study*.[145] With these mitigation measures, costs of maintenance and operation increase, and the resources required to improve and restore the structural integrity of wastewater collection and treatment systems become greater. The State Water Board has identified that developing "a long-term strategy for investments, upgrades, and funding sources to improve wastewater treatment facilities" as necessary, including preparing for climate change impacts and natural disasters.[146]

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142 California State Water Resources Control Board. 2022. *Water Board Staff Preface to Task 5 Report*. Sacramento.
https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/regs/water_efficiency_legislation.html#reg-docs; Note: Results reflect information for 299 (72% of 410) collection systems and 311 (92% of 335) wastewater treatment facilities that serve the communities receiving water from Urban Retail Water Suppliers.

143 State Water Board. *Water Board Staff Preface to Task 5 Report*; Kammeyer, Cora, Sonali Abraham, and Heather Cooley. 2021. *With Another Dry Year Looming, California Moves to Set New Urban Water Use Standards*. Pacific Institute. https://pacinst.org/with-another-dry-year-looming-california-moves-to-set-new-urban-water-use-standards/.

144 State Water Board. *Water Board Staff Preface to Task 5 Report.*

145 California Department of Water Resources. 2020. *Appendices for the Residential Water Use Study*. California Department of Water Resources.
https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/regs/water_efficiency_legislation.html#reg-docs.

146 State Water Board. *Summary of Environmental Effects*.

It is also important to note that drought can exacerbate these issues. During the 2012–2016 drought, 80% of 133 wastewater agencies witnessed declines in influent flows, over 60% observed changes in influent quality, and 1 in 3 had to take adaptive actions to maintain water quality from changes in influent quality. Additionally, 27% of wastewater collection systems reported increased frequency of blockages as flows declined, and over half of wastewater agency respondents of a survey conducted by California Association of Urban Water Agencies (CUWA) reported increased odor problems and higher operations and maintenance costs for conveyance systems. Extreme water conservation efforts during major drought events can be lessened through water efficiency efforts such as reducing indoor water use.[147]

The CEC is committed to helping ensure water conservation remains a California way of life by taking all necessary actions to prepare and respond to drought conditions, and will continue to collaborate with the State Water Board and DWR on this topic as the proceeding on water closets progresses.

Two studies conducted by PERC and detailed in **Chapter 7** further analyzed potential additional stress to existing pipe systems due to efficiency improvements in toilets. Specifically, the two studies examined solid waste transportation through a drain line system in commercial settings. They found that flush volumes of 1.6 gpf and 1.28 gpf performed effectively at transporting solid waste, but that water closet closets with a flush volume of 1.0 gpf or less is not recommended in commercial applications under certain conditions.[148] A US EPA WaterSense study conducted a similar study for residential settings and found that water closets with flush volumes of 1.0 gpf, 1.2 gpf, and 1.28 gpf effectively carried solid waste through a 13 ft drain line.[149] Therefore, the available evidence does not support that the proposed standards would have a significant environmental impact due to increase stress to existing pipe systems.

Staff is continuing to evaluate relevant studies related to any reasonably foreseeable environmental impacts of the proposed standards. Staff requests stakeholders docket any additional studies or data that have not been discussed in this report that may help inform staff's review of environmental impacts.

## Benefits

For homes and workplaces, reducing water consumption would reduce the demand for available and shrinking water supplies, which will help decrease the need of future investment to costly, large-scale infrastructure projects such as dams, canals, and reservoirs. It will also

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147 State Water Board. *Summary of Environmental Effects*.

148 Plumbing Efficiency Research Coalition. 2012. *The Drainline Transport of Solid Waste in Buildings*. Plumbing Efficiency Research Coalition. https://plumbingefficiencyresearchcoalition.org/wp-content/uploads/2012/12/Drainline-Transport-Study-PhaseOne.pdf; Plumbing Efficiency Research Coalition. 2015. *The Drainline Transport of Solid Waste in Buildings – Phase* 2.0. Plumbing Efficiency Research Coalition. https://plumbingefficiencyresearchcoalition.org/wp-content/uploads/2016/04/PERC-2-0_2-1-FINAL.pdf.

149 United States Environmental Protection Agency. 2006. *Response to Issues Raised During Public Comment on April 2006 Draft Specifications for WaterSense Labeling of Tank-Type High-Efficiency Toilets*. Washington, D.C.: United States Environmental Protection Agency. https://www.epa.gov/sites/production/files/2017-02/documents/ws-background-toilets-comment-response.pdf.

result in reduced operating costs for water utilities as it takes a significant amount of energy to get water to a home or business. Energy is needed to extract water from the source, treat, distribute, and use it, as well as collect and treat wastewater for release back into the environment.

Furthermore, reducing water consumption would decrease the amount of waste, improve water quality, and help the state maintain higher water levels in lakes, rivers, and reservoirs. On the demand side, reducing water consumption will improve air quality through reduced energy requirements for pumping, and a reduction of greenhouse gases emitted in the production of energy used to transport, treat, and heat California's water.

Staff estimates the proposal is expected to reduce water consumption by 15,902 Mgal per year after stock turnover from the specified water closets. The amount of energy associated with reducing water consumption such as extracting, treating, and distributing water is estimated to be 86 GWh per year of embedded electricity. Staff's calculations and assumptions used to estimate water savings and embedded electricity savings are in **Appendix A**.

The decrease in water consumption will result in increased availability of water to other users, decreased need for diversions, decreased associated environmental impacts to riparian and wetland habitats from those diversions, and decreased drought impacts on California.

# ACRONYMS

| Abbreviation | Definition |
|---|---|
| **AB** | Assembly Bill |
| **ASME** | American Society of Mechanical Engineers |
| **ASPE** | American Society of Plumbing Engineers |
| **AWE** | Alliance for Water Efficiency |
| **CA IOUs** | California investor-owned utility |
| **CA DWR** | California Department of Water Resources |
| **CASA** | California Association of Sanitation Agencies |
| **CASE Team** | Codes and Standards Enhancement Team |
| **CCR** | California Code of Regulations |
| **CEC** | California Energy Commission |
| **CFR** | Code of Federal Regulations |
| **CPUC** | California Public Utilities Commission |
| **CSA** | Canadian Standards Association |
| **CUWA** | California Association of Urban Water Agencies |
| **DACAG** | Disadvantaged Communities Advisory Group |
| **EPAct** | Energy Policy Act of 1992 |
| **EPCA** | Energy Policy and Conservation Act |
| **GHG** | Green House Gas emissions |
| **GPCD** | Gallons per capita per day |
| **GPF** | Gallons per flush |
| **GPHD** | Gallons per household per day |
| **GPM** | Gallons per minute |
| **GWh** | Gigawatt-hour |
| **HET** | High-efficiency toilet |
| **IAPMO** | International Association of Plumbing and Mechanical Officials |
| **ICC** | International Code Council |

| | |
|---|---|
| **IEPR** | Integrated Energy Policy Report |
| **IEUA** | Inland Empire Utilities Agency |
| **kWh** | Kilowatt-hour |
| **LPF** | Liters per flush |
| **MaP** | Maximum Performance |
| **MAEDbS** | Modern Appliance Efficiency Database System |
| **Mgal** | Million gallons |
| **MGD** | Million gallons per day |
| **MW** | Megawatts |
| **NPV** | Net present value |
| **PERC** | Plumbing Efficiency Research Coalition |
| **PMI** | Plumbing Manufacturers International |
| **PSI** | Pounds per square inch |
| **PVC** | Polyvinyl chloride |
| **RECS** | Residential Energy Consumption Survey |
| **SB** | Senate Bill |
| **U.S. DOE** | United States Department of Energy |
| **U.S. EIA** | United States Energy Information Administration |
| **U.S. EPA** | United States Environmental Protection Agency |
| **U.S. GAO** | United States General Accounting Office |

# GLOSSARY

This glossary includes basic definitions of some of the terms used in this staff report.

APPLIANCE EFFICIENCY STANDARDS -- California Code of Regulations, Title 20, Chapter 2, Subchapter 4: Energy Conservation, Article 4: Appliance Efficiency Standards. Appliance Efficiency Standards regulate the minimum performance requirements for appliances sold in California and apply to refrigerators, freezers, room air conditioners, central air conditioners, gas space heaters, water heaters, plumbing fittings, fluorescent lamp ballasts and luminaires, and ignition devices for gas cooking appliances and gas pool heaters. New National Appliance Standards are in place for some of these appliances and will become effective for others at a future date.

CALIFORNIA ENERGY COMMISSION - The state's primary energy policy and planning agency. The agency was established by the California Legislature through the Warren-Alquist Act in 1974. It has seven core responsibilities: Developing renewable energy, Transforming transportation, Increasing energy efficiency, Investing in energy innovation, Advancing state energy policy, Certifying thermal power plants, Preparing for energy emergencies.

CODES AND STANDARDS ENHANCEMENT (CASE) TEAM refers to three California Investor-Owned Utilities (IOUs) — Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison – sponsored the California Investor-Owned Utilities Comments - Title 20 Water Closets CASE Report and RFI Response (herein referred to as the CASE Team). They also sponsor other related efforts not specific to water closets.

DESIGN LIFE is the average period that a product class of appliances or devices will perform the intended function fully, given proper care and maintenance.

DISADVANTAGED COMMUNITIES refers to the areas throughout the state that most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes, as well as high incidence of asthma and heart disease.

DUAL-FLUSH EFFECTIVE FLUSH VOLUME means the average flush volume of two reduced flushes and one full flush.

DUAL-FLUSH WATER CLOSET, also referred to as a dual-flush (DF) toilet, is a water closet incorporating a feature that allows the user to flush the water closet with either a reduced or a full volume of water.

EQUITY refers to the fair treatment, meaningful involvement, and strategic investment of resources through clean transportation programs, incentives, and processes for all Californians so that race, color, national origin, or income level are not barriers to increased opportunities and participation.

FULL FLUSH VOLUME is one of the two flush volume types featured in a dual-flush water closet. Full flush volume, the greater of the two flush volumes, is used to flush solid waste and toilet tissue, or comparable waste loads.

FULL-STOCK TURNOVER SAVINGS — The annual benefits savings achieved after all existing stock in use complies with the proposed standards, in this case, 2050.

GIGAWATT-HOUR (GWh) — A unit of energy representing 1 billion (1,000,000,000) watt-hours and is equivalent to 1 million kilowatt-hours. A single watt-hour is a measure of electrical energy equivalent to a power consumption of 1 watt for 1 hour. A kilowatt-hour (kWh) is a unit of energy equal to 1 kilowatt of power sustained for 1 hour or to 3,600 kilojoules (3.6 megajoules). 1 million watt-hours = 1 megawatt-hour (MWh).

GRAVITY TANK-TYPE WATER CLOSET means a water closet that includes a storage tank from which water flows into the bowl by gravity.

INCREMENTAL CONSUMER COST is the additional cost (average) at retail that a consumer would pay for an appliance that meets the flexible demand standard. This cost is the difference between an existing base model and the same model that has the added functionality to comply with the new appliance standards for flexible demand.

INVESTOR-OWNED UTILITY — A private company that provides a utility, such as water, natural gas, or electricity, to a specific service area. The California Public Utilities Commission regulates investor-owned utilities that operate in California.

JOULE -- A unit of work or energy equal to the amount of work done when the point of application of force of 1 newton is displaced 1 meter in the direction of the force. It takes 1,055 joules to equal a British thermal unit. It takes about 1 million joules to make a pot of coffee.

NET LIFETIME BENEFITS reflect a 3 percent annual discount rate applied to the savings, allowing incremental costs and savings to be compared in terms of net present value to consumers.

REDUCED FLUSH VOLUME is one of the two flush volume types featured in a dual-flush water closet. Reduced flush volume, the lesser of the two flush volumes, is used to flush liquid waste and toilet tissue, or comparable waste loads.

SINGLE-FLUSH WATER CLOSET, also referred to as a single-flush (SF) toilet, is a water closet that allows the user to flush the water closet with a full volume of water.

TRAP means a fitting, device, or integral portion of a fixture that provides a liquid seal that prevents the back passage of sewer gas without affecting the flow of wastewater.

WATER CLOSET, also referred to as a toilet, means a plumbing fixture having a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a gravity drainage system.

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# APPENDIX A: Staff Assumptions and Calculation Methods

Appendix A discusses the information and calculations used to characterize water closets in California, the current water consumption, and potential savings. The source of much of this information is the CEC’s 2015 water closets rulemaking, comments and information submitted to the docket, trade organizations, and industry.

## Assumptions

All calculations were based on the assumption of an effective date of December 1, 2026. **Table A-1** summarizes the values and assumptions used to estimate water consumption, energy consumption, and potential savings for this analysis. Where specific data were not available for California, staff estimated data for California by correlating data from national, Western Region, Pacific Division, and other known California data sources. Furthermore, the scope identified in **Chapter 6** is simplified into two categories for the purposes of this analysis: single-flush water closets and dual-flush water closets. The term water closet is used interchangeably with toilet throughout this appendix. Sample calculations may be different from results listed in tables and actual values due to rounding. Complete listings of sources can be seen in the **References** section.

**Table A-1: Summary of Assumption Values**

| Value | Description | Source |
|---|---|---|
| 2.76 | Average person per household | U.S Census Bureau, American Housing Survey - California Household Demographics All Occupied Units: 2015, 2017, 2019, 2021 |
| 1.85 | Average number of bathrooms per household | U.S. Census Bureau, American Housing Survey - California - Rooms, Size, and Amenities - All Occupied Units: 2015, 2017, 2019, 2021 |
| 5 | Flushes per day per person | Water Research Foundation, Residential End Uses of Water Version 2 (2016) |
| 13.79 | Flushes per day per household | Staff calculation |
| 7.47 | Flushes per day per toilet | Staff calculation |
| 19% | Market share of dual-flush toilets by 2050 | CA IOUs CASE Team, Draft Analysis of Standards Proposal and Response for Information for Water Closets (2023) |
| 5.5% | Market share of dual-flush toilets in 2023 | Staff assumption based on CASE Team analysis and PMI studies |
| 94.5% | Market share of single-flush toilets in 2023 | Staff assumption based on CASE Team analysis and PMI studies |
| 0.5% | Market share growth rate of dual-flush toilets | Staff assumption based on CASE Team analysis and PMI studies |
| 13% | Market share flat rate of dual-flush toilets | Staff assumption based on CASE Team analysis and PMI studies |
| 5.1% | Annual sales rate | CEC Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets (2015) |
| 5,440 kWh/Mgal | Embedded electrical energy to deliver water | CA IOUs CASE Team, Draft Analysis of Standards Proposal and Response for Information for Water Closets (2023) |
| $6.13 per 1000 gallons | Weighted average of water delivery rate paid by California customers | CA Department of Water Resources audit water rates report, updated by staff |
| $4.46 per 1000 gallons | Weighted average water sewer rate paid by California customers | CA IOUs CASE Team, Draft Analysis of Standards Proposal and Response for Information for Water Closets (2023) |
| $0.26 per kWh | Average annual price of residential electricity paid by California customers | U.S. Energy Information Administration (2023) |

Source: CEC

## Design Life

The design life is an estimate of the length of the typical operation usefulness of a product. A water closet has an average lifetime of 25 years.[150]

## Market Characterization

Staff used data from the CEC's 2015 Water Closets Rulemaking, data submitted to the docket (22-AAER-05) for this pre-rulemaking, and supplemental research to estimate the market share of water closets starting in 2015, to the proposed effective date of 2026, and to when stock is assumed to be completely in compliance by 2050. Estimates of the market share for single-flush and dual-flush toilets in 2015 were based on a study conducted by PMI in 2015, see **Table A-2** for details on the distribution of residential toilets in the Pacific Region in the United States.

**Table A-2: Residential Toilets Installed in the Pacific Region**

| Residential Toilet Type | Installed Percentage in 2015 |
|---|---|
| Single-Flush 5gpf Toilets | 6.5% |
| Single-Flush 3gpf Toilets | 25.8% |
| Single-Flush 1.6gpf Toilets | 62% |
| Single-Flush 1.28gpf Toilets | 4.2% |
| Dual-Flush Toilets | 1.5% |
| Total | 100% |

Source: US Market Penetration of WaterSense Showerheads, Lavatory Faucets, and Toilets (PMI, 2015)

The research found in the CASE Team report suggests that by the time the stock reaches full compliance, in this case 2050, the market share of dual-flush toilets will reach 19 percent in 2050 and remain at 19 percent for the foreseeable future.[151] Staff considered this scenario as part of its analysis and determined a growth rate of 0.5 percent to align with this scenario and an initial market share of 1.5 percent in 2015 from **Table A-2** for dual-flush toilets. (See **Table A-3** for final results.) The year 2026 signifies the proposed effective date, and 2050 signifies the year when the stock turns over or when stock is assumed to be fully in compliance with the proposed standard. The growth rate scenario will show an increase in the dual-flush toilet market share and a decrease in the single-flush toilet market share from 2026 to 2050 (**Figure A-1**). These rates are an average since the sales of toilets can vary year to

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150 Singh, Harinder, Ken Rider, Tuan Ngo, and Kristen Driskell. 2015. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets, CEC-400-2015-008*. Sacramento: California Energy Commission. https://www.energy.ca.gov/publications/2015/staff-analysis-water-efficiency-standards-toilets-urinals-and-faucetss-2015.

151 Becking, Steffi, Bill Gauley, John Koeller, Mary Ann Dickinson, Helen Davis, and Kathleen Bryan. 2023. *Draft Analysis of Standards Proposal and Response to Request for Information for Water Closets*. California Investor-Owned Utilities. https://efiling.energy.ca.gov/GetDocument.aspx?tn=249521&DocumentContentId=84153.

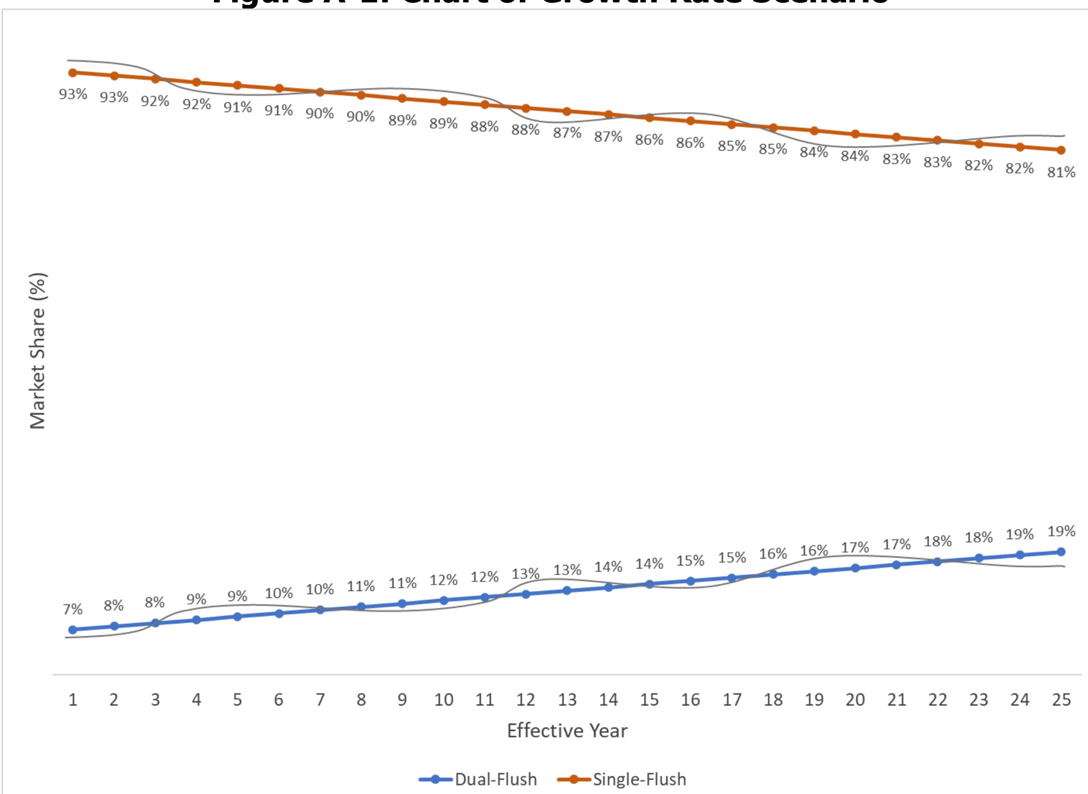
year. It is likely closer to a staircase or step function with longer plateaus than a linear function with a constant slope, see **Figure A-2**.

**Table A-3: Growth Rate Scenario – Market Share**

| Year | Dual-Flush Market Share | Single-Flush Market Share |
|---|---|---|
| 2015 | 1.5% | 98.5% |
| 2026 | 7% | 93% |
| 2050 | 19% | 81% |

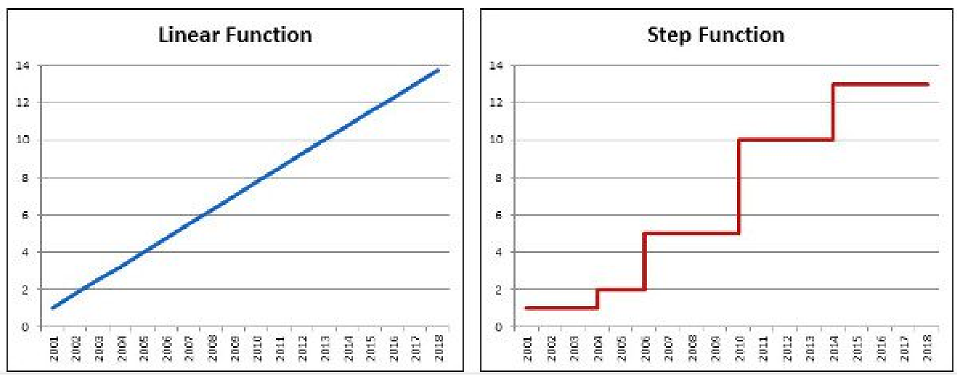
Source: CEC

**Figure A-1: Chart of Growth Rate Scenario**




Source: CEC

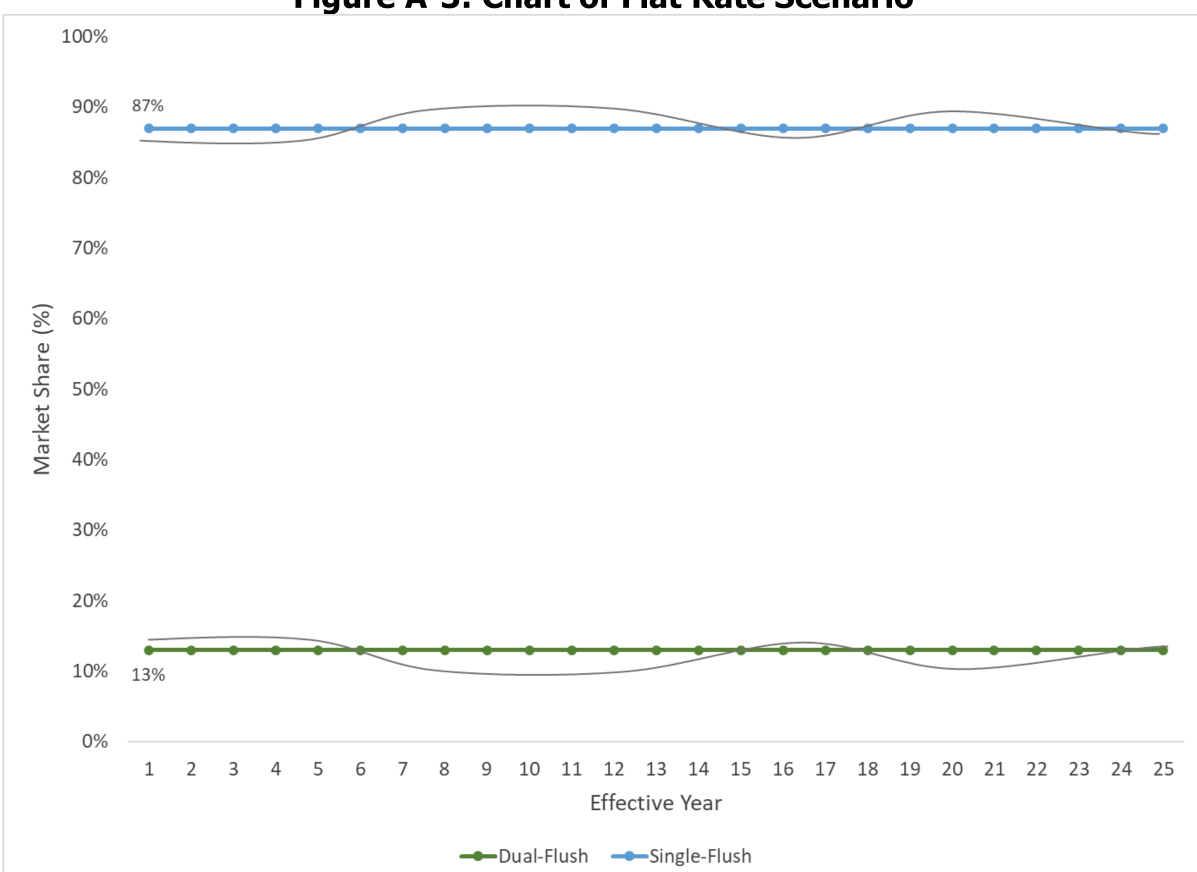
**Figure A-2: Linear Function vs. Step Function**




Source: Patheos.com

Another scenario staff considered is a flat rate scenario where the dual-flush market share could remain steady. Staff assumed a flat rate of 13 percent for dual-flush and the remaining 87 percent for single-flush — the average market share between 2026 and 2050 (**Figure A-3**).

**Figure A-3: Chart of Flat Rate Scenario**




Source: CEC

## Stock and Sales

Staff first modeled total occupied housing units from 2010 to 2050 in California based on historical data. Using housing characteristic surveys with information relative to bathrooms and correlating this information with the estimate of total housing units, staff estimated existing stock of water closets in California from 2010 to 2050. **Table A-4** lists sources of housing unit data and housing characteristics data used to estimate number of full bathrooms in California.

**Table A-4: Data Sources for Housing Units**

| Source |
|---|
| U.S. Census Bureau, American Community Survey — California Occupancy Characteristics: 2010 to 2021 |
| U.S. Census Bureau, American Housing Survey — California Household Demographics All Occupied Units: 2015, 2017, 2019, 2021 |
| U.S. Census Bureau, Characteristics of New Housing: From 1973 to 2022 |
| California Department of Housing and Community Development, Statewide Housing Plan Data Dashboard |
| U.S. Energy Information Administration, Residential Energy Consumption Survey (RECS) from 2001, 2005, 2009, 2015, 2020 |

Source: CEC

After estimating the total of bathrooms in California, staff estimated the number of toilets installed in homes while considering the number of toilets installed in new completed homes. **Tables A-5, A-6,** and **A-7** lists the estimated stock of total water closets in California based on housing data and market share estimates discussed in the previous section. The year 2026 signifies the proposed effective date, and 2050 signifies the year when the stock turns over or when stock is assumed to comply fully with the proposed standard.

**Table A-5: California Stock of Water Closets**

| Year | Total Installed Stock |
|---|---|
| 2026 | 24,427,505 |
| 2050 | 28,017,984 |

Source: CEC

**Table A-6: Flat Rate Scenario — Estimated Installed Stock of Water Closets**

| Year | Dual-Flush | Single-Flush | Total |
|---|---|---|---|
| 2026 | 3,175,576 | 21,251,929 | 24,427,505 |
| 2050 | 3,642,338 | 24,375,646 | 28,017,984 |

Source: CEC

**Table A-7: Growth Rate Scenario — Estimated Installed Stock of Water Closets**

| Year | Dual-Flush | Single-Flush | Total |
|---|---|---|---|
| 2026 | 1,709,925 | 22,717,580 | 24,427,505 |
| 2050 | 5,323,417 | 22,694,567 | 28,017,984 |

Source: CEC

**Tables A-8** and **A-9** show the estimated annual sales for each type of water closet under each scenario. Annual sales were estimated by applying a 5.1 percent sales rate.[152]

**Table A-8: Flat Rate Scenario – Estimated Annual Sales of Water Closets**

| Year | Dual-Flush | Single-Flush | Total |
|---|---|---|---|
| 2026 | 161,486 | 1,080,715 | 1,242,202 |
| 2050 | 185,222 | 1,239,564 | 1,424,787 |

Source: CEC

**Table A-9: Growth Rate Scenario – Estimated Annual Sales of Water Closets**

| Year | Dual-Flush | Single-Flush | Total |
|---|---|---|---|
| 2026 | 86,954 | 1,155,248 | 1,242,202 |
| 2050 | 270,709 | 1,154,077 | 1,424,787 |

Source: CEC

## Duty Cycle

The *duty cycle* of an appliance is an estimate of consumer behavior for that particular appliance. It is directly tied to how often the appliance is used and for how long. In the context of this report, the duty cycle is the number of flushes per day per toilet. That value was determined to be 7.47 flushes per day per toilet.

### Method

The average number of flushes per day per person is five, according to the *Residential End Uses of Water* 2016 study.[153] This value is supported by Flume's Household Water Use Index

152 Singh, H., et al. *Staff Analysis of Water Efficiency Standards for Toilets, Urinals, and Faucets*.

153 DeOreo, William B., Peter Mayer, Benedykt Dziegielewski, and Jack Kiefer. 2016. *Residential End Uses of Water Version 2 Executive Report*. Denver: Water Research Foundation. https://www.waterrf.org/research/projects/residential-end-uses-water-version-2.

2021 data, with an average flush per day per person of 5.5.[154] For this analysis, it's five flushes per day per person.

The average number of persons per household was determined to be 2.76 by averaging California household demographics data from 2015 through 2021.[155]

Multiplying the number of flushes per day per person with the number of persons per household equates to the number of flushes per day per household, as shown below.

$$5 \; flushes \; per \; day \; per \; person \; \times 2.76 \; persons \; per \; household = 13.79 \; flushes \; per \; day \; per \; houshold \qquad \textbf{Equation 1}$$

CEC staff acquired the number of toilets per household by determining the number of full bathrooms per household in California. The average number of full bathrooms or toilets per household was determined to be 1.85 by averaging California household demographics data from 2015 to 2021.[156] Staff determined the duty cycle by dividing the number of flushes per day per household with the number of toilets per household, equating to 7.47 flushes per day per toilet, as shown below.

$$\frac{13.79 \; flushes \; per \; day \; per \; household}{1.85 \; toilets \; per \; household} = 7.47 \; flushes \; per \; day \; per \; toilet \qquad \textbf{Equation 2}$$

## Compliance Rates

Compliance rate is the percentage of compliant units over the total number of units. A compliance rate percentage indicates the ratio of compliant appliances to the total market or stock. Thus, a compliance rate of 40 percent means that 40 percent of that particular appliance already meets the proposed standard.

**Tables A-10** and **A-11** list the baseline distribution of compliance rates for single-flush toilets and dual-flush toilets by flush volume, respectively. The proposed standard sets a maximum flush volume of 1.1 gpf for single-flush toilets; therefore, single-flush toilets with a flush volume greater than 1.1 is non-compliant. The proposed standard for dual-flush toilets is a maximum reduced flush volume of 0.8 gpf and a maximum full flush volume of 1.28 gpf. Thus, dual-flush toilets with a reduced flush volume greater than 0.8 gpf or a full flush volume greater than 1.28 gpf is non-compliant. The baseline represents compliance rates in which no new standards are applied to water closets.

Staff derived the compliance rates using market share estimates such as those discussed in the **Market Characterization** section of this appendix, EPA WaterSense's database,

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154 Flume. 2021. "How Much Water Do Americans Use for Toilets and Showers? Flume Household Water Use Index Reveals Increased Efficiency Levels." November 4. https://www.prnewswire.com/news-releases/how-much-water-do-americans-use-for-toilets-and-showers-301416682.html.

155 United State Census Bureau. 2023. "American Housing Survey." https://www.census.gov/programs-surveys/ahs.html.

156 Ibid.

California’s Modern Appliance Efficiency Database System, and information provided through the docket for this pre-rulemaking.

**Table A-10: Compliance Rates for Single-Flush Water Closets by Flush Volume**

| Year | ≤ 1.1 gpf [Compliant] | ≤ 1.28 gpf [Non-compliant] | ≥ 1.6 gpf [Non-compliant] | Total |
|---|---|---|---|---|
| Baseline | 13% | 75% | 12% | 100% |

Source: CEC

**Table A-11: Compliance Rates for Dual-Flush Water Closets by Flush Volume**

| Year | ≤ (0.8/1.28) gpf [Compliant] | ≤ (0.9/1.28) gpf [Non-compliant] | (>0.9)/(>1.28) gpf [Non-compliant] | Total |
|---|---|---|---|---|
| Baseline | 15% | 5% | 80% | 100% |

Source: CEC

The baseline flush volume for annual sales is the current standard — 1.28 gpf. The baseline flush volume for the installed stock by toilet type is determined by taking the weighted average of the flush volumes of each group listed in **Tables A-10** and **A-11. Table A-12** shows the results. The compliant flush volume for each type of toilet is equivalent to the proposed standards (**Table A-12**). The effective flush volume for dual-flush toilets is based on the average of two reduced flushes and one full flush.[157] For example, the effective flush volume for dual-flush toilet with a reduced flush volume of 0.8 gpf and a full flush volume of 1.28 gpf is 0.96 gpf. These values will be used to determine the baseline, compliant, and per unit water use and energy use. The year 2050 is considered the year when stock reaches full compliance with the proposed standard, also known as *full stock turnover*.

**Table A-12: Baseline and Compliant Flush Volumes**

| Applicable to: | Flush Volume (gpf) | Effective Flush Volume (gpf) |
|---|---|---|
| Baseline Annual Sales | 1.28 | 1.28 |
| Baseline Installed Stock | 1.30 | 1.22 |
| Compliant Annual Sales | 1.1 | 0.96 |
| Compliant Full-Stock Turnover (2050) | 1.1 | 0.96 |

Source: CEC

157 Definition of dual-flush effective flush volume. CCR, Title 20, Section 1602(i).

## Baseline Water Use and Embedded Energy Use

The baseline water use and embedded energy use represents the water and energy consumption under the scenario in which no new standards are applied to water closets. The baseline water consumption of the appliance is the estimate of water consumed by the market-representative percentage of compliant and noncompliant units.

The statewide annual total water use is calculated by multiplying the duty cycle, the baseline weighted flush volume, the stock, and 365 days per year, as shown in the equation below.

$$Statewide\ Baseline\ Water\ Use_{Year} = (Duty\ Cycle) \times \left(Flush\ Volume_{Baseline\_Year}\right) \times (Stock_{Year}) \times (365\frac{days}{year}) \quad \textbf{Equation 3}$$

Where:

Statewide Baseline Water Use$_{Year}$ = total water consumption in the first year or after full stock turnover

Duty Cyle = 7.47 flushes per day per toilet, see **Table A-1**

Flush Volume$_{Baseline_Year}$ = baseline flush volume (gallons per flush) in the first year or after full stock turnover, see **Table A-12**

Stock$_{Year}$ = stock in the first year or after full stock turnover. (See **Tables A-6** through **A-9**.)

Sample calculation under the flat rate scenario for single-flush toilets in the first year:

$$Statwide\ Baseline\ Water\ Use_{FY} = (7.47\ flushes\ per\ day\ per\ toilet) \times \left(1.28\frac{gallons}{flush}\right) \times (1{,}080{,}715\ toilets)$$

$$Statewide\ Baseline\ Water\ Use_{FY} = 3{,}771\ \frac{Mgal}{year}$$

The statewide baseline embedded energy use is calculated by multiplying the statewide baseline water use and the amount of electrical energy used to deliver water, as shown in the equation below.

$$Statewide\ Baseline\ Embedded\ Energy_{Year} = (Statewide\ Baseline\ Water\ Use_{Year}) \times (Embedded\ Energy\ Rate) \quad \textbf{Equation 4}$$

Where:

Statewide Baseline Embedded Energy$_{Year}$ = total embedded energy use in the first year or after full stock turnover

Statewide Baseline Water Use$_{Year}$ = total water consumption in the first year or after full stock turnover

Embedded Energy Rate = 5,440 kWh/Mgal, see **Table A-1**

Sample calculation under the flat rate scenario for single-flush toilets in the first year:

$$Statewide\ Baseline\ Embedded\ Energy_{FY} = (3{,}771\ Mgal) \times \left(5{,}440\ \frac{kWh}{Mgal}\right)$$

$$Statewide\ Baseline\ Embedded\ Energy_{FY} = 20.5\ \frac{GWh}{year}$$

This method is repeated for single-flush toilets and dual-flush toilets for 2026 and 2050 and for each scenario of market share distribution (that is, flat rate or growth rate) (**Tables A-13 and A-14**). The totals for each scenario are nearly the same, except the water use and energy use vary by toilet type because of the market share distribution in each scenario.

**Table A-13: Flat Rate Scenario — Baseline Water Use and Embedded Energy Use**

| Year/Use | FY 2026 | FY 2026 | FST 2050 | FST 2050 |
|---|---|---|---|---|
| **Toilet Type** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** |
| Single-Flush | 3,771 | 21 | 86,143 | 469 |
| Dual-Flush | 563 | 3 | 12,093 | 66 |
| Total | 4,334 | 24 | 98,236 | 534 |

Source: CEC

**Table A-14: Growth Rate Scenario — Baseline Water Use and Embedded Energy Use**

| Year/Use | FY 2026 | FY 2026 | FST 2050 | FST 2050 |
|---|---|---|---|---|
| **Toilet Type** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** |
| Single-Flush | 4,031 | 22 | 80,202 | 436 |
| Dual-Flush | 303 | 2 | 17,675 | 96 |
| Total | 4,334 | 24 | 110,123 | 599 |

Source: CEC

## Compliant Water Use and Embedded Energy Use

The compliant water use and embedded energy use represent the water and energy consumption under the scenario in which the proposed standards go into effect. The energy consumption of compliant products is estimated based on minimum requirements to the meet the proposed standards. The statewide total energy use is calculated using the same method as the baseline water and energy consumption. Results are shown in **Tables A-15** and **A-16**.

**Table A-15: Flat Rate Scenario – Compliant Water Use and Embedded Energy Use**

| Year/Use | FY 2026 | FY 2026 | FST 2050 | FST 2050 |
|---|---|---|---|---|
| **Toilet Type** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** |
| Single-Flush | 3,240 | 18 | 73,086 | 469 |
| Dual-Flush | 423 | 2 | 9,531 | 52 |
| Total | 3,663 | 20 | 82,616 | 449 |

Source: CEC

**Table A-16: Growth Rate Scenario – Compliant Water Use and Embedded Energy Use**

| Year/Use | FY 2026 | FY 2026 | FST 2050 | FST 2050 |
|---|---|---|---|---|
| **Toilet Type** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** | **Water Use (Mgal/year)** | **Embedded Energy Use (GWh/year)** |
| Single-Flush | 3,464 | 19 | 80,202 | 436 |
| Dual-Flush | 228 | 1 | 13,930 | 76 |
| Total | 3,691 | 20 | 81,975 | 446 |

Source: CEC

## Statewide Savings

The energy savings are the difference between the baseline scenario and the compliant scenario. Savings are presented for when the proposed standards become effective in 2026 and at full stock turnover in 2050. The monetary savings are calculated by multiplying the savings with the corresponding residential price of electricity or water. Details are shown in the equation below.

$$Monetary\ Savings_{Year} = [(Water\ Savings_{Year} \times (Water\ Delivery\ Rate\ + Water\ Sewer\ Rate))] + [Embedded\ Energy\ Savings_{Year} \times Electricity\ Rate]$$

**Equation 5**

Where:

Monetary $Savings_{Year}$ = statewide monetary savings in the first year or after full stock turnover

Water $Savings_{Year}$ = statewide water savings in the first year or after full stock turnover

Water Delivery Rate = $6.13 per 1000 gallons, see **Table A-1**

Water Sewer Rate = $4.46 per 1000 gallons, see **Table A-1**

Embedded Energy Savings$_{Year}$ = statewide embedded energy savings in the first year or after full stock turnover

Electricity Rate = $0.26 per kWh, see **Table A-1**

Sample calculation under the flat rate scenario for total savings in the first year:

$$Monetary\ Savings_{FY} = \left[\left(671\frac{Mgal}{year} \times \frac{10^6 gal}{1\,Mgal}\right) \times \left(\frac{\$6.13}{1000\ gal} + \frac{\$4.46}{1000\ gal}\right)\right] + \left[4\frac{GWh}{year} \times \frac{10^6\ kWh}{1\ GWh} \times \frac{\$0.26}{kWh}\right]$$

$$Monetary\ Savings_{FY} \approx \$8\ million$$

**Tables A-17** and **A-18** list the estimated total statewide water savings, energy savings, and monetary savings by toilet type for 2026 and 2050 under each scenario. The growth rate scenario for dual-flush toilets will show a lower first-year savings compared to the flat rate scenario, and higher full stock turnover savings compared to the flat rate scenario. Moreover, the full stock turnover for single-flush toilets in the growth rate scenario is lower than the flat rate scenario Because of the growth rate scenario, the dual-flush market share increases, while the single-flush toilet market share decreases from 2026 to 2050. The totals are nearly the same because the stock conditions are the same except for the market share distribution.

**Table A-17: Flat Rate Scenario – Statewide Savings by Toilet Type**

| Year | FY 2026 | FY 2026 | FY 2026 | FST 2050 | FST 2050 | FST 2050 |
|---|---|---|---|---|---|---|
| **Toilet Type** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** |
| Single-Flush | 530 | 3 | 6 | 13,057 | 71 | 156 |
| Dual-Flush | 141 | 1 | 2 | 2,562 | 14 | 31 |
| Total | 671 | 4 | 8 | 15,620 | 85 | 186 |

Source: CEC

**Table A-18: Growth Rate Scenario – Statewide Savings by Toilet Type**

| Year | FY 2026 | FY 2026 | FY 2026 | FST 2050 | FST 2050 | FST 2050 |
|---|---|---|---|---|---|---|
| **Toilet Type** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** | **Water Savings (Mgal/year)** | **Embedded Energy Savings (GWh/year)** | **Monetary Savings (M$)** |
| Single-Flush | 567 | 3 | 7 | 12,157 | 66 | 146 |
| Dual-Flush | 76 | 1 | 1 | 3,745 | 20 | 45 |
| Total | 643 | 4 | 8 | 15,902 | 86 | 191 |

Source: CEC

## Life-Cycle Costs and Benefits

The calculation for water savings per unit is the difference between the baseline and compliant water consumption per unit. The life-cycle cost includes the incremental cost. The life-cycle benefit is the product of the water savings per unit, the life of the unit, and the average residential water delivery rate.

The annual water consumption per unit is determined by multiplying the flush volume by the duty cycle for 365 days, as shown in the equation below. Results are shown in **Table A-19**.

$$Annual\ Water\ Consumption_{Unit} = (Flush\ Volume) \times (Duty\ Cycle) \times \left(365\,\frac{days}{year}\right)$$ **Equation 6**

Where:

$Annual\ Water\ Consumption_{Unit}$ = annual water consumption per unit for each toilet type

Flush Volume = flush volumes are listed in **Table A-19**

Duty Cycle = 7.47 flushes per day per toilet, see **Table A-1**

Sample calculation for the baseline, single-flush toilet annual water consumption:

$$Annual\ Water\ Consumption_{Unit} = \left(1.28\,\frac{gallons}{flush}\right) \times \left(7.47\,\frac{flushes}{day}\,per\ unit\right) \times \left(365\,\frac{days}{year}\right)$$

$$Annual\ Water\ Consumption_{Unit} = 3{,}490\,\frac{gallons}{year}\,per\ unit$$

**Table A-19: Water Consumption per Unit**

| Toilet Type | Baseline Flush Volume (gpf) | Baseline Water Consumption (gallons per year) | Compliant Flush Volume (gpf) | Compliant Water Consumption (gallons per year) |
|---|---|---|---|---|
| Single-Flush | 1.28 | 3,490 | 1.1 | 2,999 |
| Dual-Flush | 1.28* | 3,490 | 0.96* | 2,617 |

*Effective flush volume; Source: CEC

**Table A-20** lists the water savings, embedded energy savings, lifetime water savings, and lifetime embedded water savings per unit by toilet type. The water savings per unit is the difference between the baseline and compliant water consumption per unit. The embedded energy savings is calculated by multiplying the water savings by the amount of electrical energy it takes to deliver water. The lifetime water savings and lifetime embedded energy savings is calculated by multiplying the water savings or energy savings by the design life of 25 years. A summary of the equations used is shown below with sample calculations.

$$Water\ Savings_{Toilet\ Type} = Water\ Consumption_{Baseline} - Water\ Consumption_{Compliant}$$ **Equation 7**

$$Water\ Savings_{SingleFlush} = 3{,}490\frac{gallons}{year} - 2{,}999\frac{gallons}{year} = 491\ \frac{gallons}{year}$$

Where:

Water Savings$_{\text{Toilet Type}}$ = unit water savings by toilet type, gallons per year per unit

Water Consumption$_{\text{Baseline}}$ = annual baseline water consumption, gallons per year per unit

Water Consumption$_{\text{Compliant}}$ = annual compliant water consumption, gallons per year per unit

$$Embedded\ Energy\ Savings_{Toilet\ Type} = Water\ Savings_{Toilet\ Type} \times Embedded\ Energy\ Rate$$ **Equation 8**

$$Embedded\ Energy\ Savings_{SingleFlush} = 491\frac{gallons}{year} \times 5{,}440\ \frac{kWh}{Mgal} \times \frac{1Mgal}{10^6 gallons} = 2.67\ \frac{kWh}{year}$$

Where:

Embedded Energy Savings$_{\text{Toilet Type}}$ = unit embedded energy savings by toilet type, kilowatt-hour per year per unit

Water Savings$_{\text{Toilet Type}}$ = unit water savings by toilet type, gallons per year per unit

Embedded Energy Rate = 5,400 kWh/Mgal, see **Table A-1**

$$Lifetime\ Savings = Savings \times Design\ Life$$ **Equation 9**

$$Lifetime\ Savings_{SingleFlush} = 491 \frac{gallons}{year} \times 25\ years \approx 12{,}269\ gallons$$

Where:

Lifetime Savings = lifetime water savings (gallons per unit) or lifetime embedded energy savings (kilowatt-hour per unit)

Savings = annual water savings (gallons per year per unit) or annual embedded energy savings (kilowatt hours per year per unit)

Design Life = 25 years per unit

**Table A-20: Lifetime Water Savings and Embedded Electricity Savings**

| Toilet Type | Water Savings (gallons/ year) | Embedded Energy Savings (kWh/year) | Lifetime Water Savings (gallons/ year) | Lifetime Embedded Energy Savings (gallons/year) |
|---|---|---|---|---|
| Single-Flush | 491 | 2.67 | 12,269 | 67 |
| Dual-Flush | 872 | 4.75 | 21,812 | 119 |

Source: CEC

**Table A-21** lists the total lifetime monetary savings for the water savings and embedded energy savings. The lifetime monetary savings is calculated by multiplying the lifetime savings of water or embedded energy by the utility rate. A summary of the equations used is shown below with sample calculations.

$$Lifetime\ Monetary\ Savings_{Utility\ Type,Toilet\ Type} = Lifetime\ Savings\ \times Utility\ Rate$$ **Equation 10**

$$Lifetime\ Monetary\ Savings_{Water\ Delivery,Single\ Flush} = Water\ Savings\ \times Water\ Delivery\ Rate$$

$$Lifetime\ Monetary\ Savings_{Water\ Delivery,Single\ Flush} = 12{,}269 \frac{gallons}{unit} \times \frac{\$6.13}{1000\ gallons} \approx \$75\ per\ unit$$

Where:

Lifetime Monetary Savings$_{\text{Utility Type, Toilet Type}}$ = the lifetime monetary savings by toilet type and utility type (i.e., water delivery, water sewer, electricity)

Lifetime Savings = lifetime water savings (gallons per unit) or lifetime embedded energy savings (kilowatt hours per unit)

Utility Rate = water delivery rate at $6.13 per 1000 gallons, water sewer rate at $4.46 per 1000 gallons, or residential electricity rate at $0.26 per kilowatt-hour, see **Table A-1**

**Table A-21: Lifetime Monetary Savings per Unit**

| Toilet Type | Utility Water Savings ($/unit) | Utility Water Sewer Savings ($/unit) | Utility Embedded Electricity Savings ($/unit) | Total Monetary Savings ($/unit) |
|---|---|---|---|---|
| Single-Flush | 75 | 55 | 17 | 147 |
| Dual-Flus | 134 | 97 | 31 | 262 |

Source: CEC

**Table A-22** lists the average price of compliant and non-compliant products by toilet type and the incremental cost or life-cycle cost. The incremental cost is the difference between a non-compliant product and a compliant product. Details of how these values were derived are discussed in **Chapter 8** and shown in **Appendix C**.

**Table A-22: Incremental Costs by Toilet Type**

| Compliancy | Average Cost of Single-Flush Toilets ($/unit) | Average Cost of Dual-Flush Toilets ($/unit) |
|---|---|---|
| Non-compliant | $314 | $320 |
| Compliant | $312 | $306 |
| Incremental Cost | $0 [-$2] | $0 [-$14] |

Source: CEC, HomeDepot.com, Lowes.com, Build.com

**Table A-23** lists the life-cycle costs, lifetime monetary savings, the net present value of the lifetime savings, and the net lifetime benefit by toilet type. Staff assumed a 3 percent discount rate to calculate the net present value (NPV) of the energy savings or the lifetime benefit. The incremental cost is subtracted from the net present value to determine the net lifetime benefit. A summary of the equations used is shown below with sample calculations.

$$Net\ Present\ Value\ (NPV)\ of\ Savings = \sum_{n=1}^{25} \frac{Total\ Annual\ Monetary\ Savings_{Unit}}{(1 + Discount\ Rate)^n}$$ **Equation 11**

$$NPV_{n=1} = \frac{\$5.90}{(1 + 0.03)^1} \approx \$5.72$$

Where:

Net Present Value = net present worth of lifetime monetary savings by toilet type, ($/unit)

Total Annual Monetary Savings$_{Unit}$ = total lifetime monetary savings by toilet type (see **Table A-21**) divided by the design life (25 years)

Discount Rate = discount rate of 3%

n = year number

**Table A-23: Life-Cycle Costs and Benefits**

| Toilet Type | Life-cycle Cost ($/unit) | Lifetime Monetary Savings ($/unit) | NPV Lifetime Benefit ($/unit) | Net Lifetime Benefit ($/unit) |
|---|---|---|---|---|
| Single-Flush | $0 | 147 | $103 | $103 |
| Dual-Flush | $0 | 262 | $183 | $183 |

Source: CEC

**Table A-24** lists the net present value for each year by toilet type and the total lifetime net present value by toilet type.

**Table A-24: Net Present Value Results by Year**

| Year (n) | Single-Flush Toilet ($/year) | Dual-Flush Toilet ($/year) |
|---|---|---|
| 1 | 5.72 | 10.18 |
| 2 | 5.56 | 9.88 |
| 3 | 5.40 | 9.59 |
| 4 | 5.24 | 9.31 |
| 5 | 5.09 | 9.04 |
| 6 | 4.94 | 8.78 |
| 7 | 4.79 | 8.52 |
| 8 | 4.65 | 8.27 |
| 9 | 4.52 | 8.03 |
| 10 | 4.39 | 7.80 |
| 11 | 4.26 | 7.57 |
| 12 | 4.14 | 7.35 |
| 13 | 4.01 | 7.14 |
| 14 | 3.90 | 6.93 |
| 15 | 3.78 | 6.73 |
| 16 | 3.67 | 6.53 |
| 17 | 3.57 | 6.34 |
| 18 | 3.46 | 6.16 |
| 19 | 3.36 | 5.98 |
| 20 | 3.26 | 5.80 |
| 21 | 3.17 | 5.63 |
| 22 | 3.08 | 5.47 |
| 23 | 2.99 | 5.31 |
| 24 | 2.90 | 5.16 |
| 25 | 2.82 | 5.01 |
| Total | 102.67 | 182.52 |

Source: CEC

# APPENDIX B: Staff Proposed Regulatory Language

**California Code of Regulations**
**Title 20. Public Utilities and Energy**
**Division 2. State Energy Resources Conservation and Development Commission**
**Chapter 4. Energy Conservation**
**Article 4. Appliance Efficiency Regulations**

The proposed changes to the Title 20 regulations are provided below. Changes to the regulations are marked with <u>underlining</u> (new language) and ~~strikethroughs~~ (deletions). Three dots or "…" represents the substance of the existing regulations that will remain unchanged between the sections containing proposed language changes.

## § 1601. Scope

…[skipping (a) through (h)]

(i) Plumbing fixtures, which are water closets and urinals.

…[skipping (j) through (x)]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c), 25402.5.4 and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1602. Definitions

…[skipping (a) through (h)]

(i) Plumbing Fixtures.

"Blowout ~~toilet~~ <u>water closet</u>" means a water closet that uses a non-siphonic bowl with an integral flushing rim, a trap at the rear of the bowl, and a visible or concealed jet that operates with a blowout action.

"Dual-flush effective flush volume" means the average flush volume of two reduced flushes and one full flush.

"Dual-flush water closet" is a water closet incorporating a feature that allows the user to flush the water closet with either a reduced or a full volume of water.

"<u>Power-assisted</u> ~~Electromechanical hydraulic~~ water closet" <u>also known as an electromechanical hydraulic water closet,</u> means a water closet that utilizes electrically operated devices, such as, but not limited to, air compressors, pumps, solenoids, motors, or macerators in place of or to aid gravity in evacuating waste from the toilet bowl.

“Flushometer tank” means a device whose function is defined in flushometer valve but ~~that is~~ integrated within an accumulator vessel affixed and adjacent to a plumbing fixture inlet so as to cause an effective enlargement of the supply line immediately before the fixture.

“Pressure-assisted~~Flushometer tank~~ water closet” also known as flushometer tank water closet, means a water closet utilizing a flushometer tank.

“Flushometer valve” means a valve that is attached to a pressurized water supply pipe and that is designed so that when actuated it opens the line for direct flow into the fixture at a rate and predetermined quantity to properly operate the fixture, and then gradually closes in order to provide trap reseal in the fixture and to avoid water hammer. The pipe to which the device is connected is, in itself, of sufficient size that when open shall allow the device to deliver water at a sufficient rate of flow for flushing purposes.

“Flushometer valve water closet” means a water closet utilizing a flushometer valve.

“Gallons per flush (gpf)” means gallons per flush as determined using the applicable test method in section 1604(i) of this Article.

“Gravity tank-type water closet” means a water closet that includes a storage tank from which water flows into the bowl by gravity.

“Plumbing fixture” means an exchangeable device, which connects to a plumbing system to deliver and drain away water and waste. A plumbing fixture includes a water closet or a urinal.

“Prison-type urinal” means a urinal designed and marketed expressly for use in prison-type institutions.

“Prison-type water closet” means a water closet designed and marketed expressly for use in prison-type institutions.

“Trough-type urinal” means a urinal designed for simultaneous use by two or more persons.

“Urinal” means a plumbing fixture that receives only liquid body waste and, on demand, conveys the waste through a trap seal into a gravity drainage system.

“Vacuum-type urinal” means a urinal whose bowl is evacuated by the application of a vacuum.

“Vacuum-~~type~~assisted water closet” means a water closet whose bowl is evacuated by the application of a vacuum.

“Water closet” means a plumbing fixture having a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a gravity drainage system.

“Water use” means the quantity of water flowing through a water closet or urinal at point of use, determined in accordance with test procedures under Appendix T of subpart B of 10 C.F.R. part 430.

“Waterless urinal” means a urinal designed to be used without the application of water for flushing.

…[skipping (j) through (x)]

The following documents are incorporated by reference in Section 1602.

| *Number* | *Title* |
|---|---|
| FEDERAL STATUTES AND REGULATIONS | |
| C.F.R., Title 10, sections 429.14(d), 429.16(a), and 429.61(d) | |
| C.F.R., Title 10, section 430.2 | |
| C.F.R., Title 10, sections 431.25, 431.192, 431.344, 431.442, and 431.446 | |
| C.F.R., Title 10, part 430, subpart B | |
| C.F.R., Title 10, part 431, subparts A through Y | |
| Copies available from: | SUPERINTENDENT OF DOCUMENTS<br>U.S. GOVERNMENT PRINTING OFFICE<br>WASHINGTON, DC 20402<br>www.ecfr.gov |

…[skipping to the end of section 1602]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c), 25402.5.4 and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1604. Test Methods for Specific Appliances.

…[skipping (a) through (h)]

(i) Plumbing Fixtures.

The test methods for plumbing fixtures are:

(1) Test Methods for Water Closets. ~~The test method for testing gallons per flush of water closets is 10 C.F.R. Section 430.23(u) (Appendix T to subpart B of part 430). See section 1604(i)(3) of this Article for the required waste extraction test.~~

(A) The test method for testing gallons per flush of water closets is 10 C.F.R. Section 430.23(u) (Appendix T to subpart B of part 430).

(B) Performance requirements for water closets. The test method for determining the performance of water closets is Section 7.5 Granule and ball test, Section 7.6 Surface wash test, Section 7.7 Drain line transport characterization test, 7.8 Overflow test (for gravity tank-type water closets only), 7.9 Waste extraction test, and Section 7.12 or 7.13 Adjustability tests (for gravity tank-type water closets only) of ASME A112.19.2/CSA B45.1-2018.

(C) Test lab report requirements for water closets. Test lab reports shall include the reporting requirements from Section 1606 Table X of this Article and ASME A112.19.2/CSA B45.1-2018 sections specified in Section 1604(i)(1)(B) of this Article.

(2) Urinals. The test method for testing gallons per flush of urinals is 10 C.F.R. section 430.23(v) (Appendix T to subpart B of part 430).

~~(3) Waste Extraction Test for Water Closets. The waste extraction test for water closets is Section 7.10 of ASME A112.19.2/CSA B45.1-2013.~~

…[skipping rest of (j) through (x)]

The following documents are incorporated by reference in Section 1604.

*Number* *Title*

…[skipping CALIFORNIA ENERGY COMMISSION TEST METHODS]

FEDERAL TEST METHODS

C.F.R., Title 10, sections 429.56, 429.63, and 429.70

C.F.R., Title 10, section 430.23, and 10 C.F.R. Appendixes A, B, C1, D1, D2, E, F, H, I, J1, J2, M, N, O, P, Q, R, S, T, U, V, W, X, S1, Y, Z, AA, BB, CC, and DD of subpart B of part 430

C.F.R., Title 10, sections 431.15, 431.16, 431.17, 431.18, 431.19, 431.20, and 431.21

C.F.R., Title 10, sections 431.63 and 431.64

C.F.R., Title 10, sections 431.75 and 431.76

C.F.R., Title 10, sections 431.85 and 431.86

C.F.R., Title 10, sections 431.95 and 431.96

C.F.R., Title 10, sections 431.105 and 431.106

C.F.R., Title 10, sections 431.133 and 431.134

C.F.R., Title 10, section 431.193

C.F.R., Title 10, section 431.204(b)

C.F.R., Title 10, section 431.224

C.F.R., Title 10, sections 431.263 and 431.264

C.F.R., Title 10, sections 431.293 and 431.294

C.F.R., Title 10, sections 431.303 and 431.304

C.F.R., Title 10, section 431.344, Appendix A to Subpart T of 10 C.F.R., § 431

C.F.R., Title 10, sections 431.443, 431.444, and 431.445

C.F.R., Title 10, section 431.464(a) Appendix A to Subpart Y of 10 C.F.R., § 431

C.F.R., Title 10, section 431.464(b), Appendix C to Subpart Y of 10 C.F.R., § 431

C.F.R., Title 10, section 431 subpart G

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WASHINGTON, DC 20402

www.ecfr.gov

…[skipping UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) through AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)]

AMERICAN SOCIETY FOR MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME A112.19.2/CSA B45.1-201~~3~~8 | Ceramic Plumbing Fixtures |
| ASME A112.18.1-2012/CSA B125.1-2012 | Plumbing Supply Fittings |
| Copies available from: | ASME HEADQUARTERS<br>TWO PARK AVENUE<br>NEW YORK, NY 10016-5990<br>www.asme.org<br>PHONE: 800-843-2763 (U.S./CANADA)<br>001-800-843-2763 (MEXICO)<br>973-882-1170 (OUTSIDE NORTH AMERICA)<br>EMAIL: CustomerCare@asme.org |

…[skipping to the end of section 1604]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1605.1. Federal and State Standards for Federally Regulated Appliances.

…[skipping (a) through (h)]

(i) Plumbing Fixtures.

See section 1605.3(i) of this Article for water efficiency standards for plumbing fixtures.

…[skipping to the end of section 1605.1]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1605.2. State Standards for Federally Regulated Appliances

…[skipping (a) through (h)]

(i) Plumbing Fixtures.

See section 1605.3(i) of this Article for water efficiency standards for plumbing fixtures.

…[skipping to the end of section 1605.2]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1605.3. State Standards for Non-Federally Regulated Appliances.

…[skipping (a) through (h)]

(i) Plumbing Fixtures.

(1) The water consumption of water closets and urinals, other than those designed and marketed exclusively for use at prisons or mental health care facilities, shall be not greater than the values shown in Tables I-1 and I-2.

Table I-1 Standards for Plumbing Fixtures On or After January 1, 2016[1]

| *Appliance* | *Maximum Gallons per Flush or Dual-flush effective flush volume* |
|---|---|
| | ~~*Sold or Offered for Sale On or After January 1, 2016* [1]~~ |
| All Water Closets | 1.28 |
| Trough-Type Urinals | Trough length (inches)/16 |
| Wall-Mounted Urinals | 0.125 |
| Other Urinals | 0.5 |

[1] For the items identified in Table I-1, noncompliant products may not be sold or offered for sale on or after the designated date, regardless of manufacture date.

Table I-2 Standards for Water Closets On or After [Effective Date]

| *Appliance* | *Maximum Flush Volume (gallons per flush)* |
|---|---|
| Dual-Flush Water Closets | Reduced Flush = 0.8 gpf<br>Full Flush = 1.28 gpf |
| Blowout Water Closets and Flushometer Valve Water Closets | 1.28 gpf |
| All other water closets | 1.1 gpf |

(2) Water closets sold or offered for sale on or after January 1, 2016, shall pass the Waste Extraction Test (Section ~~7.10~~7.9) of ASME A112.19.2/CSA B45.1-201~~3~~8.

…[skipping (j) through (x)]

The following documents are incorporated by reference in Section 1605.3.

*Number* *Title*

…[skipping FEDERAL REQUIREMENTS through AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)]

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.2/CSA B45.1-201~~3~~8 Ceramic Plumbing Fixtures

~~Waste Extraction Test (Section 7.10)~~

Copies available from:

ASME HEADQUARTERS
TWO PARK AVENUE
NEW YORK, NY 10016-5990
www.asme.org
PHONE: 800-843-2762 (U.S./canada)
001-800-843-2763 (MEXICO)
973-882-1170 (OUTSIDE NORTH AMERICA)
email: customercare@asme.org

…[skipping to the end of section 1605.3]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1606. Filing by Manufacturers; Listing of Appliances in the MAEDbS.

(a) Filing of Statements.

…[skipping first paragraph through (3)]

Table X
Data Submittal Requirements

| *Appliance* | *Required Information* | *Permissible Answers* |
|---|---|---|
| All Appliances | *Manufacturer’s Name | |
| | *Brand Name | |
| | *Model Number | |
| | Date model to be displayed | |
| | Regulatory Status | Federally-regulated consumer product, federally-regulated commercial and industrial equipment, non-federally-regulated |

…[ skipping *Non-Commercial Refrigerators, Non-Commercial Refrigerator-Freezers, Non – Commercial Freezers* through *Commercial Pre-rinse Spray Valves*]

| | | | |
|---|---|---|---|
| I | Plumbing Fixtures | *Type | Blowout water closet, gravity tank type water closet, dual~~duel~~-flush water closet, ~~electromechanical hydraulic~~ power-assisted water closet, ~~flushometer tank~~ pressure-assisted water closet, prison-type urinal, prison-type water closet, flushometer valve water closet, trough-type urinal, wall-mounted urinal, waterless urinal, other type urinal, vacuum-assisted ~~type~~ water closet |
| | | *Water Closet Type | One-piece, Two-piece |
| | | *Flush Type (water closets only) | Single, Dual |
| | | Tank Model Number (two-piece water closets only) | |
| | | Bowl Model Number (two-piece water closets only) | |
| | | Dual-Flush Effective Flush Volume (gpf) (Until [Effective Date]) | |
| | | Reduced Flush Volume (gpf) (for dual-flush water closets only) | |
| | | Full Flush Volume (gpf) (for all water closets) | |
| | | ~~Water Consumption (dual-flush effective volume for dual-flush water closet)~~ | |
| | | ~~Passes waste extraction test~~ | ~~True, False~~ |
| | | ~~Waste extraction value~~ | ~~grams~~ |
| | | Trough Length (inches) (trough-type urinals only) | |
| | | Urinal Flush Volume (gpf) | |

* "Identifier" information as described in Section 1602(a) of this Article.

…[skipping to the end of section 1606]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code; and Sections 16, 26 and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c), 25402.5.4 and 25960, Public Resources Code; and Section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

## § 1607. Marking of Appliances.

(a) Scope of Section 1607.

Every unit of every appliance within the scope of section 1601 of this Article shall comply with the applicable provisions of this section. The effective dates of this section shall be the same as the effective dates shown in section 1605.1, 1605.2 or 1605.3 of this Article for appliances for which there is an energy efficiency, energy consumption, energy design, water efficiency, water consumption, or water design standard in section 1605.1, 1605.2, or 1605.3 of this Article. For appliances with no energy efficiency, energy consumption, energy design, water efficiency, water consumption, or water design standard in section 1605.1, 1605.2, or 1605.3 of this Article, the effective date of this section shall be January 1, 2006.

(b) Name, Model Number, and Date.

Except as provided in section 1607(c) of this Article, the following information shall be permanently, legibly, and conspicuously displayed on an accessible place on each unit;

(1) manufacturer's name or brand name or trademark (which shall be either the name, brand, or trademark of the listed manufacturer specified pursuant to section 1606(a)(2)(A) of this Article;

(2) model number; and

(3) date of manufacture, indicating (i) year and (ii) month or smaller (e.g. week) increment. If the date is in a code that is not readily understandable to the layperson, the manufacturer shall immediately, on request, provide the code to the Energy Commission.

(c) Exceptions to Section 1607(b).

(1) For plumbing fixtures and plumbing fittings, the information required by section 1607(b) of this Article shall be permanently, legibly, and conspicuously displayed on an accessible place on each unit or on the unit's packaging.

…[skipping through the end of section (c)]

(d) Energy Performance Information.

(1) Federally Regulated Consumer Products.

The marking required by 16 C.F.R. part 305 shall be displayed as required for all federally regulated consumer products of the following classes:

…[skipping (A) through (O)]

(P) water closets,

…[skipping to end of section 1607]

NOTE: Authority cited: Sections 25213, 25218(e), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code. Reference: Sections 25216.5(d), 25401.9, 25402(a)-25402(c) and 25960, Public Resources Code.

# APPENDIX C:
# Additional Background Data

**Figure C-1: International Water Efficiency Labels**

| Country/ area | Scheme | Mandatory/ Voluntary | Government/ industry/ NGO led |
|---|---|---|---|
| Australia | Water Efficiency Labelling Scheme (indoor) | Mandatory | Government |
| Australia | Smart Approved Watermark | Voluntary | NGO |
| Canada | Watersense | Voluntary | Government |
| China | Water Conservation Certificate | Voluntary | Industry with independent certification |
| Europe (including UK) | European Water Label | Voluntary | Industry |
| Hong Kong | WSD Water Efficiency Labelling Scheme | Voluntary | Government |
| India | Water Efficient Products India (WEP-I) | Voluntary | NGO - Indian Plumbing Association (IPA) |
| Malaysia | Water Efficiency Product Labelling Scheme | Voluntary | Government |
| New Zealand | Water Efficiency Labelling Scheme | Mandatory | Government |
| Portugal | ANQUIP | Voluntary | NGO |
| Singapore | Water Efficiency Labelling Scheme | Mandatory | Government |
| UAE | United Arab Emirates ESMA Water Efficiency Label | Mandatory | Government |
| UK | Water Technology List | Voluntary | Government |
| UK | Waterwise Checkmark | Voluntary | NGO |
| USA | Watersense | Voluntary | Government |

Source: International Water Association (2019)

**Table C-1: Price Dataset of Single-Flush Toilets (Including Models Greater Than $500)**

| Flush Volume (gpf) | Compliant with Proposal | Number of Brands | Number of Models | Percent of Total Models | Minimum Price ($/Unit) | Maximum Price ($/Unit) | Average Price ($/Unit) |
|---|---|---|---|---|---|---|---|
| 0.8 | Yes | 6 | 16 | 2% | $149 | $384 | $255 |
| 0.95 | Yes | 1 | 1 | 0% | $338 | $338 | $388 |
| 1.0 | Yes | 10 | 73 | 10% | $274 | $3,399 | $1,067 |
| 1.08 | Yes | 1 | 1 | 0% | $3,750 | $3,750 | $3,750 |
| 1.1 | Yes | 3 | 11 | 2% | $211 | $774 | $440 |
| 1.27 | No | 4 | 5 | 1% | $288 | $456 | $365 |
| 1.28 | No | 46 | 591 | 85% | $98 | $2,655 | $615 |
| NA | Total | 71 | 698 | 100% | Lowest: $98 | Highest: $3,750 | Average: $654 |

Source: CEC, HomeDepot.com, Lowes.com, Build.com

**Table C-2: Price Dataset of Single-Flush Toilets (Excluding Models Greater Than $500)**

| Flush Volume (gpf) | Compliant with Proposal | Number of Brands | Number of Models | Percent of Total Models | Minimum Price ($/Unit) | Maximum Price ($/Unit) | Average Price ($/Unit) |
|---|---|---|---|---|---|---|---|
| 0.8 | Yes | 6 | 16 | 4.1% | $149 | $384 | $255 |
| 0.95 | Yes | 1 | 1 | 0.3% | $338 | $338 | $388 |
| 1.0 | Yes | 6 | 16 | 4.1% | $274 | $457 | $364 |
| 1.1 | Yes | 2 | 6 | 1.5% | $211 | $398 | $320 |
| 1.27 | No | 4 | 5 | 1.3% | $288 | $456 | $356 |
| 1.28 | No | 32 | 348 | 88.8% | $98 | $499 | $313 |
| NA | Total | 51 | 398 | 100% | Lowest: $98 | Highest: $499 | Average: $314 |

Source: CEC, HomeDepot.com, Lowes.com, Build.com

**Table C-3: Price Dataset of Dual-Flush Toilets (Including Models Greater Than $500)**

| Reduced Volume/Full Volume (gpf) | Compliant with Proposal | Number of Brands | Number of Models | Percent of Total Models | Minimum Price ($/Unit) | Maximum Price ($/Unit) | Average Price ($/Unit) |
|---|---|---|---|---|---|---|---|
| 0.8/1.0 | Yes | 2 | 8 | 2.7% | $2,067 | $8,702 | $5,835 |
| 0.8/1.28 | Yes | 9 | 43 | 14.6% | $229 | $4,519 | $600 |
| 0.8/1.6 | No | 3 | 7 | 2.4% | $289 | $6,375 | $1,591 |
| 0.9/1.28 | No | 4 | 30 | 10.2% | $434 | $2,550 | $1,292 |
| 0.92/1.28 | No | 1 | 8 | 2.7% | $246 | $387 | $319 |
| 0.92/1.32 | No | 1 | 32 | 10.8% | $217 | $2,457 | $1,072 |
| 0.95/1.26 | No | 1 | 1 | 0.3% | $407 | $407 | $407 |
| 0.95/1.28 | No | 1 | 1 | 0.3% | $283 | $283 | $283 |
| 1.0/1.27 | No | 2 | 2 | 0.7% | $550 | $1,216 | $883 |
| 1.0/1.28 | No | 3 | 6 | 2.0% | $189 | $880 | $597 |
| 1.0/1.5 | No | 1 | 2 | 0.7% | $422 | $430 | $426 |
| 1.0/1.6 | No | 9 | 22 | 7.5% | $199 | $1,599 | $642 |
| 1.06/1.59 | No | 1 | 3 | 1.0% | $357 | $900 | $579 |
| 1.1/1.28 | No | 2 | 10 | 3.4% | $305 | $374 | $335 |
| 1.1/1.6 | No | 20 | 120 | 40.7% | $109 | $963 | $394 |
| NA | Total | 60 | 295 | 100% | Lowest: $109 | Highest: $8,702 | Average: $789 |

Source: CEC, HomeDepot.com, Lowes.com, Build.com

**Table C-4: Price Dataset of Dual-Flush Toilets (Excluding Models Greater Than $500)**

| Reduced Volume/Full Volume (gpf) | Compliant with Proposal | Number of Brands | Number of Models | Percent of Total Models | Minimum Price ($/Unit) | Maximum Price ($/Unit) | Average Price ($/Unit) |
|---|---|---|---|---|---|---|---|
| 0.8/1.28 | Yes | 5 | 31 | 17.4% | $229 | $442 | $306 |
| 0.8/1.6 | No | 2 | 4 | 2.2% | $289 | $420 | $368 |
| 0.9/1.28 | No | 2 | 2 | 1.1% | $434 | $497 | $466 |
| 0.92/1.28 | No | 1 | 8 | 4.5% | $246 | $387 | $319 |
| 0.92/1.32 | No | 1 | 10 | 5.6% | $217 | $478 | $324 |
| 0.95/1.26 | No | 1 | 1 | 0.6% | $407 | $407 | $407 |
| 0.95/1.28 | No | 1 | 1 | 0.6% | $283 | $283 | $283 |
| 1.0/1.28 | No | 1 | 1 | 0.6% | $189 | $189 | $189 |
| 1.0/1.5 | No | 1 | 2 | 1.1% | $422 | $430 | $426 |
| 1.0/1.6 | No | 5 | 11 | 6.2% | $199 | $459 | $335 |
| 1.06/1.59 | No | 1 | 2 | 1.1% | $357 | $479 | $418 |
| 1.1/1.28 | No | 2 | 10 | 5.6% | $305 | $374 | $335 |
| 1.1/1.6 | No | 17 | 95 | 53.4% | $109 | $499 | $312 |
| NA | Total | 40 | 178 | 100% | Lowest: $109 | Highest: $499 | Average: $320 |

Source: CEC, HomeDepot.com, Lowes.com, Build.com

## Figure C-2: U.S. EPA WaterSense Dataset for Dual-Flush Toilets

| Name | Full Flush Volume (GPF) | Reduced Flush Volume (GPF) | Number of Models | Percentage | Effective Volume |
|---|---|---|---|---|---|
| 1.60 Full/1.10 Reduced (Dual-Flush) | 1.6 | 1.1 | 838 | 47.64% | 1.27 |
| 1.60 Full/1.07 Reduced (Dual-Flush) | 1.6 | 1.07 | 5 | 0.28% | 1.25 |
| 1.60 Full/1.06 Reduced (Dual-Flush) | 1.6 | 1.06 | 2 | 0.11% | 1.24 |
| 1.60 Full/1.05 Reduced (Dual-Flush) | 1.6 | 1.05 | 10 | 0.57% | 1.23 |
| 1.60 Full/1.00 Reduced (Dual-Flush) | 1.6 | 1 | 79 | 4.49% | 1.20 |
| 1.60 Full/0.90 Reduced (Dual-Flush) | 1.6 | 0.9 | 24 | 1.36% | 1.13 |
| 1.60 Full/0.80 Reduced (Dual-Flush) | 1.6 | 0.8 | 352 | 20.01% | 1.07 |
| 1.59 Full/0.85 Reduced (Dual-Flush) | 1.59 | 0.85 | 1 | 0.06% | 1.10 |
| 1.55 Full/1.01 Reduced (Dual-Flush) | 1.55 | 1.01 | 1 | 0.06% | 1.19 |
| 1.55 Full/0.95 Reduced (Dual-Flush) | 1.55 | 0.95 | 2 | 0.11% | 1.15 |
| 1.50 Full/0.80 Reduced (Dual-Flush) | 1.5 | 0.8 | 1 | 0.06% | 1.03 |
| 1.40 Full/1.00 Reduced (Dual-Flush) | 1.4 | 1 | 1 | 0.06% | 1.13 |
| 1.40 Full/0.93 Reduced (Dual-Flush) | 1.4 | 0.93 | 1 | 0.06% | 1.09 |
| 1.32 Full/0.92 Reduced (Dual-Flush) | 1.32 | 0.92 | 19 | 1.08% | 1.05 |
| 1.30 Full/1.10 Reduced (Dual-Flush) | 1.3 | 1.1 | 3 | 0.17% | 1.17 |
| 1.30 Full/0.90 Reduced (Dual-Flush) | 1.3 | 0.9 | 13 | 0.74% | 1.03 |
| 1.29 Full/0.92 Reduced (Dual-Flush) | 1.29 | 0.92 | 2 | 0.11% | 1.04 |
| 1.28 Full/1.10 Reduced (Dual-Flush) | 1.28 | 1.1 | 4 | 0.23% | 1.16 |
| 1.28 Full/1.00 Reduced (Dual-Flush) | 1.28 | 1 | 27 | 1.53% | 1.09 |
| 1.28 Full/0.92 Reduced (Dual-Flush) | 1.28 | 0.92 | 7 | 0.40% | 1.04 |
| 1.28 Full/0.90 Reduced (Dual-Flush) | 1.28 | 0.9 | 56 | 3.18% | 1.03 |
| 1.28 Full/0.88 Reduced (Dual-Flush) | 1.28 | 0.88 | 13 | 0.74% | 1.01 |
| 1.28 Full/0.85 Reduced (Dual-Flush) | 1.28 | 0.85 | 1 | 0.06% | 0.99 |
| 1.28 Full/0.84 Reduced (Dual-Flush) | 1.28 | 0.84 | 2 | 0.11% | 0.99 |
| 1.28 Full/0.80 Reduced (Dual-Flush) | 1.28 | 0.8 | 180 | 10.23% | 0.96 |
| 1.28 Full/0.60 Reduced (Dual-Flush) | 1.28 | 0.6 | 1 | 0.06% | 0.83 |
| 1.26 Full/1.10 Reduced (Dual-Flush) | 1.26 | 1.1 | 6 | 0.34% | 1.15 |
| 1.24 Full/0.92 Reduced (Dual-Flush) | 1.24 | 0.92 | 3 | 0.17% | 1.03 |
| 1.20 Full/0.90 Reduced (Dual-Flush) | 1.2 | 0.9 | 2 | 0.11% | 1.00 |
| 1.20 Full/0.88 Reduced (Dual-Flush) | 1.2 | 0.88 | 4 | 0.23% | 0.99 |
| 1.20 Full/0.80 Reduced (Dual-Flush) | 1.2 | 0.8 | 13 | 0.74% | 0.93 |
| 1.20 Full/0.70 Reduced (Dual-Flush) | 1.2 | 0.7 | 2 | 0.11% | 0.87 |
| 1.19 Full/0.80 Reduced (Dual-Flush) | 1.19 | 0.8 | 1 | 0.06% | 0.93 |
| 1.10 Full/0.90 Reduced (Dual-Flush) | 1.1 | 0.9 | 7 | 0.40% | 0.97 |
| 1.00 Full/0.80 Reduced (Dual-Flush) | 1 | 0.8 | 65 | 3.70% | 0.87 |
| 1.00 Full/0.70 Reduced (Dual-Flush) | 1 | 0.7 | 1 | 0.06% | 0.80 |
| 0.95 Full/0.50 Reduced (Dual-Flush) | 0.95 | 0.5 | 9 | 0.51% | 0.65 |
| 0.80 Full/0.50 Reduced (Dual-Flush) | 0.8 | 0.5 | 1 | 0.06% | 0.60 |
| | | Total | 1759 | 100.00% | |

Source: U.S. EPA WaterSense