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California Energy Commission

DRAFT STAFF REPORT

STAFF ANALYSIS of WATER EFFICIENCY STANDARDS for SPRAY SPRINKLER BODIES

2017 Appliance Efficiency Pre-Rulemaking
Docket Number 17-AAER-08

California Energy Commission
Edmund G. Brown Jr., Governor

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California Energy Commission

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PREFACE

On March 14, 2012, the California Energy Commission issued an order instituting rulemaking (OIR) to consider standards, test procedures, labeling requirements, and other efficiency measures to amend the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through Section 1609). In the OIR, the Energy Commission identified a variety of appliances with the potential to save energy or water or both. The OIR also authorizes the Energy Commission to investigate and adopt, if appropriate, additional priority measures as determined by the Lead Commissioner.

On April 21, 2017, the Energy Commission released an invitation to participate to provide interested parties the opportunity to inform the Commission about the product, market, and industry characteristics of the appliances identified in the OIR, as well as additional appliances. The Energy Commission reviewed the information and data received in the docket and hosted staff workshops on July 19 through 21, 2017, to vet this information publicly.

On July 18, 2017, the Energy Commission released an invitation to seek proposals for standards, test procedures, labeling requirements, and other measures to improve the efficiency and reduce the energy or water consumption of specified appliances. The Energy Commission reviewed the proposals received in the docket and hosted a staff webinar to vet those proposals on October 24, 2017.

This staff analysis proposes standards for spray sprinkler bodies and the basis for such standards. The report includes analysis of the cost-effectiveness, technical feasibility, and statewide benefits of the proposed standard in support of the requirements of Section 25402(c)(1) of the Public Resources Code.

ABSTRACT

Assembly Bill 1928 (Campos, Chapter 326, Statutes of 2016) requires the California Energy Commission to adopt performance standards and labeling requirements for landscape irrigation equipment on or before January 1, 2019.

This staff report focuses on spray sprinkler bodies, a component of landscape irrigation systems. The water consumption of spray sprinkler bodies varies greatly, even within models of similar sizes and feature sets. To date, no federal or state regulations mandate cost-effective, readily available technologies to improve the performance of less efficient models.

This report proposes an addition to the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 to 1609). California Energy Commission staff analyzed the cost-effectiveness and technical feasibility of proposed water efficiency standards for spray sprinkler bodies. The statewide water and energy (electricity) use and savings and other related environmental impacts and benefits are included in this analysis.

The proposed updates to Title 20 would set test methods and performance standards for spray sprinkler bodies. The update will require all spray sprinkler bodies to control the outlet flow rate over a specified range of inlet water pressures.

The proposed standard for landscape emitters is cost-effective, technically feasible, and would save about 8 billion gallons of water and 30 gigawatt-hours (GWh) of electricity for the first year the standard is in effect and more than 83 billion gallons per year and 298 GWh of electricity at full stock turnover. Consumers will save about $18 per spray sprinkler body over the life of the device through reduced water use.

Keywords: Appliance Efficiency Regulations, appliance regulations, water efficiency, energy efficiency, irrigation equipment, landscape irrigation, sprinkler heads, spray sprinklers, spray sprinkler bodies

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EXECUTIVE SUMMARY

Since 1976, the California Energy Commission has adopted cost-effective and technically feasible appliance standards that set a minimum level of energy or water efficiency, as part of the Energy Commission's mandate to reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy, including the energy associated with the use of water.

Improving the efficiency of the landscape irrigation represents an opportunity to save water in California. Landscape irrigation in urban areas in California consumes more than 1.1 trillion gallons of water per year. Assembly Bill 1928 (Campos, Chapter 326, Statutes of 2016) requires the Commission to adopt performance standards and labeling requirements for landscape irrigation equipment, such as spray sprinkler bodies, on or before January 1, 2019.

Staff identified overirrigation, excessive water pressure, and leakage during nonoperation as contributing to the inefficient irrigation of landscapes. The water is lost as it runs off the landscape, evaporates into the air, or drains beneath the reach of the plant roots, as shown in **Figure ES-1**. The losses may be significant, such as in the case of overirrigation where Californians, on average, provide 50 percent more water than is needed.

Figure ES-1: Irrigation Water Losses

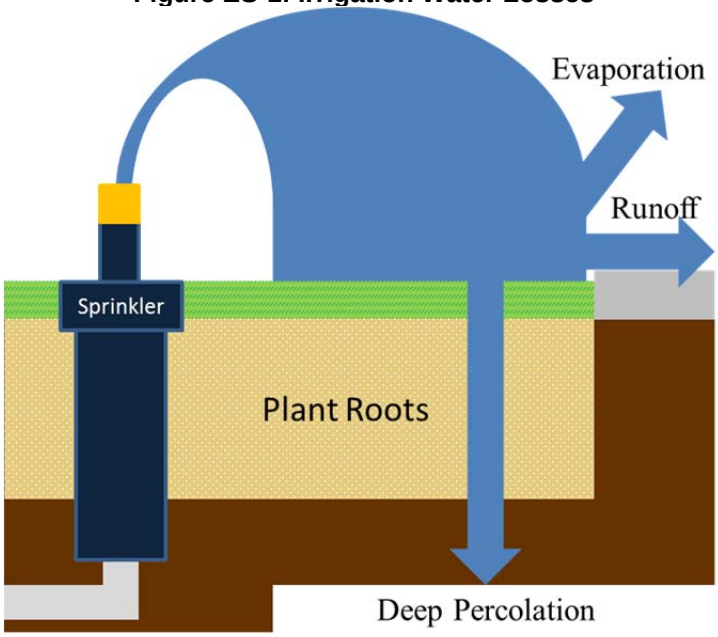

Illustration Credit: California Energy Commission

Californians water their landscapes through hand watering, lawn sprinklers, or drip irrigation. The staff proposal examines an opportunity to increase the water efficiency of the spray sprinkler body, a component of a spray sprinkler. Spray sprinkler bodies are offered with pressure regulation as an optional feature. Pressure regulation addresses the issue of excessive water pressure by maintaining the optimum water flow from the sprinkler regardless of the water

pressure. By eliminating excessively high water flow, overirrigation will also be addressed. The widespread adoption of this standard will prevent the unnecessary and wasteful use of more than 83 billion gallons of water per year once fully implemented, while saving consumers money with products available to the market.

Figure ES-2: Spray Sprinkler Body

Photo Credit: Rain Bird

Energy Commission staff analyzed the cost-effectiveness, technical feasibility, and statewide energy and water savings of the proposed spray sprinkler body standard. Cost-effectiveness is a measure of the benefits to the consumer, compared to the costs to the consumer, due to requiring the appliance to be more water- or energy-efficient. The benefit to the consumer must exceed the cost to the consumer for the proposed standard to be cost effective. To determine cost effectiveness, staff must determine the value of the water or energy saved, the effect of the standard on the usefulness of the device, and the life-cycle cost to the consumer of the efficient device.

Technical feasibility means that products are technologically capable of meeting the proposed standard by the effective date. The Energy Commission must also consider other relevant factors, including the effect on housing costs, the total statewide costs and benefits of the standard over the lifetime of the product, economic impact on California businesses, and alternative approaches and associated costs.

Staff developed a proposal based upon the test method and pressure regulation performance standard of the U.S. Environmental Protection Agency's WaterSense Specification for Spray Sprinkler Bodies, Version 1.0. The proposal would require all spray sprinkler bodies sold or offered for sale in California to be certified to the Energy Commission and meet minimum performance standards for pressure regulation when tested per the WaterSense test method. The proposed effective date would be January 1, 2020, one year after adoption by the Energy Commission.

The proposal is cost-effective. A compliant spray sprinkler body is estimated to cost $4.68 more than a noncompliant spray sprinkler body, and the consumer will save $26.90 over the 10-year lifetime of the product through a reduced water utility bill, resulting in $22.22 in savings. The life-cycle benefit of $18.26 reflects a 3 percent annual discount rate applied to the savings so the incremental costs, and savings can be compared in terms of net present value.

Table ES-1: Annual Water, Energy, and Monetary Savings

	Design Life (years)	Water Savings (gal/yr)	Embedded Electricity Savings (kWh/yr)	Incremental Costs ($)	Average Annual Savings ($/yr)	Life-Cycle Benefit ($)
Spray Sprinkler Bodies	10	442	1.6	$4.68	$2.69	$18.26

Source: California Energy Commission

The proposal is also technically feasible. The University of Florida tested six brands of spray sprinkler bodies. The test results show that four of the six brands will meet the proposed standard. The testing demonstrates the technical feasibility of staff's proposal.

Finally, the proposal will deliver significant water, electricity, and monetary savings to California. **Tables ES-2** and **ES-3** provide estimates for first-year and stock turnover savings.

Table ES-2: Water Savings and Energy Savings

Product Type	Statewide First Year (MM gal/yr)	Embedded Electricity First Year (GWh/yr)	Statewide Stock Savings (MM gal/yr)	Embedded Electricity Stock Savings (GWh/yr)
Spray Sprinkler Bodies	8,353	30	83,526	298

Source: California Energy Commission

Table ES-3: Statewide Monetary Savings

	First Year			Stock Savings		
Product Type	Water Delivery (M$/yr)	Embedded Electricity (M$/yr)	Total (M$/yr)	Water Delivery (M$/yr)	Embedded Electricity (M$/yr)	Total (M$/yr)
Spray Sprinkler Bodies	$50.8	$4.3	$55.0	$507.8	$42.6	$550.4

Source: California Energy Commission

The proposal will have a significant positive impact on the environment by reducing the diversion of billions of gallons of water from waterways and habitat. The reduction in diversions also reduces the energy required to pump water, with an associated reduction in greenhouse gas emissions.

CHAPTER 1:
Legislative Criteria

Section 25402(c)(1) of the Public Resources Code mandates that the California Energy Commission reduce the inefficient consumption of energy and water by prescribing efficiency standards and other cost-effective measures for appliances whose use requires a significant amount of energy or water statewide. Such standards must be technically feasible and attainable and must not result in any added total cost to the consumer over the designed life of the appliance.

In determining cost-effectiveness, the Energy Commission considers the value of the water or energy saved, the effect on product efficacy for the consumer, and the life-cycle cost of complying with the standard to the consumer. The Commission also considers other relevant factors including, but not limited to, 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.

Section 25401.9 of the Public Resources Code requires the Energy Commission, to the extent that funds are available, to adopt by January 1, 2019, performance standards and labeling requirements for landscape irrigation equipment, including emission devices, for reducing the wasteful, uneconomic, inefficient, or unnecessary consumption of energy or water.

CHAPTER 2:
Efficiency Policy

The Warren-Alquist Act[1] establishes the California Energy Commission as California's primary energy policy and planning agency and mandates the Energy Commission to reduce the wasteful and inefficient consumption of energy and water in the state by prescribing standards for minimum levels of operating efficiency for appliances that consume a significant amount of energy or water statewide.

For more than four 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, appliance standards have shifted the marketplace toward more efficient products and practices, reaping significant 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 30,065 gigawatt-hours (GWh)[2]of electricity in 2015 alone, resulting in about $4.84 billion in savings[3] to California consumers. In the 1990s, the California Public Utilities Commission (CPUC) decoupled the utilities' financial results from their direct energy sales, promoting utility support for efficiency programs. These efforts have reduced peak load needs by more than 8,645 megawatts (MW) and continue to save about 32,594 GWh per year of electricity.[4] The potential for additional savings remains by increasing the energy efficiency and improving the use of appliances.

Improving California's Resiliency to Future Drought

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[5] and directed state officials to take all necessary actions to prepare for and respond to drought conditions. On September 13, 2016, the Governor signed Water Efficiency: Landscape Irrigation Equipment Act (Assembly Bill 1928, Campos, Chapter 326) requiring the Energy Commission to adopt by January 1, 2019, performance standards and labeling requirements for landscape irrigation equipment, including, but not limited to, irrigation controllers, moisture sensors, emission

1 The Warren-Alquist State Energy Resources Conservation and Development Act, Division 15 of the Public Resources Code, § 25000 et seq., available at http://www.energy.ca.gov/2015publications/CEC-140-2015-002/CEC-140-2015-002.pdf.

2 California Energy Commission, *California Energy Demand 2016-2026 Revised Electricity Forecast*, January 2016, available at http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-03/TN207439_20160115T152221_California_Energy_Demand_20162026_Revised_Electricity_Forecast.pdf.

3 Using current average electric power and natural gas rates of residential electric rate of $0.164 per kilowatt-hour, commercial electric rate of $0.147 per kilowatt-hour. This estimate does not incorporate any costs associated with developing or complying with appliance standards.

4 California Energy Commission, *California Energy Demand 2016-2026 Revised Electricity Forecast,* January 2016, available at http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-03/TN207439_20160115T152221_California_Energy_Demand_20162026_Revised_Electricity_Forecast.pdf.

5 Office of Edmund G. Brown Jr., "Governor Brown Declares Drought State of Emergency," January 17, 2014. Retrieved from http://gov.ca.gov/news.php?id=18368.

devices, and valves. In response, the Energy Commission initiated a formal process to consider standards and test procedures, labeling requirements, and other efficiency measures for spray sprinkler bodies and irrigation controllers.[6] Although the drought has ended, the Energy Commission remains committed to helping ensure that water conservation remains a California way of life.

Water-Energy Nexus

Urban water use including landscape irrigation consumes significant energy to move and treat water. A 2005 Commission 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 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 *Climate Change Scoping Plan*.[11] Energy efficiency regulations are also identified as key components in reducing electrical energy consumption in the *2015 Integrated Energy Policy Report* (*IEPR*)[12] and the 2011 update to the CPUC's *Energy Efficiency Strategic Plan*.[13] Finally, Governor Brown and the Legislature have identified appliance efficiency standards as a key to doubling the energy efficiency savings necessary to put California on a path to reducing its GHG emissions to 80 percent below 1990 levels by 2050.[14] This commitment was

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6 California Energy Commission. 2017. *2017 Integrated Energy Policy Report*. California Energy Commission. Publication Number: CEC-100-2017-001-CMD, pg. 58.

7 Navigant Consulting, Inc. 2006. *Refining Estimates of Water-Related Energy Use in California*. California Energy Commission, PIER Industrial/Agricultural/Water End Use Energy Efficiency Program. CEC-500-2006-118. Pg. 16

8 Pike, Ed, and Daniela Urigwe, *Codes and Standards Enhancement (CASE) Response to Invitation to Submit Proposals-Irrigation Spray Sprinkler Bodies*, pg. 64, September 18, 2017

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, *Climate Change Scoping Plan*. available at http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.

12 California Energy Commission, *2015 Integrated Energy Policy Report, 2015*, available at http://energy.ca.gov/2015_energypolicy/.

13 CPUC, *Energy Efficiency Strategic Plan*, updated January 2011, available at http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

14 Gov. Edmund G. Brown Jr., "2015 Inaugural Address," available at http://gov.ca.gov/news.php?id=18828.

made to the Subnational Global Climate Leadership Memorandum of Understanding (Under2 MOU) agreement along with 167 jurisdictions representing 33 countries.[15]

On October 7, 2015, the Governor signed the Clean Energy and Pollution Reduction Act of 2015 or Senate Bill 350 (De León, Chapter 547, Statutes of 2015), requiring the Energy Commission 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.[16] Appliance efficiency standards will be critical in meeting this goal. In addition, the Energy Commission adopted the *Existing Buildings Energy Efficiency Action Plan* in September 2015 and updated it in December 2016 to transform existing residential, commercial, and public buildings into energy-efficient buildings.[17] Water end-use efficiency is one of the several strategies identified to increase efficiency in existing buildings.

Loading Order for Meeting the State's Energy Needs

California's loading order places energy efficiency as the top priority for meeting energy needs. The *Energy Action Plan II* strongly supports the loading order, which describes the priority sequence for actions to address increasing energy needs. Energy efficiency and demand response are the preferred means of meeting the state's growing energy needs.[18]

For the past 30 years, while per-capita electricity consumption in the United States has increased by nearly 50 percent, California's per-capita electricity use has been nearly flat. Continued progress in cost-effective building and appliance standards and ongoing enhancements to efficiency programs implemented by investor-owned utilities (IOUs), publicly owned utilities, and other entities have contributed significantly to this achievement.[19]

Zero-Net-Energy Goals

The *California Long-Term Energy Efficiency Strategic Plan*,[20] adopted in 2008 by the CPUC and developed with the Energy Commission, the California Air Resources Board (CARB), the state's utilities, and other key stakeholders, is California's roadmap to achieving maximum energy

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15 Subnational Global Climate Leadership Memorandum of Understanding, available at http://under2mou.org/background/.

16 California Energy Commission, *2016 Integrated Energy Policy Report Update*, available at http://docketpublic.energy.ca.gov/PublicDocuments/16-IEPR-01/TN216281_20170228T131538_Final_2016_Integrated_Energy_Policy_Report_Update_Complete_Repo.pdf.

17 California Energy Commission, *California's Existing Buildings Energy Efficiency Action Plan – 2016 Update,* available at http://docketpublic.energy.ca.gov/PublicDocuments/16-EBP-01/TN214801_20161214T155117_Existing_Building_Energy_Efficency_Plan_Update_Deceber_2016_Thi.pdf.

18 California Energy Commission, *Energy Action Plan II,* available at http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF, p. 2.

19 California Energy Commission, *Energy Action Plan II,* available at http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF, p. 3.

20 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan,* updated January 2011, available at http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-9477-3363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf.

savings between 2009 and 2020 and beyond. It includes four "big, bold strategies" as cornerstones for significant energy savings with widespread benefit for all Californians:[21]

- All new residential construction in California will be zero-net energy (ZNE) by 2020.
- All new commercial construction in California will be ZNE by 2030.
- Heating, ventilation, and air conditioning (HVAC) will be transformed to ensure that energy performance matches California's climate.
- All eligible low-income customers will have the opportunity to participate in the low-income energy efficiency program by 2020.

These strategies were selected based on the ability to achieve significant energy efficiency savings and bring energy-efficient technologies and products into the market.

On April 25, 2012, Governor Brown further targeted ZNE consumption for state-owned buildings. Executive Order B-18-12[22] requires ZNE consumption for 50 percent of the square footage of existing state-owned buildings by 2025 and ZNE consumption from all new or renovated state buildings beginning design after 2025.

To achieve these goals, the Energy Commission has committed to adopting and implementing building and appliance regulations that reduce wasteful energy and water consumption. The *Long-Term Energy Efficiency Strategic Plan* directs the Commission to develop a phased and accelerated "top-down" approach to more stringent codes and standards.[23] It also calls for expanding the scope of appliance standards to plug loads, process loads, and water use. The Commission adopted its detailed plan for fulfilling these objectives in the *2013 IEPR*.[24]

Governor's Clean Energy Jobs Plan

On June 15, 2010, as a part of his campaign, Governor Brown proposed the *Clean Energy Jobs Plan*,[25] which directed the Energy Commission to strengthen appliance efficiency standards for lighting, consumer electronics, and other products. The Governor noted that energy efficiency is the cheapest, fastest, and most reliable way to create jobs, save consumers money, and cut pollution from the power sector. He also stated that California's efficiency standards and programs have triggered innovation and creativity in the market. Today's appliances are not only more efficient, but they are less expensive and more versatile than ever, due in part, to California's leadership in the area. These proposed performance standards for irrigation spray bodies are in accord with the goals of the *Clean Energy Jobs Plan*.

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21 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, available at http://www.cpuc.ca.gov/NR/rdonlyres/14D34133-4741-4EBC-85EA-8AE8CF69D36F/0/EESP_onepager.pdf , p. 1.

22 Office of Edmund G. Brown Jr., "Executive Order B-18-12," April 25, 2012, available at https://www.gov.ca.gov/news.php?id=17508.

23 California Energy Commission and CPUC, *Long-Term Energy Efficiency Strategic Plan*, p. 64.

24 California Energy Commission, *2013 IEPR*, pp. 21-26.

25 Office of Edmund G. Brown Jr., *Clean Energy Jobs Plan*, available at http://gov.ca.gov/docs/Clean_Energy_Plan.pdf.

CHAPTER 3: Background

Introduction

In 1871, Joseph Lessler patented the first lawn sprinkler.[26] It consisted of a stand, a nozzle holder, and a flexible hose. Rotating and water propelled sprinklers were introduced in the 1890s.[27] The first in-ground pop-up sprinkler was patented more than 100 years ago in 1916.[28] Since these inventions, lawn sprinklers have been widely used to irrigate urban landscapes.

Figure 3-1: First Patented In-Ground Lawn Sprinkler

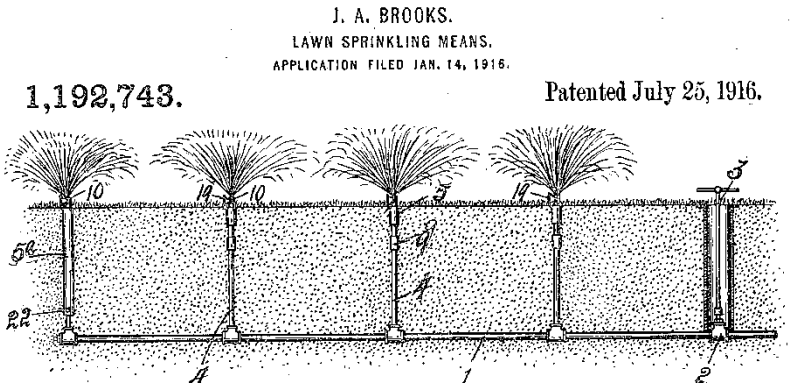

Illustration Credit: U.S. Patent 1192743 A

The California Department of Water Resources estimates that 34 percent of urban water use, or roughly 1.1 trillion gallons, are used each year to irrigate residential landscapes. Large landscapes require an additional 10 percent, or 325 million gallons per year, for irrigation. Statewide landscape water use exceeds indoor residential water use.[29] Water-saving opportunities in landscape irrigation include the use of irrigation controllers, user education, and the use of efficient landscape irrigation equipment.[30]

26 "U.S. Patent 121949A , Sprinkler Dec. 19, 1871," available at https://www.google.com/patents/US121949.

27 "U.S. Patent 425340 A, Sprinkler Apr. 8, 1890," available at https://www.google.com/patents/US425340.

28 U.S. Patent US1192743 A, Sprinkler, Jul. 25, 1916, available at https://www.google.com/patents/US1192743.

29 California Department of Water Resources, *California Water Plan Update 2013, Volume 3*, Chapter 3, pg. 3-10, http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/Vol3_Ch03_UrbanWUE.pdf.

30 Ibid., pg. 3-12 to 3-14.

Landscape Irrigation Methods

Residential and commercial property owners and occupants maintain their landscapes through several methods of irrigation, including hand watering, sprinkler systems, and drip irrigation systems. Hand watering is performed typically with a hose and a portable sprinkler that may be moved about the landscape. Sprinkler systems are permanently plumbed systems relying upon subterranean piping, valves, and landscape emitters to spray water from fixed locations. Drip irrigation systems rely on a system of hoses and microemitters to deliver water as droplets to plantings.[31]

Figure 3-2: Hand, Lawn Sprinkler, and Drip Irrigation Systems

Hand Watering | Lawn Sprinkler | Drip Irrigation

Photo Credit: Home Depot

Lawn sprinklers irrigate from 50 percent[32] to 78 percent[33] of landscapes. Thus, due to the large water use of these sprinklers, increasing the irrigation efficiency of lawn sprinklers is a key component of California's efforts to make water conservation a way of life, as well as its energy efficiency strategy.

Challenges to Water Efficiency

Overirrigation

Overirrigation of landscapes is a common occurrence in California and across the United States.[34] Overirrigation occurs when more water is applied to a landscape than can be used by the plants.

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31 "Water Use It Wisely Campaign, Efficiency Irrigation," http://wateruseitwisely.com/100-ways-to-conserve/landscape-care/principles-of-xeriscape-design/efficient-irrigation/#pros.

32 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 39, September 18, 2017.

33 Aquacraft. 2011. *Embedded Energy in Water Studies Study 3: End-Use Water Demand Profiles*. Prepared for the California Public Utilities Commission. April 29, 2011. http://www.energy.ca.gov/appliances/2013rulemaking/documents/responses/Water_Appliances_12-AAER-2C/California_IOU_Response_to_CEC_Invitation_to_Participate-Lavatory_Faucets_and_Faucet_Accessories_REFERENCES/CPUC_2011a_Embedded_Energy_in_Water_Studies-Study_3.PDF.

34 North Texas Municipal Water District, *One Out of Three North Texans Admit to Watering Their Lawns Three or More Times a Week*, June 14, 2011; Dale J. Bremer, Steven J. Keeley, Abigail Jager, Jack D. Fry, and Cathie Lavis, *In-Ground Irrigation Systems Affect Lawn-watering Behaviors of Residential Homeowners*, American Society of Horticultural Science, HortTechnology Electronic Journal, October 2012; Metropolitan Council, Efficient Water Use on Twin Cities Lawns through Assessment, Research and Demonstration, December 2016, available at https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-SUPPLY-PLANNING/Twin-Cities-Lawn-Irrigation-System-Surveys-And-Ass.aspx.

The excess water is lost through deep percolation, runoff, and evaporation, as shown on **Figure 3-3**.

Figure 3-3: Overirrigation Water Losses

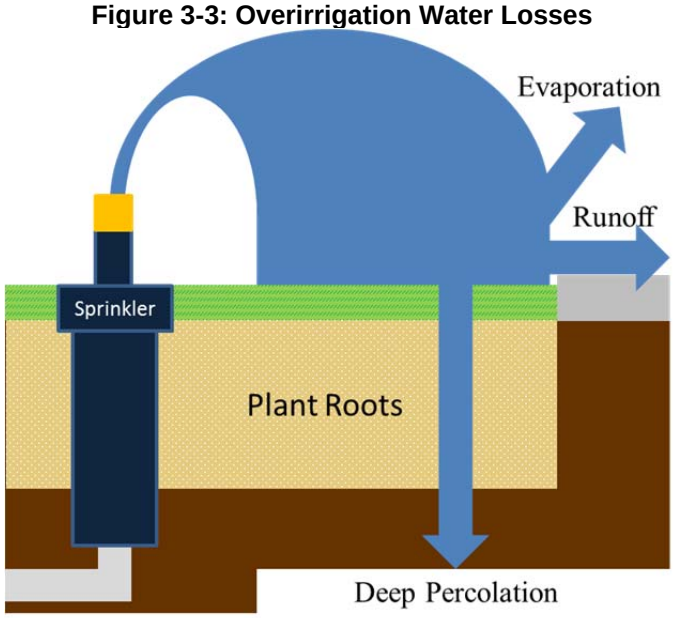

Illustration Credit: California Energy Commission

A study of smart irrigation controllers revealed how landscape irrigation practices vary in California. The study presents an application ratio, a comparison of how much is water applied versus how much water is needed. An application ratio of 100 percent means the water applied to the landscape would exactly meet the irrigation needs of the landscape. On average, Californians apply 50 percent more water than is needed.[35]

Water Supply Overpressure

Manufacturers design irrigation spray nozzles to operate at a water pressure between 30 to 45 pounds per square inch (psi).[36] Supply water pressure above the design pressure of the device can lead to inefficient device operation with excessive water flow rates; water lost to misting, wind drift, and evaporation; and poor uniformity. The supply water pressure to an irrigation system or device may vary significantly from location or time of day. A recent survey of California landscape irrigation contractors found most irrigation connections provide an excessive water pressure with a statewide water pressure mean average of 65 psi.[37]

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35 Mayer, Peter, et al, *Evaluation of California Weather Based "Smart" Irrigation Controller Programs*, 2009, pg. 95 , available at: http://ucanr.edu/sites/UrbanHort/files/99641.pdf.

36 Mecham, Brent, Irrigation Association, *Spray Sprinkler Bodies Docket Number: 17-AAER-05*, pg. 2, September 18, 2017.

37 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 94-95, September 18, 2017.

Figure 3-4: California Average Static Water Supply Pressure

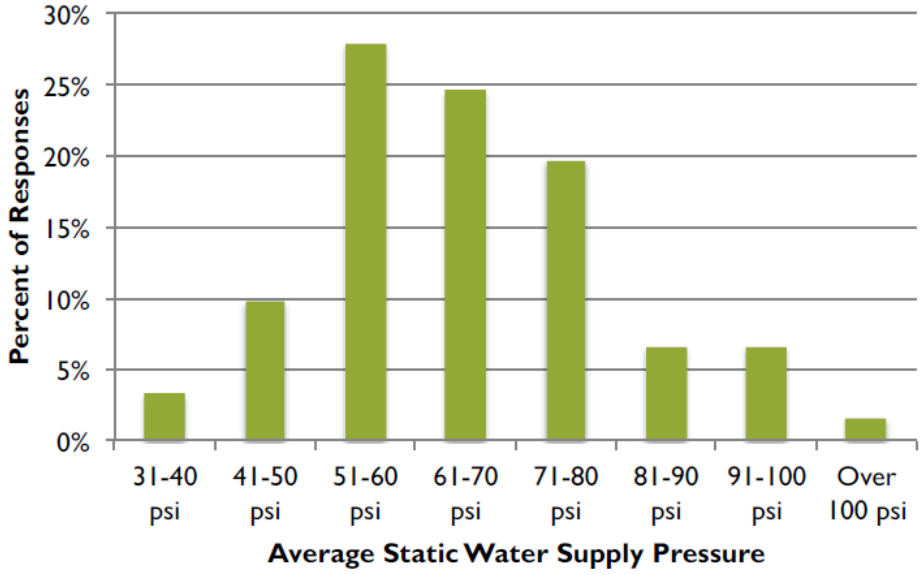

Illustration Credit: Evergreen Economics

Irrigation System Leaks During Nonoperation

Landscape irrigation components may be installed at differing elevations. If sprinkler heads are located at lower elevations than other parts of the system, then water may flow downhill and leak from the sprinkler heads when they're not operating.[38] The California investor-owned utilities' Codes and Standards Enhancement (CASE) team performed a survey of California to characterize the distribution of elevation changes within developed areas. The survey showed that elevation changes sufficient for system drainage occur in most landscapes in California.[39] The study suggests an opportunity for savings by preventing drainage from the sprinkler heads.

Figure 3-5: Irrigation System Drainage

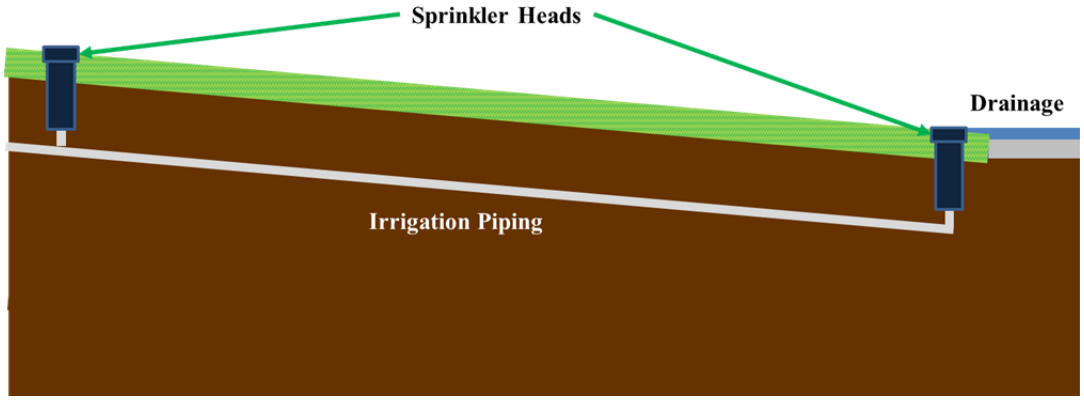

Illustration Credit: California Energy Commission

38 Mecham, Brent, Irrigation Association, *Spray Sprinkler Bodies Docket Number: 17-AAER-05*, pg. 2, September 18, 2017.

39 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 24-25, September 18, 2017.

CHAPTER 4:
Product Description

Landscape Emission Devices

The irrigation industry provides a wide variety of landscape emission devices adapted to best fit the needs of various landscapes. Emission devices are categorized according to the method of water delivery, water delivery rate, and installation. **Figure 4-1** shows the structure of the International Code Council (ICC) *802-2014 Landscape Irrigation Sprinkler and Emission Standard* definitions. This staff report follows this system of definitions in the discussion of landscape emission devices.

Figure 4-1: Landscape Emission Device Definitions

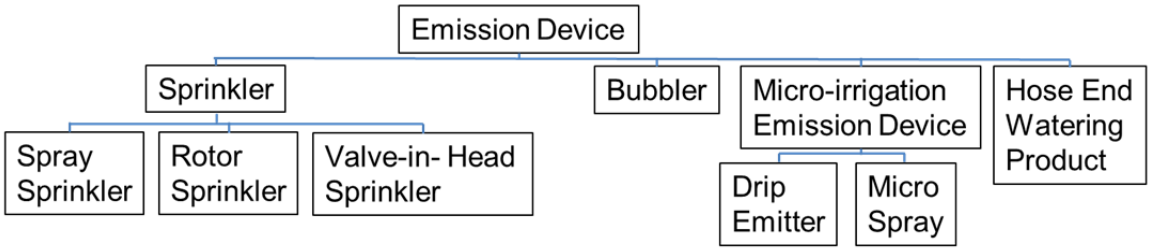

Illustration Credit: California Energy Commission

Sprinklers

Sprinklers are irrigation devices that convert irrigation water pressure to high-velocity water discharge through the air. Sprinklers are divided into three types: spray sprinklers, rotor sprinklers, and valve-in-head sprinklers. Each device is typically capable of a flow rate of more than 0.5 gallon per minute.[40]

Spray Sprinklers

A spray sprinkler relies upon a nonrotating nozzle to provide water over a continuous area. Spray sprinklers may be outfitted with a variety of nozzles, and the design of the sprinkler body may also vary depending upon the inclusion of a pop-up stem or retraction spring.

Pop-Up Spray Sprinklers

The pop-up spray nozzle sprinkler employs nozzles that spray water in a fixed pattern. They are typically used for small landscape areas, operating at 15 to 40 psi with a water spray distance of about 4 feet to 20 feet. The pattern of spray can be full-circle, half-circle, quarter circle, or rectangular strip. Some spray nozzles allow the user to set the angle of spray coverage. Spray

40 International Code Council, *Landscape Irrigation Sprinkler and Emitter Standard*, ANSI/ASABE/ICC 802-2014 Chapter 2, http://codes.iccsafe.org/app/book/content/2014_AMERICAN%20NATIONAL%20STANDARD/ICC%20802/CHAPTER%202%20DEFINITIONS.html.

heads are interchangeable between bodies and are often marketed and sold separately. The pop-up mechanism relies upon a coil spring to retract the nozzle after sprinkler operation.

Figure 4-2: Pop-Up Spray Sprinkler

Photo Credit: Rain Bird

Pop-Up Multistream, Multitrajectory Spray Sprinklers

There are also multistream, multitrajectory spray nozzles that can be connected to spray sprinkler bodies. These nozzles use the flow of the water passing through them to rotate as they spray streams of water. Multistream, multitrajectory spray nozzles can provide a longer radius of throw and have higher recommended operating pressures of 40 to 45 psi. Multistream, multitrajectory spray nozzle sprinklers are different than the high-pressure gear rotor sprinklers.

Figure 4-3: Pop-Up Multistream, Multitrajectory Spray Sprinkler

Photo Credit: K-Rain

Pop-Up Gravity Retraction Spray Nozzle

Pop-up gravity retraction spray nozzle sprinklers are legacy sprinklers to older systems and were installed typically where water pressure is low.[41] The weight of the nozzle causes the nozzle to retract when not in use compared to the previous examples that rely on a coil spring to retract the

41 "Sprinkler Warehouse product description." http://www.sprinklerwarehouse.com/Brass-Gravity-Sprinklers-s/9067.htm.

nozzle.[42] The design is susceptible to leakage at the base if insufficient water pressure is available to deploy the nozzle. The sprinkler body may be brass or plastic.

Figure 4-4: Pop-Up Gravity Spray Nozzle Sprinkler

Photo Credit: Home Depot

Non-Pop-Up Spray Sprinklers

Some spray nozzle sprinklers do not pop-up while watering. Examples include shallow sprinklers intended to be flush with the ground and shrub spray sprinklers mounted to fixed risers to spray above shrubbery. Some shrub sprinklers are sold to be paired with a separately available riser pipe while other shrub sprinklers are sold with an adjustable riser.

Figure 4-5: Shrub Spray Sprinkler With Adjustable Riser

Photo Credit: Orbit Irrigation

42 Morningstar, Bird, *The Happy Gardener*, Chapter 8, http://www.happygardener.com/text/chap8/ch8doc1.htm.

Figure 4-6: Flush Spray Sprinkler

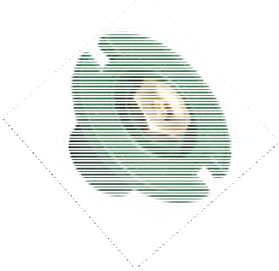

Photo Credit: Orbit Irrigation

Rotor Sprinklers

A rotor sprinkler rotates the nozzle or orifice to cover the irrigated area. The rotation may be driven by various means such as gear-driven turbines or impact mechanisms.

Gear-Driven Rotor Sprinklers

Gear-driven sprinklers use a turbine and gear train to impart a rotation to a nozzle. These typically operate at a higher pressure range of 30 to 100 psi (depending on model) and are most often used on larger landscapes due to the long water radius of throw (15 to 100 feet).[43] They offer quiet operation compared to other high-pressure sprinkler heads. The sprinklers provide larger water drops to reduce water waste from evaporation and misting.[44]

Figure 4-7: Gear-Driven Sprinkler

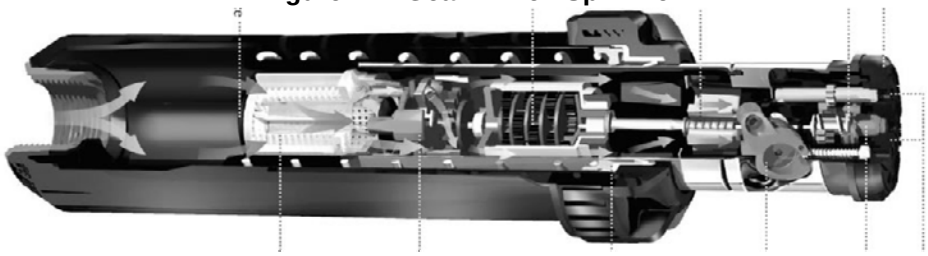

Photo Credit: Evergreen Sprinklers

Impact Rotor Sprinklers

Impact rotors were the first type of rotor sprinkler technology developed and offer the familiar sound of the spring-loaded mechanism impacting the water jet to impart rotation to the head. This type of sprinkler is used typically on larger landscapes. Impact sprinklers are offered as fixed or pop-up variants.[45]

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43 Sprinkler Warehouse, *The Different Types and Uses of Sprays, Rotors, and Impact Sprinklers,* http://www.sprinklerwarehouse.com/DIY-How-to-choose-a-sprinkler-head-s/7027.htm

44 Rain Bird Corporation, "5000 Series Rotors," http://www.rainbird.com/homeowner/products/rotors/5000.htm.

45 Sprinkler Warehouse, *The Different Types and Uses of Sprays, Rotors, and Impact Sprinklers,* http://www.sprinklerwarehouse.com/DIY-How-to-choose-a-sprinkler-head-s/7027.htm.

Figure 4-8: Impact Sprinkler

Photo Credit: Rain Bird

Gun

Athletic field irrigation is accomplished through gun sprinkler systems. The systems are capable of flow rates as high as 1,200 gallons per minute and can fire water up to 100 feet. Gun systems require high pressures to operate.[46]

Figure 4-9: Gun Sprinkler System

Photo Credit: Nelson Irrigation

Valve-in-Head Sprinklers

Valve-in-head sprinklers contain an integral valve used to remotely control the operation of individual sprinklers. The sprinklers are typically found on landscapes where there is a need for a high level of control, such as a golf course.

Bubblers

Bubblers are emission devices that are used to flood the soil and are typically used for the deep watering of shrubs and trees. The water spreads through the ground from the point of emission rather than being projected in a sprinkler system.[47]

46 Nelson Irrigation Corporation, "Sports Field Applications," http://www.nelsonirrigation.com/media/resources/BG_SPORTSFIELD.pdf.

Figure 4-10: Bubbler

Photo Credit: Hunter Industries

Microirrigation Emission Devices

Drip emitters, drip-line emitters, and microspray emitters discharge water in the form of droplets at very slow flow rates. Microirrigation systems typically have many distribution points. Microirrigation systems may be placed upon the surface of the landscape or may be buried below the surface.[48]

Figure 4-11: Types of Drip Emitters

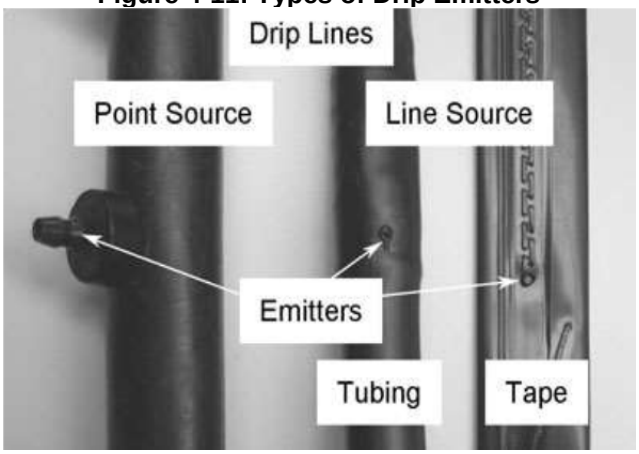

Photo Credit: New Mexico State University

47 Hunter Industries, "Bubblers and Bubbler Nozzles," http://www.hunterindustries.com/irrigation-product/nozzles/bubblers-bubbler-nozzles.

48 Hunter Industries, "Subsurface Irrigation Under Turf, Gardens, Small Shrubs," http://www.hunterindustries.com/irrigation-product/nozzles/bubblers-bubbler-nozzles.

Figure 4-12: Microspray Emitter

Photo Credit: Sprinkler Warehouse

Hose-End Watering Products

Hose-end watering products are intended for temporary placement by the user. Examples include portable lawn sprinklers and hand-held sprayers.

Figure 4-13: Hose-End Watering Products

Photo Credit: Nelson Irrigation

Landscape Emission Device Water Efficiency Technologies

Pressure Regulation

Pressure regulation provides for a uniform output pressure so that the emission device will perform at the designed pressure conditions. Manufacturers sell pressure regulation devices either incorporated into the emission device or as a separate device to be installed close to the water source connection. The pressure-regulating device adjusts the outlet pressure as the inlet pressure varies to prevent overpressurization of the landscape emission device or irrigation system.[49]

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49 Palumbo, Greg, and David Perl, Rain Bird Corporation, *Saving Water With Pressure Regulation and Check Valves-Introduction to Hydraulics*, pg. 16-30, https://www.rainbird.com/landscape/resources/webinars/Saving%20Water%20%20-%20Intro%20to%20Hydraulics.pdf.

Sprinkler Pressure Regulation

Sprinklers with pressure regulation control the output pressure to the spray nozzle to maintain the manufacturer-recommended operating pressure as the input pressure varies. Pressure-regulated sprinklers prevent excessive water flow rates, misting, wind drift, evaporation, and poor uniformity. Sprinklers are sold with and without pressure regulation.[50]

Typically, these devices feature a spring-operated flow tube centered within the sprinkler stem, which can move up and down between seats on either end of the flow tube. The movement of the tube relative to the inlet seat regulates how much water can flow through the stem, thus regulating water pressure at the outlet to the nozzle. The level of outlet-pressure regulation is determined by the strength of the spring. Different manufacturers may implement specific pressure regulation features differently and often have patented technologies.[51]

Pressure-regulator adapters are available for some landscape emission devices sold without pressure regulation, such as shrub sprinklers. The devices are threaded onto the supply pipe below the emission device.

Figure 4-14: Pressure Regulator Shrub Adapter

Photo Credit: Hunter Industries

Microemitter Pressure Regulation

Microemitter devices such as drip emitters, drip-line emitters, and bubblers are designed to operate at specific water pressures. Pressure-regulating devices are sold as part of water supply connection kits. Pressure regulation is not available as an integral feature of the microemitter.[52]

Drain Check Valve

A drain check valve closes the irrigation system to prevent the flow of water when the system is not operating. Irrigation systems may have drain check valves that are integral to the emission device, installed in-line with the irrigation piping, or installed underneath an emission device. Check valves can be added to most irrigation spray heads in the field as an add-on or sold as integral parts of the sprinkler head assembly.[53]

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50 Lacey, Dustin, *Project PRS: How Much Water Can You Really Save?*, Rain Bird Corporation, pg. 6-12, https://www.watersmartinnovations.com/documents/sessions/2015/2015-T-1536.pdf.

51 Senninger Irrigation, *How Does a Pressure Regulator Work?* http://www.senninger.com/how-does-a-pressure-regulator-work/.

52 Rain Bird Corporation, Landscape Dripline System, pg. 5, http://www.rainbird.com/documents/diy/bro_landscapedriplinesystem.pdf.

53 Palumbo, Greg, and David Perl, Rain Bird Corporation, *Saving Water With Pressure Regulation and Check Valves-Introduction to Hydraulics*, pg. 10, https://www.rainbird.com/landscape/resources/webinars/Saving%20Water%20%20-%20Intro%20to%20Hydraulics.pdf.

Missing Nozzle

Some sprinkler manufacturers offer a missing-nozzle flow feature called a flow-interrupting device.[54] The feature may reduce or stop water flow from the sprinkler when a nozzle or pop-up stem is missing or damaged.

Pressure-Compensating Screens

Some irrigation spray sprinkler bodies and bubblers[55] are available with pressure-compensating screens to reduce outlet pressure. Pressure-compensating screens are passive and fit inside the irrigation body pop-up stem. They have no moving parts. Pressure-compensating screens do not regulate pressure but impart a pressure drop by acting as an additional obstruction to water flow within the pop-up stem. The screens permit the outlet pressure to fluctuate as the irrigation system inlet pressure fluctuates.[56]

54 Qualified Water Efficient Landscaper, "QWEL Curriculum, Class 11, New Technology," pg. 17-18, http://www.qwel.net/wp-content/uploads/2011/04/QWEL-Class-11-2012.pdf.

55 Sprinkler Warehouse, "Hunter PCB-20 PCB Bubbler Nozzle," http://www.sprinklerwarehouse.com/Hunter-Sprinkler-Spray-Nozzles-p/pcb-20.htm.

56 http://www.irrigationtutorials.com/irrigation-sprinkler-head-selection/.

CHAPTER 5:
Regulatory Approaches

California Energy Commission staff considered and studied regulatory pathways to achieve water savings in spray sprinkler bodies. Staff evaluated the Irrigation Association Sprinkler Standards, the International Code Council (ICC) Landscape Irrigation Sprinkler and Emission Standard, and the U.S. Environmental Protection Agency (U.S. EPA) WaterSense Specification for Spray Sprinkler Bodies.

Historical Approach

There are no state or federal efficiency standards for spray sprinkler bodies.

Test Methods and Efficiency Standards

Irrigation Association Sprinkler Standards

The Irrigation Association (IA) developed and released several test methods with the Smart Water Application Technologies (SWAT) initiative. The goal of the initiative is to maintain a vibrant landscape while using a minimum amount of water. Although the test procedures have influenced the development of other landscape irrigation equipment test procedures and standards, no state and local regulations or product rebate programs reference the procedures.

IA released the *SWAT Testing Protocol for Spray Head Sprinkler Nozzles Performance Characteristics Version 3.2* in April 2015.[57] The test procedure tests sprinkler nozzle performance individually and in groups for distance of throw, nozzle flow, and precipitation rate. The test procedure defines the method to measure performance but does not set a performance standard.

The IA released the *SWAT Testing Protocol for Pressure Regulating Spray Head Sprinklers* V.3.0 in May 2012.[58] The procedure measures performance of pressure-regulating spray and multitrajectory nozzles. The test procedure also records the performance of sprinkler heads with a missing nozzle feature. The test method does not set a performance standard. IA provided recommended revisions to Version 3.0 as part of its comments to the Commission docket.[59]

The IA released the *SWAT Testing Protocol for Pop-up Sprinkler Head Check Valves Version 2.3* in June 2014. The test procedure tests integral check valve performance of sprinkler heads for

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57 Irrigation Association, *Smart Water Application Technologies Spray Head Sprinkler Nozzles Performance Characteristics Equipment Functionality Testing Protocol, Version 3.2*, April, 2015. https://www.irrigation.org/uploadedFiles/SWAT/Draft_Protocols/Spray_Head_Nozzles_Performance_Characteristics_Version%203.2_4-21-2015_Final.pdf.

58 Irrigation Association, *Smart Water Application Technologies Pressure Regulating Spray Head Sprinklers Equipment Functionality Testing Protocol*, Version 3.0, May, 2012. https://www.irrigation.org/uploadedFiles/SWAT/Draft_Protocols/Pressure%20Regulating%20Spray%20Head%20Sprinklers%20Testing%20Protocol%20Version%203.0%20May%202012.pdf.

59 Mecham, Brent, Irrigation Association, *Comment to Docket on the Invitation to Submit Proposals*, September 18, 2017, http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-08/TN221200_20170918T112728_Brent_Mecham_Comments_Proposed_Testing_of_Spray_Sprinklers.pdf.

seat tightness or leak resistance during nonoperation. The procedure verifies performance when new and after 2,500 cycles.[60]

International Code Council and American Society of Agriculture and Biology Engineers Sprinkler Standard

The International Code Council (ICC) developed and adopted the ASABE/ICC 802-2014, *Landscape Irrigation Sprinkler and Emission Standard*. The standard provides a test method and design and performance requirements for turf grass and landscape irrigation emitters to determine pressure-regulating, integral check valve, and missing nozzle performance. The standard does not specify a performance requirement for pressure regulation or missing nozzle performance. The standard sets a minimum check valve performance standard at a pressure head of 7 feet.[61] The U.S. EPA WaterSense Specification was developed from the ICC standard. The California Department of Water Resources references the ICC standard in the Model Water Efficient Landscape Ordinance.

ICC has begun developing the next edition of the standard. The ICC call for public input was due December 11, 2017.

U.S. Environmental Protection Agency WaterSense

The U.S. EPA WaterSense program developed a voluntary test method and standard based on ANSI ASABE/ICC 802-2014 *Landscape Irrigation Sprinkler and Emitter Standard*. The EPA evaluated the test method and measured spray sprinkler body performance for pressure regulation.[62] On September 21, 2017, the EPA published the WaterSense Specification for Spray Sprinkler Bodies. The EPA modified the test procedure to include step testing with pauses between test points, a reduction of the number of water pressure test points, and monitoring of the outlet flow rate. The EPA set minimum pressure regulation requirements based upon the as-tested performance of spray sprinkler bodies.[63]

Other Regulations and Approaches

California Model Water Efficient Landscape Ordinance

Per Executive Order B-29-15 of April 1, 2015, the Department of Water Resources (DWR) updated the State's Model Water Efficient Landscape Ordinance (MWELO) through expedited regulation.

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60 Irrigation Association, *Smart Water Application Technologies Pop-up Sprinkler Head Check Valves Equipment Functionality Testing Protocol, Version 2.3*, June, 2014 , https://www.irrigation.org/uploadedFiles/SWAT/SWAT%20Pop-up%20Sprinkler%20Head%20Check%20Valve-V2.3%20%206-18-2014.pdf.

61 International Code Council, ASABE/ICC 802-2014, *Landscape Irrigation Sprinkler and Emission Standard*,http://codes.iccsafe.org/app/book/content/2014_AMERICAN%20NATIONAL%20STANDARD/ICC%20802/CHAPTER%203%20GENERAL%20REQUIREMENTS%20FOR%20SPRINKLERS%20AND%20BUBBLERS.html.

62 Dukes, Michael D. Ph. D, P.E., University of Florida, *Pressure Regulating Spray Sprinkler Body Final Test Report*, January 16, 2017, https://www.epa.gov/sites/production/files/2017-03/documents/ws-background-ssb-performance-testing-report1.pdf.

63 U.S. Environmental Protection Agency, *WaterSense® Specification for Spray Sprinkler Bodies Supporting Statement*, September 21, 2017, https://www.epa.gov/sites/production/files/2017-09/documents/ws-products-support-statement-ssb.pdf.

Cities and counties are responsible for adopting and reporting a water-efficient landscape ordinance. Local agencies had until December 1, 2015, to adopt MWELO or adopt a local ordinance that is at least as effective in conserving water as MWELO. Local agencies had until February 1, 2016, to work together to adopt a regional ordinance. To comply, local agencies were required to perform one of the following actions:

- Adopt MWELO by reference Sections 490-495, Chapter 2.7, Division 2, Title 23 in the California Code of Regulations.
- Adopt the actual text of MWELO, Sections 490-495, Chapter 2.7, Division 2, Title 23 in the California Code of Regulations.
- Amend an existing or adopt a new local ordinance or regional ordinance to achieve the same savings as the MWELO regulations.
- Take no action and allow the MWELO to go into effect by default, and adopt a local or regional ordinance later.

MWELO applies to:

- New construction projects with an aggregate, or combined, landscape area equal to or greater than 500 square feet requiring a building or landscape permit, plan check, or design review.
- Rehabilitated landscape projects with an aggregate landscape area equal to or greater than 2,500 square feet requiring a building landscape permit, plan check, or design review.
- Cemeteries.
- Existing landscapes installed before December 1, 2015, greater than one acre.

In MWELO, local agencies are encouraged to take measures beyond those in MWELO, including measures that account for local climate, geology, topography, and environmental conditions. MWELO includes requirements for the inclusion of pressure-regulating devices and antidrain valves. However, these requirements are applied in design and construction and could possibly be omitted in the adoption of comparable regulations by local authorities.

California Independent Technical Panel on Demand Management Measures

DWR coordinated an effort to identify water-saving measures for landscape irrigation equipment and practices that culminated in the May 2016 *Recommendations Report to the Legislature on Landscape Water Use Efficiency*.[64] Section 7-2 recommends that the Energy Commission adopt appliance efficiency standards for spray sprinkler bodies that would require pressure regulation and drainage check valves.

64 Department of Water Resources, *Recommendations Report to the Legislature on Landscape Water Use Efficiency*, May 2016, pg. 45-46, http://www.water.ca.gov/wateruseefficiency/sb7/committees/urban/u2/docs/ITP%20Final%20Report%20to%20Legislature%2005-16-16%20watermark.pdf.

Regulations in Other States

The Texas Administrative Code specifies, "No irrigation design or installation shall require the use of any component, including the water meter, in a way which exceeds the manufacturer's published performance limitations for the component." This rule goes on to specify that methods must be used to ensure that emission devices be installed in a way that does not subject them to pressures above or below those published by the manufacturers. Methods listed include, but are not limited to, "a pressure regulator, or pressure compensating spray heads."[65]

International Association of Plumbing and Mechanical Officials

The International Association of Plumbing and Mechanical Officials (IAPMO) Green Plumbing & Mechanical Code Supplement Section 413.10.2 requires that sprinkler heads "utilize pressure regulating devices (as part of irrigation system or integral to the sprinkler head to maintain manufacturer's recommended operation pressure for each sprinkler and nozzle type)." The voluntary supplement serves as a resource for jurisdictions implementing green building and water efficiency programs.[66]

In November 2017, IAPMO released the 2017 Water Efficiency and Sanitation Standard (2017 WE Stand) that replaced the Green Plumbing & Mechanical Code Supplement. The WE Stand committee considered various proposals to improve the water efficiency of landscape irrigation. The Energy Commission participated as part of the Technical Committee. The standard remains voluntary and maintains many of the requirements of the preceding green code supplement, such as pressure regulation within irrigation systems.

Consideration of Alternative Proposals

The staff proposal was analyzed to determine whether it meets the legislative criteria for the Energy Commission's prescription of appliance efficiency standards. Staff also reviewed and analyzed the WaterSense specification as well as other state and local standards. Staff will continue to analyze and consider alternative proposals as they are provided to the Energy Commission.

Alternative 1: No Standard

Staff believes proposing no standard for all spray sprinkler bodies would represent a lost opportunity for water savings in California.

Alternative 2: Pressure Regulation Standard

Staff studied proposing pressure regulation for all spray sprinkler bodies since many products are available with pressure regulation. Pressure regulation provides significant water savings, and

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65 "Texas Administrative Code, Title 30, Part 1, Chapter 344, Subchapter F, STANDARDS FOR DESIGNING, INSTALLING, AND MAINTAINING LANDSCAPE IRRIGATION SYSTEMS, Rule 344.62 (a) and (c)," http://www.tceq.state.tx.us/assets/public/compliance/compliance_support/regulatory/irrigation/forms_li/344.62.pdf.

66 International Association of Plumbing and Mechanical Officials, *2012 Green Plumbing and Mechanical Code Supplement*, pg. 15, http://www.iapmo.org/Documents/2012GreenPlumbingMechanicalCodeSupplement.pdf.

when combined with the previous work performed by WaterSense, there is sufficient information to analyze cost-effectiveness, technical feasibility, and statewide water savings.

Alternative 3: Pressure Regulation and Check Valve Standard

Staff studied proposing pressure regulation and check valves on all spray sprinkler bodies since this is another common product offering. At this time, there is no available performance data to demonstrate cost-effectiveness and technical feasibility of the drain check valve. Staff has determined not to include the drain check valve as a water-saving measure but would consider this feature in the future when information becomes available regarding drain check valve performance.

Alternative 4: Pressure Regulation, Check Valve, and Missing Nozzle Standard

Staff studied proposing pressure regulation, check valve, and missing nozzle standards for all spray sprinkler bodies since some products are sold with this combination of features. Staff found insufficient evidence to estimate missing nozzle water savings and did not find a ready test procedure to verify missing nozzle performance. Staff does not propose to include missing nozzle capability in the proposed standard.

Test Method Selection

Energy Commission staff reviewed the available test procedures for spray sprinkler body pressure regulation. Staff identified the ANSI ASABE/ICC 802-2014, the IA *SWAT Testing Protocol for Pressure Regulating Spray Head Sprinklers* V.3.0, and the U.S EPA *WaterSense Specification for Spray Sprinkler Bodies, V.1.0* for evaluation.

CHAPTER 6:
Staff Proposal for Spray Sprinkler Bodies

Energy Commission staff has analyzed equipment and practices of landscape irrigation, as well as the cost-effectiveness and technical feasibility of regulating spray sprinkler bodies. Staff has determined that the water and energy savings under the proposed standard are significant while imparting a small incremental cost to consumers. The proposed standard is attainable with products currently available in the market.

Scope

Energy Commission staff reviewed the readiness of the various types of landscape emitters discussed in this report for water-saving regulations. Staff reviewed the scope of available test procedures, availability of products with pressure regulation, and whether the products meeting the standard would provide significant water savings. Staff proposed regulations for spray sprinkler bodies due to the availability of test methods, test data, currently compliant products, and significant cost-effective water savings.

Test Procedure

Staff proposes to use U.S EPA *WaterSense Specification for Spray Sprinkler Bodies, V.1.0* as the test procedure for spray sprinkler bodies.

Standard

Staff's proposed standard for all spray sprinkler bodies sold or offered for sale in California:

- All spray sprinkler bodies manufactured on or after January 1, 2020, must be certified to the Energy Commission as meeting the following requirements when tested per *WaterSense Specification for Spray Sprinkler Bodies Version 1.0, September 21, 2017*:
    - Maximum flow rate at any tested pressure level—the percentage difference between the initial calibration flow rate and the maximum flow rate at any tested pressure level, averaged for the selected samples at the test pressure levels where the maximum flow rate occurred, shall not exceed +/- 12.0 percent.
    - Average flow rate across all tested pressures—the percentage difference between the initial calibration flow rate and the flow rate at each tested pressure level, averaged across all pressure levels and all selected samples, shall not exceed +/- 10.0 percent.
    - Minimum outlet pressure—the average outlet pressure at the initial calibration point (as described in WaterSense Specification for Spray Sprinkler Bodies Versions 1.0) of the selected samples shall not be less than 67 percent of the regulation pressure.

- All spray sprinkler bodies manufactured on or after January 1, 2020, must be certified as tested in a lab approved by the Energy Commission per *WaterSense Specification for Spray Sprinkler Bodies Version 1.0, September 21, 2017* except with an initial calibration flow rate of 0.75 +/-0.1 gpm.
    - Results of the 0.75 gpm test will be reported to the Commission to provide performance information at the lower flow rate.
    - No minimum performance requirements for the 0.75 gpm flow rate standard.

The regulation will result in water savings by creating mandatory standards for products sold or offered for sale in California. Based on its independent analysis of the available data, staff has concluded that these proposed regulations are cost-effective and technically feasible. Staff assumptions and calculations are provided in Appendix A.

Certification

Manufacturers would be required to certify each model of spray sprinkler body, whether sold with or without a nozzle, to the Energy Commission's appliance efficiency database.

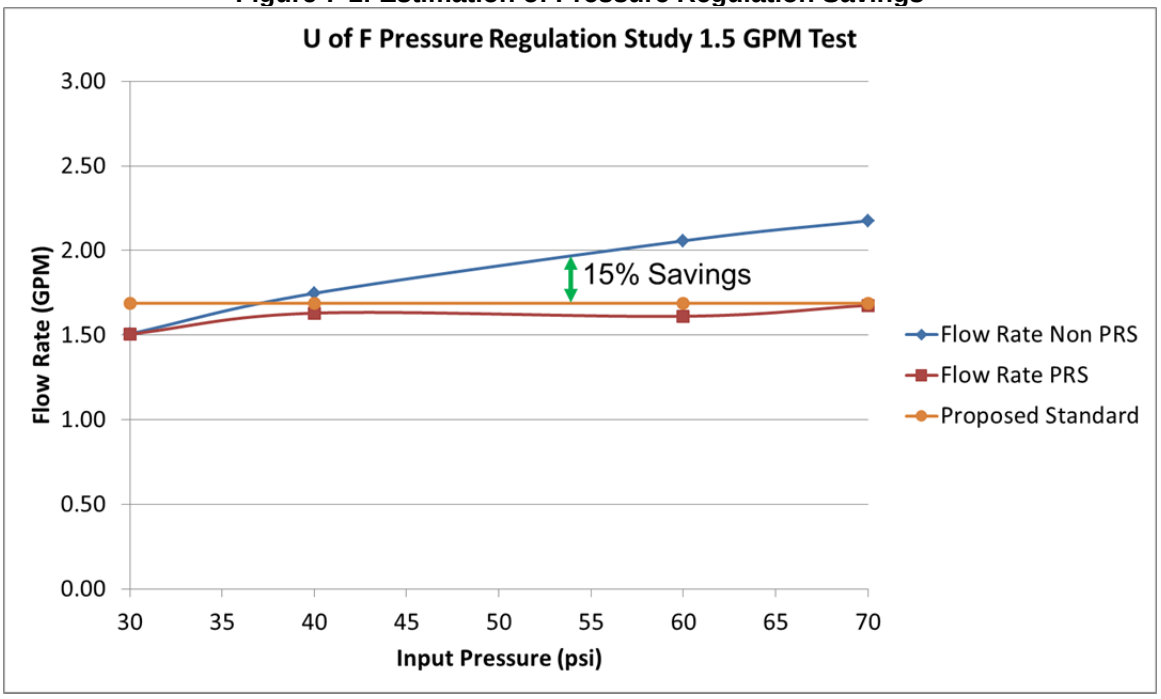
Marking

All appliances will need to be marked with the manufacturer name, brand name, or trademark; the model number; and the date of manufacture, permanently, legibly, and conspicuously on an accessible place on each unit, on the unit packaging, or, where the unit is contained in a group of several units in a single package, on the packaging of the group. Staff does not propose any additional marking or labeling requirements for spray sprinkler bodies.

CHAPTER 7:
Savings and Cost Analysis

The proposed standard for spray sprinkler bodies would significantly reduce water and energy consumption. Staff estimated per device water savings by reviewing performance data gathered by the U.S. EPA WaterSense. **Figure 7-1** shows the average pressure regulation performance for spray sprinkler bodies with and without pressure regulation. Staff calculated the percentage savings by assuming that noncompliant devices are improved only to comply minimally with the proposed standard. The average inlet water pressure to the spray sprinkler body was assumed to be 55 pounds per square inch (psi) based upon a survey by the CASE team and accounting for pressure losses in the irrigation valve and piping.

Figure 7-1: Estimation of Pressure Regulation Savings



Source: California Energy Commission illustration with U.S. EPA WaterSense performance data

To determine incremental costs of sprinkler heads that meet the proposal, Energy Commission staff gathered retail price data from sprinkler vendor websites. The data were analyzed to estimate the cost difference to consumers with the addition of the pressure regulation feature.

Table 7-1: Annual Water, Energy, and Monetary Savings

Product Type	Design Life (years)	Water Savings (gal/yr)	Embedded Electricity Savings (kWh/yr)	Incremental Costs ($)	Average Annual Savings ($/yr)	Life-Cycle Benefit ($)
Spray Sprinkler Bodies	10	442	1.6	$4.68	$2.69	$18.26

Source: California Energy Commission

The values in **Table 7-1** list the design life, incremental cost, and monetary savings in 2017 dollars. The average annual savings are the savings that consumers will receive once the product is installed. The estimation of cost and benefits is conservative as it does not consider utility rebates.

The annual savings of each unit are calculated by multiplying the annual water savings by the water delivery charge of $6.08 per 1,000 gallons.[67] Embedded electricity savings are not included in the life-cycle cost analysis. The life-cycle benefit represents the savings the consumer will receive over the life of the appliance and is the product of the average annual savings multiplied by the average design life of the unit. Staff applied a 3 percent discount rate to calculate the net present value of the anticipated savings over the design life. The net life-cycle benefits are the differences between the net present value of the savings and the incremental cost of each compliant unit.

Staff performed a sensitivity analysis to identify the minimum inlet water pressure that would provide consumers with cost-effective water savings due to the proposed standard. The proposed standard remains cost-effective for inlet pressures at or above 40 psi.[68] A study of inlet pressures shows that 8 of 10 Californians have an inlet pressure at or above 40 psi and will receive cost-effective water savings from switching from spray sprinkler bodies without pressure regulation to spray sprinkler bodies with pressure regulation.[69]

Staff reviewed a report sponsored by the California Public Utilities Commission to determine the average size of a yard for a single-family home and the percentage of homes that have an automatic irrigation system.[70] Staff then used 2016 demographic information from the California Department of Finance to find the number of single-family homes in California.[71] Staff relied on

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67 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 63, September 18, 2017

68 At 40 psi, the water savings rate is 3.4 percent, yielding a yearly savings of $0.61. The savings over 10 years discounted by 3 percent per year is $4.86. The life-cycle benefit is 0.54 = $5.22 - $4.68.

69 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 94-95, September 18, 2017

70 Funk, Andrew, and William DeOreo, *Embedded Energy in Water Studies Study 3: End-Use Water Demand Profiles*, 2011, pg. 88

71 California Department of Finance, E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark, May 2016, http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/.

this information to calculate that 209 million sprinkler heads are in use in California. Assuming a 10 percent replacement rate based upon a 10-year design life, staff estimates 20.9 million sprinkler head shipments per year in California.

The savings estimates compare the baseline water and energy consumption for sprinkler heads with the respective water and energy consumption under the proposed standards. For statewide estimates, these savings are multiplied by sales for first-year figures and by total California stock. These calculations are available in **Appendix A**. In **Tables 7-2** and **7-3**, the potential water and energy savings of the proposed standards are provided. Water and energy savings are further separated into first-year savings and stock savings. *First-year savings* are the annual reduction of water and energy consumed associated with annual sales, one year after the standards take effect. *Annual stock savings* are the annual water and energy savings achieved after all existing stock in use complies with the proposed standards

Staff calculations and assumptions used to estimate first-year savings and stock change savings are provided in **Appendix A**. As provided in **Table 7-2**, if all sprinkler heads complied with the proposed standards (annual stock savings), California would save 2,898 GWh of energy per year and more than 83 billion gallons of water. Staff calculated the benefit to water utilities by using the 2016 annual average electric rate of $0.1431/kWh from the agriculture and water-pumping sectors.[72] The proposed standards for spray sprinkler bodies would save water utilities roughly $4 million in the first year and $43 million after total stock turnover. Water consumers would save $51 million in the first year and $508 million at total stock turnover, assuming a water delivery charge of $6.08 per 1,000 gallons of water.[73]

An Energy Commission report on water supply electricity demand found that the outdoor water use of a California home contributes 0.038 kW to peak demand on a peak day.[74] Staff calculated the peak power reduction by multiplying the 0.038 kW/residence by 5.8 million homes with spray sprinkler body irrigation by a 15 percent savings rate. The peak reduction is 33 MW.

In conclusion, the proposed standards are clearly cost-effective, as consumers will receive a net savings from the installation of spray sprinkler bodies over the life of the product.

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72 Marshall, Lynn, "California Energy Demand 2018-2030 Revised Baseline Forecast - Mid Demand Case, Form 2.3," Energy Commission Supply Analysis Office, available at http://www.energy.ca.gov/2017_energypolicy/documents/2017-12-15_workshop/2017-12-15_middemandcase_forecst.php.

73 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 63, September 18, 2017.

74 House, Lon W, Ph.D, *Water Supply Related Electricity Demand in California*, pg. 52 and 63, December 2006, available at http://www.waterandenergyconsulting.com/WEDemandReport.pdf.

Table 7-2: Water Savings and Energy Savings

Product Type	Water Per Device (gal/yr)	Water Per Residence (gal/yr)	Statewide 1st Year (MM gal/yr)	Embedded Electricity 1st Year (GWh/yr)	Statewide Stock (MM gal/yr)	Embedded Electricity Stock (GWh/yr)
Spray Sprinkler Bodies	442	15,924	8,353	30	83,526	298

Source: California Energy Commission

Table 7-3: Statewide Monetary Savings

	First Year			Stock Savings		
Product Type	Water Delivery (M$/yr)	Embedded Electricity (M$/yr)	Total (M$/yr)	Water Delivery (M$/yr)	Embedded Electricity (M$/yr)	Total (M$/yr)
Spray Sprinkler Bodies	$50.8	$4.3	$55.0	$507.8	$42.6	$550.4

Source: California Energy Commission

CHAPTER 8:
Technical Feasibility

Compliant Product Availability

EPA WaterSense Product Testing

The EPA collaborated with the University of Florida to test pressure regulating and nonpressure-regulating spray sprinkler bodies. The efforts led the EPA to release the *WaterSense Specification for Spray Sprinkler Bodies, V1.0* that provides a test method and minimum performance standards for spray sprinkler bodies. The EPA used the University of Florida data to show the test method within the WaterSense specification will provide accurate and repeatable results. The EPA set minimum performance standards based upon the data provided by the University of Florida. The University of Florida study shows four of the six brands tested will meet the WaterSense standard. The results of the University of Florida study are shown in **Figures 8-1, 8-2, and 8-3.** The staff proposal sets an identical test method and standard as WaterSense. Therefore, the University of Florida study demonstrates the staff proposal is technically feasible.

Figure 8-1: EPA WaterSense Average Flow Rate Requirement

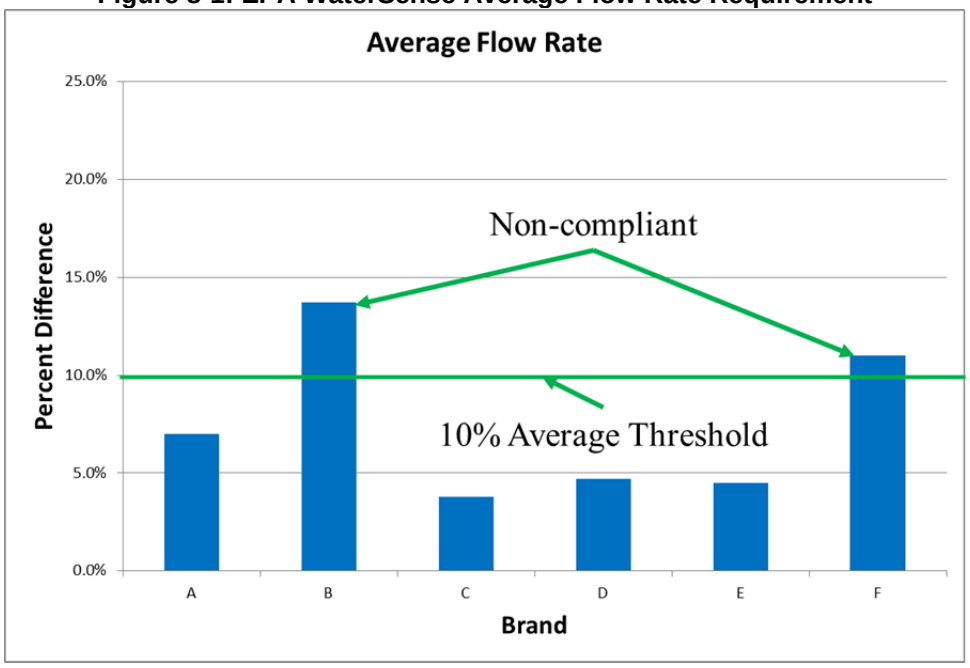

Illustration Credit: California Energy Commission with EPA WaterSense Data

Figure 8-2: EPA WaterSense Maximum Flow Rate Requirement

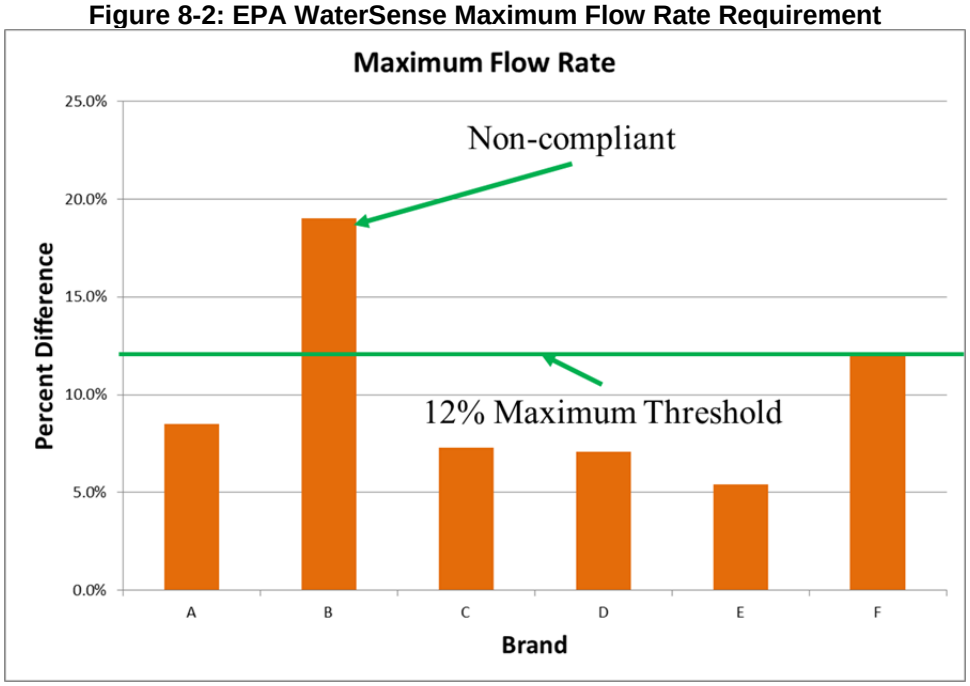

Illustration Credit: California Energy Commission with EPA WaterSense Data

Figure 8-3: EPA WaterSense Minimum Outlet Pressure Requirement

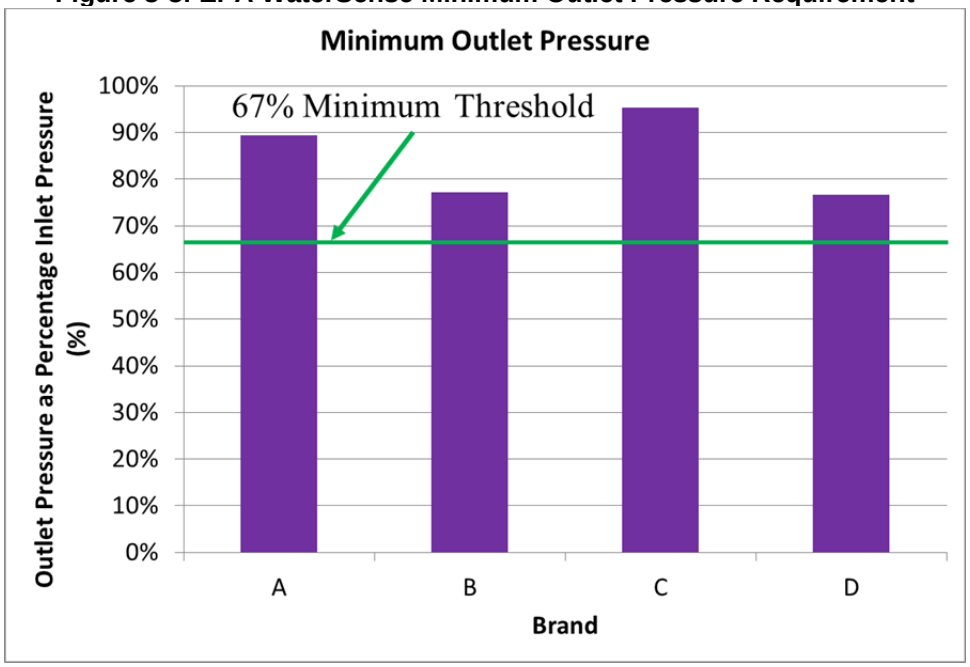

Illustration Credit: California Energy Commission with EPA WaterSense Data

Additional Pressure Regulation Product Testing

In 2014, the University of Arizona conducted a study of pressure-regulated sprinklers manufactured by Rain Bird. The study showed that the incorporation of pressure regulation can lead to substantial water savings. **Table 8-1** shows water usage differed widely between spray

sprinkler heads with pressure regulation versus those without pressure regulation. The reductions in flow due to pressure regulation are consistent with the University of Florida study and further demonstrate the technical feasibility of the staff proposal.

Table 8-1: Project PRS Spray Results

Inlet Pressure (psi)	Flow Rate Without PR (GPM)	Flow Rate With PR (GPM)	Savings per Spray Head (GPM)	% Savings
30	0.65	0.65	.00	0%
40	0.6657	0.6303	0.035	5%
50	0.717	0.6403	0.077	11%
60	0.7583	0.6503	0.108	14%
70	0.794	0.6603	0.134	17%
80	0.824	0.6703	0.134	19%

Source: Rain Bird Corporation

Staff Market Survey

Staff surveyed the spray sprinkler body market to identify companies marketing products containing integral pressure regulation. The companies and product lines are described below.

- Rain Bird markets the 1800 PRS line of spray sprinklers and the 5000 PRS line of gear-driven sprinkler heads with pressure regulation.[75, 76]
- Toro markets the 570Z series sprinkler head with pressure regulation that maintains a steady outlet pressure of 30 psi over the recommended range of inlet pressures.[77]
- Orbit markets the Eco-Spray head that maintains a constant 30 psi outlet pressure with integral pressure regulation.[78]
- Hunter markets the Pro-Spray PRS30 and PRS40 product line with integral pressure regulation and drain check valves.[79]
- Staff also found pressure-regulated models available from K-Rain and Irritrol.

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75 Palumbo, Greg, and David Perl, Rain Bird Corporation, *Saving Water With Pressure Regulation and Check Valves-Introduction to Hydraulics*, pg. 30, https://www.rainbird.com/landscape/resources/webinars/Saving%20Water%20%20-%20Intro%20to%20Hydraulics.pdf.

76 Rain Bird Corporation, http://www.rainbird.com/landscape/products/sprayBodies/1800PRS.htm.

77 The Toro Company, "570Z Pressure Regulating Spray Heads," http://watersmart.toro.com/570z-pressure-regulating-spray-heads/.

78 Orbit Irrigation Products, https://www.orbitonline.com/products/sprinkler-systems/sprinklers/spray-heads/pressure-regulating-hydroseal-springloded-pop-up/4-pr-eco-spray-slpu-wflush-plug.

79 Hunter Industries, "Pro-Spray PRS40," http://www.hunterindustries.com/irrigation-product/spray-bodies/pro-spray-prs40.

Irrigation Association Market Survey

The IA submitted comments to the docket listing manufacturers and model numbers of spray sprinklers with pressure regulation. **Table 8-2** lists manufacturers identified as offering pressure-regulating sprinklers.[80]

Table 8-2: List of Manufacturers With Pressure Regulation Products

Hydro-Rain	Signature	Irritrol	HIT Products	Orbit
Toro	K-Rain	Weathermatic	Hunter Industries	Rain Bird

Source: Irrigation Association

2-Inch Gravity Retraction and Pop-Up Sprinklers

Staff reviewed the availability of 2-inch gravity retraction and pop-up sprinkler-compliant products and found that these products are not available with pressure regulation. However, these products do not appear to provide a unique utility or consumer efficacy that would merit exempting them from the regulations. For example, a consumer could retrofit a 2-inch gravity or pop-up sprinkler with a 4-inch pop-up sprinkler using industry-accepted practices,[81] such as installing swing pipe fittings and flexible pipes that can adapt the existing lawn irrigation system so a compliant 4-inch pop up can be installed flush with the ground without modifying the existing irrigation plumbing system. The approach is cost-effective and technically feasible, even with the additional products to adapt the interface. Staff found the cost of a swivel arm or a funny pipe at less than $1. The life-cycle benefit would be reduced by $1 from around $18 to $17, which is still very cost-effective. **Figure 8-4** shows two possible methods to adapt the interface.

Figure 8-4: 2-Inch Gravity and Pop-Up Replacement Options

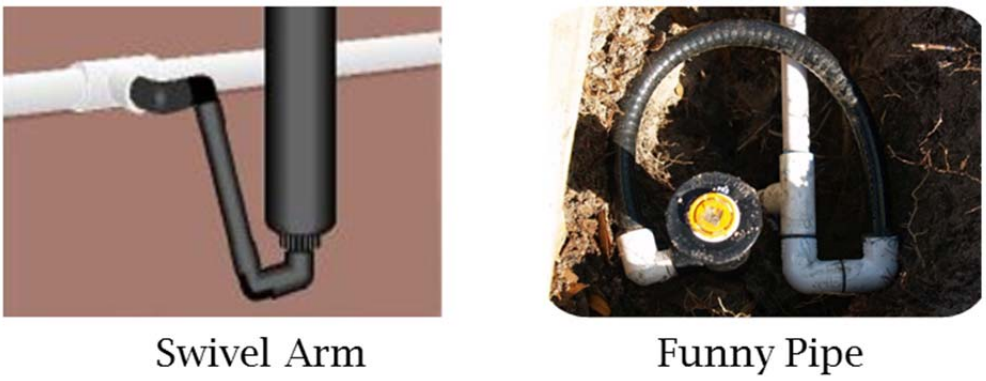

Photo Credit: Sprinkler Warehouse and Gem Sprinkler

80 Mecham, Brent, Irrigation Association, *Comment to Docket on the Invitation to Submit Proposals*, September 18, 2017, pg. 41-42, http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-08/TN221200_20170918T112728_Brent_Mecham_Comments_Proposed_Testing_of_Spray_Sprinklers.pdf.

81 Sprinkler Warehouse, "How to Connect Your Sprinkler Head to the Underground Pipe." https://www.sprinklerwarehouse.com/articles.asp?id=198.

CHAPTER 9:
Environmental Impacts and Benefits

Impacts

Spray sprinkler bodies are usually replaced when they are at the end of the useful lives; therefore, replacement of these appliances would present no additional impact to the environment beyond the natural cycle.

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 investing in costly, large-scale infrastructure projects such as dams, canals, and reservoirs. It will also result in reduced operating costs for water utilities, as it takes a significant amount of energy to get water to the spray sprinkler bodies at a home or business. Energy is needed to extract water from the source; to treat, distribute, and use it; and to collect and treat wastewater for release back into the environment.

Furthermore, reducing water consumption would 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 by reducing greenhouse gases emitted in the production of energy used to transport and treat California's water.

The proposed standards would also save significant amounts of water, estimated at more than 83 billion gallons annually, after full-stock turnover. 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.

CHAPTER 10:
Proposed Regulatory Language

The proposed changes to the Title 20 standards are provided below. Changes to the 2016 standards are marked with underlining (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.

Summary of Proposed Standards

The recommended changes will:

1. Expand regulation scope to include spray sprinkler bodies and provide definitions to describe types of landscape irrigation emission devices.

2. Define the test methods to measure the pressure regulation of spray sprinkler bodies.

3. Establish minimum pressure regulation performance requirements.

4. Establish manufacturer data submittal requirements for certification.

5. Establish marking requirements for spray sprinkler bodies.

The efficiency standards for spray sprinkler bodies would apply to products offered for sale or sold in California that are manufactured on or after January 1, 2020.

Section 1601. Scope

…

(y) Landscape irrigation equipment including spray sprinkler bodies.

…

Section 1602. Definitions

…

(y) Landscape Irrigation Equipment.

"Basic model" of a spray sprinkler means a group of spray sprinkler models that are made by a single manufacturer and that have the same spray sprinkler body. A spray sprinkler body shall be considered the same as another if the water use characteristics are the same, regardless of any cosmetic differences among the bodies.

"Landscape" means any and all areas that are planted or installed and intended to receive irrigation including, turf grass, ground covers, shrubs, trees, flowers, and similar plant materials as opposed to agricultural crops grown and harvested for monetary return.

“Maximum operating pressure” means the highest manufacturer recommended pressure to ensure proper operation.

“Nozzle” means the discharge opening or orifice of a sprinkler used to control the volume of discharge, distribution pattern, and droplet size.

“Orifice” means the emission point from a nozzle into the atmosphere.

“Regulation pressure” means the outlet pressure the product aims to achieve regardless of higher inlet pressure, as stated by the manufacturer.

“Rotor sprinkler” means a landscape irrigation system component consisting of a rotor sprinkler body with one or more orifices to convert irrigation water pressure to high-velocity water discharge through the air, discharging greater than 0.5 gallon per minute at the largest area of coverage available for the nozzle series, when operated at 30 pounds per square inch (psi) or more with a full-circle pattern.

“Rotor sprinkler body” means a sprinkler body that contains components to drive the rotation of the nozzle or orifice during operation and lacks an integral control valve.

“Spray sprinkler” means a landscape irrigation system component consisting of a spray sprinkler body with one or more orifices to convert irrigation water pressure to high-velocity water discharge through the air, discharging greater than 0.5 gallon per minute at the largest area of coverage available for the nozzle series, when operated at 30 psi or more with a full-circle pattern.

“Spray sprinkler body” means a sprinkler body that does not contain components to drive the rotation of the nozzle or orifice during operation and lacks an integral control valve.

“Sprinkler body” means the exterior case or shell of a sprinkler incorporating a means of connection to the piping system, designed to convey water to a nozzle or orifice.

“Valve-in-head sprinkler” means a landscape irrigation system component consisting of a valve-in-head sprinkler body with one or more orifices to convert irrigation water pressure to high-velocity water discharge through the air, discharging greater than 0.5 gallon per minute at the largest area of coverage available for the nozzle series, when operated at 30 psi or more with a full-circle pattern.

“Valve-in-head sprinkler body” means a sprinkler body that contains an integral control valve.

...

Section 1604. Test Methods for Specific Appliances.

...

(y) Landscape Irrigation Equipment.

(1) The test method for a spray sprinkler body and a spray sprinkler body within a spray sprinkler, manufactured on or after January 1, 2020, is the Appendix B of the WaterSense Specification for Spray Sprinkler Bodies Version 1.0, September 21, 2017. A manufacturer shall cause tests A and B per the test method and as specified by the requirements of 1604 (y) (1) (A) and 1604 (y) (1) (B).

(A) Test A shall have an initial calibration flow rate equal to 1.5 +/- 0.1 gallons per minute.

(B) Test B shall have an initial calibration flow rate equal to 0.75 +/- 0.1 gallons per minute.

The following documents are incorporated by reference in Section 1604.

...

FEDERAL TEST METHODS

...

	WaterSense Specification for Spray Sprinkler Bodies
	Version 1.0 (Rev. September 21, 2017)
Copies available from:	WaterSense
	U.S. Environmental Protection Agency
	Office of Wastewater Management
	(4204M)
	1200 Pennsylvania Avenue, N.W.
	Washington, D.C. 20460
	https://www.epa.gov/watersense

...

Section 1605.1. Federal and State Standards for Federally Regulated Appliances.

...

(y) Landscape Irrigation Equipment.

See Section 1605.3 (y) for water efficiency standards for landscape irrigation equipment.

...

Section 1605.2. State Standards for Federally Regulated Appliances.

...

(y) Landscape Irrigation Equipment.

See Section 1605.3 (y) for water efficiency standards for landscape irrigation equipment.

...

Section 1605.3. State Standards for Non-Federally Regulated Appliances.

...

(y) Landscape Irrigation Equipment.

(1) A spray sprinkler body and a spray sprinkler body within a spray sprinkler manufactured on or after January 1, 2020, shall meet the following requirements when tested per the test method in Section 1604 (y) (1) (A).

(A) Maximum flow rate at any tested pressure level—The percent difference between the initial calibration flow rate (as described in WaterSense Specification for Spray Sprinkler Bodies Versions 1.0, Appendix B) and the maximum flow rate at any tested pressure level, averaged for the selected samples at the test pressure levels where the maximum flow rate occurred, shall not exceed +/- 12.0 percent.

(B) Average flow rate across all tested pressures—The percent difference between the initial calibration flow rate (as described in WaterSense Specification for Spray Sprinkler Bodies Versions 1.0, Appendix B) and the flow rate at each tested pressure level, averaged across all pressure levels and all selected samples, shall not exceed +/- 10.0 percent.

(C) Minimum outlet pressure—The average outlet pressure at the initial calibration point (as described in WaterSense Specification for Spray Sprinkler Bodies Versions 1.0, Appendix B) of the selected samples shall not be less than 67 percent of the regulation pressure.

Section 1606. Filing by Manufacturers; Listing of Appliances in Database.

(a) Filing of Statements.

Each manufacturer shall file with the Executive Director a statement for each appliance that is sold or offered for sale in California. The statement shall contain all of the information described in paragraphs (2) through (4) of this subsection and shall meet all of the requirements of paragraph (1) of this subsection and all other applicable requirements in this Article.

The effective dates of this section shall be the same as the effective dates shown in Section 1605.1, 1605.2 or 1605.3 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. 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, the effective date of this section shall be one year after they are added to Section 1601 of this Article, unless a different effective date is specified.

...

(1) General Rules.

(A) Format and Categories. Each statement shall be in a format (including but not limited to computer formats) and in categories specified by the Executive Director.

(B) When Different Statements Are Required. The Executive Director may establish, modify, and enforce schedules for the submittal of statements where it is reasonably necessary for orderly processing of submittals, for example when manufacturers or third parties often submit many statements simultaneously.

(C) Asterisks in Model Numbers. In filing any statement, the manufacturer may use asterisks as a substitute for letters, numbers, blanks, or other characters in the model number, provided that an asterisk (i) shall be used only for a part of the model number that does not indicate energy consumption, energy efficiency, water consumption, or water efficiency, or a design or feature affecting such efficiency or consumption; (ii) shall represent a single letter, number, blank, or other character at the asterisk's location in the model number; and (iii) shall not be used for any of the first four letters, numbers, blanks, or other characters in the model number.

(D) Different Functions. Except as provided in Section 1606(a)(1)(G), if the same appliance is sold or offered for sale as more than one type of appliance shown in Table X (for example, if the appliance can serve both water heating and pool heating functions), the manufacturer shall submit a separate statement for each appliance type. Each appliance type for which a statement is submitted must match all the common identifiers shown in Table X.

(E) Multiple Statements. A manufacturer may file statements for more than one appliance in a single submittal to the Executive Director. If a submittal contains statements for more than one appliance, there shall be only one statement for each appliance, except as provided in Sections 1606(a)(1)(D) and 1606(a)(1)(G). The Executive Director shall allow multiple statements to be submitted on the same sheet of paper or in the same electronic file under conditions she or he determines are reasonably necessary to ensure accuracy and compatibility with the database.

...

(2) Manufacturer Information.

(A) The name, address, telephone number, and, if available, fax number, URL (web site) address, and e-mail address of the manufacturer; provided, however, that if a parent entity is filing on behalf of a subsidiary entity, if a subsidiary entity is filing on behalf of a parent entity, or if an affiliate entity is filing on behalf of an affiliate entity, then each entity shall be clearly identified and the information shall be provided for both entities.

(B) The name, address, telephone number, and, if available, fax number and e-mail address of the individual to contact concerning the statement pursuant to Section 1606(a)(4). There shall be only one individual to contact for each category (box) in the “Appliance” column of Table X, except that the individual may, during his or her absence, delegate his or her duties in this regard.

(C) The name, address, telephone number, and, if available, fax number and e-mail address of the person signing the declaration pursuant to Section 1606(a)(4).

(3) Testing and Performance Information.

(A) A statement that the appliance has been tested in accordance with all applicable requirements of Sections 1603 and 1604. If Section 1604 provides more than one test method that may be used, the manufacturer shall identify which method was used.

(B) The name and address and, if available, telephone number, fax number, URL (web site) address, and e-mail address of the laboratory or other institution where the testing required by Sections 1603 and 1604 was performed.

(C) The applicable information listed in Table X; provided, however, that submittal of information marked with "1" is voluntary for federally regulated appliances, and that submittal of information marked with "2" is voluntary for state-regulated appliances. Where there is text in the "Permissible Answers" column, the information provided must be one of the answers shown. If the text in the "Permissible Answers" column states "other (specify)," the information provided must be a specific response for the "Required Information" category (e.g., a response of "other" is not acceptable).

...

(E) How Tested Data Must Be Reported.

1. For any numerical value required by Table X that is produced by a test specified in Section 1604, the reported value shall be no higher for the value for which the consumer would prefer a high number, and no lower for the value for which the consumer would prefer a low number, than the values obtained by testing; unless different specific instructions are specified in the test method specified in Section 1604.

2. For any numerical value required by Table X that is produced by calculation from measured numerical test results, the reported value shall be no higher for the values where the consumer would prefer a high number than the exact result of the calculation, and no lower than the exact result of the calculation where the consumer would prefer a low number, than the values obtained by calculating, unless different specific instructions are specified in the test method specified in Section 1604.

3. Manufacturers may report:

a. Numbers higher than tested values, where the consumer would, all other things being equal, prefer lower values (or is indifferent); and

b. Numbers lower than tested values, where the consumer would, all other things being equal, prefer higher values (or is indifferent).

...

{skipping (a)(1)-(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 sections A-W of Table X} ...

	Appliance	Required Information	Permissible Answers
Y	Landscape Irrigation Equipment	Landscape Irrigation Equipment Type	Spray sprinkler body, spray sprinkler
		Regulation pressure (psi)	
		Maximum operating pressure (psi)	
		Initial calibration flow rate (per 1604 (y) (1) (A))	
		Maximum flow rate at any tested pressure level (per 1604 (y) (1) (A))	
		Percent difference at maximum flow rate (per 1604 (y) (1) (A))	
		Average flow rate across all tested pressures (per 1604 (y) (1) (A))	
		Percent difference at average flow rate (per 1604 (y) (1) (A))	
		Average outlet pressure at the initial calibration point (per 1604 (y) (1) (A))	

	Appliance	Required Information	Permissible Answers
		Average outlet pressure at the initial calibration point as a percentage of regulation pressure (per 1604 (y) (1) (A))	
		Initial calibration flow rate (per 1604 (y) (1) (B))	
		Maximum flow rate at any tested pressure level (per 1604 (y) (1) (B))	
		Percent difference at maximum flow rate (per 1604 (y) (1) (B))	
		Average flow rate across all tested pressures (per 1604 (y) (1) (B))	
		Percent difference at average flow rate (per 1604 (y) (1) (B))	
		Average outlet pressure at the initial calibration point (per 1604 (y) (1) (B))	
		Average outlet pressure at the initial calibration point as a percentage of regulation pressure (per 1604 (y) (1) (B))	

...

(4) Declaration.

(A) Each statement shall include a declaration, executed under penalty of perjury of the laws of California, that

1. All the information provided in the statement is true, complete, accurate, and in compliance with all applicable provisions of this Article;

2. If the statement is being filed electronically, that the requirements of Section 1606(g) have been and are being complied with;

3. 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, that the appliance complies with the applicable standards;

4. The appliance was tested under the applicable test method specified in Section 1604,

...

Section 1607 Marking of Appliances.

...

(c) Exceptions to Section 1607(b).

...

(2) For lamps, spray sprinkler bodies, and spray sprinklers, the information required by Section 1607(b) shall be permanently, legibly, and conspicuously displayed on an accessible place on each unit, on the unit's packaging, or, where the unit is contained in a group of several units in a single package, on the packaging of the group.

...

(d) Energy Performance Information.

...

(14) Spray Sprinkler Bodies. A spray sprinkler body manufactured on or after January 1, 2020, shall be marked, permanently and legibly, as specified by sections (A) and (B).

(A) The regulation pressure and the maximum operating pressure shall be marked on an accessible place on the product or product packaging.

(B) The presence of integral pressure regulation shall be marked on a spray sprinkler body in a location visible after installation.

APPENDIX A:
Staff Assumptions and Calculation Methods

Appendix A discusses the information and calculations used to characterize spray sprinkler bodies in California, the current water and energy use, and potential savings. Staff considered information from a variety of sources including information contained in the CASE and Irrigation Association proposals submitted to the California Energy Commission. Staff presents the research and methods to illustrate staff's approach to water and energy consumption and savings. Staff has rounded the results of the calculations as they are presented in this appendix. Unrounded numbers are used for subsequent calculations.

Assumptions

Table A-1 summarizes the values and assumptions used to analyze consumption and savings.

Table A-1: Summary of Values and Assumptions

Value	Units	Description	Source
72%	Percentage	Automatic irrigation (single-family)	CALMAC[82]
3,809	Sq. Feet	Avg. irrigated area single-family home	CALMAC[83]
93,900	Gallons	Outdoor water use of a single-family home	CALMAC[84]
8,094,422	Homes	California single-family detached homes (2016)	California Department of Finance[85]
36	Sprinklers	Sprinklers per single-family detached house	Staff Assumption
10%	Percentage	Compliant product market share	Irrigation Association[86]
$0.1431	$ per kWh	Agriculture and water pumping sector 2016 annual average electric rate	Commission Staff[87]
10	Years	Sprinkler design life	Commission Staff
3,565	kWh/MGal	Embedded electrical energy for water deliveries.	Pike & Urigwe, 2017[88]
$6.08	$ per kGal	2017 Potable water delivery price paid by consumers	Pike & Urigwe, 2017[89]

Source: California Energy Commission and as noted

Stock and Sales

Table A-2 shows staff's estimate for landscape spray sprinkler bodies in California since no published source for stock sprinkler heads are available. Staff also reviewed estimates provided by the CASE team. The estimates provide a means of validation to the staff estimate since they are similar in magnitude.

82 Funk, Andrew, and William DeOreo, *Embedded Energy in Water Studies Study 3: End-Use Water Demand Profiles,* 2011, pg. 89.

83 Ibid., pg. 88.

84 Ibid., pg. 88.

85 California Department of Finance, "E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark," May 2016, http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/.

86 Mecham, Brent, Irrigation Association, *Comment to Docket on the Invitation to Submit Proposals*, September 18, 2017, pg. 45, http://docketpublic.energy.ca.gov/PublicDocuments/17-AAER-08/TN221200_20170918T112728_Brent_Mecham_Comments_Proposed_Testing_of_Spray_Sprinklers.pdf.

87 Marshall, Lynn, "California Energy Demand 2018-2030 Revised Baseline Forecast - Mid Demand Case, Form 2.3," Energy Commission Supply Analysis Office, available at http://www.energy.ca.gov/2017_energypolicy/documents/2017-12-15_workshop/2017-12-15_middemandcase_forecst.php.

88 Pike, Ed, and Daniela Urigwe, Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies, pg. 64, September 18, 2017

89 Ibid., pg. 63.

Table A-2: Summary of Stock and Shipment Estimates

Estimate	Stock (units)	Shipment
Energy Commission	210 million	21.0 million
CASE Team[90]	170 million	18.6 million

Source: California Energy Commission and as noted

Typical Yard Head to Head Spacing Calculation Method

Figure A-1: Head-to-Head Sprinkler Layout for Typical Turf Yard

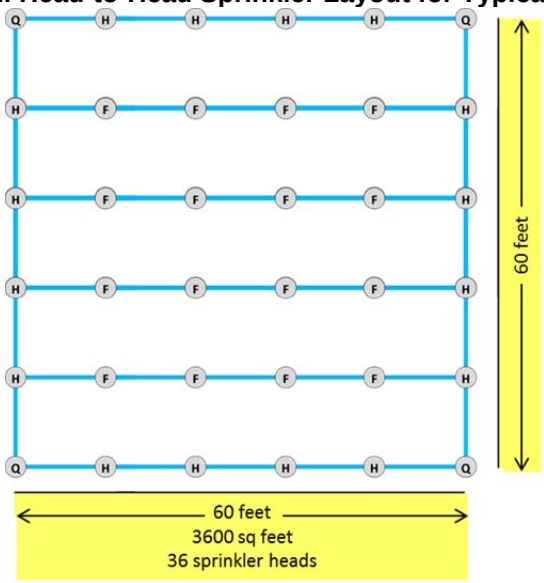

Illustration Credit: CASE Team as modified by the Energy Commission

Various irrigation manufacturer design guides recommend head-to-head spacing where the sprinkler heads are arranged so the spray from one sprinkler head will reach the adjacent sprinkler heads.[91] The overlapping sprays mean several sprinkler heads contribute to the watering of an area in the yard. Staff illustrated the head-to-head spacing for a 3,600 sq. ft. yard, which is equivalent to the average California yard, as determined in the CALMAC study for the California Public Utilities Commission.[92] Staff estimates this arrangement would require 36 sprinkler heads with a 12-foot radius of throw. Staff determined that roughly 5.8 million houses in California would have an automatic sprinkler system based upon data from the California Department of Finance and CALMAC study.[93] [94] The stock calculation is conservative in that it does not consider sprinklers used to irrigate multifamily properties, commercial properties, or large landscapes.

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90 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 36, September 18, 2017.

91 Rain BIRD Sprinkler Manufacturing Corporation, *Landscape Irrigation Design Manual*, 2000, pg. 41.

92 Funk, Andrew, and William DeOreo, *Embedded Energy in Water Studies Study 3: End-Use Water Demand Profiles*, 2011

93 Ibid.

94 California Department of Finance, "E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark," May 2016, http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/.

Stock Calculation:

Single-Family Homes x % Homes with Automatic Irrigation= Homes with Automatic Irrigation

8,094,422 Homes *72%=5,827,984 Homes with Automatic Irrigation

Homes with automatic irrigation* 36 devices/home = Stock Sprinklers

5,827,984 homes*36 devices/home=209,807,418 Sprinkler heads

Annual Sales Calculation:

Stock Sprinklers/ Design Life = Yearly Sales

209,807,424 Sprinklers/10 years = 20,980,742 Sprinklers per year

Sprinkler head design life is estimated by surveying manufacturer and contractor websites.[95]

Table A-3: Estimated Stock

Year	First-Year Stock (Annual Units)	Stock (Units)	Design Life (years)
2017	20,980,742	209,807,418	10

Source: California Energy Commission

Baseline Water and Energy Use

Landscape water usage may be calculated from recommendations on the water required by the landscape. Staff gathered irrigation data from the University of California, Division of Agriculture and Natural Resources (UC ANR), regarding recommended weekly sprinkler run times. Recommended run times vary by season and climate region and are expressed in minutes, assuming a precipitation rate of 1 inch per hour.[96] The recommendation takes into account the irrigation efficiency, effects of percolation, and incident rainfall. Staff converted the run times to inches of precipitation per year and then averaged the regions to arrive at the average required inches of precipitation the sprinklers must provide. The total volume of water provided by sprinklers is then calculated by multiplying the inches of precipitation by the area of the yard. The per-device volume of water is calculated by dividing the volume of water delivered to the yard by the number of devices.

95 TriState Water Works, "How Long Will My Sprinkler System Last?" http://www.tristatewaterworks.com/how-long-will-my-sprinkler-system-last/.

96 University of California, Agriculture and Natural Resources, "Lawn Watering Guide for California," Publication 8044, http://anrcatalog.ucanr.edu/pdf/8044.pdf.

UC ANR Calculation Method

Total Run Time Region 1 (Northern California Coast) =

(Jan+Feb+Mar+Apr+May+Jun+Jul+Aug+Sep+Oct+Nov+Dec) (minutes/week) x Week to Month Conversion Factor)

52 weeks/ 12 months = 4.3 weeks per month

(7+18+27+34+44+48+47+45+38+24+16+11) (minutes/week)x 4.3 = 1,543.7 minutes per year

Total precipitation = Run time (minutes)/60 minutes per hour * precipitation rate

1,543.7 minutes per year/60 minutes per hour x 1 inch per hour = 25.7 inches per year

Average Total Precipitation across all regions=

(Region 1 Precipitation +Region 2 Precipitation + Region 3 Precipitation +Region 4 Precipitation + Region 5 Precipitation +Region 6 Precipitation +Region 7 Precipitation +Region 8 Precipitation +Region 9 Precipitation +Region 10 Precipitation +Region 11 Precipitation)/ 11 regions

(25.7+40.1+40.9+51.5+50.8+46.9+49.1+43.7+41.2+55.7+75.5)(inches per year)/11 regions= 47.4 inches per year

Water volume per yard=area of yard (sq. ft.)*inches of precipitation/12 inches per foot

3,809 sq. ft. x 47.4 inches per year/12 inches per foot = 15,037 cubic feet per year

15,037 cubic feet x 7.48 gallons per cubic foot= 112,476 gallons per year

Water per emission device per year = Water volume per yard/number of devices

112,476 gallons/36 devices = 3,124 gallons per device per year

Baseline Water Consumption

Gallons per device per year x Total Stock= Baseline Water Consumption

3,124 gallons per device per year x 209,807,418 devices = 655,508 million gallons per year

Alternatively water usage may also be estimated based upon data gathered in the CALMAC study of 415 single family residential sites.[97] The study estimates that on average 93,900 gallons are used for outdoor water use.[98] The 93,900-gallon value agrees well with the 112,476 gallon value calculated by the UC ANR method.

97 Funk, Andrew, and William DeOreo, *Embedded Energy in Water Studies Study 3: End-Use Water Demand Profiles*, 2011, pg. 54.

98 Ibid., pg. 88.

CALMAC Calculation Method

Water Emission per device per year= Water volume per yard/number of devices

93,900 gallons/36 devices = 2,608 gallons per device per year

Baseline Statewide Water Consumption

Gallons per device per year x Total Stock= Baseline Water Consumption

2,608 gallons per device per year x 209,807,418 devices = 547,248 million gallons per year

Smart Irrigation Controller Calculation Method

The Smart Irrigation Controller report found an average total precipitation of 52.5 inches per year.[99] Staff used the same method as the UC UNR method to estimate per device and statewide water use.

3,809 sq. ft. x 52.5 inches per year/12 inches per foot = 16,664 cubic feet per year

15,037 cubic feet x 7.48 gallons per cubic foot= 124,650 gallons per year

Water per emission device per year = Water volume per yard/number of devices

124,650 gallons/36 devices = 3,462 gallons per device per year

CASE Team Estimate

The CASE provides a statewide baseline water use estimate of 551,000 million gallons/yr. Staff divided the baseline estimate by the estimated stock to determine the per device use.

Baseline Water Consumption/ year/Total Stock = Gallons per device per year

551,000 million gallons/yr /209,807,418 devices = 2,626 gallons/year

Table A-4 compares the estimated water use for each calculation method. Staff chose the average among the four methods to estimate the water use per device. The baseline use is the weighted average of both compliant and noncompliant devices. 2,955 gallons per device is used for the remainder of the analysis. Embedded electricity is estimated using the value from the CASE Team report of 3,565 kWh/ million gallons.[100]

Average per Device Water Use Calculation:

(UC ANR + CALMAC + Smart Irrigation + CASE)/ 4 = average per device use

(3,124 + 2,608 + 3,462 + 2,626)/4 = 2,955 gal/yr

Embedded Electrical Energy Calculation:

Statewide Water Consumption x Embedded Energy per water consumption

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99 Mayer, Peter, William DeOreo, et al, *Evaluation of California Weather Based "Smart" Irrigation Controller Programs*, 2009, pg. 86, http://ucanr.edu/sites/UrbanHort/files/99641.pdf.

100 Pike, Ed, and Daniela Urigwe, *Statewide Codes and Standards Enhancement (CASE) Team Response to Request for Proposals: Irrigation Spray Sprinkler Bodies*, pg. 64, September 18, 2017.

620,053 million gallons x 3,565 kWh/million gallons= 2,210 GWh/yr

Table A-4: Baseline Water and Energy Use

Calculation Method	Water Per Device (gal/yr)	Water Per Residence (gal/yr)	Statewide Water Use (MM gal/yr)	Embedded Electricity (GWh/yr)
UC ANR	3,124	112,476	655,508	2,337
CALMAC	2,608	93,900	547,248	1,951
Smart Irrigation	3,462	124,650	726,455	2,590
CASE Team	2,626	94,544	551,000	1,964
Average	2,955	106,392	620,053	2,210

Source: California Energy Commission

Compliant Water and Energy Use

The Irrigation Association estimated that 10 percent of current sprinkler spray bodies comply with the proposed pressure regulation standard.[101]

The University of Florida performed testing per the EPA WaterSense Specification for Spray Sprinkler Bodies and provided data to compare performance of products with and without pressure regulation. Staff reduced the data to provide the average output flow for spray sprinkler bodies with and without pressure regulating devices. The data are graphed in **Figure A-1**.

Staff calculated the water pressure at the spray sprinkler body by assuming 65 psi at the supply inlet and subtracting 5 psi for irrigation valve losses and 5 psi for pipe losses.

Water pressure at spray sprinkler body = Supply pressure – valve losses – pipe losses

55 psi = 65 psi – 5 psi – 5 psi

The water savings rate was calculated by determining the difference between the nonpressure-regulated flow rate and the maximum flow rate allowed by the proposed standard. The calculation was performed using performance values at a water pressure of 55 psi.

Water saving rate = (flow $rate_{NPR}$ –flow $rate_{compliant}$)/ flow $rate_{NPR}$

Water saving rate at 55 psi = (1.98 gpm-1.69 gpm)/1.98 gpm = 14.7%

101 Mecham, Brent, Irrigation Association, *Spray Sprinkler Bodies Docket Number: 17-AAER-05,* pg. 45, September 18, 2017.

Figure A-2: Estimation of Pressure Regulation Savings

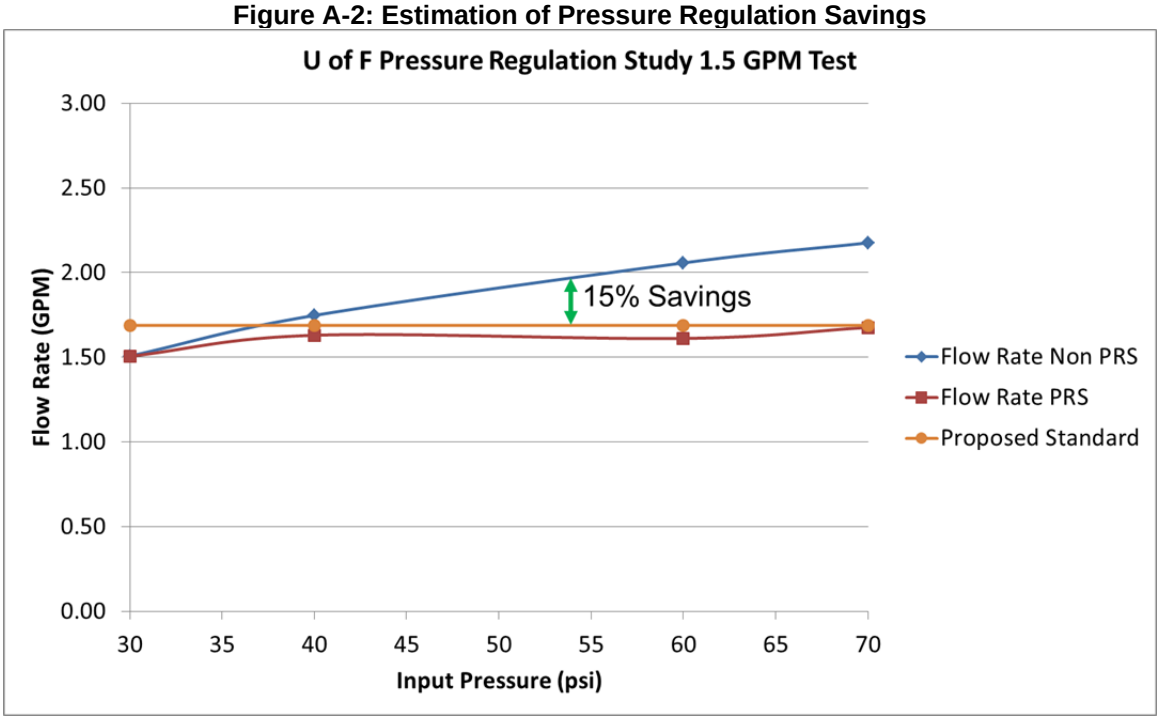

Illustration Credit: California Energy Commission with EPA WaterSense Data

Staff assumes no change in duty cycle when compliant products replace noncompliant products. Since the baseline usage per device is the weighted average use of both compliant and noncompliant devices, staff will calculate the water use for compliant and noncompliant devices using the savings rate found above and the compliance rate provided by the Irrigation Association.

Noncompliant water use per device:

Noncompliant use = Baseline use / [(1-compliance rate) + (1-savings rate) x compliance rate)]

Noncompliant use = 2,955 gal/yr / [(1-10%) + (1-14.7%) x 10%)] = 3,000 gal/yr

Compliant water use per device:

Compliant use = (1-savings rate) x non-compliant use

Compliant use = (1-14.7%) x 3,000 gal/ yr= 2,557 gal/yr

Table A-5: Compliant Water and Energy Use

Calculation Method	Water Per Device (gal/yr)	Water Per Residence (gal/yr)	Statewide Water Use (MM gal/yr)	Embedded Electricity (GWh/yr)
Average	2,557	92,060	536,527	1,913

Source: California Energy Commission

Cost and Savings

Table A-6 lists the annual water and energy savings for the first year the proposed standards become effective. It also lists the water, energy, and monetary savings upon complete stock turnover to products compliant with the proposed standards in 2030.

Staff estimated and tabulated statewide savings in **Table A-6** using the results listed in **Tables A-4** and **A-5**. Staff assumptions, as well as sample calculations, are provided below.

Water savings per device = Non-compliant water use – compliant water use

Water savings per device = 442 gal / yr =3,000– 2,557

Water savings per residence = water savings per device x devices per residence

Water savings per residence = 15,924 gal /yr = 442 gal /yr x 36 devices

Statewide water savings = Baseline water usage – compliant water usage

Statewide water savings = 83,526 million gallons /yr = 620,053 – 536,527

Statewide Energy Savings = Baseline Embedded Electricity – Compliant Embedded Electricity

Statewide Energy Savings = 298GWh/yr = 2,210 GWh/yr – 1913 GWh/yr

Table A-6: Water Savings and Energy Savings

Calculation Method	Water Per Device (gal/yr)	Water Per Residence (gal/yr)	Statewide (MM gal/yr)	Embedded Electricity (GWh/yr)
Average	442	15,924	83,526	298

Source: California Energy Commission

Table A-7 provides statewide monetary savings based upon the CASE Report, which provided costs of residential water as $6.08 per 1000 gallons and embedded electricity costs. Although the CASE team projects a yearly water delivery rate increase, staff chose to keep the water delivery rate flat since an increasing rate is not needed to show cost effectiveness.

Stock Water Delivery Savings = Statewide Water Savings x water delivery charge

Stock Water Delivery Savings = 83,526MM gal/yr x $6.08/1000 gal = $507.8M/ yr

First year Water Delivery Savings= Stock Water Delivery Savings/Design Life

First year Water Delivery Savings=$507.8 M/10 yrs = $50.8 M

Stock Embedded Energy Savings = Embedded Electricity x cost of electricity

Stock Embedded Energy Savings = 298 GWh/yr x $0.1431/kWh = $42.6 M/yr

Table A-7: Statewide Monetary Savings

	First Year			Stock Savings		
Product Type	**Water Delivery (M$/yr)**	**Embedded Electricity (M$/yr)**	**Total (M$/yr)**	**Water Delivery (M$/yr)**	**Embedded Electricity (M$/yr)**	**Total (M$/yr)**
Spray Sprinkler Body	$50.8	$4.3	$55.0	$507.8	$42.6	$550.4

Source: California Energy Commission

Staff surveyed manufacturer and retailer websites to determine the average retail price of sprinkler heads with and without pressure regulation. The results are presented in **Table A-8**.

Table A-8: Average Sprinkler Head Price

Stem (Pop-up height in inches)	Spray Body (No Nozzle)	Spray Body With Pressure Regulator	Spray body With Pressure Regulator and Check Valve
Gravity 2"	$3.92	N/A	N/A
2"	$2.03	N/A	N/A
4"	$1.76	$5.06	$6.33
6"	$6.10	$10.78	$11.52
12"	$10.23	$13.26	$15.96

Source: California Energy Commission

Table A-9 presents the incremental cost between a noncompliant and compliant product. Since staff could not find a compliant 2" gravity or 2" pop-up, the incremental costs for this product represent a compliant 4" pop-up installed with a flexible pipe adapter called a "funny pipe."

Table A-9: Sprinkler Head Incremental Costs

Stem(Pop-up height in inches)	Spray Body With Pressure Regulator	Spray Body With Pressure Regulator and Check Valve
2"	$2.22	$3.16
4"	$3.30	$4.57
6"	$4.68	$5.42
12"	$3.03	$5.73

Source: California Energy Commission

Table A-10 lists the annual water and energy savings for spray sprinkler bodies once the proposed standard becomes effective. It also lists the design life, annual monetary savings, the incremental cost, and the life-cycle benefit of spray sprinkler bodies. Because water delivered to customers typically carries a fixed price, savings resulting from embedded electrical energy are not factored into staff calculations for monetary savings per unit. Staff chose the highest incremental cost of $4.68 for the 6" pop-up stem for the life-cycle benefit calculation. Since other types of spray sprinkler bodies have lower incremental costs, the life-cycle benefit calculation is conservative. Staff assumed a 3 percent discount rate to calculate the net present worth of the water savings. The incremental cost is subtracted from the net present worth of the savings to determine the life-cycle benefit.

Table A-10: Annual Water, Energy, and Monetary Savings

Design Life (years)	Water Savings (gal/yr)	Embedded Electricity Savings (kWh/yr)	Incremental Costs ($)	Average Annual Savings ($/yr)	Life-Cycle Benefit ($)
10	442	1.6	$4.68	$2.69	$18.26

Source: California Energy Commission

Average annual savings = water savings/year x water delivery charge

Average annual savings = 442 gallons/year x $6.08/1,000 gal= $2.61/year

Net present worth (NPW) of savings = Σ [(annual savings) / (1+discount rate) ^ year]

Table A-11: Net Present Worth Calculation Result by Year

Year	1	2	3	4	5	6	7	8	9	10	Total
Savings	$2.61	$2.54	$2.46	$2.39	$2.32	$2.25	$2.19	$2.12	$2.06	$2.00	$22.94

Source: California Energy Commission

Life-Cycle Benefit = Net present worth savings – Incremental Cost

Life-Cycle Benefit = $22.94 - $4.68 = $18.26