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EVERGREEN ECONOMICS

Economic Impact Analysis of the Water Efficiency Standards for Spray Sprinkler Bodies

A Draft Report to Pacific Gas and Electric Company

Submitted by Evergreen Economics

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1 Introduction

In May 2018, Pacific Gas and Electric Company (PG&E) engaged Evergreen Economics (Evergreen) to conduct an economic analysis of the proposed new performance standards for spray sprinkler bodies (SSB). Evergreen used IMPLAN modeling software to estimate how the proposed standards will affect California residences, businesses, and government facilities with irrigated landscaping, as well as spray sprinkler manufacturers based in California. In addition, Evergreen examined the economic benefits associated with increased in-stream flows due to less water being used for irrigation and the value of avoided emissions from the generation of electricity that would have been used for pumping and treating water (e.g., carbon dioxide—CO^2, nitrogen oxides—NO_X, and sulfur oxides—SO_X).

In conducting the analysis and presenting the results in this report, Evergreen segmented those affected by the proposed new performance standard into the following three groups:

Single-family Residences consists of all *detached* single-family residences that have irrigated landscapes.

Businesses and Multi-Family Residences consists of commercial, retail, and industrial businesses with irrigated landscapes, including golf courses, as well as all *attached* residential dwellings including both owner and renter occupied, single-family attached homes and multi-family dwellings with two or more units.

Government consists of all state, local, and federal government facilities, including K-12 schools, community colleges, and universities, and state, local, and national parks and monuments.

2 Background on Sprinkler Standards

The Warren-Alquist Act[1] established the California Energy Commission (Energy Commission) as California's primary energy policy and planning agency. The act mandates that the Energy Commission reduce the wasteful and inefficient consumption of energy and water in the state by prescribing statewide standards for minimum levels of operating efficiency for appliances that consume a significant amount of energy or water. On March 14, 2012, the 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).[2] In 2017, the Energy Commission began reviewing received proposals and data related to the updated standards and testing procedures—focused on improving energy efficiency—for the various measures and appliances identified during the 2012 discussions. These measures were identified based on their potential to save energy, water, or some combination of both.

Among these identified measures were SSB used in landscape irrigation systems. Beginning in 2019, the Energy Commission will be required to adopt performance standards and labeling requirements for landscape irrigation equipment that become effective in 2020.[3] Currently, water consumption differs between various sprinkler devices, and no regulations exist to help promote and improve the efficiency levels of the sprinkler devices. According to the Energy Commission, landscape irrigation in urban parts of California consumes more than one trillion gallons of water per year (34 percent of all urban water use), a portion of which is attributable to sprinkler device technology inefficiencies and usage practices including over-irrigation, excessive water pressure, and leakage.[4]

To address these inefficiencies and the legislative mandate of Assembly Bill 1928,[5] Energy Commission staff proposed an addition to the Appliance Efficiency Regulations that outlines specific test methods and performance standards for SSB. The goal of the Energy Commission's review process was to identify available and technically feasible procedures and products that would provide significant water savings and be cost effective to

[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/2017publications/CEC-140-2017-001/CEC-140-2017-001.pdf

[2] Steffensen, Sean. 2018. *Final Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*. California Energy Commission, CEC-400-2018-005-SD1

[3] Assembly Bill 1928 (Campos, Chapter 326, Statues of 2016)

[4] Steffensen, Sean. 2018.

[5] Assembly Bill 1928 requires the California Energy Commission to adopt performance standards and labeling requirements for landscape irrigation equipment on or before January 1, 2019. The Bill states that the Energy Commission must consider the Irrigation Association's Smart Water Application Technology Program testing protocols when adopting performance standards for landscape irrigation equipment.

consumers. Given the current inefficiencies with excessive water pressure, the Energy Commission staff identified pressure regulation—which maintains the ideal sprinkler water flow regardless of water pressure—as a key component to target when adopting the new sprinkler testing methods and standards. Specifically, the Energy Commission proposed an update that would "require all spray sprinkler bodies to control the outlet flow rate over a specified range of inlet water pressures," as described in detail in the 2018 Final Staff Analysis Report.[6] All sprinkler devices offered in California would also need to be tested and certified using the U.S. EPA *WaterSense Specification for Spray Sprinkler Bodies, V.1.0*. By reducing excessively high water flow in inefficient SSB, Energy Commission staff estimates that the new standards could result in a reduction of nearly 14 billion gallons of water used for irrigation by residences, businesses, and government facilities[7] in the first year of implementation and 138 billion gallons per year once all SSB are replaced, which is assumed to be in 10 years.[8]

To further analyze the potential impacts of the proposed SSB standards, the Energy Commission is required to complete a Standardized Regulatory Impact Assessment (SRIA) by the California Department of Finance (DOF). The SRIA includes a broader statewide economic impact model based on the estimated household savings that would result from the proposed regulatory standards. The SRIA provides further context for impacts on the regional economy in California, highlighting economic output, employment, and labor income resulting from the improved efficiency of SSB.

[6] Steffensen, Sean. 2018.
[7] Government facilities include federal, state, and local government, including K-12 schools, universities, and community colleges, and any other public facilities associated with education.
[8] The Energy Commission staff report includes schools within the business sector; we exclude schools in this analysis of economic impacts.

3 Economic Impact Analysis

To estimate the direct market-based economic impacts of the proposed update to the performance standards for SSB, Evergreen used Impact Analysis for Planning (IMPLAN) v3.1 modeling software. IMPLAN is an input-output model used to estimate the economic effects of proposed policies and projects. Most of the direct economic impacts are associated with greater discretionary spending by California single-family residents due to net monetary savings from a reduction in water usage for irrigation. In addition, the higher marginal cost of compliant sprinklers will lead to more revenue for sprinkler manufacturers, approximately one-third of which are located in California.[9] Businesses, including owners of multi-family structures, and government will also be positively affected by the proposed update, but will not result in additional economic activity.

3.1 Key Assumptions and Inputs for Estimating Economic Impacts from Increased Spending by California Residents

The proposed update to the performance standard for SSB will result in residential customers paying more for sprinkler devices, but this increase in cost will be more than offset by monetary savings from lower demand for water for lawn irrigation. Evergreen relied on estimates of the value of water savings by residents developed by Energy Commission staff.[10] Key assumptions of the analysis by Energy Commission staff are shown in Table 1.

Table 1: Key Assumptions in Energy Commission Staff Analysis

Description	Assumed Value
California home type affected by the proposed rule change	Single-family detached
Number of single-family detached homes in CA	8,094,422
Percentage of CA single-family homes with automatic irrigation	72%
Average number of sprinkler devices per home	36
Percentage of sprinkler devices compliant with proposed performance standard	10%
Expected useful life (EUL) of a sprinkler device (compliant or non-compliant)	10 years
Annual water volume per non-compliant sprinkler device (gallons)	3,011
Annual water volume per compliant sprinkler device (gallons)	2,457
2017 potable water delivery price for residential customers (1,000 gallons)	$5.76
Incremental cost of a compliant sprinkler device (with pressure regulator)	$4.68

Source: *Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*, 2017 Appliance Efficiency Pre-Rulemaking Docket Number 17-AAER-08.

[9] Based on IMPLAN data for California, 33.4 percent of spending in California on products in IMPLAN *sector 254 Valve and Fittings, other than Plumbing, Manufacturing*, which contains sprinkler device manufacturing, is to firms located in California. This is referred to as the local purchasing percentage (LPP).

[10] *Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*, 2017 Appliance Efficiency Pre-Rulemaking Docket Number 17-AAER-08.

Based on these and other underlying assumptions, Energy Commission staff assumed that each year, California residences, businesses, and government will replace on failure 10 percent of non-compliant sprinkler devices with compliant sprinkler devices and that within 10 years, all sprinkler devices installed in residences and businesses will comply with the proposed efficiency standard.[11] Table 2 shows how the assumptions made by Energy Commission staff would affect the typical residence with lawn and landscape irrigation over the first 10 years of the new standard. As the table shows, while the average incremental cost per residence stays constant over time, the benefits accruing to residents increase as the residents continue to replace failed non-compliant sprinkler devices with compliant devices. In its analysis, Energy Commission staff made the conservative assumption that the incremental cost of compliant sprinkle devices will not decrease over time. In reality, technical change driven by competition between manufacturers will likely drive down the incremental cost of compliant sprinkler devices.

Table 2: Average Financial Impact of Proposed Standard Per Residence with Irrigation, 2018 Dollars

Year	Sprinkler Devices Replaced*	Incremental Cost	Value of Annual Water Savings	Net Savings (Cost – Savings)
2020	3.24	$15.16	$10.34	-$4.82
2021	3.24	$15.16	$20.68	$5.51
2022	3.24	$15.16	$31.02	$15.85
2023	3.24	$15.16	$41.36	$26.19
2024	3.24	$15.16	$51.69	$36.53
2025	3.24	$15.16	$62.03	$46.87
2026	3.24	$15.16	$72.37	$57.21
2027	3.24	$15.16	$82.71	$67.55
2028	3.24	$15.16	$93.05	$77.89
2029	3.24	$15.16	$103.39	$88.23

* Computed as 36 sprinkler devices per detached single-family residence with irrigation × (1 – 10% compliance rate) × (10-year EUL / 10). Of course, residents will not replace fractional sprinkler devices.

Energy Commission staff estimated that the stock of sprinkler devices installed in single-family residential applications is 209.8 million and that on average, 10 percent of sprinkler devices are replaced each year due to failure.[12] Table 3 shows the impact of the proposed change in efficiency standard across all California single-family residences assumed to have lawn and landscape irrigation systems. For purposes of estimating economic impacts to residents, Evergreen assumed that the total net savings shown in Table 3 represent

[11] Ibid. Evergreen assumes the same rate of replacement and useful life for sprinkler devices installed at government facilities.
[12] Ibid.

increased disposable income that residents will spend on additional goods and services. The economic impacts represent the total amount of economic activity—measured by value of economic output, employment, and wages—within California from the direct spending by single-family residents plus the additional economic activity as businesses directly affected by increased consumer spending purchase additional inputs and increase spending on employees, who in turn spend some portion of their additional wages on goods and services.

Table 3: Total Financial Impact of Proposed Standard for Residences with Irrigation, 2018 Dollars

Year	Incremental Cost*	Value of Annual Water Savings	Net Savings (Cost – Savings)
2020	-$88,370,885	$60,255,348	-$28,115,537
2021	-$88,370,885	$120,510,696	$32,139,811
2022	-$88,370,885	$180,766,043	$92,395,159
2023	-$88,370,885	$241,021,391	$152,650,506
2024	-$88,370,885	$301,276,739	$212,905,854
2025	-$88,370,885	$361,532,087	$273,161,202
2026	-$88,370,885	$421,787,434	$333,416,550
2027	-$88,370,885	$482,042,782	$393,671,897
2028	-$88,370,885	$542,298,130	$453,927,245
2029	-$88,370,885	$602,553,478	$514,182,593

* Computed as 20,980,742 SSB replaced each year × 90% of bodies that are non-compliant × $4.68 incremental cost of a compliant SSB.

Since only those California residences with irrigated lawns and landscapes would be affected by the proposed update to the performance standard for sprinkler devices, and the rate of home ownership is positively related to income and wealth, the total financial impacts shown in Table 3 would not be distributed equally across California households. Instead, the impacts will be greater for higher income households, which are most likely to live in owner-occupied single-family homes. This may be an important consideration in estimating the economic impacts associated with additional spending by households because what households spend their money on differs by their income level. For instance, higher income households spend more on discretionary goods and services than do lower-income households.

Table 4 shows the distribution of California households by income and our estimates of the number of those households with irrigation systems. As income goes up, the likelihood

that a household lives in a home with an irrigation system increases.[13] Nevertheless, we still assume there are many lower-income homes (i.e., an annual household income below $30,000) with irrigation systems. At first glance, this may seem surprising, but many (or even most) of these lower income households would be composed of retirees with assets and fixed regular income, and would likely own their home.

Table 4: Estimated Distribution of Households and Homes by Income Category

Household Income Category	Distribution of Households*	Distribution of Homes with Sprinklers**	Homes with Sprinklers**
Less than $15K	11.6%	4.7%	273,915
$15K - $30K	15.3%	7.7%	448,755
$30K - $40K	9.2%	7.4%	431,271
$40K - $50K	8.5%	8.6%	501,207
$50K - $70K	13.5%	15.0%	874,198
$70K - $100K	15.3%	18.7%	1,089,833
$100K - $150K	14.0%	18.4%	1,072,349
$150K - $200K	6.0%	8.4%	489,551
$200K +	6.8%	11.1%	646,906
Total	**100.0%**	**100.0%**	**5,827,984**

* Data obtained from the California American Community Survey, 1-Year Report, http://www.dof.ca.gov/Reports/Demographic_Reports/documents/2011ACS_1year_Rpt_CA.pdf
** Estimated by Evergreen Economics based on analysis of data from (a) Count of single-family homes in California (8,094,422) reported by California Department of Finance "*E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011- 2016 with 2010 Census Benchmark*," May 2016; (2) Energy Commission staff estimate of 72% of single-family homes with automatic irrigation; (3) U.S. Census estimates of homeownership rates for households above and below median household income. https://www.census.gov/housing/hvs/files/currenthvspress.pdf

3.2 Key Assumptions Regarding SSB Installed in Landscaping Around Businesses and Multi-Family Structures

Businesses and multi-family structures with irrigated landscaping will also be impacted by the proposed update to the performance standard for SSB, and like single-family residences, the higher incremental costs for compliant sprinkler devices will be more than offset by lower water costs for irrigation. We assume, however, that net savings to businesses and owners of multi-family buildings with irrigated landscapes will not lead to additional spending by these firms and building owners and, therefore, will not result in

[13] Recall that we rely on the Energy Commission staff assumption that the only residences with irrigation systems are detached single-family homes and that only 72 percent of these residences actually have irrigation systems.

additional economic activity. Nevertheless, California will experience economic benefits in three ways as businesses and owners of multi-family buildings replace at failure non-compliant sprinkler devices with those meeting the higher performance standards.

1. The higher incremental cost of compliant sprinkler devices will result in positive economic impacts for California as increased spending on compliant sprinkler devices cycles through the economy.
2. Reduced water use for irrigation by businesses will result in more water available for in-stream flow, which has significant economic value, or for other direct economic uses.
3. Reduced water use for irrigation by businesses will lead to lower demand for electricity needed for pumping and/or treating water, which will result in avoided emissions from fossil fuel-based electricity generation.

Based on the Energy Commission staff estimate of total water demand for landscape irrigation by businesses and multi-family structures (186,839 million and 67,524 million gallons per year, respectively) and the staff's assumption that the baseline average flow-rate per sprinkler device used in landscaping around businesses and multi-family structures is the same as for (single-family) residential irrigation (2,955 gallons per year), Evergreen estimates that the stock of SSB installed in landscaping around businesses in California is about 86 million [(186,839 + 67,524) million /2,955 ≈ 86 million)].[14]

3.3 Key Assumptions Regarding SSB Installed in Landscaping Around Government Facilities

Evergreen estimated the count of SSBs installed at government facilities that is altogether separate from the estimate of SSBs installed at businesses. Similar to businesses, government properties with irrigated landscaping will be impacted by the proposed update, as this sector will incur higher incremental costs for compliant sprinkler devices, which will be more than offset by lower water costs for irrigation. We assume that net savings to government facilities with irrigated landscapes will not result in additional spending by these facilities that would drive additional economic impacts.[15] Nevertheless, we assume California will experience economic benefits from reduced water consumption by government facilities in the same three ways as described for businesses.

We are not aware of any source of information on the stock of sprinkler devices used for irrigation at government facilities in California. However, we believe it is reasonable to

[14] This includes golf courses, which account for more than half of the water used in commercial/industrial irrigation, but excludes schools. Baseline water use per device assumes a 90/10 mix of non-compliant and compliant sprinkler devices (Steffensen, Sean. 2018).

[15] Government facilities include federal, state, and local government, including K-12 schools, universities, and community colleges, and any other public facilities associated with education.

assume that on average, government facilities utilize sprinkler devices at approximately the same rate as businesses and that employment is a suitable measure for which to approximate water use by government facilities for landscape irrigation. In 2017, average monthly employment in California was 16.8 million, and 15 percent of employment (2.55 million people) worked in federal, state, or local government (see Table 5). Evergreen multiplied the number of sprinkler devices estimated to be installed at businesses (63 million) by 15 percent to derive an estimate of the number of SSB installed at government facilities: 9.5 million sprinkler devices.[16]

Table 5: Monthly and Average Annual Employment in California (in Thousands), Total Non-Farm and Government, 2017

Sector	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
Total Employment	16,457	16,576	16,665	16,725	16,821	16,865	16,721	16,794	16,858	17,009	17,119	17,140	16,813
Total Gov.	2,542	2,564	2,584	2,586	2,600	2,593	2,417	2,437	2,518	2,589	2,610	2,602	2,553
Federal	247	247	247	247	248	250	250	248	248	248	247	249	248
State Education	260	265	269	269	270	266	241	234	243	269	275	276	261
State Non-Educ.	264	264	265	266	267	268	270	269	269	270	269	268	268
Local Education	977	993	1,006	1,005	1,011	990	834	868	948	994	1,013	1,005	970
Local Non-Educ.	794	794	796	798	803	818	823	819	809	808	806	806	806
Percent Gov.	***15.4%***	***15.5%***	***15.5%***	***15.5%***	***15.5%***	***15.4%***	***14.5%***	***14.5%***	***14.9%***	***15.2%***	***15.2%***	***15.2%***	***15.2%***

Source: U.S. Department of Labor, Bureau of Labor Statistics, https://www.bls.gov/sae/#tables

3.4 Key Assumptions for Estimating Economic Impacts from Increased Revenue Received by Sprinkler Device Manufacturers

As discussed above, Energy Commission staff estimated that the incremental cost of a compliant sprinkler device is $4.68.[17] This additional cost to California residents is revenue to manufacturers of compliant sprinkler devices, approximately one-third of which are located in California (see footnote 9 on page 4). In developing estimates of economic impacts, we assume that approximately one-third of the incremental spending by residents on compliant sprinkler devices will go to manufacturers located in California and it is this spending that is the basis for developing estimates of economic impacts. The remaining two-thirds of incremental spending on sprinkler devices will go to manufacturers outside the state, and California will not enjoy any economic impacts from this additional spending.

[16] In order to err on the side of being too conservative, we used total employment in the denominator rather than total private sector employment. This estimate of the count of sprinklers installed at government facilities is not a subset of the estimate of sprinkler installed at businesses, but rather is a stand-alone estimate.

[17] Ibid.

3.5 Regional Economic Impact Modeling

A regional economic impact model is a tool for estimating how policy actions will affect a regional economy. There are two standard approaches to conducting economic impact analysis: input-output models and computable general equilibrium (CGE) models. Input-output models rely on detailed information regarding household spending on goods and services and similarly detailed matrices of interdependencies between industry sectors that produce those goods and services. Input-output models are especially useful in analyzing how small (relative to the overall regional economy) changes in household spending or business or government investment may affect output, employment, and employee wages in each sector of the regional economy.

The CGE modeling approach also accounts for interrelationships between households and industry sectors, but generally not in as great detail as input-output models. However, CGE models account for optimizing behaviors by households and businesses (e.g., profit maximization); adjustments over time in the economy, demand, supply, and price; and forecasting of economic activities in future years. CGE models are more sophisticated than input-output models. This greater sophistication is warranted when considering a policy change or action that is expected to have significant impacts on a region's economy. For a policy or event that is expected to have relatively small impacts on a regional economy, the greater investment in time and cost associated with developing a CGE model and the added complexity associated with the CGE approach is not warranted and would likely produce similar results as the input-output approach.

3.5.1 Estimating Economic Impacts Using Input-Output Modeling

The input-output modeling approach provides estimates of the economic impacts that spending associated with a capital investment, event, government policy, or other action has on a region's economic output, employment, and labor income. There are three widely-used input-output models for conducting economic impact analysis:

1. RIMS-II (Regional Input-Output Modeling System);
2. REMI (Regional Economic Models, Inc.); and
3. IMPLAN (Impact Analysis for Planning).

Underlying each of these models are matrices quantifying the value of goods and services that flow between industrial sectors. The matrices account for the value of goods and services produced "domestically" (i.e., within the geography of interest) and the value of "imported" (i.e., produced outside the geography of interest) goods and services brought into the geography of interest.[18] IMPLAN is the most commonly used economic impact

[18] The geography of interest for this analysis is the state of California, but could be an individual or collection of zip codes, counties, or states.

model due to its ease of use; extensive detailed information on output, employment, and wage at the sub-industry level;[19] availability of information at the state, county, and zip code level; and the frequency at which data are updated.

RIMS-II

The RIMS-II model is essentially a set of multipliers that the analyst applies to develop estimates of economic impacts, which are economy wide with limited or no detail by industry sector. The tables of multipliers are developed by the U.S. Bureau of Economic Analysis (BEA) and cannot be modified by the analyst, nor does RIMS-II allow for the introduction of new industries into a region. The RIMS-II model is a static representation of a region's economy at a point in time. While a limiting characteristic, the static nature of the model is only a shortcoming when the policy change being considered is likely to have a substantial impact on consumer purchasing decisions and/or the economic structure of the region.

REMI

REMI is the most complex of the three models. It combines the input-output modeling capabilities of IMPLAN and RIMS-II with a dynamic general equilibrium model that allows for economic adjustments and forecasting. This additional capability comes at a cost in that REMI provides less sectorial detail than IMPLAN (about 100 sectors for REMI compared to 536 for IMPLAN), and REMI is far more expensive than IMPLAN. For most economic impact analyses, the additional capabilities that REMI provides are not necessary, and its greater complexity may make the modeling process and results seem less transparent.

IMPLAN

IMPLAN, like RIMS-II, reflects the impacts on the regional economy as it exists at a point in time. In this way, IMPLAN assumes that the technology employed by each industrial sector remains static, the local share of each industry's economic activity is assumed to be fixed into the future, and supply constraints are perfectly elastic—meaning there is no capacity limit to an industry's ability to respond to an economic event.[20] IMPLAN also assumes that changes in household income will impact household demand based on average expenditure patterns. However, economists typically assume that a change in

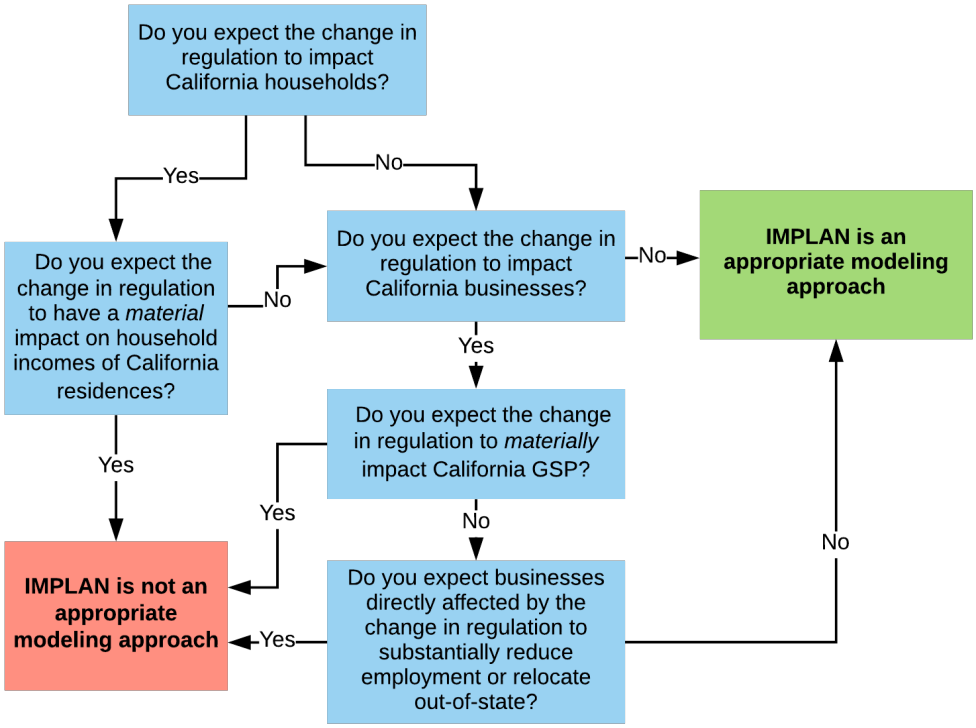
[19] IMPLAN organizes industry data into 536 sectors. While these sectors are not exactly aligned to the North American Industrial Classification System (NAICS), IMPLAN sectors can be linked to corresponding NAICS sectors.

[20] In addition, the IMPLAN and RIMS-II models do not account for "welfare effects," which consider how changes in resource allocation may affect the wellbeing of society.

income will impact household expenditure at the *margin*, resulting in increased demand for some goods and services and lower or unchanged demand for others.

It is necessary to consider these limitations when determining if IMPLAN is an appropriate modeling approach for conducting an economic analysis of the impact of a regulatory change that is expected to affect California households or businesses, which requires completion of a Standardized Regulatory Impact Assessment (SRIA). The flow chart shown in Figure 1 is a simple guide for judging whether IMPLAN is an appropriate modeling approach for conducting the economic impact analysis required for an SRIA.

Figure 1: Is IMPLAN an Appropriate Modeling Approach?



There is not a set rule for concluding that IMPLAN is or is not a suitable modeling approach; however, the guide shown in Figure 1 provides a framework for making this determination. If the regulatory change is expected to materially impact household incomes of California residences—either positively or negatively—this would suggest the regulatory change will affect household demand for goods and services, which would require adjustments to the regional economy to accommodate.[21] In this case, since

[21] Deciding what is a "material" impact to household income is to some degree arbitrary. A possible rule of thumb to consider would be an annual change of 1 percent or more in median household income, which was

IMPLAN is a static model and does not consider potential structural changes in the economy, we would likely conclude it is not a suitable modeling approach. Likewise, if the regulatory change is expected to affect California businesses in such a way as to materially impact Gross State Product (GSP)—either positively or negatively—or lead California businesses to reduce employment and/or relocate out-of-state, we would likely conclude IMPLAN is not a suitable modeling approach. Additional details on IMPLAN and how program savings are calculated can be found in Appendix A of this report.

3.5.2 Limitations of the Economic Impact Analysis

Evergreen used the IMPLAN model to estimate the economic impacts of the proposed regulatory change on the California economy by considering (a) how the increased disposable income available to California residents due to the regulatory change will cycle through the California economy and (b) how additional spending on irrigation sprinklers, much of which will go to California-based firms, will impact other California businesses. While this analysis provides important insights and reasonable estimates of the economic impact to California of the proposed change to the performance standards of SSB, it is important to note that, as described above, the input-output-based economic impact analysis does not account for potential adjustments in household spending and water-use behaviors, technical changes in the manufacturing of the compliant sprinkler devices, or potential shifts in the proportion of sprinkler devices manufactured in California.

$63,783 in California in 2016 for a four-person household.
https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

4 Key Findings

Energy Commission staff analyzed the cost-effectiveness, technical feasibility, and statewide energy and water savings of the proposed spray sprinkler device standard.[22] Their analysis found that the primary beneficiaries of the proposed regulatory change are California single-family households that irrigate their landscapes with lawn sprinklers.

Single-Family Residences
Energy Commission staff estimates first-year savings for these households of 10.47 billion gallons and 104.65 billion gallons in annual savings once the stock of non-compliant residential sprinkler devices has been replaced, which Energy Commission staff estimates will take 10 years.[23]

Businesses and Multi-Family Residences
Energy Commission staff estimates a first-year reduction of 3.4 billion gallons of water used to irrigate landscapes around businesses and 34.3 billion gallons per year beginning in 10 years once the stock of sprinkler devices has been replaced.[24] Evergreen estimates the first-year water savings around multi-family structures will be 1.1 billion gallons and 11.4 billion gallons once the stock of non-compliant sprinkler bodies has been replaced.

Government
Evergreen estimates the first-year water savings around government buildings will be about 473 million gallons and 4.73 billion gallons once all non-compliant SSB are replaced in 10 years.

We begin with a summary of state-level impacts on Gross State Product (GSP), employment, and expectations regarding potential impacts on business creation or elimination in California. We then provide results separately for residences, businesses, and government facilities that would be affected by the rule change.

4.1 Total Statewide Impacts

4.1.1 California Gross State Product

As discussed in greater detail below, we assume residents will spend the money saved from lower water bills on goods and services for their household. Most of this spending will occur locally (i.e., in California), but some will be for goods and services purchased from out of state. Local spending by these residents results in a small increase in economic activity in California, which is measured in jobs created and wages paid, and in the value of economic activity (GSP) resulting from the additional spending.

[22] For details on the Energy Commission staff analysis, see Steffensen, Sean. 2018.
[23] Ibid.
[24] Ibid; Energy Commission staff included schools, which Evergreen removed from this calculation.

Table 6 shows our estimates of the impacts the proposed change in the performance standards of SSB will have on California's GSP over the 10-year period beginning in 2020. The overall impact to GSP is positive beginning in 2020 and will grow each year. The higher performance standards for SSB will result in more efficient use of water in irrigation, which in turn will provide monetary savings to residents with irrigated lawns and landscapes. These monetary savings will grow as non-compliant sprinkler devices are replaced at failure with those meeting the higher performance standards. Energy Commission staff assumes that all of the non-compliant sprinkler devices will be replaced in 10 years (see assumptions in Table 1).

Table 6: Total Estimated Impacts to California GSP From Proposed Change in Performance Standards of SSB, 2018 dollars

Year*	GSP Impacts from Spending by Single-Family Residents	GSP Impacts from Revenue Received by Producers**	GSP Impacts from Businesses, Multi-Family, and Government	Total Change in Economic Output
2020	-$42,043,713	$74,330,584	$0.0	$32,286,871
2021	$48,061,575	$74,330,584	$0.0	$122,392,159
2022	$138,166,863	$74,330,584	$0.0	$212,497,447
2023	$228,272,150	$74,330,584	$0.0	$302,602,735
2024	$318,377,438	$74,330,584	$0.0	$392,708,022
2025	$408,482,726	$74,330,584	$0.0	$482,813,310
2026	$498,588,014	$74,330,584	$0.0	$572,918,598
2027	$588,693,301	$74,330,584	$0.0	$663,023,886
2028	$678,798,589	$74,330,584	$0.0	$753,129,173
2029	$768,903,877	$74,330,584	$0.0	$843,234,461

* Assumes full year impacts.
** Includes incremental revenue for compliant sprinkler devices received from California residences and businesses, and from federal, state, and local governments (including schools) in the state.

4.1.2 California Employment

Table 7 shows estimated statewide impacts on employment from the proposed change in performance standards for SSB. As with GSP, the impact on jobs is positive and grows each year. When considering the estimated changes in employment, it is important to remember that the additional spending by California households will occur statewide and, therefore, the impacts will be spread across many businesses. Our analysis demonstrates that the effect on the vast majority of businesses will be small and will result in little or no adjustment in employment levels. However, a relatively small number of businesses may need to make modest adjustments to the hours worked by some employees, and a handful of businesses may find it necessary to hire additional workers. The California economy is enormous and currently employs more than 18.5 million people. The estimated job impacts from our analysis—even once all the job impacts are realized—represent an infinitesimal portion of the state's employment. With this in mind, the overall estimated

impact on employment in the first year (2020) is a net gain of 23 jobs across the state. Job impacts are small, but positive, in the following year and reach 5,041 by 2029.

Table 7: Total Estimated Impacts to California Employment From Proposed Change in Performance Standards of Spray Sprinkler Devices

Year*	Job Impacts from Spending by Single-Family Residents	Job Impacts from Revenue Received by Producers	Job Impacts from Businesses, Multi-Family, and Government	Total Change in Jobs
2020	-260	283	0	23
2021	297	283	0	580
2022	855	283	0	1,138
2023	1,413	283	0	1,696
2024	1,970	283	0	2,253
2025	2,528	283	0	2,811
2026	3,086	283	0	3,369
2027	3,643	283	0	3,926
2028	4,201	283	0	4,484
2029	4,758	283	0	5,041

* Assumes full year impacts.

4.1.3 Increased Investment by California Businesses

The proposed change in the performance standard for SSB will likely result in a modest change in capital investment by California businesses. Included in the IMPLAN-based economic analysis are estimates of "proprietor income," which represent the returns to business and property owners and shareholders associated with the increased economic activity described above. Though varying significantly among businesses and property owners and over time, it is these funds that would be available to business and property owners for capital investment. Table 8 shows Evergreen's estimates of change in proprietor income.

Table 8: Total Estimated Change in Proprietor Income in California from Proposed Change in Performance Standards of Spray Sprinkler Devices

Year*	Proprietor Income from Spending by Single-Family Residents	Proprietor Income from Revenue Received by Producers	Proprietor Income from Businesses, Multi-Family, and Government	Total Change in Proprietor Income
2020	-$2,082,228	$1,584,694	0	-$497,534
2021	$2,380,265	$1,584,694	0	$3,964,959
2022	$6,842,758	$1,584,694	0	$8,427,452
2023	$11,305,252	$1,584,694	0	$12,889,946
2024	$15,767,745	$1,584,694	0	$17,352,439
2025	$20,230,238	$1,584,694	0	$21,814,932
2026	$24,692,731	$1,584,694	0	$26,277,426
2027	$29,155,225	$1,584,694	0	$30,739,919
2028	$33,617,718	$1,584,694	0	$35,202,412
2029	$38,080,211	$1,584,694	0	$39,664,905

* Assumes full year impacts.

To estimate what proportion of proprietor income would reasonably go to new capital investment, Evergreen analyzed national data on corporate profits and capital investment by businesses that expand a firm's capital stock (referred to as net private domestic investment, or NPDI). Between 2013 and 2017, NPDI as a percentage of corporate profits ranged from 26 to 34 percent, and the average was 29.3 percent. While only an approximation of the proportion of business income used for net capital investment, we believe it provides a reasonable estimate of the proportion of proprietor income that would be reinvested by business owners into expanding their capital stock.

For those businesses that do experience increased economic activity due to the proposed change in the performance standard for SSB and respond by investing in capital stock expansion, we believe it is most likely that they will not make such investments until after the first year of implementation of the new standard. Some of the businesses investing in capital expansion will likely do so in a single year (e.g., 2021) in anticipation of increased future economic activity, while others may do so incrementally over multiple years. Because it is uncertain when California businesses would make the capital investments, we calculated our estimates of capital investment as if they all occurred in a single year—though it is likely they actually will occur in other years as well—by discounting proprietor income for years 2021 through 2029 to a single base year.[25]

[25] As stated earlier in the paragraph, we exclude estimates of proprietor income for 2020 because we believe the soonest businesses will begin to make capital expanding investments is two years after implementation.

We developed estimates of investment in capital expansion and examined the reasonableness of these estimates by comparing them to California's GSP in the three steps shown in Table 9.

Table 9: Estimating Investment in Capital Stock Expansion by California Businesses

Step	Description	Results
1.	Computed the present value (in 2018 dollars) of proprietor income for years 2021 through 2029 by discounting the values shown in the last column of Table 8 by an assumed real rate of return of 3 percent.	$153 million
2.	Computed the present value (in 2018 dollars) of investment in capital stock expansion by multiplying the present value of proprietor income by 29.3 percent, the ratio of NPDI to U.S. after-tax corporate profit.	$44.9 million
3.	Computed the ratio of our estimate of investment in capital stock expansion by California businesses to California's GSP*	0.0016%

* According to data published by the U.S. Bureau of Economic Analysis, California's GSP in 2017 was $2.75 trillion.

We estimate that the proposed change in the performance standards for SSB will lead to a total increase in proprietor income of $153 million in 2018 dollars for those businesses directly and indirectly affected by the proposed change. Of this, we estimate that $44.9 million will be invested by these businesses to expand their capital stock. While these investments in capital stock expansion will likely occur over multiple years, we discounted these investments to a single year to more concisely express the overall impact on capital investment. This level of capital investment represents a mere 0.0016 percent of the value of California's GSP.

4.1.4 Creation of New Businesses or Elimination of Existing Businesses Within the State

We do not foresee any new businesses being created, nor do we think any existing businesses will be eliminated due to the proposed change in the performance standard for SSB.

4.2 Costs and Benefits to Single-Family Residents in California from Reduced Spending on Water for Irrigation

The increase in the watering efficiency of sprinkler devices purchased by California single-family residents will lead to lower water bills for these residents and provide a de facto increase in their disposable income.[26] Evergreen Economics examined how money saved by California residents due to the regulatory change will likely result in additional economic activity in California through increased household spending. In conducting this

[26] Household disposable income is the income remaining after taxes, Social Security and other deductions, and mandatory expenses, which realistically includes some minimal amounts of water and energy, available to be saved or spent on goods and services.

analysis, we made the simplifying assumption that single-family residents within each household income category will purchase, on average, the distribution of goods and services developed by IMPLAN based on data from the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS) Consumer Expenditure (CE) Survey.[27]

Households living in single-family residences were segmented into nine income categories (see Table 4) to account for differences in household consumption patterns—that is, the distribution of spending on goods and services by the typical household in that category.[28] The household income categories also differ slightly with respect to the proportion of goods and services purchased in California. Overall, about 84 percent of household purchases are local (in California), with the remainder consisting of online, subscription, or other purchases from sources outside California, as well as travel outside the state.

Table 10 shows expected savings to California single-family residents associated with the regulatory change affecting SSB. In the first year, the net impact on households is a small increase in costs of $4.82 for the typical affected household and $28.1 million across all California single-family residences with SSB.

Table 10: Estimated Annual Savings for CA Single-Family Residents, 2018 dollars*

	Average per Residence		All CA Single-Family Residents	
Year**	Annual Value of Water Savings	Net Savings***	Annual Value of Water Savings	Net Savings**
2020	$10.34	-$4.82	$60,255,348	-$28,115,537
2021	$20.68	$5.51	$120,510,696	$32,139,811
2022	$31.02	$15.85	$180,766,043	$92,395,159
2023	$41.36	$26.19	$241,021,391	$152,650,506
2024	$51.69	$36.53	$301,276,739	$212,905,854
2025	$62.03	$46.87	$361,532,087	$273,161,202
2026	$72.37	$57.21	$421,787,434	$333,416,550
2027	$82.71	$67.55	$482,042,782	$393,671,897
2028	$93.05	$77.89	$542,298,130	$453,927,245
2029	$103.39	$88.23	$602,553,478	$514,182,593

* Based on California Department of Finance estimate of 8,094,422 single-family residences and Energy Commission staff estimate of 72 percent of single-family residences with automatic irrigation.
** Assumes full year savings.
*** Based on Energy Commission staff estimate of $4.68 incremental cost for a compliant sprinkler device.

[27] In reality, it is likely that additional household expenditure would look different from *average* household spending. In addition, households may save some of the money, but we do not speculate on savings rates, and instead assume the additional money is spent.
[28] We do not foresee any impact on household income per se. Rather, households will enjoy net savings from this update to the performance standard that can be used for other purchases.

In each subsequent year, however, residents save cumulatively more as the old non-complying sprinkler devices are replaced at failure. In their feasibility analysis, Energy Commission staff assumed an estimated useful life (EUL) for SSB of 10 years. Thus, we show savings through 2029, when all non-complying sprinkler devices should be replaced. By 2029 and in each ensuing year, California single-family residents will save about $88 by reducing their water consumption.

Table 11 shows our estimates of the economic impacts likely to occur in California as households living in single-family residences spend the money saved through reduced spending on landscape irrigation. The economic impacts shown in Table 11 account for the incremental cost of the compliant sprinkler device (i.e., the net savings to residents). We assume that all of the money saved by households due to reduced spending on water for irrigation will be spent on other goods and services. Approximately 84 percent of this spending will occur within California, and it is only this local spending that we consider in the analysis.

Changes in labor income and economic output follow a similar trend, with negative impacts in the first year and cumulative increases in subsequent years. By 2029, we estimate the additional spending by households will result in an additional $263 million in labor income and nearly $770 million in additional economic output.

Table 11: Estimated Economic Impacts to California From Additional Household Spending by California Single-Family Residents, 2018 dollars

Year*	Spending by CA Households	Changes in Employment**	Changes in Labor Income	Changes in Economic Output
2020	-$28,115,537	-260	-$14,387,812	-$42,043,713
2021	$32,139,811	297	$16,447,189	$48,061,575
2022	$92,395,159	855	$47,282,190	$138,166,863
2023	$152,650,506	1,413	$78,117,191	$228,272,150
2024	$212,905,854	1,970	$108,952,192	$318,377,438
2025	$273,161,202	2,528	$139,787,193	$408,482,726
2026	$333,416,550	3,086	$170,622,194	$498,588,014
2027	$393,671,897	3,643	$201,457,195	$588,693,301
2028	$453,927,245	4,201	$232,292,196	$678,798,589
2029	$514,182,593	4,758	$263,127,197	$768,903,877

* Assumes full year impacts.
** Since the additional spending will occur statewide, its effect will be modest, but will be felt by a large number of businesses, leading a few to hire additional employees. However, most businesses will make due by increasing hours of existing employees where necessary.

4.3 Costs and Benefits to California Businesses from Reduced Spending on Water for Irrigation

The increase in the watering efficiency of SSB will also lead to lower water bills for California businesses and multi-family buildings with irrigated landscapes. Based on analysis by Energy Commission staff, the stock of SSB installed in landscaping for businesses and multi-family structures in California is approximately 86.1 million.[29] Energy Commission staff assumes the baseline average annual water use of sprinkler devices installed in the landscaping of businesses and multi-family structures is the same as for single-family residences (2,955 gallons per device per year) and that the stock of existing (non-compliant) sprinklers will be replaced at the same rate (10 percent per year).

While we assume water savings will be the same for sprinkler devices used by businesses and multi-family buildings as they are for single-family residences, we think it is unlikely that the money saved by businesses and building owners will be noticeably directed to other uses. Likewise, we do not think businesses and building owners will be adversely affected by the first-year net cost of replacing failed sprinkler devices with compliant sprinklers. Therefore, in an effort to err on the side of being too conservative, we assume no additional economic impacts associated with money saved by businesses and multi-family building owners. Table 12 shows the expected savings due to the higher efficiency standards for the sprinkler devices, which we estimate will reach $211 million by 2029.

Table 12: Annual Savings for Businesses and Multi-Family Structures, 2018 Dollars

Year*	Annual Value of Water Savings	Net Savings**
2020	$24,721,332	-$11,535,134
2021	$49,442,664	$13,186,198
2022	$74,163,996	$37,907,530
2023	$98,885,328	$62,628,862
2024	$123,606,660	$87,350,194
2025	$148,327,992	$112,071,526
2026	$173,049,325	$136,792,858
2027	$197,770,657	$161,514,190
2028	$222,491,989	$186,235,522
2029	$247,213,321	$210,956,855

* Assumes full year impacts.
** Based on Energy Commission staff estimate of $4.68 incremental cost for a compliant sprinkler device.

[29] Energy Commission staff estimated the stock of SBS installed at multi-family buildings to be 22,850,878 and at businesses to be 68,820,759, however, this includes public K-12 schools, UC and State campuses, and community colleges (p. A.5 of *Draft Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*).

4.4 Costs and Benefits to Government Facilities in California from Reduced Spending on Water for Irrigation

The increase in the watering efficiency of SSB will lead to reduced spending on water at government facilities with irrigated landscapes. Evergreen estimates the stock of SSB installed in landscaping around government facilities in California to be approximately 9.5 million.[30] We assume the baseline average annual water use of sprinkler devices installed in the landscaping around government facilities is the same as Energy Commission staff assumes for businesses and residences (2,955 gallons per device per year) and that the stock of existing (non-compliant) sprinklers will be replaced at the same rate (10 percent per year).

As we did for businesses, we assume the money saved from reduced water use associated with more efficient irrigation will not be used for other uses. Likewise, we do not think government facilities will be adversely affected by the first-year net cost of replacing failed sprinkler devices with compliant sprinklers. Therefore, we assume no additional economic impacts associated with money saved by government facilities. Table 13 shows the expected savings to government facilities due to the higher efficiency standards for the sprinkler devices, which we estimate will reach $23 million by 2029.

Table 13: Estimated Annual Savings for Government Facilities, 2018 Dollars

Year*	Annual Value of Water Savings	Net Savings**
2020	$2,723,806	-$1,270,946
2021	$5,447,612	$1,452,860
2022	$8,171,418	$4,176,666
2023	$10,895,224	$6,900,472
2024	$13,619,030	$9,624,278
2025	$16,342,836	$12,348,084
2026	$19,066,641	$15,071,890
2027	$21,790,447	$17,795,696
2028	$24,514,253	$20,519,502
2029	$27,238,059	$23,243,308

* Assumes full year impacts.
** Based on Energy Commission staff estimate of $4.68 incremental cost for a compliant sprinkler device.

[30] See Section 3.3 for discussion of how Evergreen estimated the stock of sprinkler devices installed at government facilities.

4.5 Statewide Economic Impacts from Additional Revenue Received by California Spray Sprinkler Manufacturers

In addition to the economic impacts associated with California residents spending money saved through water conservation, there are also impacts associated with the purchases of compliant SSB as existing SSB fail. Energy Commission staff estimates that the incremental cost of a compliant spray sprinkler device is $4.68. Based on data provided by IMPLAN for California for 2016, we estimate that 33.4 percent of the SSB purchased by California residences, businesses, and government facilities are currently supplied by and will continue to be supplied by California-based businesses.[31] Firms located outside California (including outside the U.S.) supply the rest of the SSB purchased by California residences and businesses. We do not foresee that the proposed change in performance standard of SSB will have any material impact on compliant sprinkler device imports to or exports from California. We do, however, expect increased investment in labor and potentially in capital stock by manufacturers and their suppliers both inside and outside California to meet the demand for compliant sprinkler devices. This additional investment is embedded within the economic impacts described below.

In this analysis, we only consider the portion of incremental spending on compliant SSB by California residences, businesses, and government facilities estimated to be produced by manufacturers located in California (33.4%). The remainder of incremental spending will go to firms located outside the state. We do not foresee any competitive advantages or disadvantages for firms currently manufacturing SSB in the state, nor do we foresee the proposed regulation affecting the ability of California businesses to compete with businesses in other states.

Energy Commission staff estimates that California residences, businesses, and government facilities will purchase and install about 25.4 million compliant SSB each year to replace non-compliant sprinkler devices upon failure.[32] In total, we estimate that about $43 million of the incremental spending on compliant sprinkler devices by California residences, businesses and multi-family building owners, and government facilities will be paid to producers located in California.

[31] IMPLAN Version 3.1.1001.12, California model year 2016. We know of no other source to corroborate the proportion reported in IMPLAN. It is likely that at least some of the California-based businesses that produce spray sprinkler devices have manufacturing and/or other business components outside of the state. This is accounted for in the IMPLAN model.

[32] This total accounts for the 10 percent current compliance rate assumed by Energy Commission staff (see Table 1). The estimated count of sprinklers installed in landscapes around businesses does not include sprinklers installed at public K-12 schools, UC and State campuses, and community colleges.

Table 14: Annual Estimated Incremental Spending on Compliant SSB by California Residences, Businesses, and Government Facilities, 2018 dollars

Sector	Compliant Spray Sprinklers	Purchased from California Producers*	Total Incremental Spending to CA Firms
Single-Family Residences	18,882,668	6,306,811	$29,515,875
Businesses	5,690,529	1,900,637	$8,894,980
Multi-Family Structures	2,056,579	686,897	$3,214,680
Government Facilities	853,579	285,096	$1,334,247
Total	**27,483,355**	**9,179,441**	**$42,959,782**

* Assumes 33.4 percent of spray sprinklers purchased in California are produced in California.

Table 15 shows estimated economic impacts in California from increased spending on compliant SSB by California residences, businesses, and government facilities. The increase in employment, 283 jobs, will continue each year and will pay on average about $78,000.[33]

Table 15: Annual Estimated Economic Impacts in California from Increased Spending on High Efficiency SSB, 2018 dollars

Incremental Revenue Received by California Producers	Change in Employment	Change in Labor Income	Change in Economic Output
$42,959,782.08	283	$22,170,849	$74,330,584

4.6 Costs and Benefits to California Landscape Professionals

Our understanding is that there is no difference in the installation and expected useful life of compliant and non-compliant sprinkler devices. We assume the incremental cost of compliant sprinkler devices will be passed on to the consumer, thus we foresee no impacts on California landscape professionals.

4.7 Costs and Benefits to California Urban Water Suppliers

The proposed change to the performance standards of SSB will lead to a reduction in the demand for potable water from urban water suppliers. We assume this reduction will result in lower revenue for water suppliers; however, the projected reduction is much less than the April 2015 order by Governor Brown to reduce urban water use by 25 percent due to the ongoing drought in California. In fact, lower demand for water for irrigation is consistent with California's long-term efforts to conserve the state's scarce water resources.

[33] Computed by dividing labor income by employment.

Given the complexity of the infrastructure, bureaucracies, and politics of water resources and demand in California and the state's focus on conservation, the IMPLAN model is not capable of accurately modeling the economic impacts of water conservation to urban water suppliers.

4.8 Impacts on Investments in California

We do not foresee the proposed change to the performance standards of SSB resulting in any additional or reduced investment in California water capacity or distribution, nor do we believe the proposed standards will lead to additional investment in other industries.

4.9 Incentives for Innovation

The proposed change in performance standard is intended to promote innovation for the regulated product category.[34] Due to California's large market share among the states and its reputation for innovation, there is the possibility that the proposed change in performance standard would lead manufacturers to incorporate the higher efficiency technologies into SSB sold outside of the state.

4.10 Competitive Advantage or Disadvantage for Businesses

The regulation would apply to all businesses manufacturing SSB inside and outside of the state that are sold to California customers.[35] It is therefore not anticipated that the regulation will have an adverse effect on the competitiveness of California businesses.

4.11 Benefits from Water and Energy Conservation

The purpose of the regulatory change to the spray sprinkler device standard is to improve energy and water efficiency.[36] As we showed above, California residences, businesses, and government facilities will save a substantial amount of money through lower water bills even after factoring in the incremental cost of the compliant SSB. We assumed residents will spend the money they save on landscape irrigation on additional goods and services consumed by the household and that this spending will generate additional economic activity.

In addition to the market-based economic impacts associated with the regulatory change, there are also societal benefits that can be quantified. First, by irrigating landscaping around single-family residences, businesses and multi-family structures, and government

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[34] Gov. Code, § 11346.3(c)(1)(E); 1 CCR § 2003(a)(3)(E)
[35] Gov. Code, §§ 11346.3(c)(1)(C), 11346.3(a)(2); 1 CCR § 2003(a)(3) Competitive advantages or disadvantages for CA businesses currently doing business in the state.
[36] Gov. Code, § 11346.3(c)(1)(F); 1 CCR § 2003(a)(3)(F) Benefits of regulations, including, but not limited to, benefits to health, safety, and welfare of California residents, worker safety, and the state's environment and quality of life, among any other benefits identified by the agency.

facilities more efficiently, the demand for scarce water resources is reduced. This is especially important given California's recent years of drought and likely future years of drought or unusually dry conditions. Energy Commission staff estimates annual water savings of 152 billion gallons per year once all non-compliant sprinkler devices are replaced in about 10 years—a 16 percent reduction from the baseline estimate of water use.[37] Water saved through more efficiently irrigating residential, business, and government facility landscapes can be used for other purposes, including other residential, commercial, agricultural, or public uses, as well as remaining in streams and rivers to support state and federal efforts to provide fish and wildlife habitat and outdoor recreation. While we are unaware of recent estimates of the marginal conservation value of water in California, the value is estimated to be $23.07 per acre-foot (325,851 gallons equals 1 acre foot).[38] Adjusting this value to 2018 dollars ($30.17/acre-foot) and multiplying it by the volume of water expected to be saved gives an estimated annual value of $14.1 million dollars in environmental benefits associated with the water savings.[39] This value is in addition to the economic impacts discussed above.

Finally, increased efficiency of SSB will also lead to reductions in the energy needed to transport and treat the water for municipal consumption. Reduced energy demand in turn leads to avoided emissions associated with combustion-based electricity generation. Evergreen Economics used AVERT (the AVoided Emissions and geneRation Tool) to analyze avoided emissions associated with the new water efficiency standard for SSB. AVERT is a free, publicly accessible tool to estimate emissions impacts of energy efficiency and renewable energy policies and programs. AVERT estimates generation that will not take place because energy efficiency and/or renewable energy programs are meeting consumers' energy needs.[40] The tool quantifies the displaced emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), and particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$). AVERT combines historical data on electricity generation and emissions reported by fossil fuel-fired electric generating units (EGUs) with load reduction profiles for energy efficiency and renewable energy resources. AVERT allows one to estimate the impact that policies affecting energy efficiency and renewable energy resources have on emissions from EGUs.[41] AVERT can be used to predict energy efficiency

[37] Energy Commission staff estimates 138,949 MMG, but this includes public schools, universities, and community colleges, which are included in Government Facilities in this analysis.
[38] Brown, Thomas C. "The Marginal Economic Value of Streamflow From National Forests." Discussion Paper DP-04-1, RMRS-4851. p. 63 [Table 26] (2004).
https://www.fs.fed.us/rm/value/docs/marginal_economic_value_streamflow_forests.pdf
[39] Inflation adjusted using the U.S. Gross Domestic Product, Implicit Price Deflator, 2009 =1.00, https://fred.stlouisfed.org
[40] AVoided Emissions and geneRation Tool (AVERT), *User Manual Version 2.0*, May 2018, p. 1.
[41] Historical generation, heat input, and emissions data used by AVERT come from three EPA programs:
1. Clean Air Markets Division (CAMD). https://www.epa.gov/airmarkets
2. Acid Rain Program (ARP). https://www.epa.gov/airmarkets/acid-rain-program
3. Air Markets Program Data (AMPD). https://ampd.epa.gov/ampd/

and renewable energy-related emissions for near-future years, although it is based on historical behavior rather than predicted economic behaviors.[42]

AVERT has three main components:

- **Main Module** – The Excel-based Main Module allows users to estimate displaced emissions that are likely to result from energy efficiency and renewable energy policies and programs. The Main Module uses data files generated by the Statistical Module to analyze energy efficiency and renewable energy scenarios. This can be done for either a historical base year or a future year.
- **Statistical Module** – The Statistical Module performs analysis on historical generation, heat input, and emissions data, which are collected in the EPA Clean Air Markets Division's Air Markets Program Data, to produce data files that are then used by AVERT's Main Module.
- **Future Year Scenario Template** – The Excel-based Future Year Scenario Template allows users to modify base year emissions data. Users can retire and add EGUs as well as change emission rates.[43]

We used AVERT to project avoided emissions over a 10-year period beginning in 2020. In this scenario, we assumed that the amount of electricity provided by the only coal-powered EGU that services the California region, the Intermountain Power Plant, would decrease in each year of the projection period. By assuming that electricity supplied by the Intermountain Power Plant will decrease each year—irrespective of energy savings associated with the new efficiency standards for SSB—we account for likely emissions reductions associated with changes to California's electricity generation portfolio. Table 16 shows our projection of avoided emissions from reduced electricity demand associated with installation of the compliant SSB in residential, business, and government facility irrigated landscapes.

AVERT models California as a single region.
Load reduction profiles identify the time of day, week, or year that (a) energy efficiency measures reduce energy usage or (b) renewable energy generation reduces fossil fuel-based electricity generation.
[42] Ibid, 4.
[43] Ibid, 10.

Table 16: Projected Reductions in Emissions Associated with Water Savings*

Year	Electricity Savings (GWh/Yr)**	SO_2 (lbs)	NO_x (lbs)	CO_2 (tons)	$PM_{2.5}$ (lbs)
2020	54	-11,522	-47,851	-61,430	-5,800
2021	108	-13,488	-59,536	-88,290	-7,741
2022	163	-15,072	-70,418	-116,831	-9,702
2023	217	-16,223	-79,578	-143,482	-11,466
2024	271	-17,571	-89,547	-171,229	-13,328
2025	326	-18,972	-99,579	-198,367	-15,171
2026	380	-20,632	-110,590	-226,571	-17,120
2027	434	-22,341	-121,489	-253,663	-19,011
2028	489	-24,245	-133,158	-281,533	-21,007
2029	543	-26,257	-145,167	-309,475	-23,028

* Estimated by Evergreen Economics using U.S. EPA AVERT model; tons are measured as short tons (2,000 lbs).
** Calculated by Energy Commission staff and Evergreen Economics.

4.12 Economic Value Of Avoided Emissions

The estimates of reduced emissions shown in Table 16 are meaningful only to the extent that they show that the proposed change in the performance standard of SSB will reduce the amount of these substances emitted into the atmosphere. To provide a more meaningful context for policymakers and regulators, we converted the volumes of each of the emissions reductions shown in Table 16 into the dollar value of damage avoided shown in Table 17.

Table 17: Economic Value of Avoided Emissions from Reduced Water Use, 2018 Dollars

Year	SO_2 (lbs.)	NO_x (lbs.)	CO_2 (tons)	$PM_{2.5}$ (lbs.)	Total
2020	$247,966	$1,724,993	$1,784,814	$776,037	$4,533,811
2021	$290,286	$2,146,203	$2,565,222	$1,115,359	$6,117,069
2022	$324,382	$2,538,509	$3,394,465	$1,475,914	$7,733,269
2023	$349,147	$2,868,704	$4,168,789	$1,812,590	$9,199,230
2024	$378,159	$3,228,065	$4,974,968	$2,163,117	$10,744,309
2025	$408,319	$3,589,728	$5,763,448	$2,505,948	$12,267,443
2026	$444,027	$3,986,670	$6,582,902	$2,862,246	$13,875,846
2027	$480,823	$4,379,560	$7,370,046	$3,204,497	$15,434,926
2028	$521,799	$4,800,200	$8,179,780	$3,556,569	$17,058,347
2029	$565,099	$5,233,137	$8,991,631	$3,909,562	$18,699,429

Source: Estimated by Evergreen Economics using U.S. EPA AVERT model; values of avoided SO_2, NO_X, and CO_2 emissions from Shindell, D.T. *Climatic Change* (2015) 130: 313. https://doi.org/10.1007/s10584-015-1343-0; value of avoided $PM_{2.5}$ from Hamilton, K. "Calculating PM2.5 Damages for Top Emitters: A Technical Note." New Climate Economy background note, 2014. http://newclimateeconomy.net.

The estimates of the economic value (measured as social benefit) of avoided emissions for SO_2, NO_X, and CO_2 are from a 2015 study published in *Climate Change*, which we adjusted to 2018 dollars using the GDP Implicit Price Deflator.[44] The estimated benefits of avoided SO_2 and NO_X are reported as present values and are, respectively, $21.52 and $36.05 per pound in 2018 dollars. The estimated economic value for avoided CO_2 is $29.05 per ton.

The estimate of the economic value of avoided $PM_{2.5}$ (also measured as social benefit) is from a 2014 report from the Global Commission on the Economy and Climate.[45] The social benefit of avoided $PM_{2.5}$ is measured as a localized co-benefit of reduced carbon emissions.[46] As such, the societal value of avoided $PM_{2.5}$ is measured based on per-ton reductions in CO_2 emissions. The study presents the benefits of avoided $PM_{2.5}$ as a range from $87 to $126 in present value, with a mid-point of $106.50 (in 2010 dollars). Given the localized nature of the benefits of avoided $PM_{2.5}$ and the fact that the avoided emissions would be from power generation facilities generally located away from populated areas, we reduced the mid-point estimate of the per-ton benefit by 90 percent to provide a conservative estimate of the economic value of the avoided $PM_{2.5}$ ($12.63 per ton of CO_2 avoided).

[44] Shindell, D.T. *Climatic Change* (2015) 130: 313. https://doi.org/10.1007/s10584-015-1343-0.
Values adjusted from 2007 dollars to 2018 dollars using Inflation adjusted using the U.S. Gross Domestic Product, Implicit Price Deflator, 2009 =1.00, https://fred.stlouisfed.org

[45] Hamilton, K. "Calculating PM2.5 Damages for Top Emitters: A Technical Note." New Climate Economy background note, 2014. http://newclimateeconomy.net

[46] As compared to the benefits of reduced carbon emissions, which have global benefits. Since it is the local residents who enjoy the benefits of reducing $PM_{2.5}$ (most notably from lower morbidity) from a policy standpoint, regulations targeting $PM_{2.5}$ may receive greater support from some residents than regulations targeting CO_2.

5 Alternatives

The proposed update to performance standards for SSB analyzed in this report is one of three alternative updates developed by Energy Commission staff. The three alternative updates to the performance standards are as follows and:[47]

Alternative 1: Check Valves on all SSB.

Alternative 2: Pressure Regulation on all SSB. This is the preferred alternative proposed by Energy Commission staff and analyzed in this report.

Alternative 3: Pressure Regulation and Check Valves on all SSB.

Estimates of water savings by Energy Commission staff increase with each alternative and so do the associated economic impacts. The households and industries impacted by the three alternatives are the same. Therefore, from the perspective of the economic impact analysis, Alternative 1 and Alternative 3 represent a scaling (down for Alternative 1 and up for Alternative 3) of the impacts described in this report for Alternative 2. We limit the comparison of the economic impacts of the alternatives to the state-level impacts on Gross State Product (GSP) and employment. Table 18 shows the expected annual water savings and the expected incremental cost per SSB for the three alternatives.

Table 18: Savings and Costs from Proposed Performance Standard

Annual Water Savings (gallons/unit)			Incremental Cost ($/unit)		
Alternative 1 Less Stringent	***Alternative 2 Preferred***	Alternative 3 More Stringent	Alternative 1 Less Stringent	***Alternative 2 Preferred***	Alternative 3 More Stringent
40	***554***	594	$1.93	***$4.68***	$5.42

Source: Energy Commission staff

Table 19 and Table 20 show our estimates of the impacts of the three alternatives on California's GSP and employment over the 10-year period beginning in 2020. The overall impact on GSP is positive beginning in 2020 for Alternatives 2 and 3, but does not become positive until 2023 for Alternative 1. The impacts that Alternative 1 would have on GSP in subsequent years are negligible. With the exception of 2020, Alternative 3 has a slightly greater impact on GSP than Alternative 2 that grows over time.

The three alternatives have similar relative impacts on employment. We estimate that alternatives 1 and 3 would have a slight negative impact on employment in 2020, while the impact is small, but positive, for Alternative 2. For Alternative 1, employment would turn positive in 2025, but employment gains would be modest in subsequent years. For

[47] For details on the alternatives, see Steffensen, Sean. 2018. *Draft Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*. California Energy Commission, CEC-400-2018-005-SD

Alternatives 3, employment would be positive in the second year (2021) and alternatives 2 and 3 would grow each year. We project the impact on employment would be slightly greater for Alternative 3 beginning in 2022 and the spread between Alternative 2 and Alternative 3 would continue to grow, though given the size of California's economy and the inherent uncertainty of the future, the impacts the two alternatives would have on employment (and GSP) are not materially different.

Table 19: Total Estimated Impacts to California GSP From Alternative Proposed Changes in Performance Standards of SSB, 2018 dollars

Year*	Alternative 1 Check Value	Alternative 2 Pressure Regulator (Preferred)	Alternative 3 Check Value & Pressure Regulator
2020	-$17,338,123	$32,286,871	$29,650,440
2021	-$10,832,326	$122,392,159	$126,261,525
2022	-$4,326,529	$212,497,447	$222,872,609
2023	$2,179,268	$302,602,735	$319,483,694
2024	$8,685,065	$392,708,022	$416,094,779
2025	$15,190,862	$482,813,310	$512,705,864
2026	$21,696,659	$572,918,598	$609,316,948
2027	$28,202,456	$663,023,886	$705,928,033
2028	$34,708,253	$753,129,173	$802,539,118
2029	$41,214,050	$843,234,461	$899,150,202

* Assumes full year impacts.

Table 20: Total Estimated Impacts to California Employment From Alternative Proposed Changes in Performance Standards of SSB

Year*	Alternative 1 Check Value	Alternative 2 Pressure Regulator (Preferred)	Alternative 3 Check Value & Pressure Regulator
2020	-180	23	-22
2021	-140	580	576
2022	-100	1,138	1,174
2023	-60	1,696	1,772
2024	-19	2,253	2,370
2025	21	2,811	2,968
2026	61	3,369	3,566
2027	102	3,926	4,164
2028	142	4,484	4,762
2029	182	5,041	5,359

* Assumes full year impacts.

Appendix: Economic Modeling – Methods and Assumptions

Evergreen Economics used the IMPLAN input-output model to develop estimates of the economic impacts associated with the proposed update to the performance standards for spray sprinkler bodies (SSB). The IMPLAN model is a widely used modeling approach for conducting economic analysis. More than 2,000 public and private institutions have used IMPLAN to conduct economic impact analysis, including the Federal Reserve Bank, the U.S. Forest Service, and Ernst & Young.[48]

IMPLAN is an input-output based modeling approach, which allows for the development of regional economic models using production, employment, and payroll data for more than 500 industry sectors, as well as information on income and consumption of households located in the region and government employment and spending.[49] This high level of detail allows for accurate mapping of spending and economic activity by industry sector and household income categories. The analysis conducted using the IMPLAN model is based on actual economic data for California (from 2016), reflecting the economy as it actually exists.

The IMPLAN model relies on user-specified inputs (e.g., a change in household discretionary income) to generate estimates of economic impacts to the region, including changes in Gross State Product (GSP), employment, and wages. Three types of economic effects are estimated in the analysis and aggregated in this report:

- *Direct effects* are the first level of economic impact and represent expenditures by consumers or producers as a result of a project, policy, or other activity.
- *Indirect effects* occur in response to a change in demand for factor inputs by producers.
- *Induced effects* represent changes in spending by workers and households (generally) as a result of a change in labor income. The term "induced" refers to the fact that these effects reflect impacts on industries that were not directly involved with the program or in supplying a program's factor inputs.

Economic impacts were estimated for a 10-year period beginning in 2020 and extending through 2029. Evergreen Economics chose the 10-year analysis period to match the estimated useful life (EUL) for SSB reported by Energy Commission staff.[50] The economic

[48] See references at www.implan.com.
[49] For this analysis, the region was the state of California. However, a region could be defined as a single zip code, county, or state, or a group of zip codes, counties, or states.
[50] Steffensen, Sean. 2018. *Final Staff Analysis of Water Efficiency Standards for Spray Sprinkler Bodies*. California Energy Commission, CEC-400-2018-005-SD1

analysis required numerous inputs and assumptions, which are described in Chapter 3 (Sections 3.1 through 3.4) of this report. Key inputs and assumptions are as follows:

- All of the money saved by California single-family residences through replacement of existing non-compliant SSB with compliant SSB will be spent on additional consumer goods and services. [Evergreen Economics assumption]
- Approximately 84 percent of the additional spending by single-family residents will be local (in California), with the remainder consisting of online, subscription, or other purchases from sources outside California, as well as travel outside the state. [IMPLAN assumption]
- Increased spending by California single-family residents for goods produced and services provided in California will result in a small increase in expansive capital investment. [Evergreen Economics assumption based on IMPLAN and Federal Reserve data]
- Money saved by businesses, multi-family building owners, and government facilities through replacement of existing non-compliant SSB with compliant SSB will not be used for other economic purposes. [Evergreen Economics assumption]
- Approximately 33 percent of spending in California on compliant SSB will be for devices manufactured in California. The remaining demand will be met by domestic and foreign imports. [IMPLAN assumption]
- Increased demand for compliant SSB will not have a significant impact on manufacturers in California, but will lead to modest expansive capital investment by manufacturers. [Evergreen Economics assumption based on IMPLAN and Federal Reserve data]