Future Potential Water Efficiency Study

Irvine Ranch Water District

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Irvine Ranch Water District

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ABBREVIATIONS AND ACRONYMS

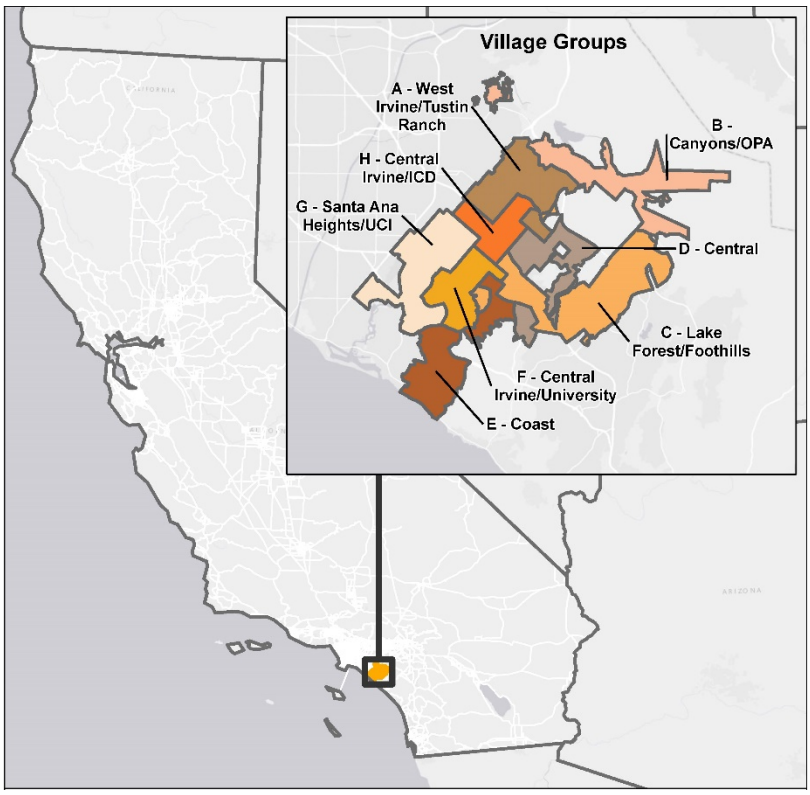
ac	acre
ACS	American Community Survey
AFY	acre-feet per year
AFY/ac	acre-feet per year per acre
AWE	Alliance for Water Efficiency
CA	California
CCF	one-hundred cubic feet
CEC	California Energy Commission
CII	commercial, industrial, and institutional
DU	dwelling unit
DWR	Department of Water Resources
EPA	Environmental Protection Agency
ET	evapotranspiration
FMR	Metro Fair Market Rents
FY	fiscal year
gpd	gallons per day
gpf	gallons per flush
gpm	gallons per minute
gpy	gallons per year
HECW	high efficiency clothes washer
HET	high efficiency toilet
HUD	Housing and Urban Development
ID	identifier
IRWD	Irvine Ranch Water District
KWhr	kilowatt hour
MFR	multi-family residential
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
OPA	Orange Park Acres
PHET	premium high efficiency toilet
PRV	pressure regulating (reducing) valves
psi	pounds per square inch
SFR	single-family residential
SP	service point
sq ft	square feet
TSV	thermostatic shut-off valve
UCI	University of California Irvine
UWMP	Urban Water Management Plan

WBIC	weather-based irrigation controller
WE	water efficiency
WF	water factor

1. EXECUTIVE SUMMARY

The Irvine Ranch Water District (IRWD or District) provides water and wastewater service to over 115,000 connections across its approximately 181-square mile service area in Southern California (**Figure ES-1**).

Figure ES-1
IRWD Location and Village Groups



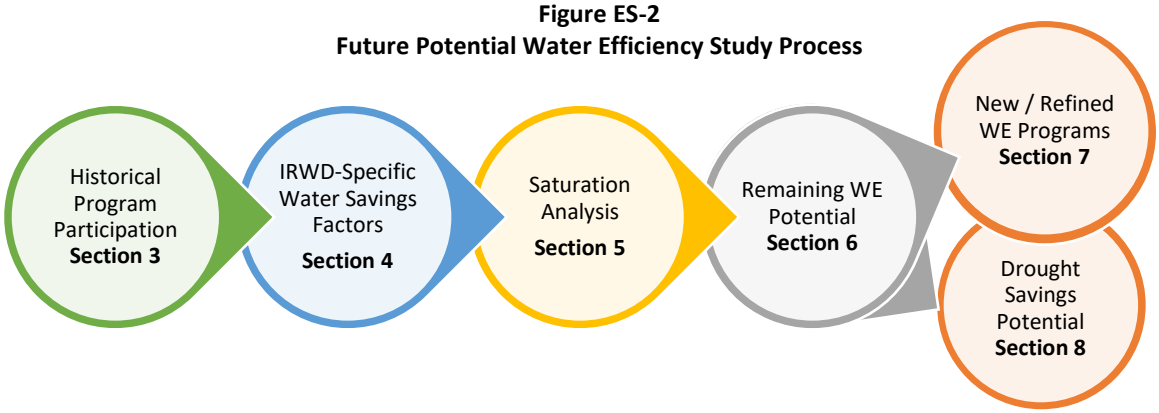
IRWD has a long and progressive history of providing innovative water use efficiency (WE) programs that have resulted in increased water efficiency by its customers for decades. At the same time, the State of California is increasing its water efficiency requirements for water suppliers including the development of new urban water use objectives under the *Making Water Conservation a California Way of Life* (AB-1668/SB-606) legislation. The methods for setting these new water use objectives are still in development. Urban retail water suppliers are supposed to begin reporting on and complying with the water use objectives in the 2023-2024 timeframe.

Given both IRWD's long history of WE and the uncertainty in the forthcoming State requirements, this *Future Potential Water Efficiency Study* (Study) was developed to take a thorough look at IRWD's progress to date in WE in order to: (1) identify the remaining WE potential in the IRWD service area, and (2) provide the District with a set of analyses and analytical tools that serve as a foundation to strategically inform and guide the District's future WE program planning efforts as the State requirements and other WE drivers evolve. **Figure ES-2** outlines the process documented in this Study to achieve these two objectives.

To address the first objective of identifying the remaining WE potential in the IRWD service area, this Study includes: (1) analysis of past WE program participation and effectiveness, (2) an assessment of device saturation, (3) quantification of the water savings achieved through past WE program implementation, (4) identification of four specific future WE program strategies, (5) an assessment of the avoided water and embedded energy cost savings, and the cost-effectiveness of these strategies, and (6) an assessment of potential water savings that could be achieved during future droughts.

Per the second objective, the analyses presented throughout the document were designed to provide the District with a set of analytical tools that can serve as a foundation to strategically inform and guide the

Figure ES-2
Future Potential Water Efficiency Study Process



District's future WE program planning. The resulting work product is presented as both static figures and tables in this Study, and as dynamic tools through the raw data files, queries and other content provided as companion to this document.

This Executive Summary presents the key findings for each of the analyses conducted as part of this Study. Details describing the methodologies, assumptions, and additional results are presented in Sections 3 through 8 and the Study Appendices. For purposes of this Study, IRWD's 76 villages were grouped into eight "Village Groups" based on location and similar characteristics, as described in Section 2.3 and shown in **Figure ES-1**.

Based on the analyses performed for this Study, the largest remaining opportunities for water savings are in outdoor water use across all customer sectors, particularly through continued turf removal, and potentially through the implementation of a Pressure Reducing Valve (PRV) program. Marketing and outreach has proven to drive customer participation in WE programs to date, as particularly evidenced by the increased participation rates observed in response to marketing efforts during the statewide 2013-2017 drought. In fact, these outreach and marketing efforts appear to have a much more significant effect on program participation than the dollar amounts of rebates (Section 3.7). Therefore, this Study recommends that WE efforts by the District focus on outdoor water savings potential and strategic ways to target the marketing and cross promote these programs.

Past Program Participation (Section 3)

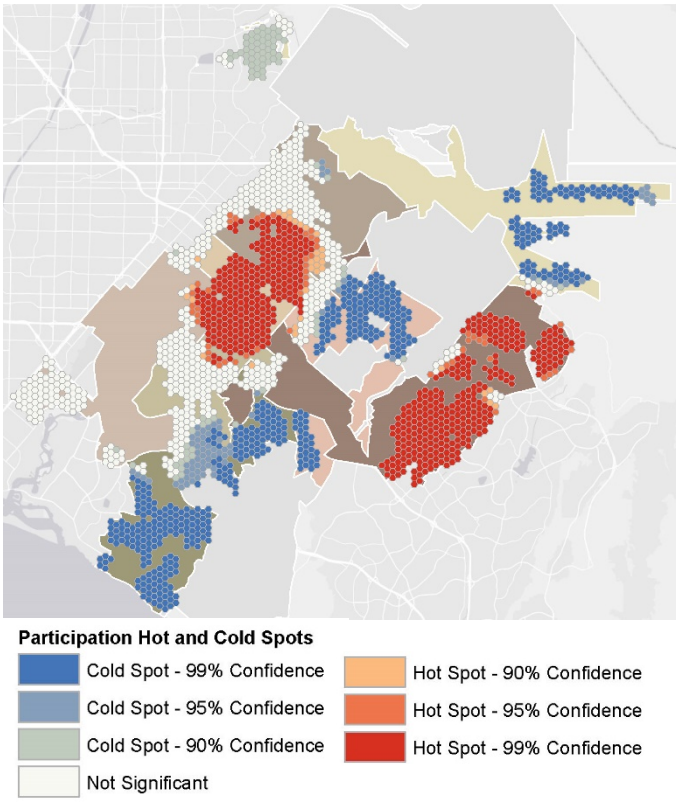
The District's customers are offered a wide range of WE programs, and the particular programs and suite of offerings are continually adapted to respond to a variety of drivers. A subset of programs offered to IRWD customers was selected for detailed geospatial and customer demographic trend analyses, including:

- Participation rates over time and by Village Group;
- Statistical "hot spot" or participation density analysis (see example shown in **Figure ES-3**);
- Analysis of building stock and landscape characteristics;
- Demographic factors including income and home-ownership;
- Participation in multiple programs;
- Land use and business type characteristics for large landscape and commercial, industrial, and institutional (CII) programs; and

- WE program funding levels (i.e., rebate values).

The key take-aways relative to the historical performance of the WE programs that were reviewed and analyzed are summarized below:

Figure ES-3
Participation Density Hot Spot Analysis for Single Family Residential Turf Removal Rebates



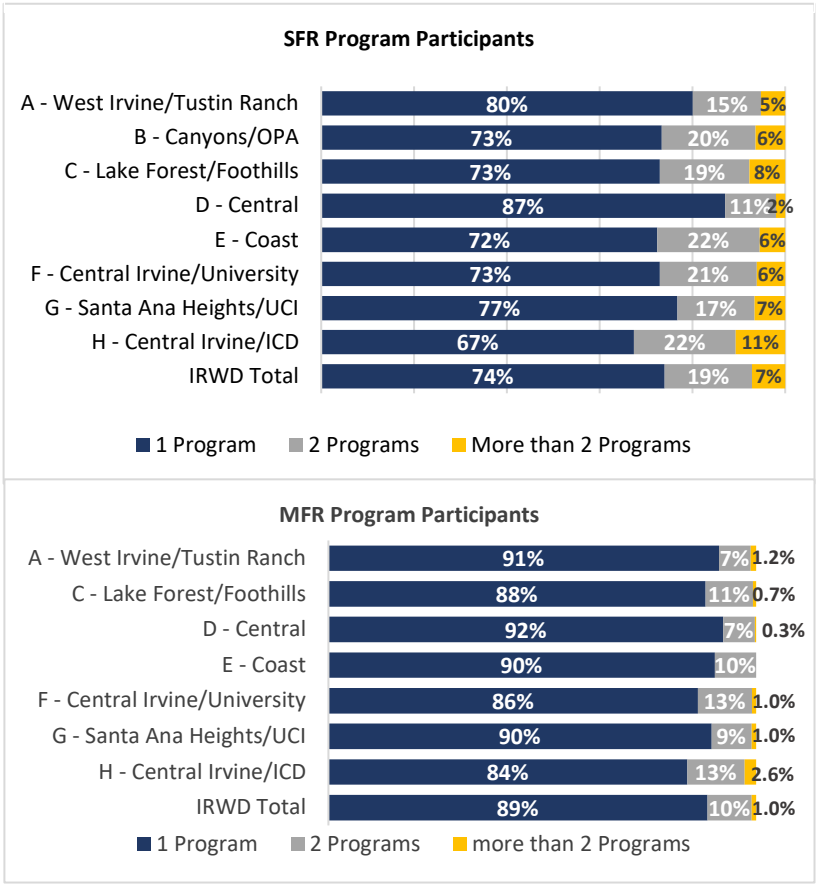
- **The WE programs appear to have effectively targeted customers with the most potential to achieve water savings** (i.e., service points [SPs] at older homes had a higher participation rate in indoor device replacement programs and SPs with larger-than-typical landscapes had a higher participation rate in irrigation efficiency device programs).
- **Program participation rates are not consistent throughout the District and reflect diverse demographic and property characteristics**, which can be generally correlated based on geographic location within the District (i.e., Village Groups). On the whole, the highest participation rates by Single-Family Residential (SFR) customers occurred in the Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD Village Groups, and the lowest participation rates have been in the Canyons/OPA and Coast Village Groups. In addition, SFR customers in predominantly high income areas (median household income between $85,000 and $128,000) tended to participate at lower rates than those in very high income areas (median household income >$128,000/year). As such, there appear to remain potential opportunities for more targeted outreach to encourage increased WE program participation in certain areas and across certain demographics.
- **Different program models can broaden/accelerate participation.** As shown in **Figure ES-4**, although WE programs are made available to all customers, residential customers have generally tended to participate in only one program, typically replacing only one device. Of those customers that have participated in multiple programs, they have tended to do so over the course of multiple years with approximately half participating in both indoor and outdoor-focused programs. The One-Stop-Shop program was specifically targeted to a subset of SFR customers and, through a partnership with local energy utilities, provided a suite of water and energy efficient devices to customers at no-cost. In its short lifetime, the One-Stop-Shop program was very successful at distributing a large number of devices and at reaching different subsets of customers. Specifically, participants in the One-Stop-Shop program tended to reflect a broader cross-section of SPs than was otherwise observed in the more traditional, primarily rebate-based, programs. While very

successful, programs that are "no-cost" to the customer, like the One-Stop-Shop, are costly and resource-intensive for the District. However, if the goal is to accelerate progression towards water efficiency in a short period of time, comprehensive no-cost programs such as the One-Stop-Shop have proven more effective at increasing the change out of multiple WE devices than relying on a series of rebate-based, single-device programs.

- **CII and landscape irrigation customers remain a potential untapped opportunity**. In general, the overall participation rates and trends between Village Groups by non-residential landscape irrigation customers are similar to those of SFR customers. The highest participation in Weather-Based Irrigation Controller (WBIC) and Turf Removal Programs has been in the Lake Forest/Foothills and Central Irvine/ICD Village Groups, while the lowest level of participation relative to the total irrigated area has been in the Canyons/OPA and Santa Ana Heights/UCI Village Groups. Overall there has been relatively little participation in programs by CII customers compared to that by SFR and landscape irrigation customers. What participation there has been, has been primarily in West Irvine/Tustin Ranch Village Group for the Indoor Device Rebates and in Santa Ana Heights/UCI and Central Irvine/ICD Village Groups for the Turf Removal Rebates. As such, these areas of lower participation remain a potential opportunity for more targeted outreach to encourage increased WE program participation.

- **Opportunities have been identified for increased water savings through strategic WE program planning,** including strategic targeting based on program type, key customer demographics, and SP location within the District. Taken together, the analyses conducted as part of this Study suggest that, depending on IRWD's goals for its future WE programs, there remain large portions of the District for which there may be a substantial benefit in terms of WE program participation rates and associated water savings. Depending on IRWD's goals, these WE results can be achieved by modifying program design and/or focusing outreach in areas of the District and to

Figure ES-4
Participation by Residential Customers in Multiple WE Programs



customers that have had comparatively low levels of WE program participation to date, but for which opportunities for increased WE remain.

- **Unless a rebate increase is coupled with a substantial marketing and outreach effort, the actual rebate value does not appear to be a substantial driver for customer participation.** Given this finding, in order to increase WE program participation, increased marketing and outreach should be considered as well as the rebate value when considering WE program development and implementation.
- **The analyses included in this Study are intended to be tools that will support WE implementation into the future and as the State annual water use objectives are further developed.** This Study included multiple analyses, including hot spot/participation density, difference-in-difference water savings analysis, demographic, property characteristic and funding level trend assessments, and more that are well-documented and can provide a basis for future analysis by the District. In addition to the written Study, the tools developed as part of the Study (e.g., the database queries, GIS shapefiles, etc.) are provided to IRWD for on-going use.

Estimated Water Efficiency Program Water Savings (Section 4)

Per capita water use by IRWD's customers is declining in part due to the District's implementation of WE programs. However, passive water savings, regulatory requirements, drought conditions, economic influences, and a greater public awareness of responsible water use are likely also contributing to the observed water use reduction, all to varying degrees. In order to isolate and quantify the impact of IRWD's WE programs, the amount of water savings directly resulting from WE program participation was estimated using a Difference-in-Differences method.[1] The resultant water savings estimates on a per-participant and per-program basis are summarized in **Table ES-1**, and presented on a Village Group-by-Village Group basis in Section 4.

Table ES-1
Summary of IRWD-Specific Water Savings Factors for WE Program Implementation

Sector	Measure	IRWD-Specific Savings Factors
SFR	Turf Removal	3.0 AFY/ ac
SFR	WBIC	0.017 AFY/unit
SFR	HET	0.014 AFY/unit
SFR	PHET	0.013 AFY/unit
SFR	HECW	0.012 AFY/unit
SFR	One-Stop-Shop	0.046 AFY/SP
Landscape Irrigation, Potable	Turf Removal	0.38 – 0.77 AFY/ac based on size of landscape area
Landscape Irrigation, Potable	WBIC	0 – 0.017 AFY/ac based on size of landscape area

Of the WE programs considered in this analysis, the Turf Removal Rebate and One-Stop-Shop programs resulted in the largest per-participant water savings. However, it is noted that these are currently among

[1] The Difference-in-Difference method is a standard method used in economics and social science for quantitatively evaluating observational study data by studying the differential effect of a treatment on a "treatment group" versus a "control group," when a true controlled experiment cannot be performed.

the highest cost programs for the District to implement, which may limit their implementation and/or scalability.

The One-Stop-Shop program has been particularly effective in creating water savings because it has resulted in the change-outs of multiple device types[2] at a single account for over 60% of SFR participants and approximately 57% of multi-family residential (MFR) participants. By comparison, only about 25% of SFR customers and about 10% of MFR customers received more than one type of device/measure through participation in more than one of the WE programs that have been offered to date. This disparity in "multiple device changeout rates" points to an opportunity to either introduce a new multiple device program or to increase cross-promotion of WE programs at the time of customer engagement.

Among the programs that target large landscapes, the Turf Removal Rebate program appears to result in more savings per acre for smaller landscapes than for larger landscapes. This same size vs. savings relationship is not observed, however, for the WBIC Rebate program.

The IRWD-specific unit water saving factors differ somewhat from the general industry standard and regional savings rates that have historically been used to assess program cost-benefits (Section 4.7). Using IRWD-specific savings rates that have been developed as part of this Study and that reflect participation trends and intra-District customer variability can be used to improve local planning estimates and inform program prioritization, funding, targeting, and marketing.

Device Saturation Assessment (Section 5)

A key focus of this Study was to assess what the remaining water savings potential might be. There has been extensive participation in WE programs in the District to date, and the District was concerned that participation rates may have already achieved effective "saturation" (i.e., that the majority of high-water-using devices have already been replaced through natural replacement and/or WE program participation). Therefore, as presented below, the saturation levels of key devices and measures were estimated based on known program participation and estimates of natural device replacement.

- **Toilet Saturation** – Based on this assessment, very few pre-1994 toilets appear to remain within the District. It is estimated, however, that the majority (i.e., 70%) of the toilets installed in the 1994 to 2009 period remain; these present a potential opportunity for increased water efficiency through replacement with a premium high efficiency toilet (PHET). However, the relative amount of savings that would be realized by replacing a 1994 to 2009 era toilet (likely 1.6 gallons per flush [gpf]) with a PHET (~0.8 gpf) will be less substantial than that achieved by replacing a 3.5+ gpf pre-1994 toilet and may not be cost effective. For SFR accounts, nearly 60% of the remaining potential to effect toilet change-out rates is located in the West Irvine/Tustin Ranch and Coast Village Groups. For MFR accounts, nearly 70% of the remaining potential to effect toilet change-out rates is located in the West Irvine/Tustin Ranch, Coast, and Central Irvine/ICD Village Groups.

[2] The One-Stop-Shop program includes the replacement of faucet aerators, showerheads, toilets, weather-based irrigation controllers (WBICs) and lighting fixtures.

- **Clothes Washer Saturation** – It is estimated that between 35% and 56% of pre-2010 era clothes washers remain in the District.[3] For SFR accounts, nearly 50% of the remaining potential to effect clothes washer change-out rates is located in the Lake Forest/Foothills and Central Irvine/ICD Village Groups. For MFR accounts, nearly 70% of the remaining potential to effect clothes washer change-out rates is located in the Lake Forest/Foothills, Central Irvine/University, and Santa Ana Heights/UCI Village Groups.
- **Turf Removal** – Approximately 20% of the irrigated area (excluding agricultural and horse corral areas) within the District consist of turf areas. To date, turf removal programs have removed over 100 acres of turf, which amounts to approximately 5.6% of the irrigated turf area, where the total irrigated turf is estimated to be 1,863 acres (**Table 3-16)**.[4] Commercial and SFR uses comprise approximately 44% and 21% of irrigated turf area in the District, respectively, and represent an opportunity to reduce overall turf area and associated irrigation water use. Over 800 acres[5] of turf is associated with commercial land uses, with the majority located in the Coast, Central Irvine/University, and West Irvine/ Tustin Ranch Village Groups. Approximately 400 acres of turf is associated with the SFR sector, with over 200 acres associated with SFR customers with the largest overall turf sizes, based on a quartile analysis (**Table 6-2**). The majority of turf for the SFR customers with the largest turf areas is located in the Central Irvine/ICD and Lake Forest/Foothills Village Groups.

Based on these saturation rates, it is estimated that up to 3,800 acre-feet per year (AFY) of indoor savings were achieved through toilet and clothes washer change-outs by SFR and MFR customers from 2009 to 2018. Based on estimated device saturation alone, the opportunities for additional residential sector indoor WE appear to be limited. However, these are estimates based on a variety of assumptions and modeled values. To further confirm this finding, changes in indoor water use were evaluated in Section 6.

Between 2009 and 2018, over 100 acres of turf have been replaced by IRWD customers directly through WE programs, resulting in an estimated potable savings of 383 AFY (when the SFR multiplier effect is accounted for). Given the acreage of turf remaining in the District, outdoor WE programs that target the removal of turf present the greatest opportunity for increased WE.

Opportunities for Increased Water Efficiency (Section 6)

Overall, indoor water use has decreased throughout the IRWD service area over the last several decades and, based on the analysis conducted as part of this Study, is approaching the apparent "maximum

[3] Water use by clothes washers is measured by "water factor," or the number of gallons of water used per cycle per cubic foot of washer capacity. The lower the water factor, the more efficient a washer is. Clothes washers historically and currently available on the market have a wide range of water factors, and the market has been trending towards more efficient washers over time.

[4] It should be noted that while this is the best and most comprehensive available data for total turf area, the landscape classification dataset (from the 2016 Quantum Spatial Study) has certain key limitations that are expected to somewhat underrepresent the total turf area and a lower level of precision in attributing the landscape uses to specific customer accounts, particularly for non-SFR customers. These limitations are discussed in detail in Section 2.2.5.

[5] This estimate includes all turf assumed to be associated with commercial accounts, and includes some areas functional turf, including golf courses, that would not be a candidate for removal.

reasonable efficiency" based on current technology and practices. This finding suggests that limited cost-effective potential remains to further reduce indoor water use through implementation of WE programs.

Figure ES-5
Population Shift in Estimated Annual Indoor Water Use for SFR and MFR SPs

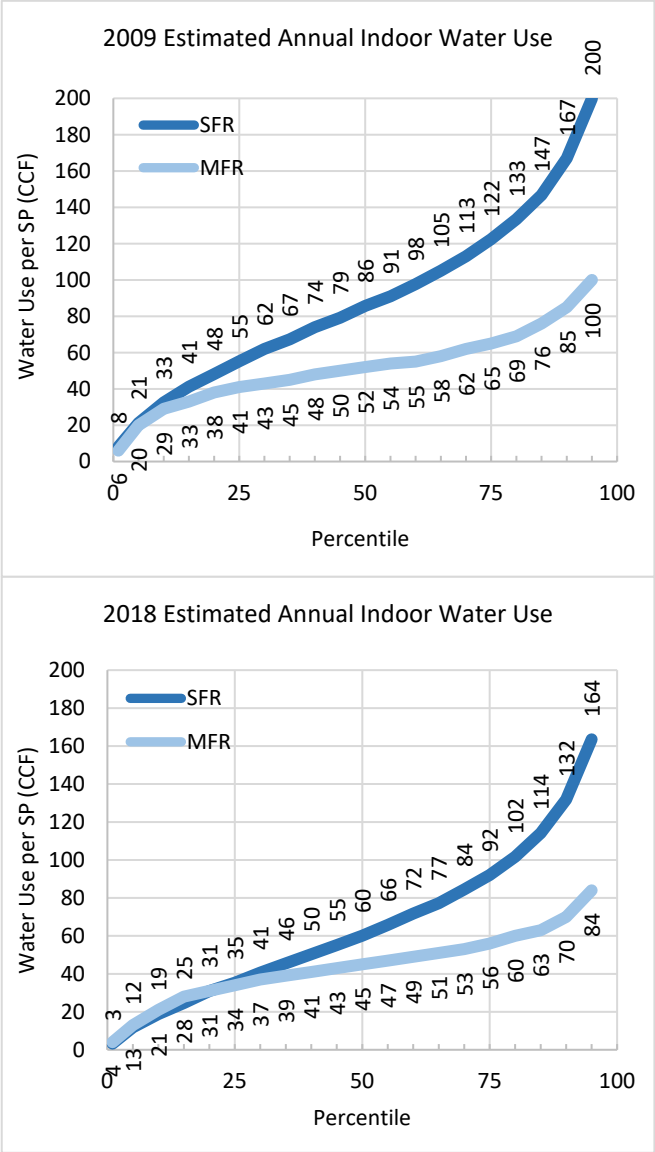


Figure ES-5 shows how estimated indoor water use by residential customers has changed over the last ten years. This shift reflects the increased efficiency due to IRWD's WE program success as well as passive savings due to natural changeout of fixtures and appliances, more proactive identification and repair of leaks, and changes in customer behavior, among other things. SFR customers tend to have a higher estimated indoor water use than MFR customers; however, estimated indoor water use within the two sectors appears to have converged for the lowest 30% of water users, and the gap appears to have narrowed for the remaining 70% of residential customers. This convergence is likely reflective of the large portions of the population that have reached a "maximum reasonable efficiency" based on current technology and practices.

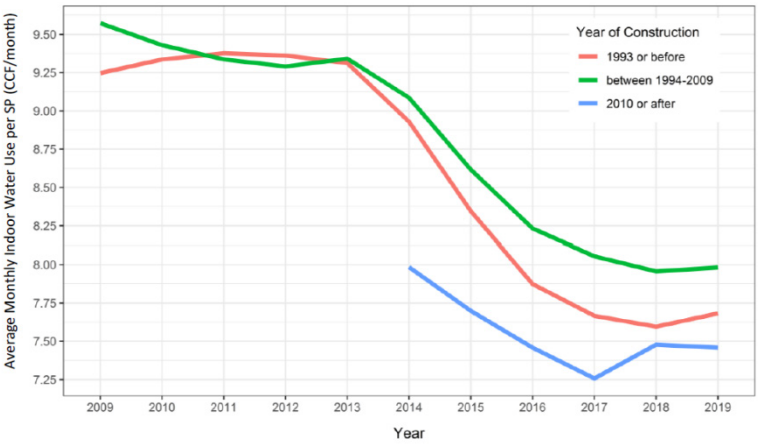
In further support of this, when indoor water use by SFR homes is compared relative to the age of the home, the newest constructed homes appear to be inherently more efficient than older homes, and that due to WE program efforts and natural replacement of fixtures, the oldest homes (pre 1994 homes) in the District have become more efficient over time (**Figure ES-6)**.

While outdoor water use has also decreased throughout the IRWD service area, potential appears to remain to reduce outdoor water use through implementation of WE programs, especially in some Village Groups where outdoor water use still accounts for 70% of total water use. As such, four potential programs were evaluated to assess potential for increased outdoor water use efficiency:

1. SFR Turf Removal Prioritized by Turf Size
2. SFR Turf Removal Targeted at Customers That Reduced Water Use During the Drought
3. Targeted Non-Residential Turf Removal Program
4. Potential Pressure Regulating Valve Program

SFR Turf Removal Rebate Programs: Based on the aerial imagery study conducted by Quantum Spatial (2016), approximately 400 acres of irrigated turf area associated with SFR accounts are present within the District. Two approaches for targeting and implementing SFR Turf Removal programs were identified:

Figure ES-6
Estimated SFR Average Monthly Indoor Water use by Year of Construction

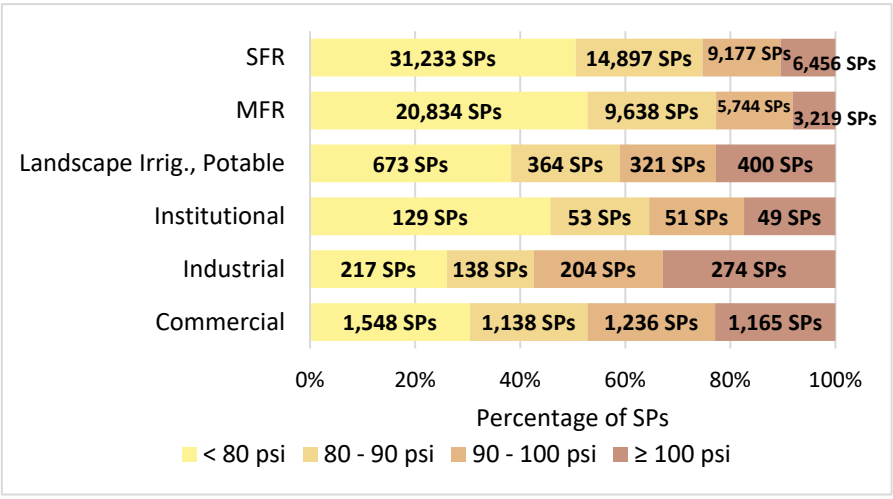


- Prioritize SFR Turf Removal Rebate program marketing by turf size. Approximately 60% of the SFR turf area (239 acres) is associated with one-quarter of SFR customers **Table 6-2**).
- Target SFR customers that decreased their outdoor water use during the drought, but have since increased their water use to pre-drought levels (i.e., likely let their lawns or other landscaping go brown during the drought). This represents approximately 23 acres of turf and 2,800 SPs.

Non-Residential Turf Removal Rebate Programs: Approximately 118 acres of irrigated turf associated with non-SFR uses (i.e., commercial, industrial, and potable landscape irrigation accounts) are present in areas of the District that are not currently served by recycled water.[6] Given that these areas are not served by recycled water, turf removal is the best option for reducing potable water use in these areas.

Pressure Reducing Valves: Pressure within the District's potable water distribution system ranges from 30 to 180 pounds per square inch (psi)[7], which exceeds the optimal design operating pressure of most water using devices (i.e., 40 to 60 psi) and can increase leakage rates (see **Figure ES-7**). Further, based on an analysis of water use by potable landscape irrigation accounts within

Figure ES-7
Number and Percentage of SPs by Average System Pressure



[6] As discussed in Section 2.2.5, due to data limitations, this is a rough estimate and may be an underestimation of actual turf area.
[7]Data provided by IRWD, *Potable Water System Average Water Pressure*, 10-psi contour shapefile, on 9 August 2019.

IRWD, an increase in water pressure of 10 psi is correlated with approximately 0.8 to 1.9 gallons of additional water use per square foot of landscape during the summer months due to increased irrigation inefficiency. The California Plumbing Code (§608.2) requires that property owners install pressure regulating valves or pressure reducing/regulating valves (PRVs) at service connections where the system water pressure exceeds 80 psi. However, not all SPs may have PRVs installed and not all PRVs may be regulating the pressure to the degree intended. Further, while the Plumbing Code requires an 80 psi PRV to be installed, use of PRVs in the 60 psi to 70 psi range may result in additional water savings, while still maintaining pressures within an ideal range for customers. To assess whether a new WE program designed to increase pressure regulation would have value, the District could consider implementing a pilot program to install 60 psi PRVs at SPs in targeted areas of the District and evaluate the resultant water savings.

Estimated Potential Savings by New / Refined Water Efficiency Programs (Section 7)

Based on the above analysis, the potential water and energy savings and the associated benefit-cost ratios for IRWD (i.e., expected savings in terms of reduced water and energy costs relative to the cost to implement the WE program) were calculated for four potential new or refined WE programs and associated implementation scenarios, as summarized below. Each WE program was evaluated at three implementation levels, generally consisting of (1) "business-as-usual", (2) "increased", and (3) "aggressive and targeted." These scenarios bracket a range of potential savings, which are dependent on how the programs are implemented. This analysis also shows that there are generally diminishing returns (i.e., a lower benefit/cost ratio) with increased intensity of implementation. Thus, the more aggressive scenarios are not recommended under normal conditions. However, the aggressive scenarios can be used to support planning for future extreme drought or other conditions. **Table ES-2** summarizes the relative benefit/cost ratios for each program and implementation scenario.

Table ES-2
Summary of Benefit/Cost Ratios for WE Program Implementation Scenarios

Program Approach	Benefit/Cost Ratio for Implementation Scenario		
	Business-As-Usual	Increased	Aggressive
SFR Turf - Targeting Largest Landscape Areas	**2.3**	**2.3**	**1.7**
SFR Turf -Targeting Drought-Reducing Customers	**2.3**	**2.0**	**2.0**
Non-Residential Turf Removal Rebate Targeting[8]	0.2	0.2	0.2
PRV Program Pilot Study for SFR SPs	0.6		
PRV Program Pilot Study for Potable Landscape Irrigation Accounts	**4.4**		

- **SFR Turf Removal Rebate Program Prioritized by Size**. The potential water savings for the SFR Turf Removal program, depending on implementation approach (i.e., from "business-as-usual" to "aggressive") ranges from 23 AFY to 79 AFY, for one year of implementation. The associated cost savings to IRWD, inclusive of water and embedded energy costs, is estimated to range from

[8] Based on this assessment, the Non-Residential Turf Removal Rebate program targeting areas of the District not served by recycled water was not found to be cost-effective.

approximately $33,000/year to $112,000/year. The associated benefit-cost ratio for IRWD for all scenarios over an assumed lifetime of 10 years ranges from 1.7 to 2.3.

- **SFR Turf Removal Rebate Targeted at Customers that Reduced Water Use During Drought**. By targeting SFR accounts that reduced their water use during the 2013-2017 drought but have since increased their water use to post-drought levels (and thus likely let their lawn or other landscaping go brown during the drought), the potential savings could range from 3.2 AFY to 14 AFY for one year of implementation, depending on the implementation approach. The associated cost savings to IRWD is estimated to range from approximately $4,700/year to $20,000/year. The associated benefit-cost ratio for IRWD for all scenarios over an assumed lifetime of 10 years ranges from 2.0 to 2.3.
- **Non-Residential Turf Removal Rebate Program**. By targeting commercial, industrial, and potable landscape irrigation accounts in the areas of the District that do not have access to recycled water, the identified potential savings ranges from 0.7 AFY to 15 AFY for one year of implementation, depending on the implementation approach. The associated cost savings to IRWD is estimated to range from approximately $1,000/year to $21,000/year. The associated benefit-cost ratio for IRWD for all scenarios over an assumed lifetime of 10 years is about 0.2, and thus not considered to be cost-effective by this assessment. Of the programs analyzed, the cost-effectiveness of this program is the least sensitive to varying levels of program participation and implementation.
- **PRV Pilot Programs**. Opportunities for a new WE program based on the installation of PRVs in high pressure zones within the IRWD service area are identified. Recommendations are made for implementation of a pilot program to help the District better quantify the specific opportunities and water savings potential for this potential new program. Based on a preliminary estimate, a benefit-cost ratio range of 0.6 was estimated for a pilot program targeting SFR accounts and a ratio of 4.5 was estimated for a pilot program targeting potable irrigation landscape accounts. Based on this assessment, only the program targeting potable irrigation landscape accounts is found to be cost-effective. However, it should be noted that the available water savings data on this program are more limited than the others evaluated, and thus further evaluation or a smaller scale SFR pilot study could be appropriate.

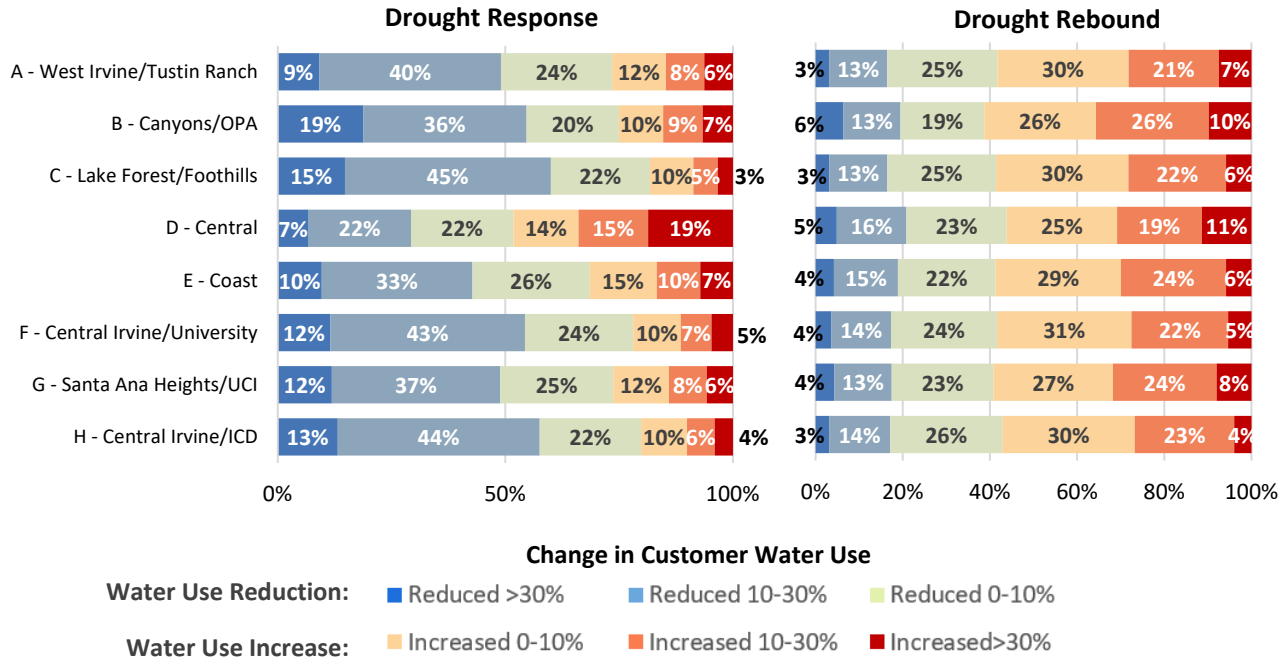
Drought Savings Opportunities (Section 8)

IRWD customers reduced their water use during the historic statewide 2013-2017 drought, and water use has not fully rebounded to pre-drought conditions. Water savings during the drought would have resulted from a combination of behavioral changes (such as irrigating less) and more permanent fixture/device changes (such as replacing old fixtures and removing turf). Customers whose water use has not rebounded are assumed to be "demand-hardened." The water use rebound by customers is identified and quantified as those savings that were likely the result of behavioral changes and represent the remaining potential for short-term savings opportunities in a future drought. Depending on the water savings needed in future droughts or water shortages, IRWD will likely need to increase outreach and other efforts to achieve the same results as during the 2013-2017 drought period, and even then, due to demand hardening, the same level of savings may not be feasible.

Figure ES-8 illustrates the changes in water use by SFR customers in response to the drought and in rebound from the drought, where water use in 2013 is considered pre-drought water use, water use in

2016 is the drought response, and 2018 is the drought rebound.[9] This analysis was performed for all sectors, but SFR is provided as an example. Accounting for the demand hardening based on the limited rebound to date, if drought outreach and messaging were conducted at levels similar to that done in the 2013-2017 drought timeframe, it is estimated that approximately 15% water savings could be achieved in the SFR sector, 11% in the MFR sector, and 19% in the potable landscape irrigation sector. This represents approximately 5,000 AFY of potential potable water drought conservation savings.

Figure ES-8
Summary of Drought Response and Rebound by SFR SPs



Conclusions

The WE programs implemented to date by IRWD have been successful, with over 150,000 devices and over 100 acres of turf replaced by District customers through participation in the wide variety of WE programs offered over the last ten years. Participation in these WE programs coupled with natural replacement with newer more efficient devices has resulted in measurable water savings and a substantial reduction in water use per account.

Based on the analyses performed for this Study, the largest remaining opportunities for water savings are in outdoor water use across all customer sectors, particularly through continued turf removal, and potentially through the implementation of a PRV program. Marketing and outreach has proven to drive customer participation in WE programs to date, as particularly evidenced by the increased participation rates observed in response to marketing efforts during the 2013-2017 drought. In fact, these outreach

[9] The change in water use patterns calculation was normalized by ET zone but not explicitly normalized by annual ET. As shown in **Table 6-1**, the evapotranspiration rate has been consistent each year, and between 2013, 2016, and 2018 has varied at most by 0.1 inch within each of the three ET zones. The method applied controls for the variation between ET zones, which over the period evaluated varied by more than 10 inches.

and marketing efforts appear to have a much more significant effect on program participation than the dollar amounts of rebates (Section 3.7). Therefore, the WE program opportunities and scenarios evaluated in this Study focused on the outdoor water savings potential and strategic ways to target the marketing of these programs. As new technologies and devices are developed and available on the market, more water savings opportunities may arise.

In addition to the specific conclusions and recommendations detailed herein, the analyses and associated raw files developed as part of this Study provide an extensive set of data and analytical tools that will serve as a foundation to strategically inform and guide the District's WE program planning efforts as the new State WE requirements and other WE drivers evolve.

How this Study Supports IRWD's Future WE Efforts

In support of IRWD's future WE planning efforts, this detailed and comprehensive Study:

- Documents the estimated water savings achieved through IRWD's implementation of WE programs over the last 10 years;
- Provides a detailed evaluation of WE program participation drivers and trends based on past participation, and in terms of intra-District geography and key demographic and property characteristics;
- Provides IRWD-specific water savings factors for WE key programs that reflect participation trends and intra-District customer variability and can be used to improve local planning estimates and inform WE program prioritization, funding, targeting and marketing;
- Provides a framework for periodic future analyses to monitor changes in WE program performance (e.g., by evaluating participation density/hot spot analyses change over time);
- Documents analyses that will serve to support future targeted marketing outreach efforts, grant applications, and documentation of WE program implementation to the State;
- Provides an assessment of device saturation based on historical WE program implementation, natural replacement rates, and the observed changes in customer water use;
- Concludes that residential indoor WE devices are highly saturated and little opportunity for increased water savings remains, based on both a device saturation assessment and an analysis of change in estimated indoor water use;
- Concludes that the greatest potential WE remains in outdoor water use and identifies four new and refined WE programs and a cost-benefit analysis of the associated implementation scenarios targeting these opportunities: (1) SFR Turf Removal Rebate Program Prioritized by Size, (2) SFR Turf Removal Rebate Targeted at Customers that Reduced Water Use During Drought, (3) Non-Residential Turf Removal Rebate Program,[10] and (4) PRV Pilot Programs; and
- Evaluates the demand hardening that has occurred since the statewide 2013-2017 drought and estimates that the maximum conservation savings that could be achieved in a future similar drought or water shortage scenario is approximately 5,000 AFY of potable water.

[10] Based on this assessment, the Non-Residential Turf Removal Rebate program targeting areas of the District not served by recycled water was not found to be cost-effective.

2. INTRODUCTION

The Irvine Ranch Water District (IRWD or District) provides water and wastewater service to over 115,000 connections across approximately 181-square mile. IRWD has a long and progressive history of providing water use efficiency (WE) programs to its customers to encourage more efficient use of water. The primary purpose of this *Water Efficiency Potential Study* (Study) is to identify the remaining water conservation potential in the IRWD service area and to strategically inform and guide the District's future WE program planning efforts. The work conducted as part of the Study included: (1) analyzing past program participation and effectiveness, (2) conducting an assessment of device saturation, (3) quantifying the water savings achieved through past WE programs, (4) identifying future WE program strategies, (5) conducting an assessment of the avoided water and embedded energy cost savings, and cost-effectiveness of these strategies, and (6) conducting an assessment of potential water savings that could be achieved during future droughts.

The analyses presented throughout the document were designed to provide the District with a set of analytical tools that can serve as a foundation to strategically inform and guide the District's future WE program planning. The resulting work product is presented as both static figures and tables in this Study, and as dynamic tools through the raw data files, queries and other content provided separately from this document. The text box above highlights the specific findings and analytical tools that will be used to support IRWD's WE efforts into the future.

How this Study Supports Future WE Efforts

In support of IRWD's future water efficiency planning efforts, this detailed and comprehensive Study:

- Documents the water savings achieved through IRWD's implementation of WE programs over the last 10 years;
- Provides a detailed evaluation of WE program participation drivers and trends based on past participation, and in terms of intra-District geography and key demographic and property characteristics;
- Provides IRWD-specific water savings factors for WE key programs that reflect participation trends and intra-District customer variability and can be used to improve local planning estimates and inform WE program prioritization, funding, targeting and marketing;
- Provides a framework for periodic future analyses to monitor changes in WE program performance (e.g., by evaluating participation density/hot spot analyses change over time);
- Documents analyses that will serve to support future targeted marketing outreach efforts, grant applications, and documentation of WE program implementation to the State;
- Provides an assessment of device saturation based on historical WE program implementation, natural replacement rates, and the observed changes in customer water use;
- Concludes that residential indoor WE devices are highly saturated and little opportunity for increased water savings remains, based on both a device saturation assessment and an analysis of change in estimated indoor water use;
- Concludes that the greatest potential WE remains in outdoor water use and identifies four new and refined WE programs and a cost-benefit analysis of the associated implementation scenarios targeting these opportunities: (1) SFR Turf Removal Rebate Program Prioritized by Size, (2) SFR Turf Removal Rebate Targeted at Customers that Reduced Water Use During Drought, (3) Non-Residential Turf Removal Rebate Program, and (4) PRV Pilot Programs; and
- Evaluates the demand hardening that has occurred since the statewide 2013-2017 drought and estimates that the maximum conservation savings that could be achieved in a future similar drought or water shortage scenario is approximately 5,000 AFY of potable water.

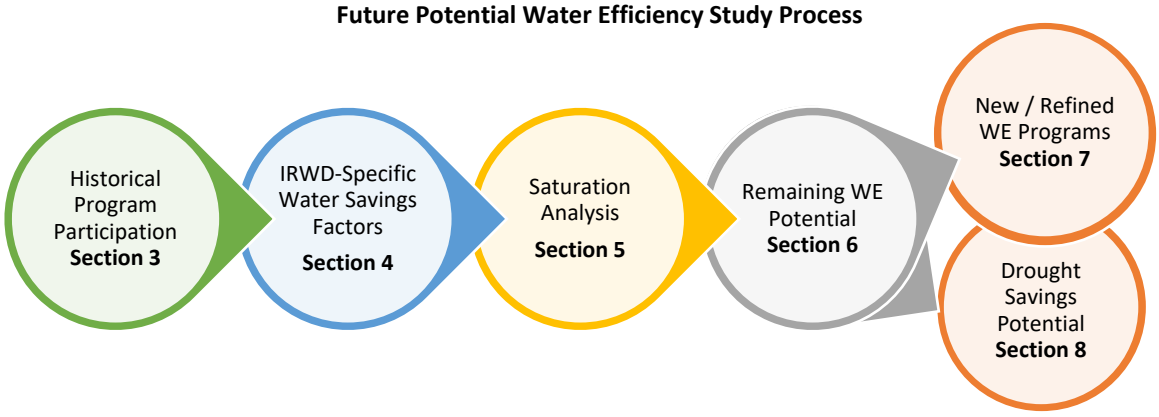
2.1. Document Organization

The Water Efficiency Potential Study is organized as follows:

- **Section 1** provides an Executive Summary, or high-level overview of key findings and takeaways for this Study;
- **Section 2** provides an overview of the Study development goals, organization, primary data sources, and approaches to grouping data for purposes of these analyses;
- **Section 3** provides a detailed discussion and analysis of past participation in WE programs, including analysis of geospatial, demographic, land use, and funding level trends relative to customer participation in selected WE programs;
- **Section 4** provides an analysis of the water savings achieved by IRWD customers as a result of WE program participation and a comparison of these results to industry standard savings estimates;
- **Section 5** provides a discussion and assessment of WE device saturation within the IRWD service area, including WE devices replaced as a result of both active WE program participation and natural replacement, as well as an assessment of the associated water savings;
- **Section 6** evaluates the remaining potential water savings opportunities and strategic WE program targeting, and identifies four specific program opportunities;
- **Section 7** provides an analysis of the potential water and costs savings and a benefit-cost analysis of the identified WE program opportunities;
- **Section 8** provides an assessment of future drought savings potential based on the degree of rebound and demand hardening observed by IRWD customers since the historic statewide 2013-2017 drought; and
- **Section 9** provides a summary of the Study conclusions and how the elements of this Study will support future efforts by IRWD; and
- **Section 10** provides key references and sources.

Additional supporting information is provided in **Appendices A** through **F**.

Future Potential Water Efficiency Study Process



2.2. Primary Data Sources

The key data and sources used to support the Study are described briefly below and in Appendix A.

2.2.1. Customer Water Use Data

The District provided EKI with monthly customer water use information for the past 10 years (2009 – 2018). This dataset consists of over 11,000,000 records and includes: monthly water use by account, service type (customer sector and subsector), water source (potable or non-potable), monthly water budgets, and a unique service point (SP or meter) identifier (ID). Customer water use data were used to evaluate water savings achieved through WE program participation, water efficiency gained through passive conservation, and potential remaining opportunities for increased water use efficiency.

2.2.2. Water Efficiency Program Participation Data

The District provided EKI with participation records for the WE programs implemented from 2006 through 2018. This dataset consists of approximately 35,000 records documenting IRWD's implementation of device and turf rebate and installation programs. The available data generally include: SP ID, device type, number of installed or rebated devices, and installation and/or purchase date. In addition, the data for programs related to turf removal include the area of turf replaced. The WE program participation data were used to evaluate geospatial, demographic, and temporal trends in program participation, water savings achieved through program participation, and to inform the assessment of efficient device saturation.

2.2.3. Parcel Data

The District provided EKI with georeferenced Orange County Assessor parcel data for the IRWD service area, consisting of over 160,000 parcels. This dataset includes detailed property characteristic information tracked by the Assessor Department, including: lot size, building size, building construction age, and property transfer date, among other characteristics. These data were used to assess the building stock, rates of water savings and use relative to property characteristics, and opportunities for future WE programs within the IRWD service area.

2.2.4. Census Data

The United States Census Bureau American Community Survey (ACS) 5-year estimates (2012-2016), TIGER/Line Shapefiles by Block Group were used to support analyses of key customer demographics and characteristics.[11] Census data used for this Study included estimates of median household income and home ownership.

2.2.5. Land Use Classification Data

Land use classification data are based on aerial imagery processing study conducted by Quantum Spatial in 2016. Quantum Spatial identified irrigated and non-irrigated land within the District, and further classified it as irrigated turf, irrigated non-turf, swimming pools, etc. This Study primarily uses the areas identified as irrigated turf area. The geospatial data provided by Quantum Spatial were further processed

[11] TIGER/Line Shapefiles by Block Group, available: https://www.census.gov/geo/maps-data/data/tiger-data.html

by IRWD for purposes of this Study to attribute the land use classifications to individual parcels and SP IDs. This processing necessitated certain assumptions, and as a result some data limitations and uncertainties, including:

- The identified landscape areas are limited to the areas within the Village Groups that could be assigned to an SP ID and parcel. The resultant excluded area is expected to be primarily undeveloped and unirrigated land.
- A single parcel may be served by multiple meters and thus have multiple SP IDs (e.g., a commercial lot served by a dedicated irrigation meter and a primarily indoor water use meter, or a mixed-use development with a combination of commercial, multi-family residential [MFR], and dedicated irrigation meters). In these cases, the specific SP ID and associated sector assigned to a given parcel may not reflect the dedicated irrigation meter. Therefore, while the assignment of SFR parcels and SP IDs is expected to be generally accurate, the assignment of non-SFR sector classifications and SP IDs is expected to have a higher degree of error.
- For the SFR sector, the landscape area associated with SPs with recycled water service were excluded from this dataset. However, for the same reasons as above, for non-SFR sectors, a landscape area may be served by recycled water and not identified as such by the assigned SP ID.
- The Quantum Spatial Study was conducted using 2016 aerial images. It is known that some customers let their lawns go brown as a specific result of the drought, and thus these lawns would be identified as non-irrigated areas in the available dataset.
- Because the landscape area measurements are based on aerial imagery, and not boots-on-the-ground measurements, areas of turf obscured by tree canopies or other impediments are not reflected in the data.
- Some of the turf area, particularly that associated with Institutional sector accounts, is considered to be functional turf and as such is not reasonably expected to be replaced by alternative landscaping.

For the SFR sector, these data limitations are expected to result in an underestimate of the amount of turf within the District, primarily due to the timing of the imagery and visual obstructions. For the non-SFR sector, these data limitations also result in a lower level of certainty as to what specific turf areas are associated with a given SP and whether such turf is a true candidate for turf removal. These limitations should be considered in context of the turf area data and associated analyses presented herein.

2.2.6. Other Service Area Characteristic Data

The District provided several other additional datasets of service area characteristics, which were used to supplement the evaluation of WE program opportunities, cost savings, and other analyses. These datasets include, among others:

- Prior IRWD studies (IRWD, 2016;[12] and Navigant, 2015);
- Boundaries of evapotranspiration (ET) zones within the service area;

[12] IRWD, 2016. Multiplier Effect Study 2016 Update, Irvine Ranch Water District.

- Geospatial landscape classification data, identifying irrigated and potentially irrigated lands within the service area;
- Meter locations corresponding to customer water use and parcel data;
- Self-reported WE device saturation results from Water Smart software surveys;
- Boundaries of 76 villages and unincorporated areas;
- Embedded energy zones; and
- Average water distribution system pressures.

2.3. Data Grouping for Analysis

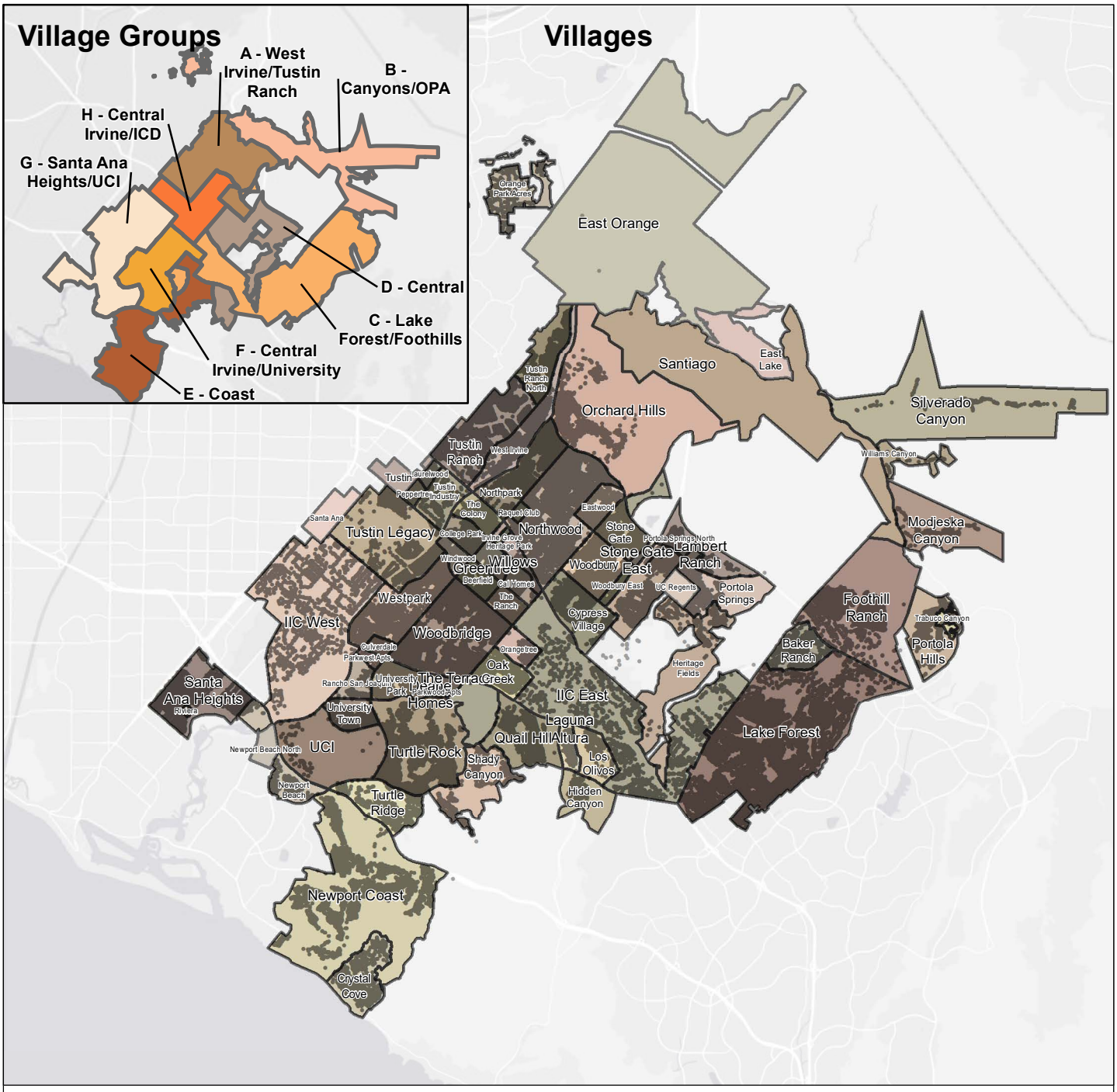
In order to support streamlined and meaningful analyses in this Study, some consolidation and grouping of key District characteristics was necessary. Specifically, grouping of District villages and SP types were done based on the classifications described below.

2.3.1. Villages

The IRWD service area is comprised by 76 villages and unincorporated areas (see **Figure 2-1**). The number of SPs per village ranges widely, from dozens to over 12,000, and over half of the villages currently have less than 1,000 SPs. To facilitate analyses and discussion for this Study, the 76 villages were consolidated into eight (8) "Village Groups", identified in **Figure 2-1** and **Table 2-1**. Villages were grouped based on geographic location, age of SPs, and building construction date, and based on IRWD's direction. **Table 2-1** shows which villages are included in each group. The majority of SPs in most villages consist of SFR and MFR SPs, generally consistent with the overall proportion of SPs by sector for the service area. However, a few villages have predominantly commercial, industrial, and institutional (CII) (particularly industrial SPs), and therefore would be expected to have different water use patterns; these villages are identified in **Table 2-1** as well.

2.3.2. Customer Sector

The District classifies customer SPs (or meters) into 28 categories. For the purposes of this Study, these categories have been grouped into seven water use sectors: (1) SFR, (2) MFR, (3) Potable Landscape Irrigation, (4) Non-Potable Landscape Irrigation, (5) Commercial, (6) Industrial, and (7) Institutional/Public Authority. **Table 2-2** presents the grouping of these 28 categories into water use sectors. The table also provides a breakdown of the number of SPs (also referred herein as accounts) by sector and by water source type. Over half of all SPs in the service area are SFR sector. Together with MFR, the residential sector comprises nearly 90% of SPs within the IRWD service area.



Legend

Village Boundary

Service Meter Location

Sources

1. IRWD service area received from Irvine Ranch Water District in January 2019.

N

0 3 6

(Scale in Miles)

Abbreviations

IRWD = Irvine Ranch Water District

Notes

1. All locations are approximate.

Villages and Village Groups

Irvine Ranch Water District
December 2019
B80129.00

Figure 2-1

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 2-1-Villages.mxd

Table 2-1

Village Grouping

Irvine Ranch Water District

Village Group	Village Name	Majority CII Accounts	Number of Service Points						
			Total	SFR	MFR	Landscape	Commer-cial	Industrial	Institu-tional
A - West Irvine /Tustin Ranch	Eastwood		1,332	431	842	43	16	0	0
	Northpark		3,142	1,743	1,149	172	73	0	5
	Orchard Hills		1,932	1,177	517	173	58	1	6
	Stone Gate		2,340	1,491	715	110	22	0	2
	Stone Gate East		251	2	234	10	5	0	0
	Tustin Ranch		5,229	1,886	2,960	239	124	13	7
	Tustin Ranch North		1,529	1,202	208	105	9	0	5
	West Irvine		2,162	1,410	592	79	66	0	15
	Village Group A		**17,917**	**9,342**	**7,217**	**931**	**373**	**14**	**40**
B - Canyons /OPA	Modjeska Canyon		225	215	0	0	3	0	7
	Orange Park Acres		561	551	0	2	8	0	0
	Santiago		17	12	0	1	2	0	2
	Silverado Canyon		432	419	0	1	6	0	6
	Williams Canyon		44	41	0	1	1	0	1
	Village Group B		**1,279**	**1,238**	**0**	**5**	**20**	**0**	**16**
C - Lake Forest /Foothills	Baker Ranch		1,736	1,106	424	87	117	2	0
	Foothill Ranch		3,921	2,646	846	219	201	2	7
	IIC East	X	2,218	1	60	757	1,016	373	11
	Lake Forest		12,563	8,328	2,788	718	702	4	23
	Portola Hills		1,836	1,018	755	54	8	0	1
	Trabuco Canyon		36	8	16	12	0	0	0
	Village Group C		**22,310**	**13,107**	**4,889**	**1,847**	**2,044**	**381**	**42**
D - Central	Cypress Village		2,104	687	1,235	139	35	0	8
	Heritage Fields		2,787	1,341	1,249	157	40	0	0
	Hidden Canyon		255	235	0	16	4	0	0
	Laguna Altura		637	597	0	36	4	0	0
	Lambert Ranch		188	170	0	15	3	0	0
	Los Olivos		198	0	118	61	19	0	0
	Portola Springs		1,574	524	909	115	25	0	1
	Portola Springs North		1,153	678	379	86	10	0	0
	Woodbury		2,681	1,517	932	141	87	0	4
	Woodbury East		620	220	367	26	7	0	0
	Village Group D		**12,197**	**5,969**	**5,189**	**792**	**234**	**0**	**13**
E - Coast	Crystal Cove		957	669	0	260	25	0	3
	Newport Coast		4,274	2,616	727	712	204	1	14
	Oak Creek		1,846	1,137	570	90	46	0	3
	Quail Hill		1,859	1,081	636	86	51	0	5
	Shady Canyon		746	386	0	351	9	0	0
	Turtle Ridge		1,374	892	358	94	27	0	3
	Village Group E		**11,056**	**6,781**	**2,291**	**1,593**	**362**	**1**	**28**

Table 2-1

Village Grouping

Irvine Ranch Water District

Village Group	Village Name	Majority CII Accounts	Number of Service Points						
			Total	SFR	MFR	Landscape	Commer-cial	Industrial	Institu-tional
F - Central Irvine /University	Culverdale		466	460	0	5	1	0	0
	Deane Homes		315	304	0	10	1	0	0
	Orangetree		522	270	204	29	17	0	2
	Parkwest Apts.		33	0	26	3	3	0	1
	Parkwood Apts		34	0	11	5	18	0	0
	Rancho San Joaquin		187	0	122	47	17	0	1
	The Terrace		530	1	508	18	3	0	0
	Turtle Rock		3,977	2,228	1,456	234	49	0	10
	University Park		1,793	613	1,093	49	31	0	7
	University Town		1,696	0	1,534	74	75	10	3
	Woodbridge		8,888	3,158	5,160	378	167	6	19
	Village Group F		**18,441**	**7,034**	**10,114**	**852**	**382**	**16**	**43**
G - Santa Ana Heights /UCI	IIC West	X	1,869	0	375	312	783	391	8
	Newport Beach		708	432	161	78	35	1	1
	Riviera		203	161	25	9	6	0	2
	Santa Ana Heights		3,276	1,873	1,050	160	191	0	2
	Tustin Legacy		2,663	1,319	980	157	183	10	14
	Westpark		5,517	2,272	2,876	206	145	3	15
	Windwood		1,023	268	660	43	49	2	1
	Village Group G		**15,259**	**6,325**	**6,127**	**965**	**1,392**	**407**	**43**
H - Central Irvine /ICD	Cal Homes		757	649	84	9	13	0	2
	College Park		1,059	1,018	5	27	4	0	5
	Deerfield		1,022	609	369	31	8	0	5
	Greentree		656	626	0	27	2	0	1
	Heritage Park		393	0	317	25	40	0	11
	Irvine Grove		239	18	214	5	2	0	0
	Laurelwood		544	244	278	21	1	0	0
	Northwood		9,190	6,258	2,410	331	168	1	22
	Peppertree		357	354	0	2	0	0	1
	Raquet Club		300	296	0	3	0	0	1
	The Colony		1,016	931	1	37	44	3	0
	The Ranch		892	732	96	20	41	0	3
	Tustin Industrial	X	240	0	0	34	174	32	0
	Willows		515	510	0	4	0	0	1
	Village Group H		**17,180**	**12,245**	**3,774**	**576**	**497**	**36**	**52**

Table 2-1

Village Grouping

Irvine Ranch Water District

Village Group	Village Name	Majority CII Accounts	Number of Service Points						
			Total	SFR	MFR	Landscape	Commer-cial	Industrial	Institu-tional
Not included in analysis	East Lake		0	0	0	0	0	0	0
	East Orange	X	7	0	0	2	1	0	4
	Unincorporated	X	10	0	0	2	7	0	1
	Great Park	X	50	0	0	24	24	1	1
	UC Regents	X	4	0	0	3	1	0	0
	UCI	X	107	0	0	53	46	1	7
	Irvine Coast	X	8	0	0	4	0	0	4
	Newport Beach North		0	0	0	0	0	0	0
	Santa Ana		0	0	0	0	0	0	0
	Tustin		0	0	0	0	0	0	0

Abbreviations:

MFR = Multi-Family Residential

na = not applicable

SFR = Single Family Residential

Notes:

(a) See Table 4-2: Housing Stock Characteristic of Cohort Group and SFR Program Participants for service point characteristics.

Table 2-2
Service Point Types Grouped by Water Use Sector
Irvine Ranch Water District

Water Use Sector	Number of Service Points			Service Point Type Description	Water Source	Number of Service Points
	Potable	Non-Potable	Total			
Residential - Single Family	62,625	0	62,625	Residential - Single Family - Potable Water - No Sewer	Potable	2,681
				Residential - Single Family - Potable Water & Sewer	Potable	59,412
				OPA - Residential - Potable Water - No Sewer	Potable	526
				OPA - Residential - Potable Water & Sewer	Potable	6
Residential - Multi-Family	40,203	0	40,203	Residential - Apartment - Potable Water & Sewer	Potable	5,345
				Residential - Condo - Potable Water - No Sewer	Potable	766
				Residential - Condo - Potable Water & Sewer	Potable	28,346
				Residential - Detached Condo - Potable Water & Sewer	Potable	2,519
				Residential - Multi Family Apartment- Potable Water & Sewer	Potable	2,103
				Residential - Multi Family Apartment- Potable Water- No Sewer	Potable	83
				Residential - Multi Family Condo - Potable Water & Sewer	Potable	759
				Residential - Multi Family Condo - Potable Water- No Sewer	Potable	282
Potable Landscape Irrigation	1,879	0	1,879	Landscape Irrigation - Potable - Water	Potable	1,877
				OPA - Landscape Irrigation - Potable Water	Potable	2
Non-Potable Landscape Irrigation	0	5,849	5,849	Landscape Irrigation - Irvine Lake Pipeline - Water	Non-Potable	76
				Residential - Landscape Irrigation - Recycled Water	Recycled	665
				Landscape Irrigation - Recycled - Water	Recycled	5,108
Commercial	5,331	98	5,429	Commercial - Potable - Water - No Sewer	Potable	457
				Commercial - Potable - Water & Sewer	Potable	4,866
				Commercial - Recycled - Water & Sewer	Recycled	97
				Commercial - Santiago Aqueduct Commission - Water	Non-Potable	1
				OPA - Commercial - Potable - Water - No Sewer	Potable	8
Industrial	846	6	852	Industrial - Potable - Water - No Sewer	Potable	21
				Industrial - Potable - Water & Sewer	Potable	825
				Industrial - Recycled - Water - No Sewer	Recycled	4
				Industrial - Recycled - Water & Sewer	Recycled	2
Institutional/ Public Authority	317	0	317	Public Authority - Potable Water - No Sewer	Potable	83
				Public Authority - Potable Water & Sewer	Potable	234

3. PAST PROGRAM PARTICIPATION DRIVER ANALYSIS FOR SELECTED PROGRAMS

The following section evaluates past participation in water efficiency (WE) programs by Irvine Ranch Water District (IRWD) customers in ten (10) selected programs, including participation trends based on customer demographics, property characteristics, and geography within the District, as well as changes in participation relative to rebate funding levels. The goal of these analyses is to identify participation drivers and help IRWD better understand more about which customers are participating in which WE programs so that IRWD may accordingly use this information to inform the strategic design, selection, and marketing of future WE programs and services. By reviewing and analyzing past participation in WE programs, this Study highlights key insights on how and which IRWD customers tend to participate in various programs (see text box to the right and Section 3.8 for further discussion). Section 5 takes a comprehensive look at participation in all programs (i.e., not just the ten selected programs reviewed in Section 3) for purposes of evaluating device saturation. These collective findings were used to inform the program opportunity evaluation and approaches identified in Sections 6 and 7.

Key Program Participation Findings

The key take-aways relative to the historical performance of the WE programs that were reviewed and analyzed are briefly summarized below and further described in Section 3.8:

- The WE programs appear to have effectively targeted customers with the most potential to achieve water savings.
- Program participation rates are not consistent throughout the District and reflect diverse demographic and property characteristics, which can be generally correlated based on geographic location within the District (i.e., Village Groups).[13]
- Different program models can broaden/accelerate participation.
- CII and landscape irrigation customers remain a potential untapped opportunity.
- Opportunities have been identified for increased water savings through strategic WE program planning, including strategic targeting based on program type, key customer demographics, and SP location within the District.
- Unless a rebate increase is coupled with a substantial marketing and outreach effort, the actual rebate value does not appear to be a substantial driver for customer participation.

The District's customers are offered a wide range of WE programs, and the particular programs and suite of offerings are continually adapted to respond to a variety of drivers. The following ten WE programs (which represent a subset of all programs offered to IRWD customers) have been selected for geospatial and customer demographic trend analyses. A brief description of each program and key marketing strategies are provided below.

1. **Single-Family Residential (SFR) Turf Removal Rebates** – 2010 to present. This is a regional program administered by Metropolitan Water District of Southern California (MWD), Municipal Water District of Orange County (MWDOC), and/or IRWD. The available funding level and

[13] Village Groups are represented as letters in the attached tables and figures, and their full names are as follows: A - West Irvine/Tustin Ranch; B - Canyons/OPA; C - Lake Forest/Foothills; D - Central; E - Coast; F - Central Irvine/University; G - Santa Ana Heights/UCI; H - Central Irvine/ICD.

maximum project size have varied by fiscal year over the course of the program. At times, IRWD has added additional funding to the regional incentive.

2. **SFR Weather-Based Irrigation Controller (WBIC) Rebates** – 2005 to present. This is a regional program administered by MWD. Participants must choose from a list of eligible WBIC models to qualify for the program. The list of qualifying models is subject to change over time. At times, IRWD has added additional funding to the regional incentive.
3. **SFR WBICs through One-Stop-Shop Program** – 2017 only. The One-Stop-Shop program was a direct-installation program provided at no cost to participants. Qualified customers of IRWD, Southern California Edison, and SoCalGas were eligible to receive faucet aerators, showerheads, HETs, WBICs, and energy saving features, such as lighting fixtures and heating, ventilation, and air conditioning (HVAC) tune-ups.[14] A strategic marketing approach was employed to identify customers with the highest savings potential for all three utilities. Bundling water and energy efficiency devices in a single visit made customers more likely to participate. These customers typically lived in older homes (pre-2000) and had no previous participation in rebate programs. Customers were targeted with marketing through email, physical mail, or both, and distributed materials included an application deadline date.
4. **SFR High Efficiency Toilet (HET) Rebates** – 2013 to present. This is a regional program administered by MWD. Participants must choose from a list of eligible models to qualify for the program. The list of qualifying models is subject to change over time. At times, IRWD has added additional funding to the regional incentive.
5. **SFR HETs through One-Stop-Shop Program** – 2017 to 2018. HETs were provided through the same program described under #3 above.
6. **SFR High Efficiency Clothes Washer (HECW) Rebates** – 2005 through present. This is a regional program administered by MWD. Participants must choose from a list of eligible models to qualify for the program. The list of qualifying models is subject to change over time. At times, IRWD has added additional funding to the regional incentive.
7. **Turf Removal Rebates for Landscape Irrigation Service Points (SPs)** – 2010 through present. This is a regional program administered by MWD, MWDOC, and/or IRWD. The available funding level and maximum project size have varied by fiscal year over the course of the program. At times, IRWD has added additional funding to the regional incentive.
8. **WBIC Rebates for Large Dedicated Irrigation** – 2009 through present. This is a regional program administered by MWD. Participants must choose from a list of eligible models to qualify for the program. The list of qualifying models is subject to change over time. At times, IRWD has added additional funding to the regional incentive.
9. **Turf Removal Rebates for Commercial, Industrial, Institutional (CII) SPs** – 2010 to present. This is a regional program administered by MWD, MWDOC, and/or IRWD. The available funding level

[14] IRWD did not provide funding for the non-water using energy-saving features, such as lighting fixtures and HVAC tune-ups.

and maximum project size have varied by fiscal year over the course of the program. At times, IRWD has added additional funding to the regional incentive.

10. **CII Indoor Device Rebates** – 2011 to present. This is a regional program administered by MWD. Participants must choose from a list of eligible models to qualify for the program. The list of qualifying models is subject to change over time. At times, IRWD has added additional funding to the regional incentive.

The specific analysis that were conducted to ascertain trends in WE program participation include:

- Participation rates over time and by Village Group;[15]
- Statistical "hot spot" or participation density analysis;
- Analysis of building stock and landscape characteristics;
- Demographic factors including income and home-ownership;
- Participation in multiple programs; and
- Land use and business type characteristics for large landscape and CII programs; and
- Funding Levels.

3.1. Temporal and Spatial Trends in Program Participation

The IRWD service area includes 76 villages and covers approximately 181-square miles and most of the WE programs analyzed herein have had high levels of participation. Given the large amount of participation data spread across such a large area, it can be difficult to ascertain whether participation in these programs has been evenly distributed across the service area, or if participation tends to be clustered in certain parts of the service area. In order to better understand the spatial distribution of WE program participation a statistical "hot spot" or participation density analysis was performed for selected programs and is described in the following sections. The results of this analysis are provided in **Figure 3-1** through **Figure 3-10.** In addition**, Table 3-1** through **Table 3-10** show the breakdown of participation within each Village Group[16] and the total participation relative to the total number of devices and rebates, as applicable. The blue shading in the tables is provided as a visual mechanism to compare relative participation, where darker blue indicates a higher level of participation in a given year or Village Group area. A discussion of the change in participation levels relative to rebate amounts is provided further below under Section 3.7.

In order to identify program participation density for WE programs in the IRWD service area, a geostatistical spatial analysis was performed.[17] This analysis identifies participation "hot spots," which are areas where a higher density of participation is observed than would be expected by randomly distributed participation. Similarly, "cold spots," or areas of lower than expected participation, are identified. High density participation areas are identified in red on the attached figures and low density participation areas

[15] Section 2.3 describes how the 76 IRWD villages were grouped into eight Village Groups.
[16] Section 2.3 describes how the 76 villages were grouped into eight Village Groups.
[17] The ESRI ArcGIS 10.6 Optimized Hot Spot Analysis tool was used for spatial hot spot analysis of program participation. The hot spot analysis calculates a Getis Ord GI* statistic for each cell. This statistical z-score evaluates how the event (in this case, participation in the program) clusters spatially, by looking at the cell in the context of the neighboring cells. For the purposes of this study, hot and cold spots are identified as cells with a 90% or greater level of statistical confidence.

are identified in blue. The size of the cluster analysis hexagonal grid cells is a function of the amount of participation data included in the analysis; therefore, larger grid cells are shown in the attached figures for WE programs with lower overall participation. This analysis is sensitive due to several factors, including the pre-processing of the data to address the irregular parcel/neighborhood shapes, particular configurations of neighborhoods, and the selection of the analysis grid (i.e., hexagonal or square grid). In acknowledgement of this, two alternative pre-processing methods were used and are presented in Appendix B to illustrate this affect. It should be noted that these analyses are intended to be a measure of relative performance between neighborhoods/areas of the District and between programs.

3.1.1. Outdoor Irrigation Programs for Single-Family Residential Customers

This section includes analysis and comparison of the following three programs:

1. SFR Turf Removal Rebates;
2. SFR WBIC Rebates; and
3. SFR WBICs through One-Stop-Shop Program.

Participation Rate and Temporal Trends

Table 3-1 provides a summary of participation in the SFR Turf Removal program by SFR SPs. Since its start in 2010, over 1,700 SFR landscapes in the IRWD service area have been converted from turf to a water efficient landscape through this program during the eight-year implementation period, representing nearly 3% of residential parcels. As identified in Section 4.2, this amounts to 33 acres of turf area directly replaced through this program and approximately 119 acres total replaced when accounting for the multiplier effect identified by IRWD (2016).[18] The number of participants peaked in 2015 during the height of the statewide drought and then gradually decreased. In Fiscal Year (FY) 2018-2019, the program underwent several modifications, including renaming the program to the "Landscape Transformation Program" and adjustments to the project requirements. The program name change may have contributed to the decrease in participation observed during this time, as well as the loss in momentum from the regional program being suspended, and given that the drought-associated marketing and outreach was no longer being implemented. The Lake Forest/Foothills and Canyons/OPA Village Groups have the highest participation rates at 4.8% and 3.5% of SFR SPs, respectively. The Central Village Group, which generally consists of newer homes and smaller lots (less turf area), had the lowest participation rate at just 0.43% of SFR SPs.

[18] The *Multiplier Effect Study* suggests that the multiplier effect may be as high as 2.6 (i.e., for every acre of turf transformed through a regional rebate program, another 2.6 acres is also transformed).
IRWD, 2016. Multiplier Effect Study 2016 Update, Irvine Ranch Water District.

Table 3-1
Summary of Participation in SFR Turf Removal program

Village Group	Year											Total	Percentage of Res. Meters
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	--	1	1	35	62	56	15	4	**174**	**1.8%**
B - Canyons/ OPA	--	--	--	--	2	2	6	15	12	3	1	**41**	**3.5%**
C - Lake Forest/ Foothills	--	--	--	2	6	9	74	268	175	64	37	**635**	**4.8%**
D - Central	--	--	--	--	--	--	2	12	7	2	3	**26**	**0.43%**
E - Coast	--	--	--	--	2	--	17	42	28	5	10	**104**	**1.5%**
F - Central Irvine/University	--	--	--	1	3	5	26	75	54	20	13	**197**	**2.8%**
G - Santa Ana Heights/UCI	--	--	--	--	1	2	25	49	35	23	5	**140**	**2.2%**
H - Central Irvine/ICD	--	--	--	1	5	8	45	159	115	52	26	**411**	**3.4%**
Total	**--**	**--**	**--**	**4**	**20**	**28**	**230**	**682**	**483**	**184**	**99**	**1,730**	**2.8%**

As shown in **Table 3-2** the SFR WBIC Rebate program has had more than 1,400 participants during the 11-year implementation period analyzed.[19] This represents 2.4% of the SFR SPs in the District. The SFR WBIC Rebate program has shown a high level of participation over the last four years. While participation increased during the drought, the highest levels of participation have actually been following the drought. This participation trend may reflect the maturing market and increased awareness and availability of this relatively new technology. This increased awareness may also be influenced by the WE programs outside of the rebates, that provide direct installation of WBICs as well. Participation rates between Village Groups are generally consistent, ranging from 1.5% for the Canyons/OPA and Coast Village Groups to 3.1% for the Lake Forest/Foothills Village Group. Based on this assessment, SFR customers in the Central Village Group seem to favor the SFR WBIC Rebate program over the SFR Turf Removal program, while customers in the Canyons/OPA and Central Irvine/ICD Village Groups tend to favor the SFR Turf Removal program.

[19] In addition to the rebate program, WBICs have been offered to IRWD customers through direct installation programs, such as one funded through a Proposition 84 grant. WBICs installed through these programs are included in the saturation analysis described under Section 4.

Table 3-2
Summary of Participation in WBIC Rebates for SFR SPs Program

Village Group	Year											Total	Percentage of Res. Meters
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	1	5	4	17	13	10	29	40	60	49	**228**	**2.4%**
B - Canyons/OPA	--	1	1	1	--	--	1	3	4	5	2	**18**	**1.5%**
C - Lake Forest/Foothills	4	2	6	12	19	19	30	49	85	95	80	**401**	**3.1%**
D - Central	--	--	2	1	4	4	3	22	21	42	38	**137**	**2.2%**
E - Coast	1	1	--	4	6	2	8	17	21	26	19	**105**	**1.5%**
F - Central Irvine/University	2	4	--	5	9	4	1	26	28	30	40	**149**	**2.1%**
G - Santa Ana Heights/UCI	1	--	1	6	9	6	4	20	14	38	26	**125**	**2.0%**
H - Central Irvine/ICD	2	4	2	2	20	20	11	35	48	83	75	**302**	**2.5%**
Total	**10**	**13**	**17**	**35**	**84**	**68**	**68**	**201**	**261**	**379**	**329**	**1,465**	**2.4%**

The One-Stop-Shop program funded through a Department of Water Resources (DWR) Water-Energy Grant was offered to IRWD customers from January 2017 through February 2018. Through this program, customers were offered a variety of energy- and water-saving devices, including WBICs, HETs, and others, at no cost. As shown in **Table 3-3**, in its short history, the One-Stop-Shop program provided WBICs to about 600 participants, representing approximately 1% of SFR SPs. Participation varied between Village Groups, with the highest rate of participation in the West Irvine/Tustin Village Group, and very little to no participation in the Canyons/OPA, Central, and Coast Village Groups. Due to the targeted marketing efforts, the One-Stop-Shop program appears to have been particularly successful in reaching customers in the Central Irvine/ICD Village Group, compared to the SFR WBIC Rebate program.

Table 3-3
Summary of SFR Participation in One-Stop-Shop Program, Receiving WBIC

Village Group	Year		Total	Percentage of Res. Meters
	2017	2018		
A - West Irvine/ Tustin Ranch	81	--	**81**	**0.86%**
B - Canyons/OPA	--	--	**0**	**0%**
C - Lake Forest/Foothills	136	--	**136**	**1.0%**
D - Central	23	--	**23**	**0.38%**
E - Coast	13	--	**13**	**0.19%**
F - Central Irvine/University	73	--	**73**	**1.0%**
G - Santa Ana Heights/UCI	55	--	**55**	**0.88%**
H - Central Irvine/ICD	231	--	**231**	**1.9%**
Total	**612**	**--**	**612**	**1.0%**

Participation Density Analysis

Figures 3-1, 3-2, and **3-3** show the results of the participation density analysis for SFR Turf Removal Rebate, SFR WBIC Rebates, and WBIC One-Stop-Shop program participants, respectively. Participation rates for the SFR Turf Removal and WBIC Rebates programs are similar, at approximately 1,700 and 1,500 participants, respectively. However, as shown on the figures, the spatial distribution of these programs is somewhat different. Participation in the SFR WBIC Rebate Program is more even across the service area, with some distinct areas of higher participation (Lake Forest/Foothills and Central Irvine/ICD Village Groups) and lower participation (Canyons/OPA, Coast, and Santa Ana Heights/UCI Village Groups). While participation in the SFR Turf Removal program has been much more intensely concentrated in the same general areas. One notable area of difference is in the Portola Springs area, which is a new development and may not have much turf to be removed, within the Central Village Group, where there was a high level of participation in the SFR WBIC Rebate program, but very low in the SFR Turf Removal program.

Although much shorter in duration, the One-Stop-Shop program has had nearly half as many participants as the SFR WBIC Rebates Program, with approximately 600 participants. The One-Stop-Shop program was a targeted program, with outreach and marketing aimed at SFR customers with older homes and no prior participation in WE programs. The spatial distribution of these two programs is similar, although like the SFR Turf Removal program, the One-Stop-Shop program reflects more discrete areas of high density and low density participation. The Central Village Group has had a higher level of participation in the WBIC and in the One-Stop-Shop or Turf Removal program. The northern portion of the Lake Forest/Foothills Village Group (Foothill Ranch area) has had higher participation in both the WBIC and Turf Removal rebates than in the One-Stop-Shop program. Targeting of the One-Stop-Shop program was successful, having been fully allocated and reaching customers in the southwestern portion of the Lake Forest/Foothill Group (southwestern Lake Forest) and in the Central Irvine/University Village Groups (Woodbridge and Westpark areas) than the SFR Turf Removal program.

Across all three SFR outdoor irrigation focused programs, there is consistently low density of participation in portions of the Coast and Santa Ana Heights/UCI Village Groups.

Participation Density
Turf Removal for SFR Accounts
2011 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for Turf Removal for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-1

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-1_HotSpot_TurfRemoval_SFR.mxd

Participation Density
WBIC Rebates for SFR Accounts
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for WBIC Rebates for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-2

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-2_HotSpot_WBIC_Rebates_SFR.mxd

Participation Density
SFR One-Stop-Shop WBICs
2017 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC SFR No-Cost Program

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for SFR One-Stop-Shop WBICs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-3

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-3_HotSpot_WBIC_NoCost_SFR.mxd

3.1.2. Single-Family Residential High Efficiency Toilet Programs

This section includes analysis and comparison of the following 2 programs:

1. SFR HET Rebates; and
2. SFR HETs through One-Stop-Shop Program.

Participation Rate and Temporal Trends

As shown in **Table 3-4**, the HET Rebate program has been very popular, with over 3,000 participants, representing 5% of the SFR SPs within the District. No rebates were issued during 2011 or 2012. Although these rebates have been offered for years, there was a large increase in participation in 2015, at the height of the drought, representing approximately one-third of participation over the study period. Since 2015, participation has declined, with the lowest participation yet in 2018. Participation rates vary between Village Groups, with the highest rates of participation in the Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD Village Groups, and the lowest participation in the Central and Coast Village Groups. The Central and Coast Village Groups tend to have newer homes, which are not eligible for participation in HET replacement programs.

Table 3-4
Summary of Participation in SFR HET Rebate Program

Village Group	Year											Total	Percentage of Res. Meters
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	17	24	28	--	--	24	86	114	37	11	4	**345**	**3.7%**
B - Canyons/OPA	2	7	7	--	--	3	8	13	5	1	1	**47**	**4.0%**
C - Lake Forest/Foothills	34	86	75	--	--	60	196	294	71	25	18	**859**	**6.5%**
D - Central	1	1	3	--	--	10	17	23	9	4	3	**71**	**1.2%**
E - Coast	1	9	11	--	--	4	24	52	24	6	7	**138**	**2.0%**
F - Central Irvine/University	37	88	55	--	--	22	87	146	29	9	3	**476**	**6.8%**
G - Santa Ana Heights/UCI	12	34	24	--	--	7	46	90	22	11	1	**247**	**3.9%**
H - Central Irvine/ICD	62	113	92	--	--	43	160	331	76	21	12	**910**	**7.4%**
Total	**166**	**362**	**295**	**--**	**--**	**174**	**624**	**1,063**	**273**	**88**	**49**	**3,094**	**5.0%**

As discussed above, the One-Stop-Shop program was only available from January 2017 through February 2018. As shown in **Table 3-5**, over 1,200 SFR SPs have participated in this program, representing 2% of SFR SPs within the District. As with the HET Rebate program, participation between Village Groups is highly variable, in large part due to the fact that program marketing targeted customers with older homes. As with the SFR HET Rebate program, the Central Irvine/ICD Village Group has had the highest rate of

participation with One-Stop-Shop HETs. Compared to the rebate program, relatively lower rates of participation are observed in the Canyons/OPA, Central, and Coast Village Groups.

Table 3-5
Summary of SFR Participation in One-Stop-Shop Program, Receiving HET

Village Group	Year		Total	Percentage of Res. Meters
	2017	2018		
A - West Irvine/ Tustin Ranch	131	4	**135**	**1.4%**
B - Canyons/OPA	3	--	**3**	**0.3%**
C - Lake Forest/Foothills	266	2	**268**	**2.0%**
D - Central	29	1	**30**	**0.5%**
E - Coast	40	--	**40**	**0.6%**
F - Central Irvine/University	149	2	**151**	**2.1%**
G - Santa Ana Heights/UCI	122	2	**124**	**2.0%**
H - Central Irvine/ICD	481	6	487	**4.0%**
Total	**1,221**	**17**	**1,238**	**2.0%**

Participation Density Analysis

Figures 3-4 and **3-5** show the results of the participation density analysis for SFR HET Rebate and One-Stop-Shop HET program participants, respectively. Overall, there has been nearly three times as many participants in the HET Rebate program (approximately 3,000 participants) as there has been in the much shorter duration One-Stop-Shop program (approximately 1,200 participants). The highest levels of participation in both programs are generally consistent with the oldest areas of the District, as would be expected. Areas of high density participation in the One-Stop-Shop program are somewhat more discretely clustered than those in the SFR HET Rebate program. Both the Santa Ana Heights area of Village Group G and the Orange Park Acres areas of Village Group B have high portions of older (pre-1992) homes, but have had low levels of participation in both programs.

3.1.3. Single-Family Residential High Efficiency Clothes Washer Rebate Program

This section includes analysis of the SFR HECW Rebate program.

Participation Rate and Temporal Trends

As shown in **Table 3-6** and **Figure 3-6**, the SFR HECW Rebate program has been very successful, with nearly 20% of total SFR SPs within the District having participated (i.e., the highest participation rate of any WE program). Overall participation increased through 2010 and then has been gradually decreasing since. Over time, the number of washer models on the market that meet the rebate eligibility criteria has varied. Rebate eligibility is based on washers meeting a minimum efficiency (i.e., water factor (WF)[20] value) and the minimum qualifying efficiency has been increased over the course of the program. As fewer eligible washers are available, this may also play a factor in the observed participation rate decline. Given that

[20] WF is measured as the number of gallons of water used to wash one cubic foot of laundry.

Participation Density
SFR HET Rebate Program
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HET Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for SFR HET Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-4

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-4_HotSpot_HET_Rebates_SFR.mxd

Participation Density
SFR One-Stop-Shop HETs
2017-2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR No-Cost HET Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for SFR One-Stop-Shop HETs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-5

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Participation Density
SFR HECW Rebate Program
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HECW Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HECW = high efficiency clothes washer
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for SFR HECW Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-6

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participation in this program can include purchase of new machines, rather than replacement of devices, some of the participation in this program may be driven by new development. Apart from Village Group B, rates of participation appear to be very consistent between Village Groups. Participation by the Canyons/OPA Village Group SFR customers, however, has been less than half that observed in the other areas.

Table 3-6
Summary of Participation in SFR HECW Rebate Program

Village Group	Year											Total	Percentage of Res. Meters
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	104	151	274	218	227	261	215	147	164	168	82	**2,011**	**21%**
B - Canyons/OPA	3	14	17	15	9	9	9	7	5	8	4	**100**	**8.4%**
C - Lake Forest/Foothills	130	187	329	274	267	255	262	251	187	172	91	**2,405**	**18%**
D - Central	32	36	148	113	91	166	182	115	93	89	85	**1,150**	**19%**
E - Coast	64	96	167	146	141	89	104	92	86	67	34	**1,086**	**16%**
F - Central Irvine/University	77	108	196	168	162	137	124	119	95	83	43	**1,312**	**19%**
G - Santa Ana Heights/UCI	52	121	151	126	127	68	106	87	93	47	43	**1,021**	**16%**
H - Central Irvine/ICD	170	277	424	341	332	248	240	233	160	157	67	**2,649**	**22%**
Total	**632**	**990**	**1,707**	**1,401**	**1,356**	**1,234**	**1,242**	**1,051**	**883**	**794**	**460**	**11,734**	**19%**

Participation Density Analysis

Table 3-6 shows the results of the participation density analysis for the SFR HECW Rebate program. There have been very high levels of participation in this program, with over 11,000 participants across the District and representing nearly 20% of SFR SPs. However, despite this high level of participation, there are still clear spatial density trends observed. The overall density distribution is similar to that of the SFR HET Rebate program, with the highest density of participation generally corresponding to the oldest and highest density residential areas of the District. However, between the HET and HECW Rebate programs, the higher levels of participation are observed in the SFR HECW Rebate program in the West Irvine/Tustin Ranch and Central Village Groups, including the Stonegate, Portola Springs, Woodbury, and Heritage Fields areas. The homes in these areas are very new, generally constructed since 2000. The homes in the Baker Ranch area of the Lake Forest/Foothills Village Group are also very new (generally constructed since 2014) but show a low level of participation density. The Portola Hills area of the Lake Forest/Foothills Village Group is dominated by homes constructed in the 1980s to 1990s but shows a low level of participation in the SFR HECW Rebate program. These results suggest that new construction is a strong driver of participation in this program, rather than merely replacement of existing appliances.

As with the other programs evaluated herein, there is consistently low density of participation in the SFR HECW program in the Canyons/OPA, Coast, and Santa Ana Heights/UCI Village Groups.

3.1.4. Outdoor Irrigation Programs for Landscape Irrigation, Commercial, Industrial, and Institutional Service Points

This section includes analysis and comparison of the following three programs:

1. WBIC Rebates for Large Landscape SPs;
2. Turf Removal Rebates for Landscape Irrigation SPs; and
3. Turf Removal Rebates for CII SPs.

Participation Rate and Temporal Trends

Tables 3-7a and **3-7b** show participation in the CII WBIC Rebates program by potable and non-potable large landscape SPs, respectively. While this program is primarily aimed at SPs with dedicated landscape irrigation meters, it is also open to SFR SPs with very large landscapes. Of the 692 total participants in the program, 21 have been SFR SPs. The program participation percentages shown represent the rate of participation relative to the total number of potable and non-potable landscape irrigation SPs. Participation rates in this program have not been particularly consistent over time. A peak in participation occurred in 2014, in the middle of the drought, followed by decreases and increases in subsequent years. Overall, 4.2% of potable landscape irrigation SPs and 10% of non-potable landscape irrigation SPs have participated in this program. The Coast Village Group has had by far the highest participation rate, at 59% of potable and 23% of non-potable landscape irrigation SPs. To date, no landscape irrigation SPs in the Canyons/OPA Village Group have received a WBIC rebate through this program; however, IRWD did implement a separate non-rebate WBIC program in OPA, which is not reflected here.

Table 3-7a
Summary of Participation in WBIC Rebates for Potable Water Large Landscape SPs Program

Village Group	Year											Total – Including SFR SPs	Total - Landscape Irrigation SP	Percentage of Landscape Irrigation SPs
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018			
A - West Irvine/ Tustin Ranch	--	--	--	--	--	--	--	1	3	--	3	7	**1**	**1.6%**
B - Canyons/OPA	--	1	1	--	1	1	--	1	--	1	1	7	**0**	**0%**
C - Lake Forest/Foothills	--	--	--	--	3	8	6	12	5	5	1	40	**37**	**3.7%**
D - Central	--	--	--	--	--	--	--	--	--	--	--	0	**0**	**0%**
E - Coast	--	--	--	--	--	--	23	--	--	--	--	23	**22**	**59%**
F - Central Irvine/University	--	--	--	--	--	--	--	6	5	1	1	13	**6**	**2.9%**
G - Santa Ana Heights/UCI	--	--	--	--	--	3	2	1	2	--	--	8	**8**	**2.1%**
H - Central Irvine/ICD	--	--	--	--	--	1	2	1	1	1	--	6	**4**	**2.7%**
Total	**0**	**1**	**1**	**0**	**4**	**13**	**33**	**22**	**16**	**8**	**6**	**104**	**78**	**4.2%**

Table 3-7b
Summary of Participation in WBIC Rebates for Non-Potable Water Large Landscape SPs Program

Village Group	Year											Total	Percentage of Landscape Irrigation SPs
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	--	1	7	12	2	4	9	1	36	**4.1%**
B - Canyons/OPA	--	--	--	--	--	--	--	--	--	--	--	0	**0%**
C - Lake Forest/Foothills	--	--	--	--	2	2	2	1	1	--	--	8	**1.0%**
D - Central	--	--	--	--	--	--	59	4	--	--	--	63	**8.0%**
E - Coast	1	2	--	--	12	14	30	27	65	161	46	358	**23%**
F - Central Irvine/University	--	--	--	--	--	8	14	8	7	13	--	50	**7.9%**
G - Santa Ana Heights/UCI	--	--	--	--	2	8	--	--	24	1	1	36	**6.3%**
H - Central Irvine/ICD	--	--	--	--	--	--	15	11	10	--	1	37	**8.8%**
Total	**1**	**2**	**0**	**0**	**17**	**39**	**132**	**53**	**111**	**184**	**49**	**588**	**10%**

Table 3-8a and **Table 3-8b** show participation in the CII Turf Removal program by potable and non-potable landscape irrigation SPs, respectively. Despite the program being targeted at potable irrigation accounts, overall total participation is split evenly between potable and non-potable SPs. This amounts to approximately 3% of all potable landscape irrigation SPs having participated in this program, and only 1% of non-potable landscape irrigation SPs having participated. As identified in Section 5.3.3, this amounts to approximately 59 acres of turf area replaced for landscape irrigation accounts through this program. Participation in this program peaked in 2015 at the height of the drought, with very low levels of participation before and after. The highest proportion of participation by potable SPs has been in West Irvine/Tustin Ranch and Coast Village Groups and by non-potable SPs in the Lake Forest/Foothills Village Group.

Table 3-8a
Summary of Participation in Turf Removal for Potable Water Landscape Irrigation SPs Program

Village Group	Year								Total	Percentage of Potable SPs
	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	2	9	--	--	1	**12**	**19%**
B - Canyons/OPA	--	--	--	--	--	--	--	--	**--**	**0%**
C - Lake Forest/Foothills	--	--	--	1	5	--	--	--	**6**	**0.6%**
D - Central	--	--	--	--	--	--	--	--	**--**	**0%**
E - Coast	--	--	--	2	3	--	--	1	**6**	**16%**
F - Central Irvine/University	--	--	--	4	10	--	--	--	**14**	**6.9%**
G - Santa Ana Heights/UCI	--	--	1	1	8	1	--	--	**11**	**2.8%**
H - Central Irvine/ICD	--	--	--	--	9	1	--	1	**11**	**7.5%**
Total	**0**	**0**	**1**	**10**	**44**	**2**	**0**	**3**	**60**	**3.3%**

Table 3-8b
Summary of Participation in Turf Removal for Non-Potable Water Landscape Irrigation SPs Program

Village Group	Year								Total	Percentage of Non-Potable SPs
	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	--	1	--	--	--	**1**	**0.1%**
B - Canyons/OPA	--	--	--	--	--	--	--	--	**--**	**n/a**
C - Lake Forest/Foothills	1	1	1	2	24	5	4	1	**39**	**4.6%**
D - Central	--	--	--	--	--	--	--	--	**--**	**0%**
E - Coast	--	--	--	--	--	--	--	--	**--**	**0%**
F - Central Irvine/ University	--	1	--	--	--	1	--	--	**2**	**0.3%**
G - Santa Ana Heights/UCI	--	--	2	3	3	1	--	1	**10**	**1.8%**
H - Central Irvine/ICD	--	--	1	1	4	--	--	--	**6**	**1.4%**
Total	**1**	**2**	**4**	**6**	**32**	**7**	**4**	**2**	**58**	**1.0%**

Table 3-9 shows the participation in the Turf Removal program by CII SPs. Overall, there has been moderate participation in this program by CII SPs to date, representing approximately 3% of SPs with mixed-use meters (i.e., both indoor and outdoor water use on the same meter). As identified in Section 5.3.3, this amounts to approximately 10 acres of turf area replaced through this program. As with

participation by large landscape SPs described above, participation in this program peaked in 2015 at the height of the drought, with low levels of participation before and after.

Table 3-9
Summary of Participation in Turf Removal Rebates for CII Program

Village Group	Year						Total	Percentage of CII SPs (Mixed Use Meters)
	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	--	--	--	**0**	**0%**
B - Canyons/OPA	--	--	--	--	--	--	**0**	**0%**
C - Lake Forest/Foothills	--	--	3	1	--	--	**4**	**3.2%**
D - Central	--	--	--	--	--	--	**0**	**0%**
E - Coast	--	--	--	--	--	--	**0**	**0%**
F - Central Irvine/ University	--	--	--	--	--	--	**0**	**0%**
G - Santa Ana Heights/UCI	3	1	12	3	1	1	**20**	**2.6%**
H - Central Irvine/ICD	--	1	4	--	1	--	**6**	**5.3%**
Total	**3**	**2**	**19**	**4**	**2**	**1**	**30**	**2.8%**

Participation Density Analysis

Figures 3-7, 3-8, and **3-9** show the results of the participation density analysis for the CII WBIC Rebate and Turf Removal programs for large landscape SPs and the Turf Removal program for CII SPs, respectively. Overall District-wide participation in these programs ranged from 30 participants in the Turf Removal program for CII SPs, 120 participants in the Turf Removal program for large landscape SPs, and nearly 700 participants in the CII WBIC Rebate program for large landscape SPs, which includes potable and non-potable dedicated irrigation SPs, as well as 21 SFR SPs with large landscapes. The relatively low level of participation in the two Turf Removal programs is reflected by the large grid cell size in their respective figures. The participation density analysis is more robust for the CII WBIC Rebate program and identifies two large areas of high participation in the Coast Village Group and the Central and Central Irvine/ICD Village Groups, centered on the Woodbury area. Overall program saturation in these programs are discussed in Section 4.

3.1.5. Commercial, Industrial, and Institutional Indoor Device Rebate Programs

This section includes analysis of the CII Indoor Device Rebate program.

Participation Rate and Temporal Trends

Table 3-10 shows by CII SPs in the CII Indoor Device Rebate program, inclusive of all indoor devices offered to CII customers. Devices received by District customers include HETs, urinals, HECWs, cooling tower controllers, and plumbing control valves. It should be noted that participation by the University of California at Irvine campus is excluded from the summary below and the comparison to total CII SPs, and that the number of CII SPs is highly variable between Village Groups. As with the Turf Removal program participation by CII and landscape irrigation SPs described above, participation in the CII Indoor Device Rebate program peaked in 2015 at the height of the drought, with very low levels of participation before and after. Overall, less than 1% of CII SPs have received rebates for indoor devices.

Participation Density
WBIC Rebates for Large Landscape Accounts
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for Large Landsacpe Accounts

Abbreviations

IRWD = Irvine Ranch Water District
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for WBIC Rebates for Large Landscape Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-7

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Path: X:\B80129\Maps\2019\12_Final\Fig 3-7_HotSpot_WBIC_LargeLandscape.mxd

Participation Density
Turf Removal for Landscape Irrigation Accounts
2011 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for Landscape Irrigation Accounts

Abbreviations

IRWD = Irvine Ranch Water District

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N

0 2 4
(Scale in Miles)

Participation Density for Turf Removal for Landscape Irrigation Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure 3-8

eki environment & water

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Participation Density
Turf Removal Rebates for CII Accounts
2013 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal Rebates for CII Accounts

Abbreviations

IRWD = Irvine Ranch Water District
CII = commercial, industrial, and institutional

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for Turf Removal Rebates for CII Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-9

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-9_HotSpot_TurfRemoval_CII.mxd

Table 3-10
Summary of Participation in CII Indoor Device Rebate Program

Village Group	Year								Total	Percentage of CII SPs
	2011	2012	2013	2014	2015	2016	2017	2018		
A - West Irvine/ Tustin Ranch	--	--	--	--	5	--	--	--	**5**	**1.2%**
B - Canyons/OPA	--	--	--	--	--	--	--	--	**--**	**0%**
C - Lake Forest/Foothills	--	4	1	1	3	1	--	--	**10**	**0.41%**
D - Central	--	--	--	--	--	--	--	--	**--**	**0%**
E - Coast	--	--	--	--	--	--	--	--	**--**	**0%**
F - Central Irvine/ University	--	--	--	1	--	--	1	--	**2**	**0.45%**
G - Santa Ana Heights/UCI	1	--	3	3	5	1	1	--	**14**	**0.74%**
H - Central Irvine/ICD	1	--	--	--	--	--	--	--	**1**	**0.17%**
Total	**2**	**4**	**4**	**5**	**13**	**2**	**2**	**--**	**32**	**0.5%**

Participation Density Analysis

Figure 3-10 shows the results of the participation density analysis for the CII Indoor Device Rebate program. There has been relatively little participation in this program, which is reflected in the large grid cell size of the participation density analysis. Due to the small amount of participation to date, little information can be gleaned from the participation density analysis; however, it indicates that there are opportunities for growth and increased participation in the program.

3.2. Building Stock Characteristics

Certain characteristics related to building age can influence, or at least be correlated with, water use. In general, older homes and businesses tend to have higher water using fixtures that were installed prior to passage of key changes to the Federal and California Plumbing, Energy, and Building Codes; these SPs present an opportunity for increasing water efficiency. Homes and business with larger landscaped areas tend to use more water than those with smaller landscaped areas. Similarly, larger homes may have more occupants and, therefore, more water use.

3.2.1. Customer Sector and Village Group

In order to assess the distribution of housing stock and other key water use characteristics, service area-wide data were evaluated based on Orange County Assessor parcel data and IRWD customer account

Participation Density
All CII Indoor Rebate Programs
2011 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- All CII Indoor Rebate Programs

Abbreviations

IRWD = Irvine Ranch Water District
CII = commercial, industrial, and institutional

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Participation Density for All CII Indoor Rebate Programs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure 3-10

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-10_HotSpot_CII_Indoor_Rebates.mxd

records. These data included lot and building sizes, landscape area,[21] and building construction date. These data are summarized in **Table 3-11** by Village Group and on a service area-wide basis for SFR, multi-family residential (MFR), landscape irrigation, and CII SPs, and building construction date is shown on **Figure 3-11**.

Single-Family Residential

Across the IRWD service area, the median construction date for SFR homes is 1993, with nearly half of the building stock having been constructed after the implementation of the Energy Policy Act of 1992, which was the first of several pieces of legislation to mandate minimum water efficiency standards for selected devices. Approximately one third of the SFR homes were built between 1961 and 1980, and nearly one third were built after 2000. As shown in the chart in **Table 3-11**, the distribution of housing stock varies widely between Village Groups, with median construction dates ranging from 1964 to 2013. The oldest areas of the District include the Canyons/OPA, Central Irvine/University, and Central Irvine/ICD Village Groups, and the newest areas include the West Irvine/Tustin, Central, and Coast Village Groups.

Across the IRWD service area, the median lot size is approximately 5,600 square feet (sq ft) and the median home size (interior) is approximately 2,200 sq ft. Median lot size is generally consistent among Village Groups, with the notable exceptions of the Canyons/OPA Village Group (northern canyon area of the District) and the Coast Village Group (southern coastal area of the District) with median lot sizes of approximately 20,000 sq ft and 11,000 sq ft, respectively. Based on the available billing system landscape area data, the Canyons/OPA and Lake Forest/Foothills Village Groups tend to have larger irrigated landscape areas at approximately 5,700 sq ft and 2,200 sq ft, respectively. The median interior home size is similarly consistent across Village Groups, with a tendency for larger homes in the West Irvine/Tustin, Central, and Coast Village Groups (corresponding with the areas of newer homes), and smaller homes in the Canyons/OPA Village Group (the area with the oldest homes).

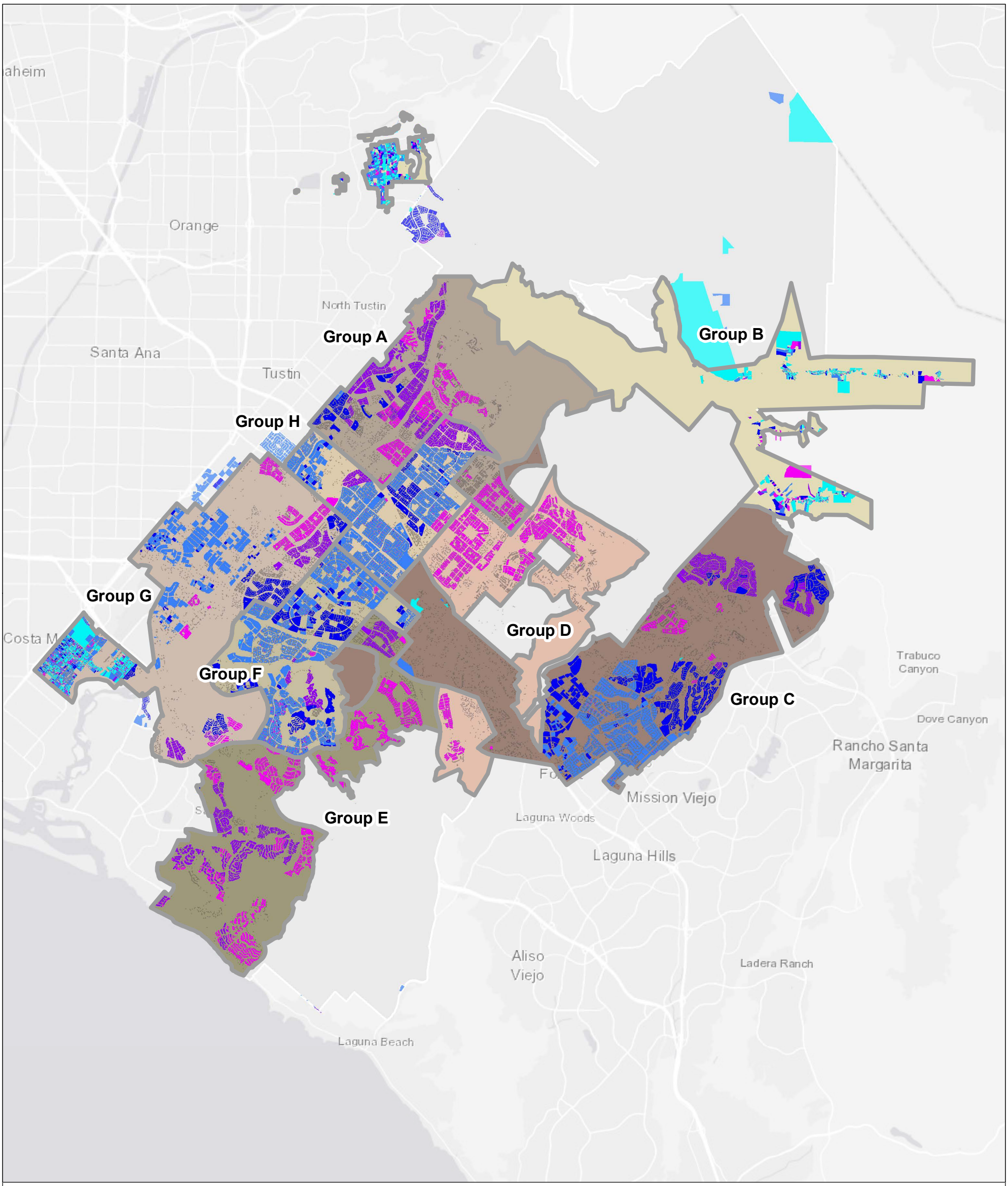
Multi-Family Residential

Across the IRWD service area, the median construction date for MFR homes is 1989, with over half of the building stock having been constructed prior to the implementation of any water efficiency legislation. The distribution of MFR housing stock varies between Village Groups, although less widely than with SFR housing stock; median MFR construction dates range from 1980 to 2014 between Village Groups.

Landscape Irrigation

Table 3-11 shows a summary of lot size and landscaped area for potable and non-potable landscape irrigation SPs, based on landscape area identified in the billing system data, which includes both measured landscape values and, where measured values are not available, default values for purposes of establishing a water budget. Lot size varies among landscape irrigation SPs. Based on available parcel data, landscape irrigation SPs supplied by potable water have a median lot size of approximately 2 acres across the District, and a range of median lot sizes from 0.2 acres to 5 acres among Village Groups. The actual

[21] Landscape area is based on customer billing data. For billing purposes, landscape area is assumed for service points where exact landscape area measurements are not available. These assumptions are reflected in the SFR and MFR landscape area medians summarized in **Tables 3-11** and **3-12.**



Legend

Village Group Boundary

Year Built

- <1961
- 1961 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 and newer
- Service Point Location

N

0 2 4

(Scale in Miles)

Age of Building Stock

Notes

1. All locations are approximate.

Sources

1. County of Orange Parcel Data, provided by IRWD, January 2019.

eki environment & water

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure 3-11

Path: X:\B80129\Maps\2019\12_Final\Fig 3-11_BldgStock.mxd

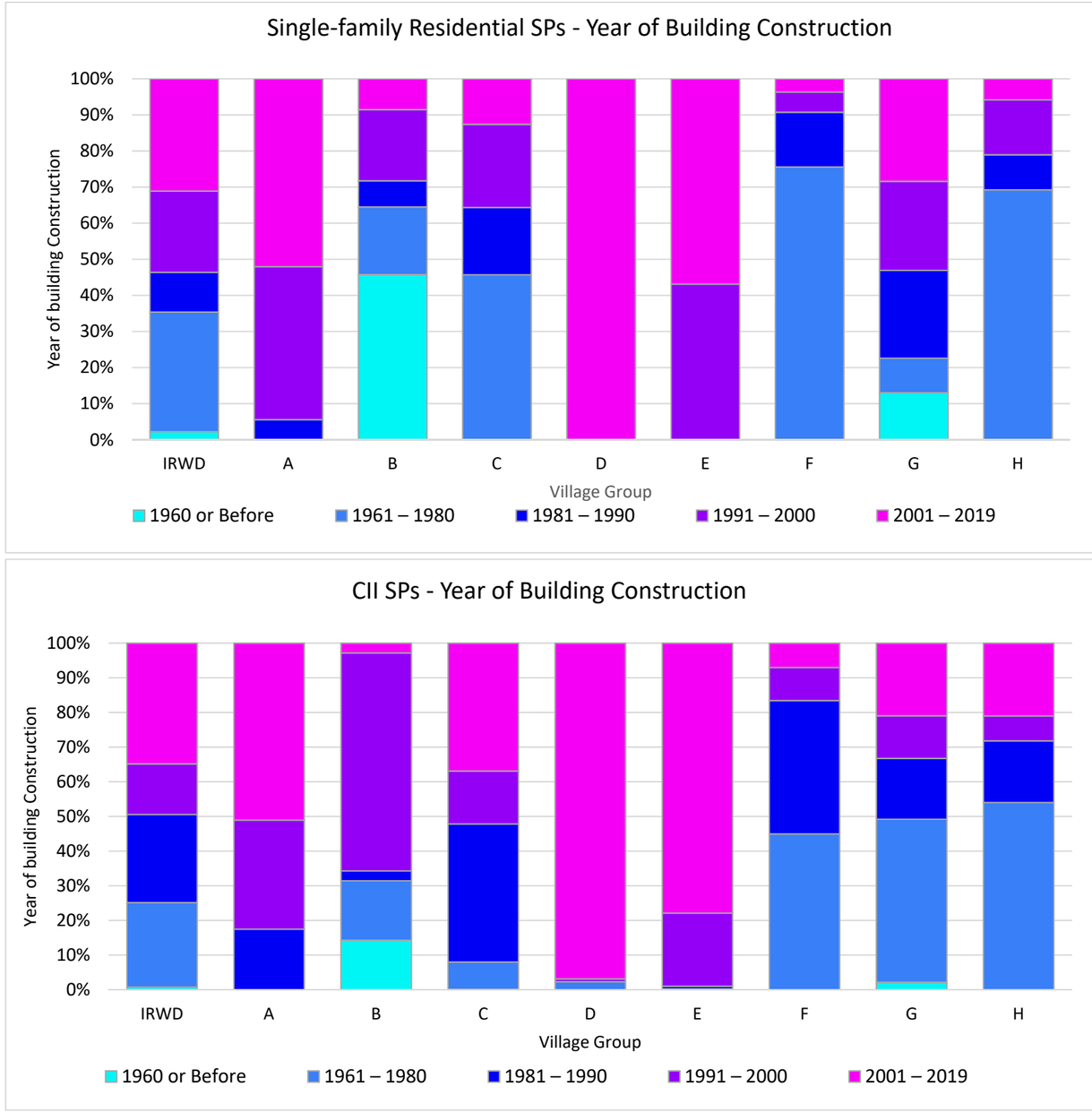
Table 3-11
Distribution of Building Stock by Village Group
Irvine Ranch Water District

Village Group	Single-Family Residential SPs									Multi-Family Residential SPs								
	Median Year Built	Median Interior Size (sq ft)	Median Lot Size (sq ft)	Median Landscape Area (sq ft)	Year of Construction					Median Year Built	Median Interior Size (sq ft)	Median Lot Size (ac)	Median Landscape Area (sq ft)	Year of Construction				
					1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019					1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019
A - West Irvine/Tustin Ranch	2001	2,470	5,269	1,300	0%	0%	5.5%	42%	52%	2000	1,482	6.2	435	0%	0%	31%	24%	45%
B - Canyons/OPA	1964	1,682	20,423	5,738	46%	19%	7.3%	20%	8.5%	na	na	na	na	na	na	na	na	na
C - Lake Forest/Foothills	1985	2,130	5,616	2,159	0.02%	46%	19%	23%	13%	1987	1,060	6.7	435	0%	17%	54%	18%	11%
D - Central	2013	2,459	6,900	1,300	0%	0%	0%	0%	100%	2014	1,719	3.5	435	0%	0%	0%	0%	100%
E - Coast	2002	3,023	11,063	1,300	0%	0%	0%	43%	57%	2002	1,533	7.8	435	0%	0%	0%	41%	59%
F - Central Irvine/University	1977	2,093	5,500	1,300	0%	76%	15%	5.6%	3.7%	1980	1,498	7.3	435	0%	50%	47%	2.4%	0.08%
G - Santa Ana Heights/UCI	1994	2,105	5,000	1,300	13%	10%	24%	25%	28%	1989	1,580	6.5	435	1.5%	7.0%	50%	15%	27%
H - Central Irvine/ICD	1977	2,092	5,200	1,300	0%	69%	10%	15%	5.8%	1985	1,336	6.6	435	0%	38%	47%	12%	3.0%
IRWD	**1993**	**2,239**	**5,562**	**1,300**	**2%**	**33%**	**11%**	**22%**	**31%**	**1989**	**1,435**	**6.5**	**435**	**0%**	**19%**	**37%**	**13%**	**31%**

Village Group	Potable Landscape Irrigation SPs									Non-Potable Landscape Irrigation SPs								
	Median Year Built	Median Interior Size (sq ft)	Median Lot Size (ac)	Median Landscape Area (ac)	Year of Construction					Median Year Built	Median Interior Size (sq ft)	Median Lot Size (ac)	Median Landscape Area (ac)	Year of Construction				
					1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019					1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019
A - West Irvine/Tustin Ranch	na	na	0.59	0.12	na	na	na	na	na	na	na	7.5	0.9	na	na	na	na	na
B - Canyons/OPA	na	na	na	0.085	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C - Lake Forest/Foothills	na	na	1.9	0.68	na	na	na	na	na	na	na	2.8	1.0	na	na	na	na	na
D - Central	na	na	0.17	0.61	na	na	na	na	na	na	na	12	1.0	na	na	na	na	na
E - Coast	na	na	4.9	2.2	na	na	na	na	na	na	na	0.56	0.73	na	na	na	na	na
F - Central Irvine/University	na	na	2.0	0.52	na	na	na	na	na	na	na	2.2	1.3	na	na	na	na	na
G - Santa Ana Heights/UCI	na	na	2.3	0.26	na	na	na	na	na	na	na	5.0	0.99	na	na	na	na	na
H - Central Irvine/ICD	na	na	2.4	0.24	na	na	na	na	na	na	na	4.6	1.0	na	na	na	na	na
IRWD	**na**	**na**	**2.0**	**0.50**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**1.2**	**0.99**	**na**	**na**	**na**	**na**	**na**

Village Group	CII SPs								
	Median Year Built	Median Interior Size (sq ft)	Median Lot Size (ac)	Median Landscape Area (ac)	Year of Construction				
					1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019
A - West Irvine/Tustin Ranch	2001	na	3.2	0.12	0%	0%	17%	31%	51%
B - Canyons/OPA	2000	1,705	1.6	1.7	14%	17%	2.9%	63%	2.9%
C - Lake Forest/Foothills	1995	17,257	2.3	0.14	0.12%	7.9%	40%	15%	37%
D - Central	2012	957	12	0.44	0%	2.4%	0%	0.8%	97%
E - Coast	2004	na	3.1	0.17	0%	0.25%	0.76%	21%	78%
F - Central Irvine/University	1982	55,036	4.6	0.085	0%	45%	38%	10%	7.0%
G - Santa Ana Heights/UCI	1981	17,850	1.6	0.20	2.2%	47%	18%	12%	21%
H - Central Irvine/ICD	1980	17,770	1.9	0.28	0%	54%	18%	7.2%	21%
IRWD	**1990**	**17,853**	**2.3**	**0.20**	**0.77%**	**24%**	**25%**	**15%**	**35%**

Table 3-11
Distribution of Building Stock by Village Group
Irvine Ranch Water District



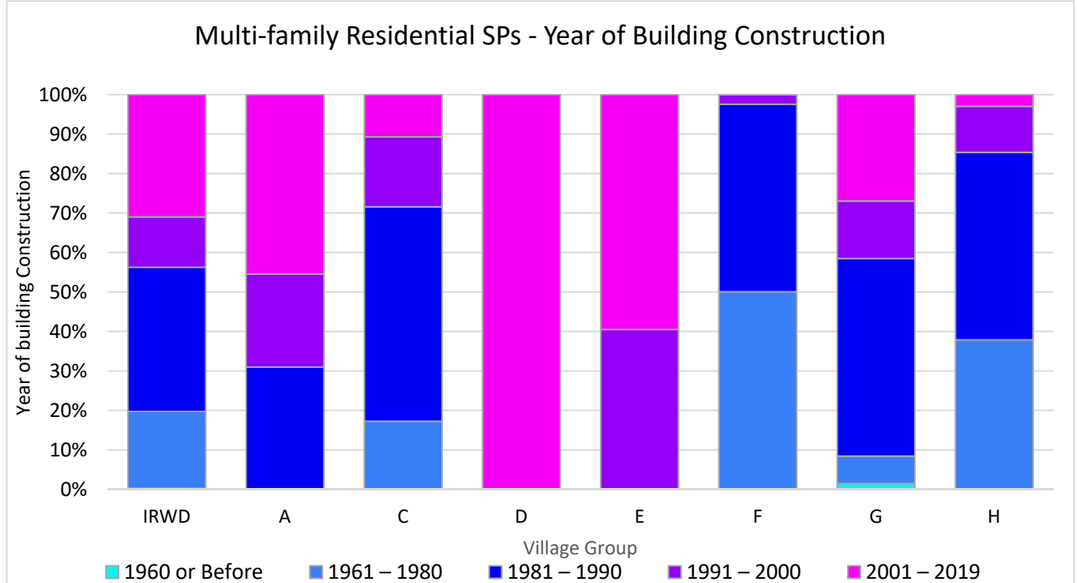


Table 3-11
Distribution of Building Stock by Village Group
Irvine Ranch Water District

Abbreviations:

ac = acre
CII = commercial, industrial, institutional
IRWD = Irvine Ranch Water District
SFR = single-family residential
SPs = Service Points
sq ft = square feet

Notes:

a) SPs included in this assessment are limited to those for which relevant parcel data or customer billing landscape area are available.
b) Landscape area is based on customer billing data. For billing purposes, landscape area is assumed for service points where landscape area measurements are not available. These assumptions are reflected in the SFR landscape area medians.

landscape area tends to be smaller, with a median of 0.5 acres District-wide, ranging from almost 0.1 acres to 2.2 acres by Village Group.

The lot size for irrigation accounts supplied by non-potable water tends to be smaller, but the landscaped area tends to be larger. Across the District, the median lot size is 1.2 acres, with Village Group medians ranging from 0.6 acres to 7.5 acres. However, the actual landscape area for these SPs is much more consistent, with a District-wide median of 1 acre and variation between Village Groups ranging from just 0.7 acres to 1.3 acres.

Commercial, Industrial, and Institutional

The median construction date for CII SPs is 1990, and median construction dates range between the Village Groups from 1980 to 2012. At least 80% of the properties in the West Irvine/Tustin, Central, and Coast Village Groups were built after 1990. The Central Irvine/University, Santa Ana Heights/UCI, and Central Irvine/ICD Village Groups contain older CII properties, with more than 60% of the properties built before 1990.

Similar to the Landscape Irrigation SPs, the properties for the CII SPs also have a wide range of median interior size, median lot size, and landscape area. The Central Village Group has the largest median lot size and yet smallest median interior size among all the Village Groups. The Central Irvine/University Village Group has the largest median interior size. The median landscape area (based on billing data landscape area) for all CII SPs in the District is 8,700 sq ft; however, the Canyons/OPA and Central Village Groups tend to have larger CII landscape areas, with medians of 75,000 sq ft and 19,000 sq ft, respectively.

3.2.2. WE Program Participants

Single-Family Residential

Table 3-12 shows the building stock characteristics of WE program participants. The distribution of building ages for SFR program participants is generally skewed much older than that of the overall building stock in the District. The overall median home construction date for SFR SPs in the IRWD service area is 1993, but the median home construction date for SFR participants in the HET One-Stop-Shop, HET Rebate, Turf Removal, and WBIC One-Stop-Shop Programs is 1986 or earlier. Based on this, it appears that the SFR HET One-Stop-Shop, HET Rebate, Turf Removal, and WBIC One-Stop-Shop Programs have been successfully reaching those customers with older homes and the least water-efficient devices.

Participants in the SFR HECW Rebate and SFR WBIC Rebate programs tend to have newer homes, with median construction dates of 1994 and 1992, respectively, which indicates that program participation rates are generally consistent with that of the overall District building stock. Participants receiving a WBIC through the One-Stop-Shop tended to have much older homes (median 1986) than those participating in the WBIC Rebate program (median 1992). This suggests that the targeted marketing and outreach for the One-Stop-Shop program was effective at reaching more customers with older homes than would likely have installed one through the rebate program alone. By contrast, the distribution of participant home age for the HET Rebate program and the no-cost HETs through the One-Stop-Shop program are essentially the same.

Table 3-12
Building Stock Characteristics by Program Participants
Irvine Ranch Water District

Water Efficiency Program (a)	Sector	Median Year Built	Median Interior Size (sq ft)	Median Lot Size	Median Landscape Area	Year of Construction					
						Unknown	1960 or Before	1961 – 1980	1981 – 1990	1991 – 2000	2001 – 2019
SFR Turf Removal	Residential - Single Family	1983	2,272	5,850 sq ft	1,959 sq ft	0.24%	2.3%	46%	16%	26%	10%
SFR WBIC Rebates	Residential - Single Family	1992	2,355	5,525 sq ft	1,300 sq ft	0.48%	0.82%	34%	12%	27%	25%
SFR One-Stop-Shop WBICs	Residential - Single Family	1986	2,254	5,400 sq ft	1,300 sq ft	0%	0.16%	43%	16%	30%	11%
SFR HET Rebates	Residential - Single Family	1981	2,152	5,390 sq ft	1,300 sq ft	0.16%	1.4%	48%	18%	25%	8.1%
SFR One-Stop-Shop HETs	Residential - Single Family	1981	2,129	5,275 sq ft	1,300 sq ft	0%	0.24%	50%	16%	24%	10%
SFR HECW Rebates	Residential - Single Family	1994	2,233	5,489 sq ft	1,300 sq ft	0.74%	0.98%	32%	12%	26%	28%
Turf Removal for Landscape Irrigation SPs, Potable	Landscape Irrig., Potable	na	na	4.7 ac	0.73 ac	na	na	na	na	na	na
Turf Removal for Landscape Irrigation SPs. Non-Potable	Landscape Irrig., Non-Potable	na	na	0.58 ac	1.0 ac	na	na	na	na	na	na
WBIC Rebates for Large Landscape SPs, Potable	SFR & Landscape Irrig., Potable	na	na	0.58 ac	0.64 ac	na	na	na	na	na	na
WBIC Rebates for Large Landscape SPs, Non-Potable	Landscape Irrg., Non-Potable	na	na	3.0 ac	1.6 ac	na	na	na	na	na	na
CII Turf Removal	CII	1979	31,115	2.4 ac	0.32 ac	19%	0%	69%	9.4%	3.1%	0%
All CII Indoor Device Rebates	CII	1979	25,200	5.4 ac	0.20 ac	42%	3.2%	19%	16%	6.5%	13%

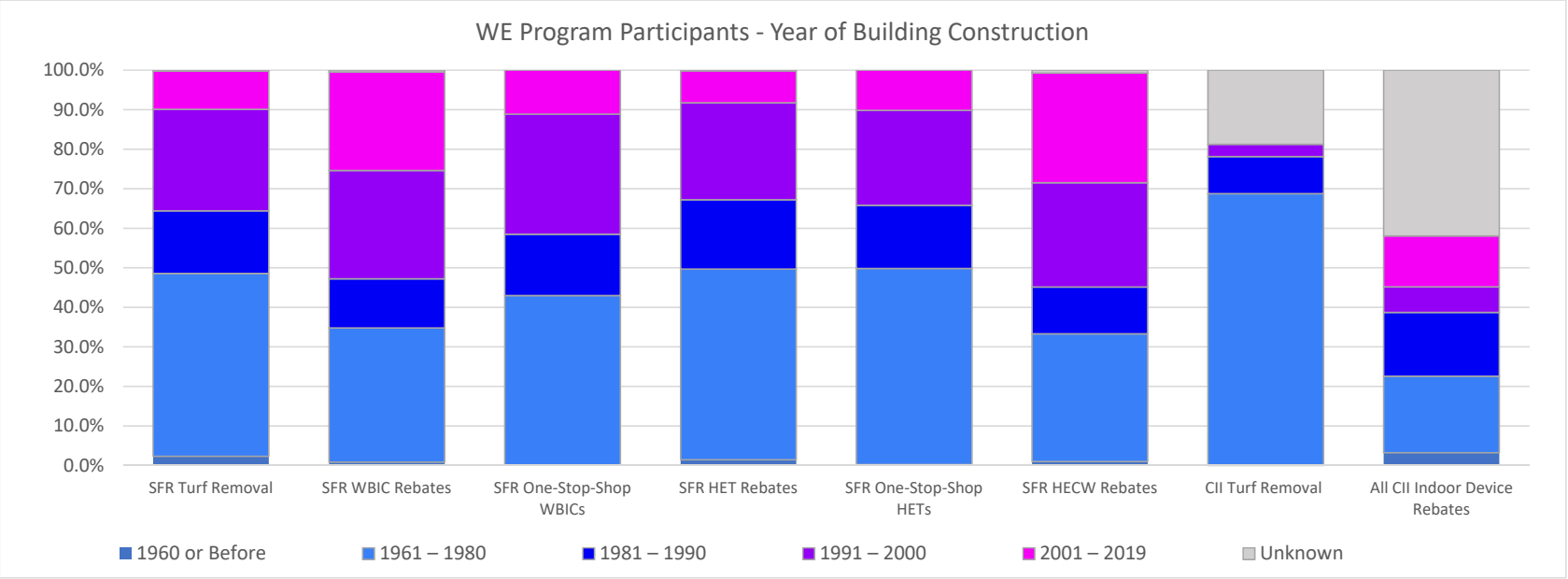


Table 3-12

Building Stock Characteristics by Program Participants

Irvine Ranch Water District

Abbreviations:

ac = acre
CII = commercial, industrial, and institutional
HECW = high efficiency clothes washer
HET = high efficiency toilet
SFR = single-family residential
SPs = service Points
sq ft = square feet
WBIC = weather-Based Irrigation Controller

Notes:

a) Program participant SPs included in this assessment are limited to those for which relevant parcel data are available.

b) Landscape area is based on customer billing data. For billing purposes, landscape area is assumed for service points where landscape area measurements are not available. These assumptions are reflected in the SFR landscape area medians.

The interior and lot sizes for the SFR program participants are very consistent with that of the IRWD service area and between programs, indicating that these factors are not primary drivers influencing program participation.

Landscape Irrigation

As shown in **Table 3-12**, the median landscape area for potable landscape irrigation SPs participating in the Turf Removal and WBIC Rebate programs are approximately 4.7 acres and 0.58 acres, respectively. For non-potable SPs participating in these programs, the median landscape areas are approximately 0.58 acres and 3.0 acres, respectively. The median landscape area for potable and non-potable landscape irrigation SPs in the District is approximately 0.5 acres and 1 acre, respectively. Based on this, landscape irrigation SPs served by potable water that participate in the Turf Removal program and to a lesser extent the WBIC Rebate program tend to be those that have larger than typical landscape areas. For non-potable landscape irrigation SPs, larger than typical landscape areas are likely to participate in the WBIC Rebate program, but a similar effect is not apparent with the Turf Removal program. It should be noted that recycled water SPs have not always been eligible for the Turf Removal program.

Commercial, Industrial, and Institutional

As shown in **Table 3-12**, the median landscape area for CII accounts participating in the Turf Removal program was 0.32 acres, nearly twice the overall median for the District. The median lot size for these participants is approximately 2.4 acres, indicating that on whole, the landscape represents a small portion of these CII properties. The median construction year for CII Indoor Device Rebate participants was 1979, substantially older than the overall District median of 1990. This indicates that this program is successful at reaching the older CII SPs in the District.

3.3. Demographic Characteristics of Residential Water Efficiency Program Participation

Residential WE programs are generally open to all residents in the IRWD service area. Although the programs are available to all residents, those with certain demographic characteristics can tend to participate at higher rates than others in some WE programs. The analyses described in the following sections were performed for ten selected programs in order to better understand trends in customer demographics among residential WE program participants in the IRWD service area – specifically, income and whether the home occupants rent or own the property.

3.3.1. Methodology

Household income data were based on the estimated 2016 median household income by Census Block Group (Census, 2019).[22] The estimated 2016 median household income by Census Block Group was compared to the Income Limits for the Santa Ana-Anaheim-Irvine, California (CA) Housing and Urban Development (HUD) Metro Fair Market Rents (FMR) Area for a 3-person household in FY 2016 (HUD, 2016). These income levels are defined as follows: low income (<$70,200/year), moderate income ($72,001-$85,000), high income ($85,001-$128,000), and very high income (>$128,001). For these purposes, very

[22] Census Block Group is the smallest geographical unit for which the United States Census Bureau publishes income data.

high income is considered to be greater than 1.5 times the area's median income.[23] The following sections discuss the breakdown of program participation in residential programs by income classification. Given that these classifications reflect the median of all households in a given Census Block Group, this reflects the predominant income for that area but does not mean that every participant or household in that area falls within the same income group.

Rentership status was based on 2016 Census estimates of the population within a Census Block Group that live in a renter-occupied home versus an owner-occupied home (Census, 2019). Rentership is thus presented as the proportion of the population within a Census Block Group that lives in a renter-occupied home. Thus, a Census Block Group with a rentership of less than 25% indicates that the area consists primarily of owner-occupied homes, while a rentership population of greater than 75% indicates that the area is predominantly made up of those who rent their homes.

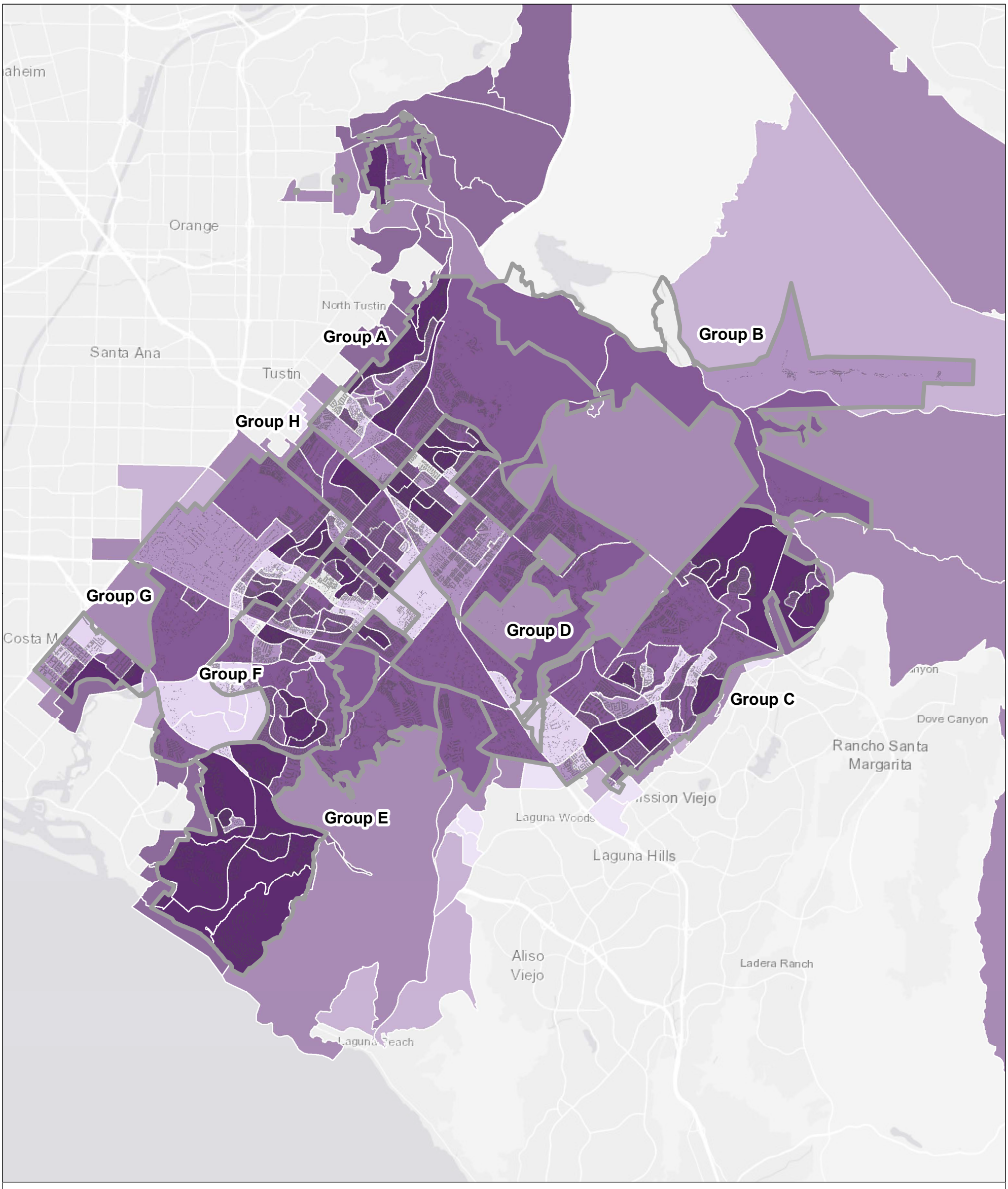
3.3.2. Household Income Trends

Figure 3-12 shows the distribution of median household income by Census Block Group across the IRWD service area and **Table 3-13a** shows the distribution of SFR WE program participants by income level. Nearly 90% of SFR SPs in the District are located in predominantly high income or very high income neighborhoods. The first chart in **Table 3-13a** shows the percentage of participants in each program that live in areas of each income level grouping. In every WE program, between 89% and 93% of participants live in high income and very high income areas, which is generally consistent with the overall population of SFR SPs.

The second chart on **Table 3-13a** shows participation rates controlled for the number of parcels within the IRWD service area within each income group. When the relative proportion of number of parcels within each income group is controlled for, all the WE programs show a clear trend that households in very high income areas are more likely to participate than those in high income level. This difference appears to be relatively substantial, with households in very high income areas up to 12% more likely to participate and those in high income areas up to 9% less likely. SFR SPs in low and moderate income areas participate at slightly lower rates, from 1% to 3%, but the largest discrepancies are found with households in the high and very high income areas. This discrepancy is most pronounced in the Turf Removal and the One-Stop-Shop WBIC programs, while the participation rate in the SFR HECW Rebate program is the most consistent with the income composition of the District. SFR SPs in very high income areas have a higher level of participation receiving WBICs through the One-Stop-Shop program than compared to the WBIC Rebate program. When comparing HETs received though rebates versus the One-Stop-Shop program, the income effect is less pronounced (as would be expected given that the One-Stop-Shop program is no-cost), with a higher rate of very high income area participation in the rebate program.

Tables 3-13b through **3-13g** show a breakdown of each SFR WE program by income and by Village Group, including total participation and relative percent difference in participation compared to the income composition of each Village Group. In general, the biggest disparities in participation by income is seen in

[23] It was initially proposed in the first technical memorandum that very high income classification would be identified as two times the median income. However, using a factor of 1.5 times the median results in a more even distribution of service points among the classifications and was used in all subsequent analyses.



Legend

Village Group Boundary

Median Household Income

- <$70,200 (Low)
- $70,200 - $85,000 (Median)
- $85,000 - $128,000 (High)
- >$128,000 (Very High)
- Service Point Location

Abbreviations

FY = fiscal year
HUD = Department of Housing and Urban Development

Notes

1. All locations are approximate.
2. Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Very high income is shown as greater than 1.5 times the regional median household income.

Sources

1. U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau.
2. HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016

N

0 2 4

(Scale in Miles)

Median Household Income in IRWD

eki environment & water

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure 3-12

Path: X:\B80129\Maps\2019\12_Final\Fig 3-12_IncomeDistribution.mxd

Table 3-13a
SFR Program Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of SFR SPs (District-Wide)	Percentage of Participating SFR SPs (b)					
			SFR Turf Removal	SFR WBIC Rebates	SFR One-Stop-Shop WBICs	SFR HET Rebates	SFR One-Stop-Shop HETs	SFR HECW Rebates
Low Income	<$70,200	3.2%	3.8%	2.3%	2.3%	3.6%	3.2%	2.8%
Moderate Income	$72,001-$85,000	7.9%	5.4%	6.4%	4.7%	6.6%	4.7%	7.7%
High Income	$85,001-$128,000	54%	44%	51%	48%	49%	52%	53%
Very High Income	>$128,000	35%	47%	40%	45%	41%	40%	37%

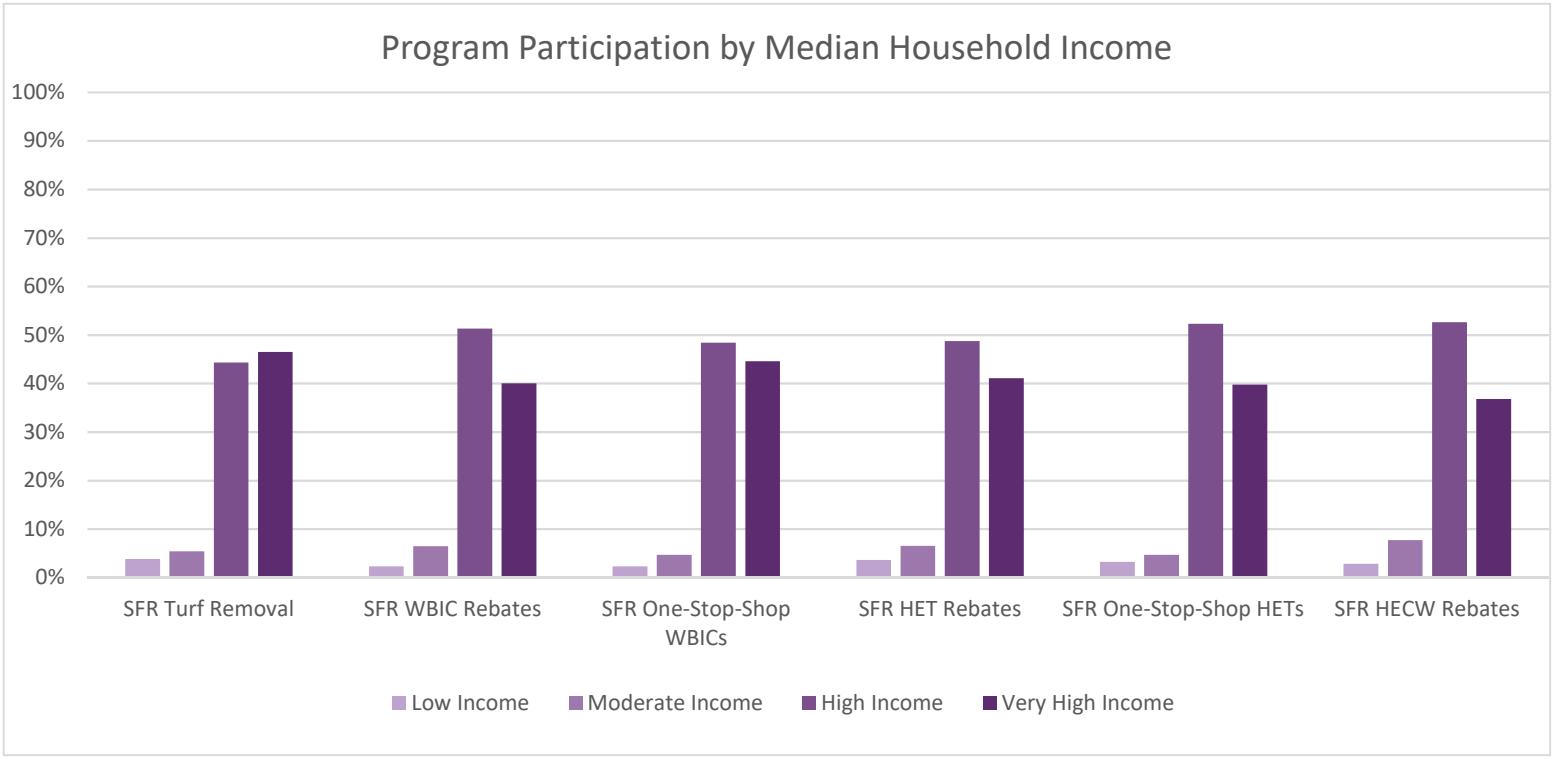
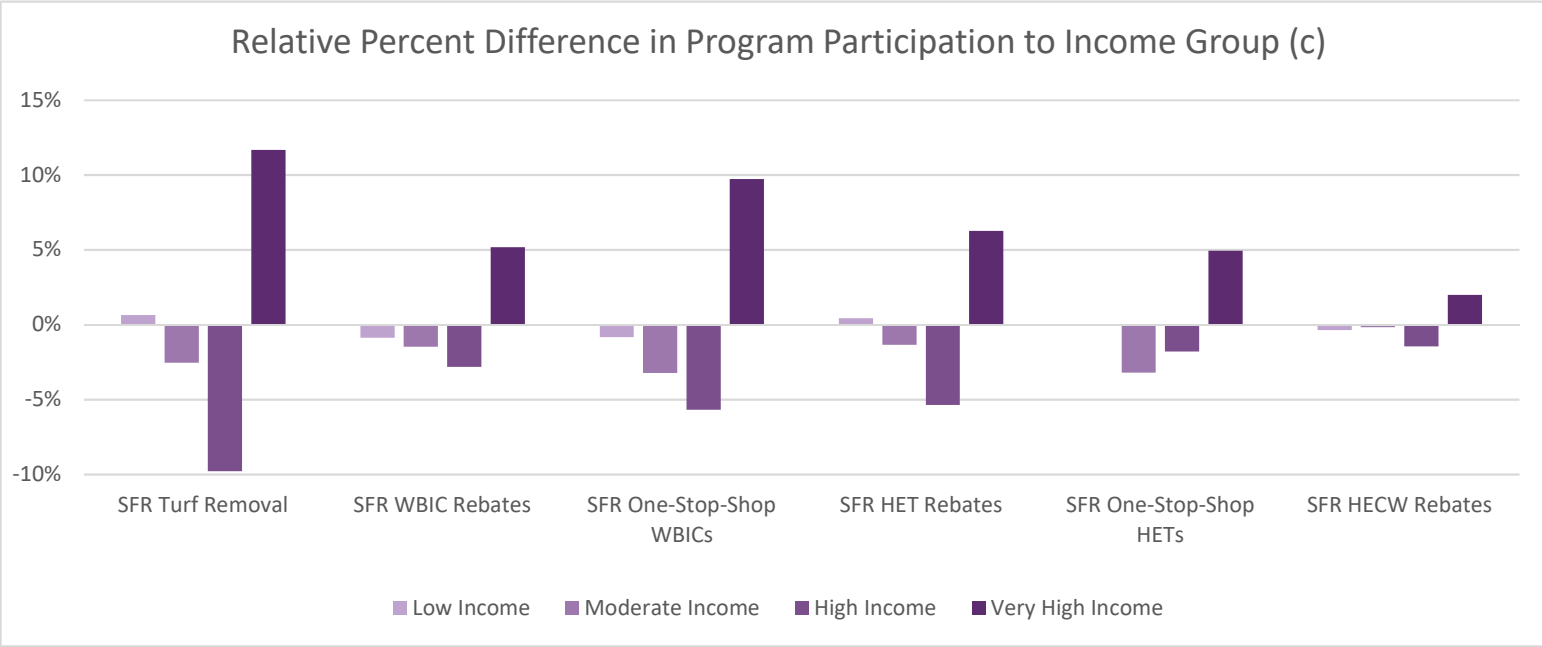


Table 3-13a
SFR Program Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HECW = high efficiency clothes washer
HET = high efficiency toilet
HUD = United States Department of Housing and Urban Development
SFR = single-family residential
SPs = service Points
WBIC = weather-based irrigation controller

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within the service area.

Table 3-13a
SFR Program Participation by Median Household Income
Irvine Ranch Water District

References:
HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016
U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13b
Turf Removal SFR Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	3.1%	0%	5.3%	0%	0%	1.6%	13%	1.3%
Moderate Income	$72,001-$85,000	4.9%	10%	4.5%	31%	0%	2.7%	15%	4.4%
High Income	$85,001-$128,000	36%	51%	41%	69%	38%	65%	40%	45%
Very High Income	>$128,000	56%	38%	49%	0%	62%	31%	32%	49%

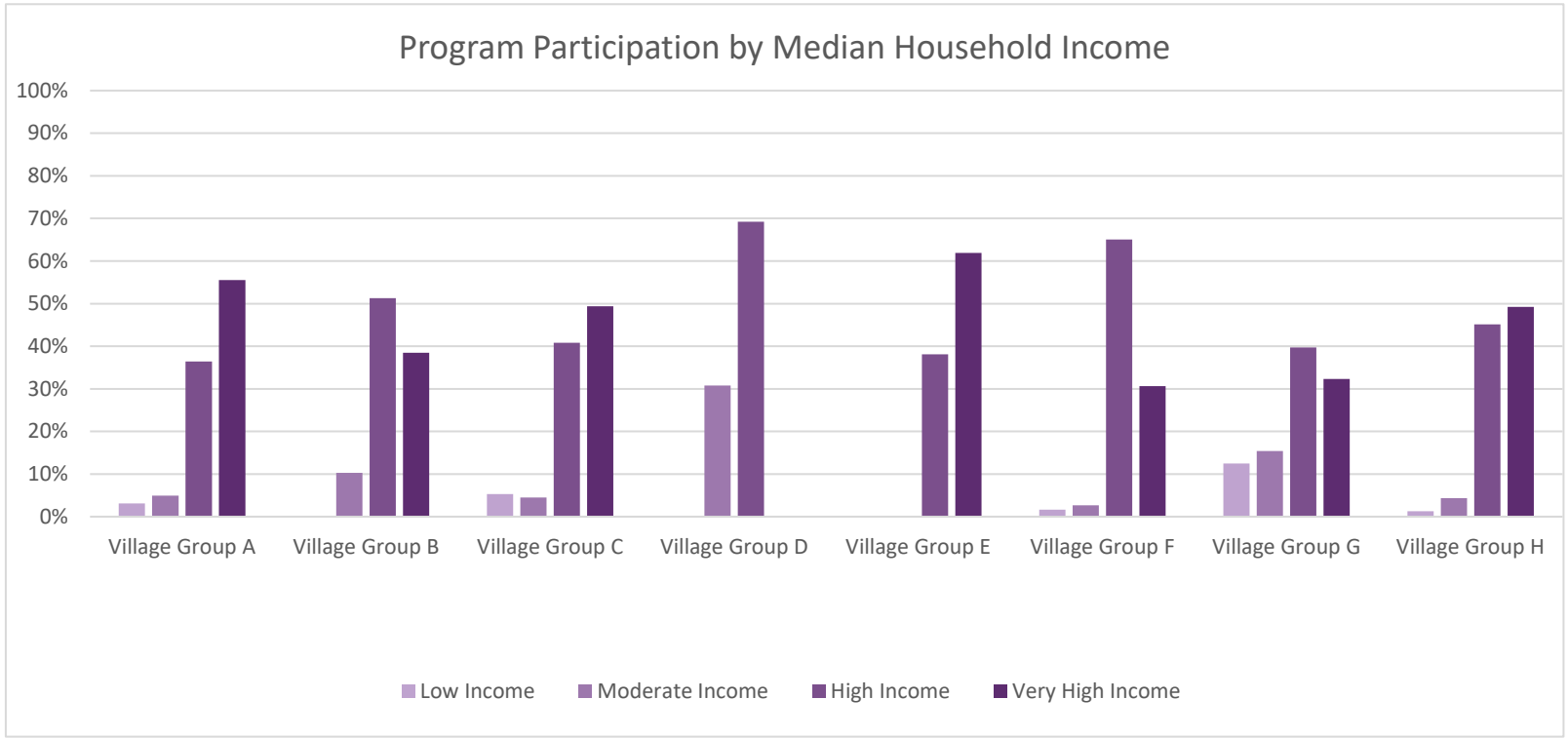
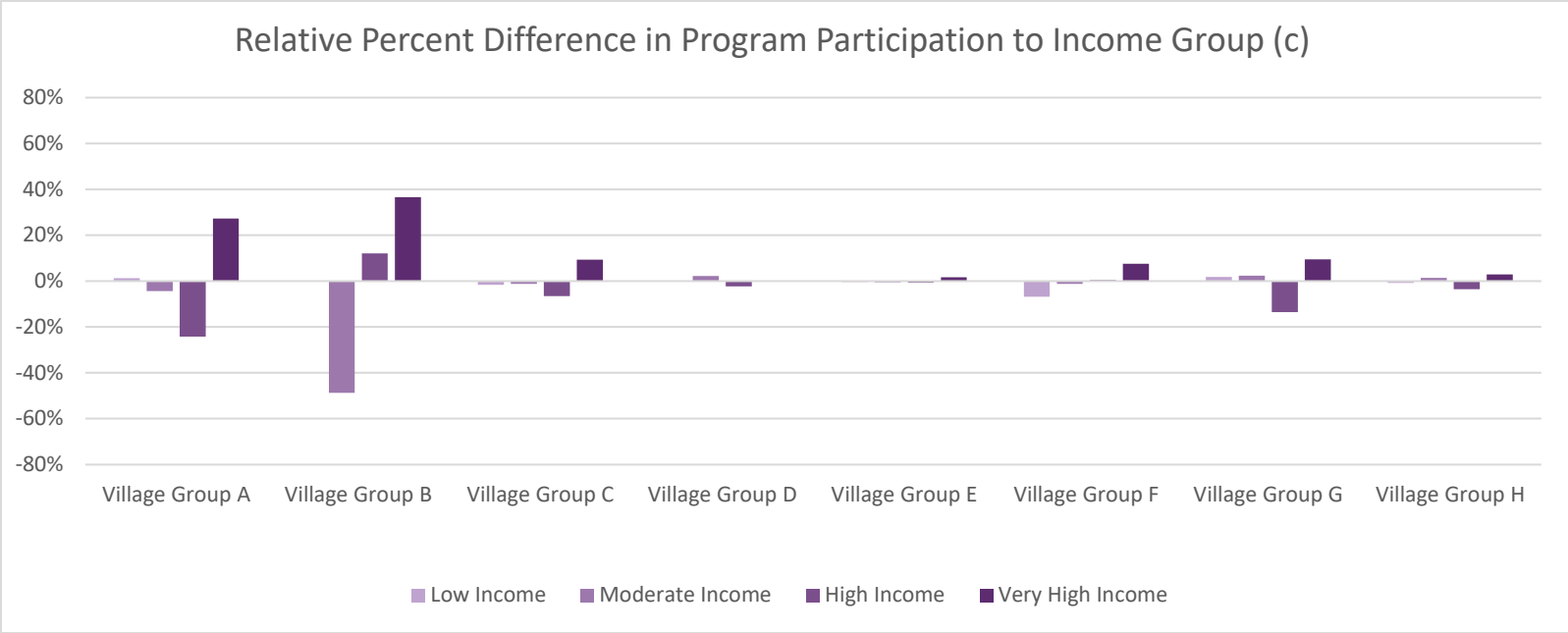


Table 3-13b
Turf Removal SFR Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HUD = United States Department of Housing and Urban Development
FMR = fair market rents
SFR = single-family residential
SPs = service Points

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.

Table 3-13b
Turf Removal SFR Participation by Median Household Income
Irvine Ranch Water District

References:
HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016
U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13c
WBIC Rebate SFR Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	1.9%	0%	3.5%	0%	0%	2.0%	6.4%	1.3%
Moderate Income	$72,001-$85,000	8.8%	28%	3.2%	23%	0%	4.1%	5.6%	3.7%
High Income	$85,001-$128,000	52%	39%	44%	77%	42%	63%	62%	43%
Very High Income	>$128,000	38%	33%	50%	0%	58%	31%	26%	52%

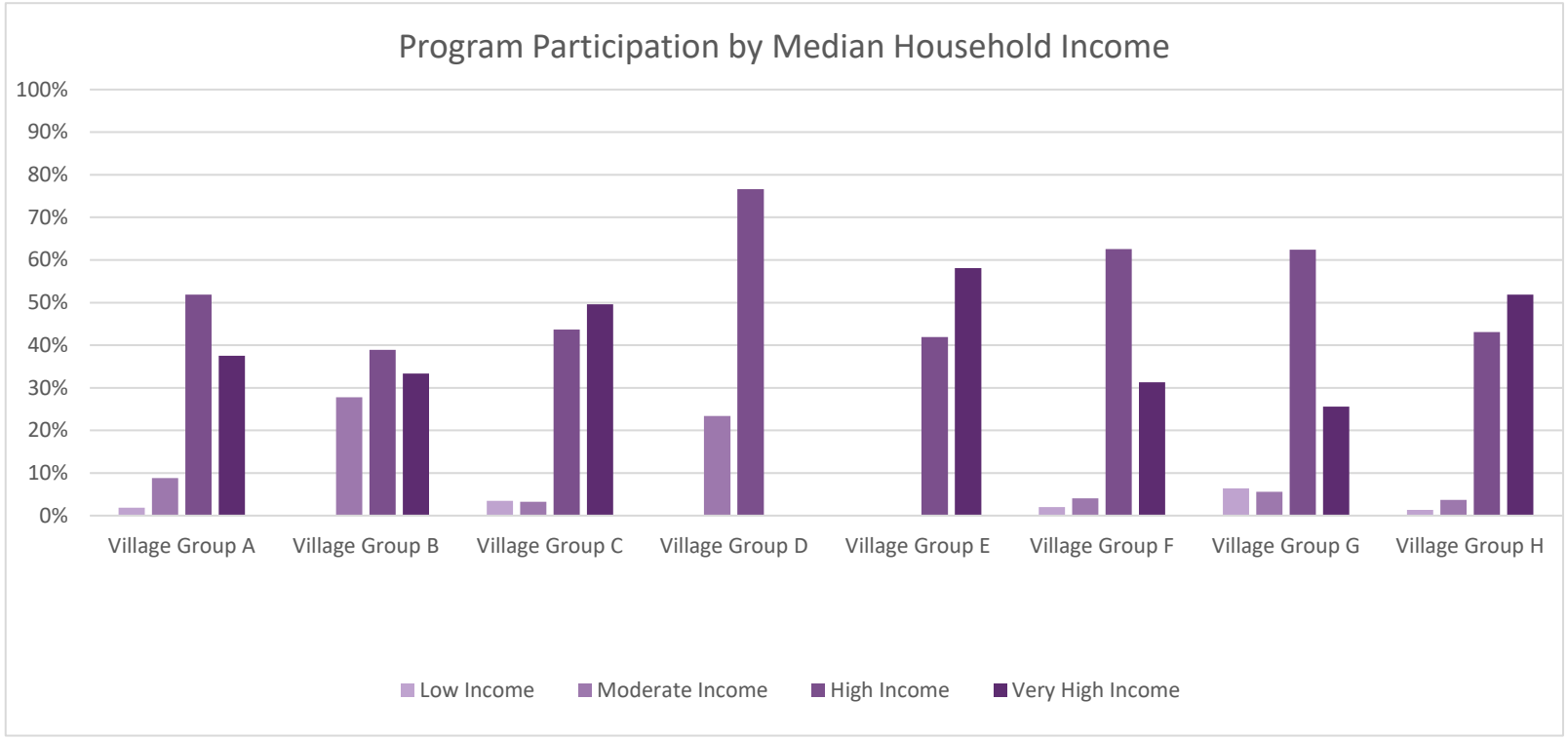
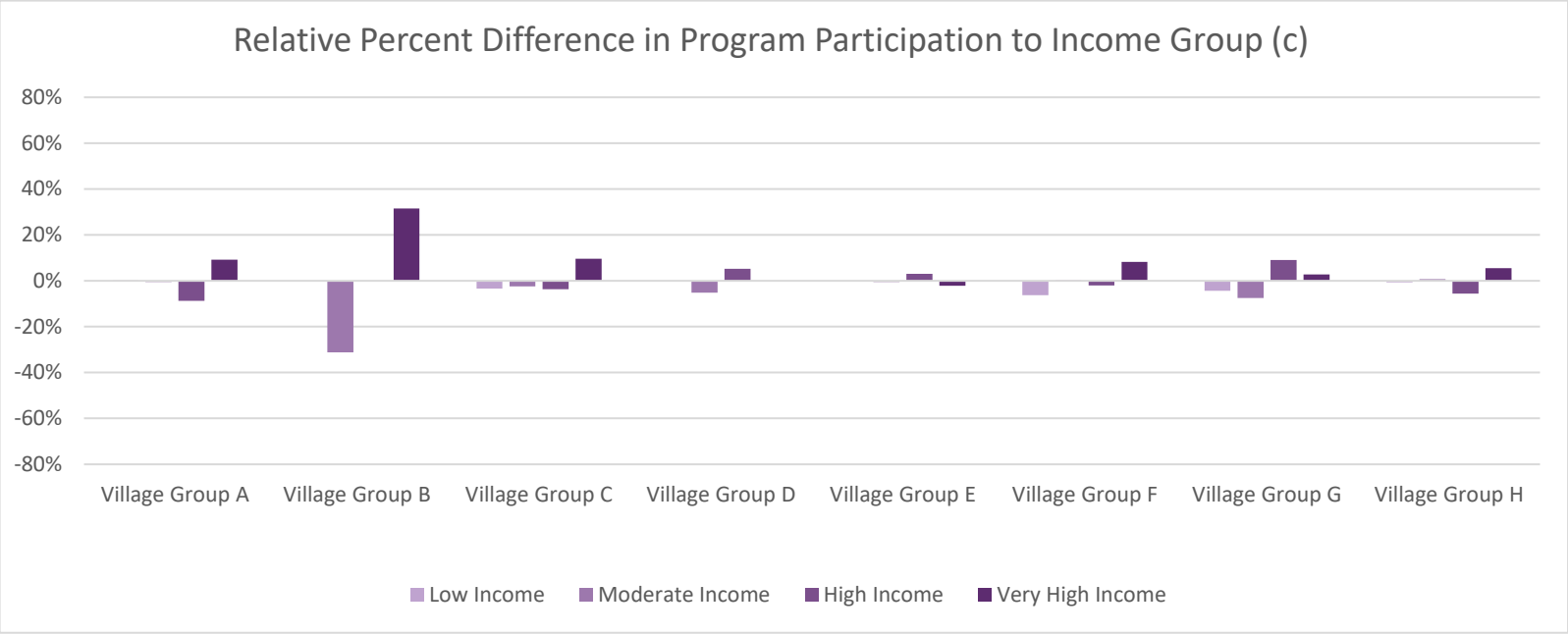


Table 3-13c
WBIC Rebate SFR Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HUD = United States Department of Housing and Urban Development
FMR = fair market rents
SFR = single-family residential
SPs = service points
WBIC = weather-based irrigation controller

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.

Table 3-13c

WBIC Rebate SFR Participation by Median Household Income

Irvine Ranch Water District

References:

HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016

U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13d
SFR WBIC One-Stop-Shop Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	1.3%	0%	2.2%	0%	0%	7.0%	7.3%	0.44%
Moderate Income	$72,001-$85,000	13%	0%	5.9%	17.4%	0%	1.4%	0%	2.2%
High Income	$85,001-$128,000	40%	0%	35%	83%	77%	65%	53%	48%
Very High Income	>$128,000	45%	0%	57%	0%	23%	27%	40%	49%

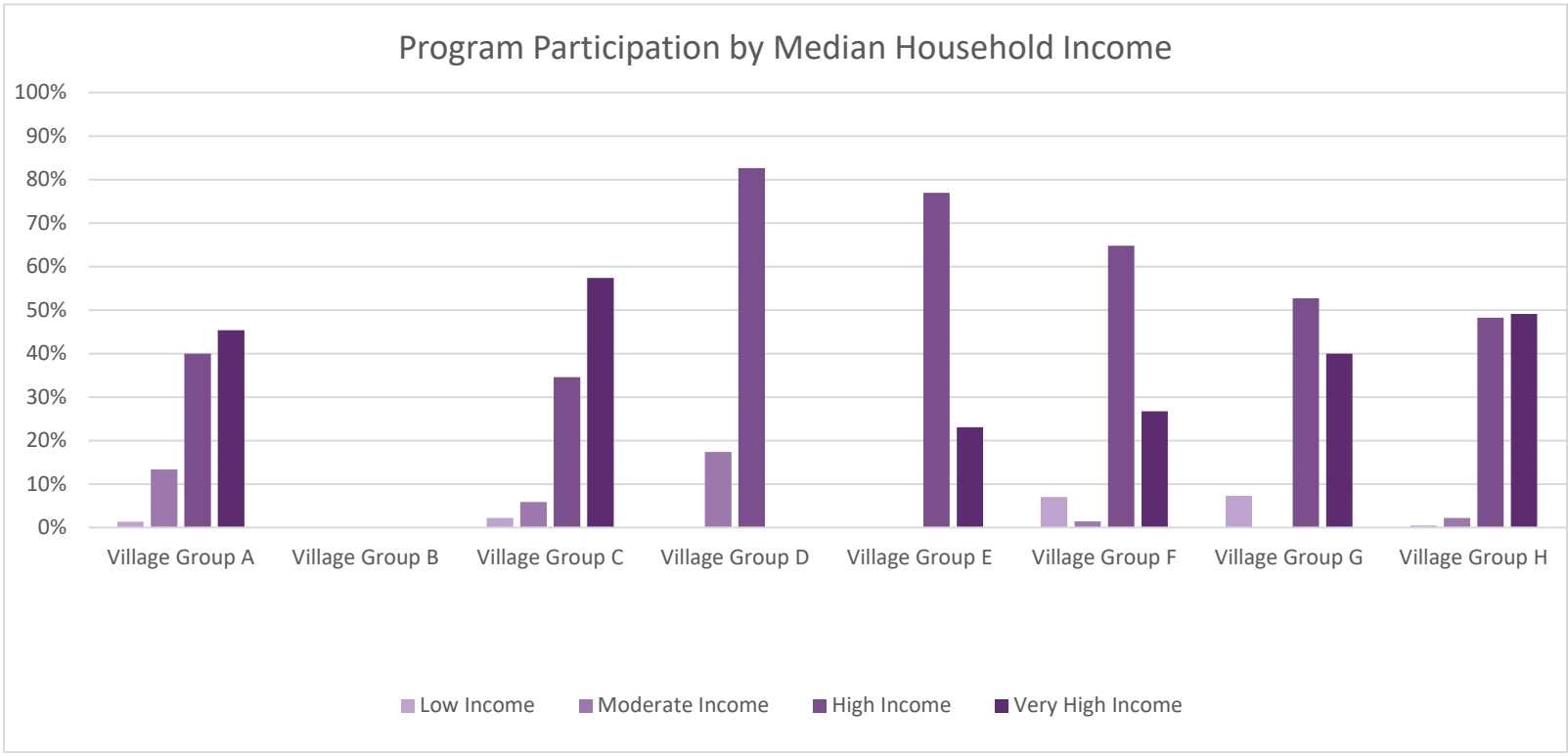
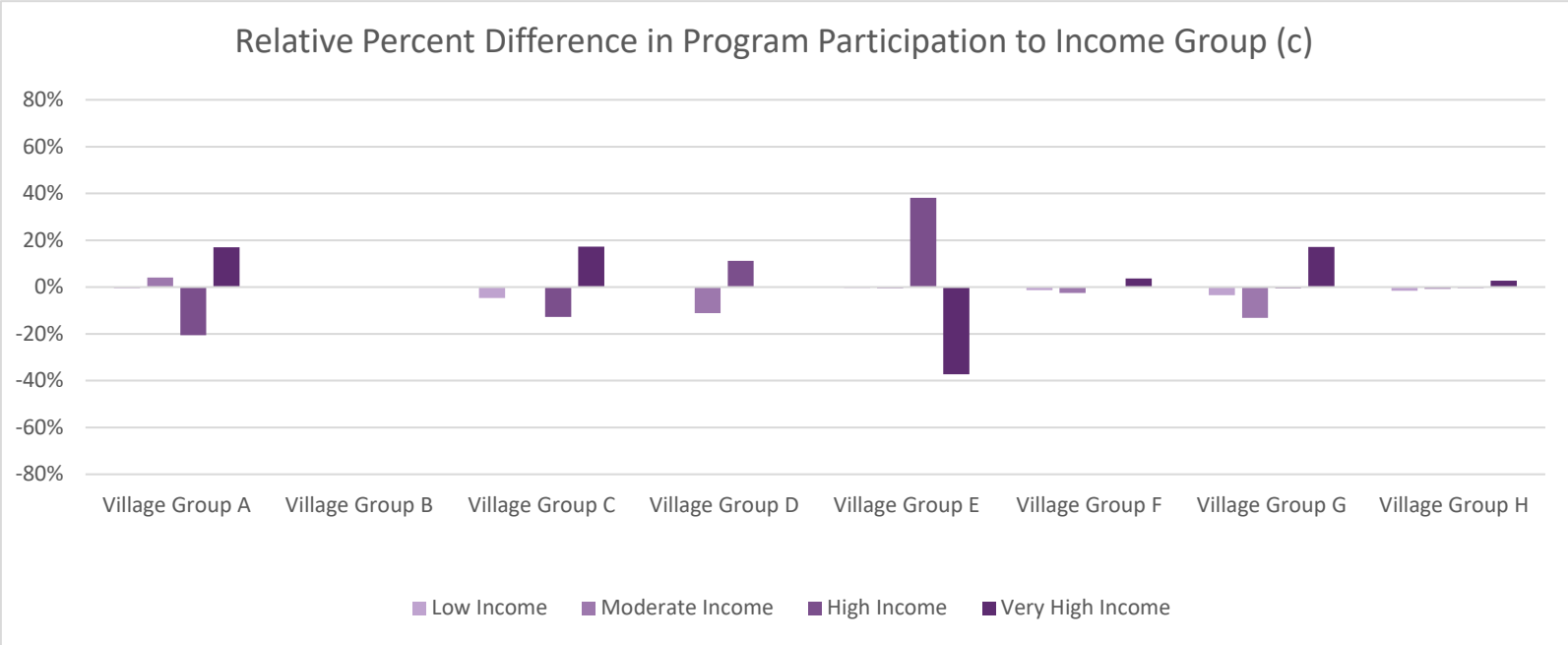


Table 3-13d
SFR WBIC One-Stop-Shop Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HUD = United States Department of Housing and Urban Development
FMR = fair market rents
SFR = single-family residential
SPs = service Points
WBIC = weather-based irrigation controller

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.
(d) No SFR SPs from Village Group B participated in the SFR WBIC One-Stop-Shop program.

Table 3-13d

SFR WBIC One-Stop-Shop Participation by Median Household Income

Irvine Ranch Water District

References:

HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016

U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13e
SFR HECW Rebate Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	1.7%	0%	5.8%	0%	0%	5.3%	5.2%	1.2%
Moderate Income	$72,001-$85,000	8.7%	32%	4.8%	33%	0%	3.9%	6.9%	3.2%
High Income	$85,001-$128,000	54%	46%	45%	67%	50%	66%	55%	46%
Very High Income	>$128,000	36%	22%	44%	0%	50%	24%	33%	50%

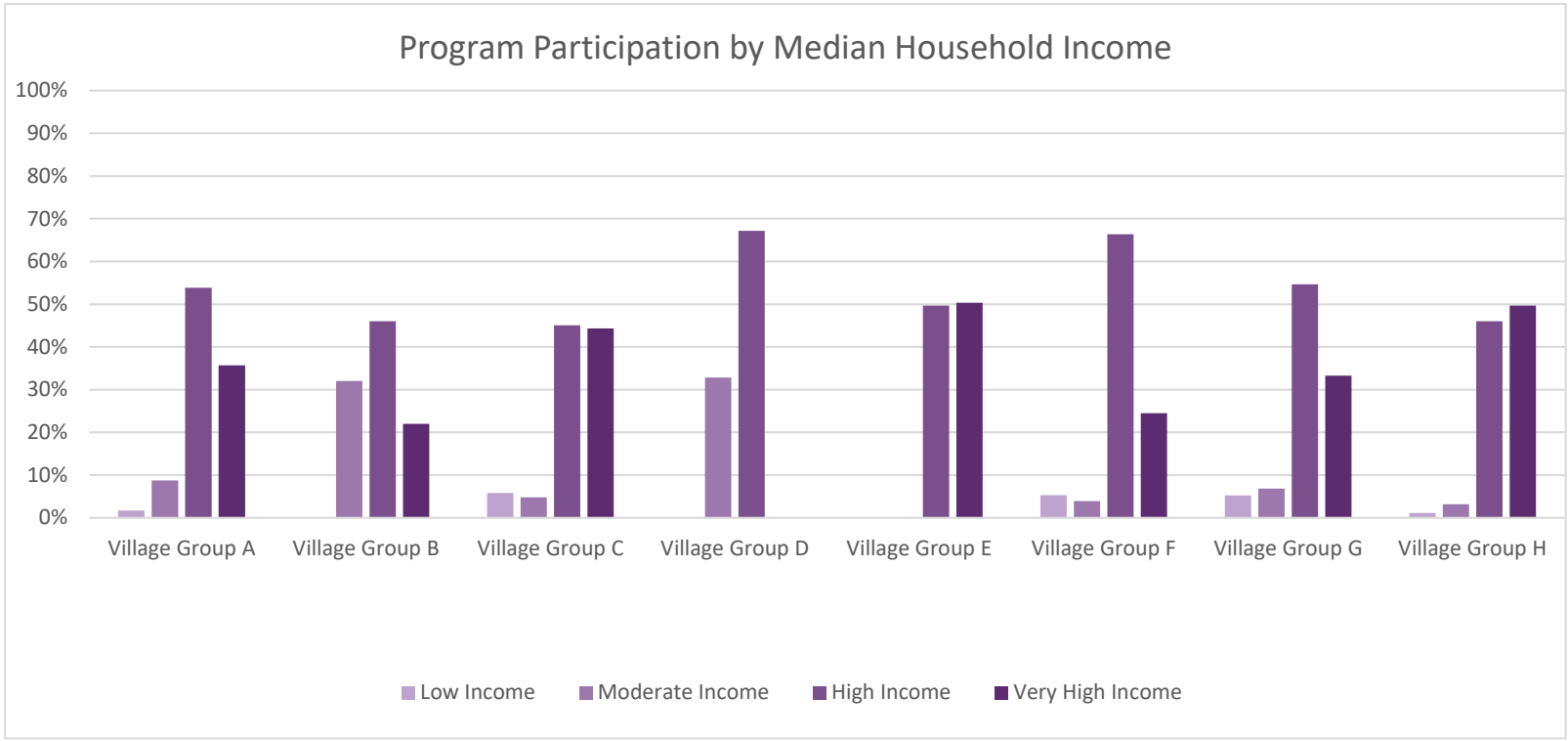
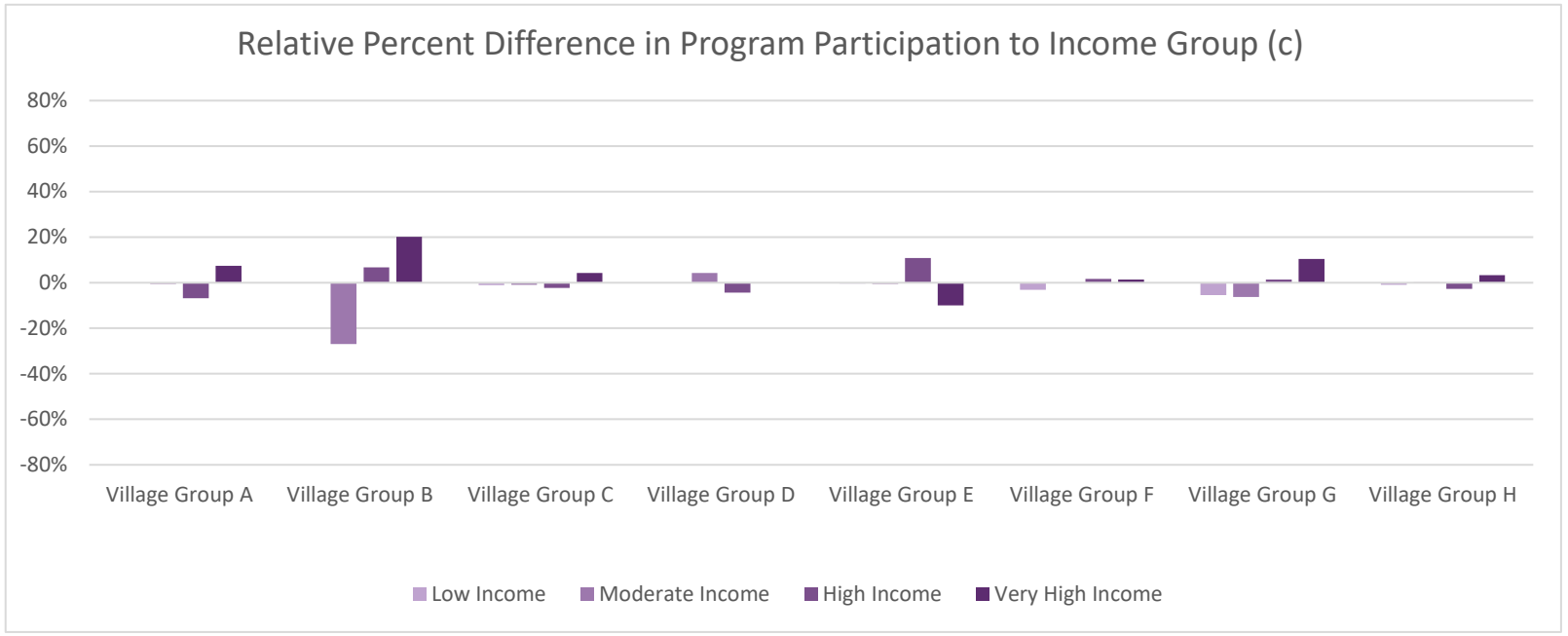


Table 3-13e
SFR HECW Rebate Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HECW = high efficiency clothes washer
HUD = United States Department of Housing and Urban Development
FMR = fair market rents
SFR = single-family residential
SPs = service Points

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.

Table 3-13e
SFR HECW Rebate Participation by Median Household Income
Irvine Ranch Water District

References:
HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016
U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13f
SFR One-Stop-Shop HET Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	0.78%	0%	6.7%	0%	0%	6.0%	4.8%	1.1%
Moderate Income	$72,001-$85,000	10.9%	0%	5.6%	37%	0%	2.7%	1.6%	2.3%
High Income	$85,001-$128,000	41%	25%	38%	63%	63%	69%	60%	54%
Very High Income	>$128,000	47%	75%	50%	0%	37%	22%	34%	43%

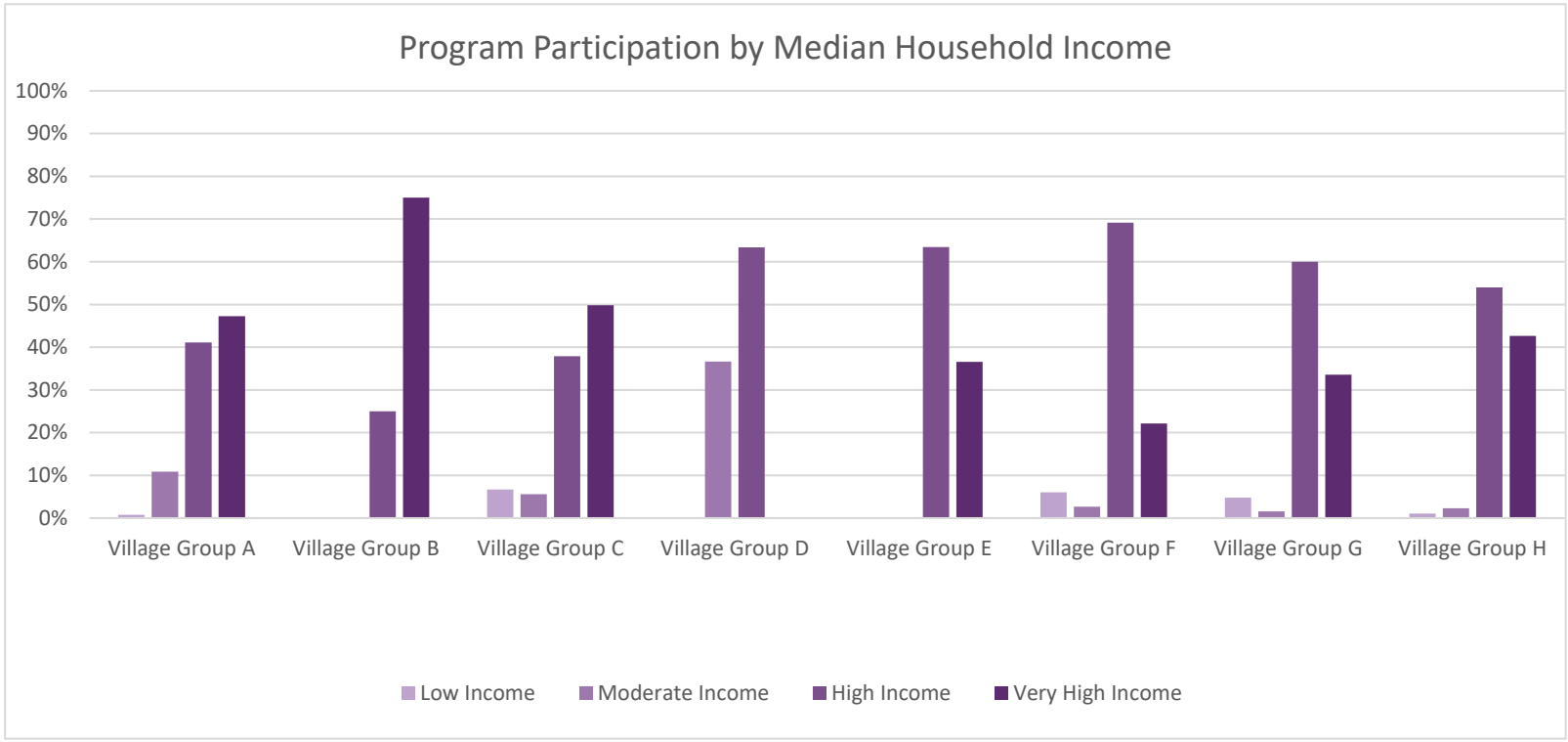
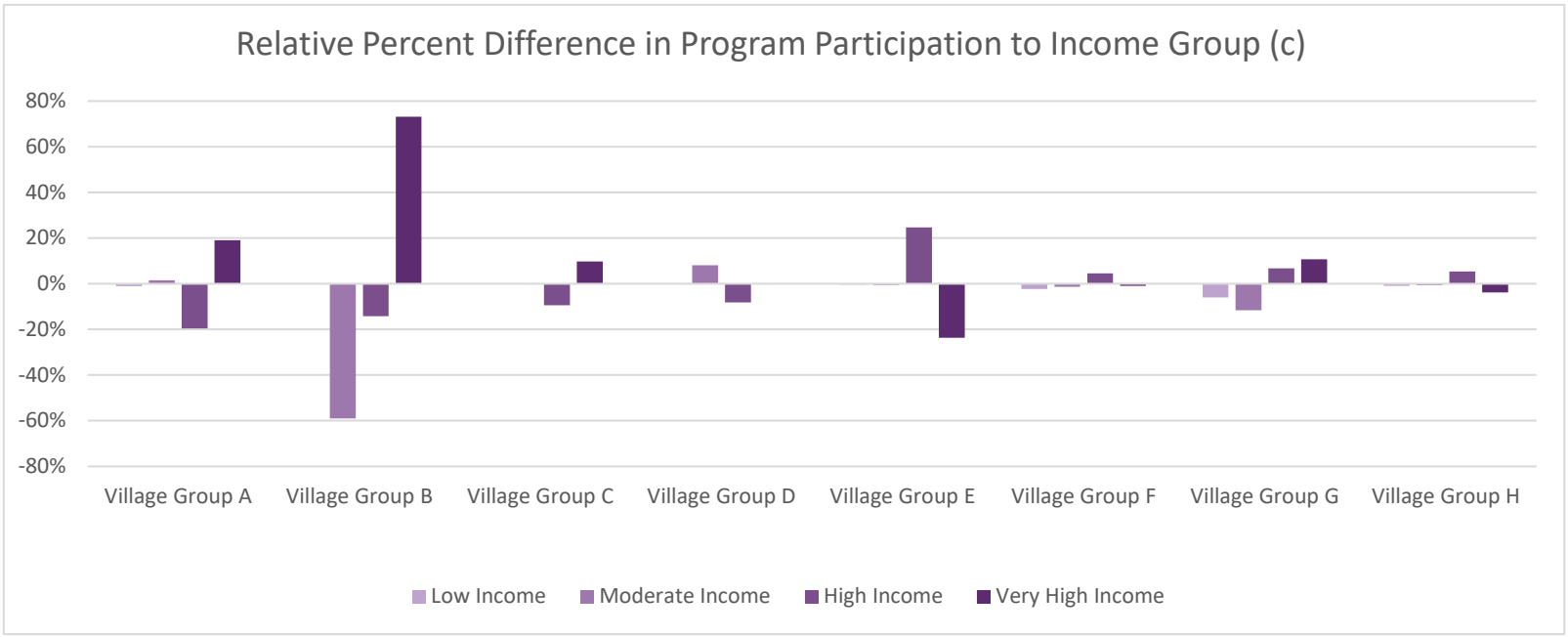


Table 3-13f
SFR One-Stop-Shop HET Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HET = high efficiency toilet
FMR = fair market rents
HUD = United States Department of Housing and Urban Development
SFR = single-family residential
SPs = service Points

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.

Table 3-13f

SFR One-Stop-Shop HET Participation by Median Household Income

Irvine Ranch Water District

References:

HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016

U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13g
SFR HET Rebate Program Participation by Median Household Income
Irvine Ranch Water District

Median Household Income (a)		Percentage of Participating SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	3.2%	0%	5.0%	0%	0%	6.0%	6.1%	1.4%
Moderate Income	$72,001-$85,000	18%	31%	5.5%	23%	0%	4.3%	5.7%	3.3%
High Income	$85,001-$128,000	32%	53%	45%	77%	44%	63%	50%	48%
Very High Income	>$128,000	46%	16%	44%	0%	56%	27%	38%	47%

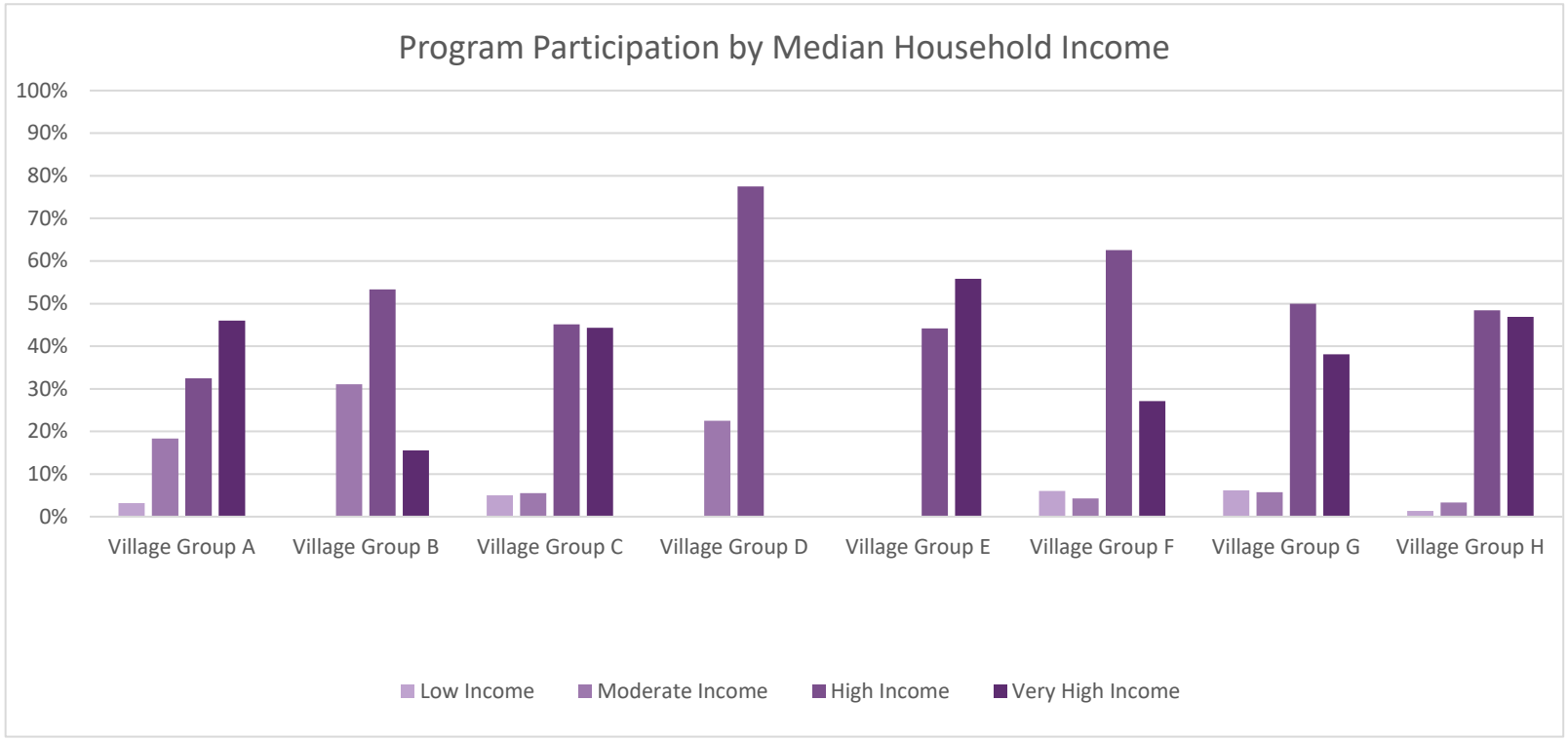
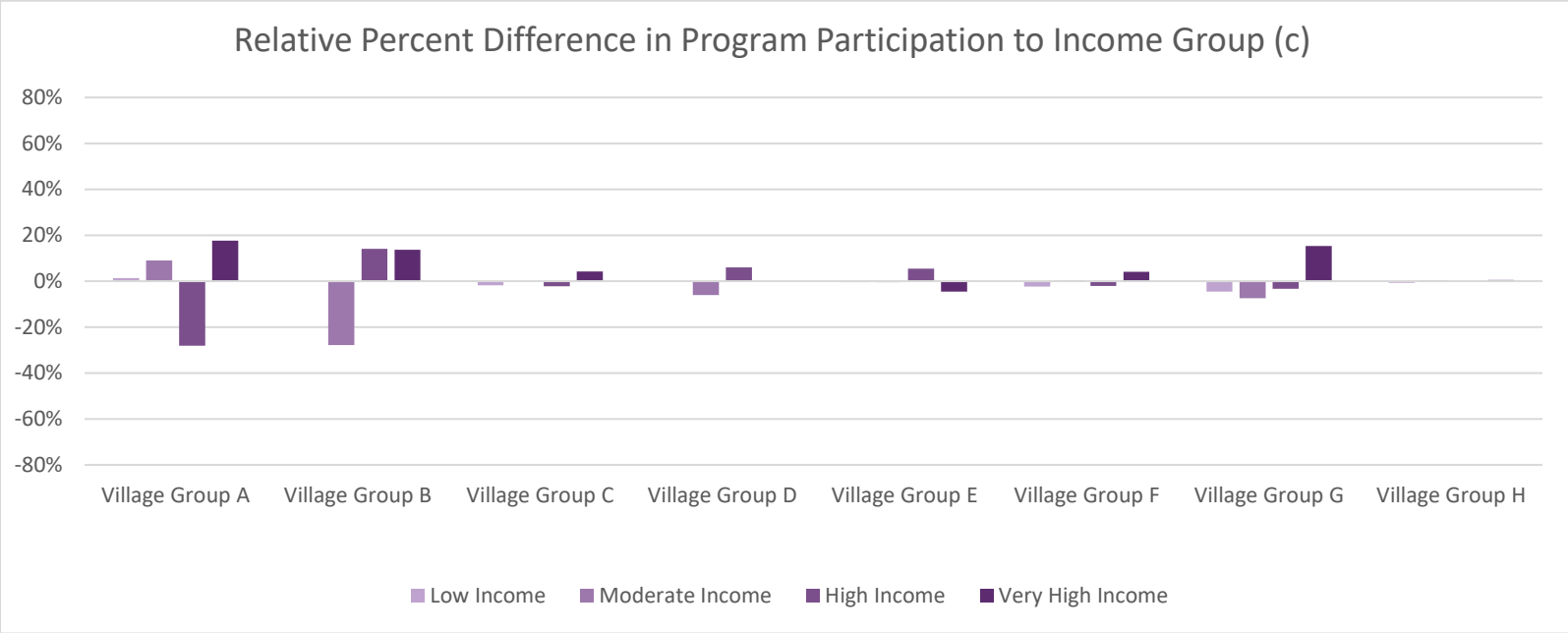


Table 3-13g
SFR HET Rebate Program Participation by Median Household Income
Irvine Ranch Water District



Abbreviations:

FY = fiscal year
HET = high efficiency toilet
FMR = fair market rents
HUD = United States Department of Housing and Urban Development
SFR = single-family residential
SPs = service Points

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR service points by income group within each village group detailed on Table TM2-13h.

Table 3-13g
SFR HET Rebate Program Participation by Median Household Income
Irvine Ranch Water District

References:
HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016
U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-13h
Median Household Income by Village Group
Irvine Ranch Water District

Median Household Income (a)		Percentage of SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Income	<$70,200	1.8%	0%	6.9%	0%	0.44%	8.4%	11%	2.0%
Moderate Income	$72,001-$85,000	9.3%	59%	5.7%	29%	0.48%	3.9%	13%	2.9%
High Income	$85,001-$128,000	61%	39%	47%	71%	39%	65%	53%	49%
Very High Income	>$128,000	28%	1.8%	40%	0%	60%	23%	23%	46%

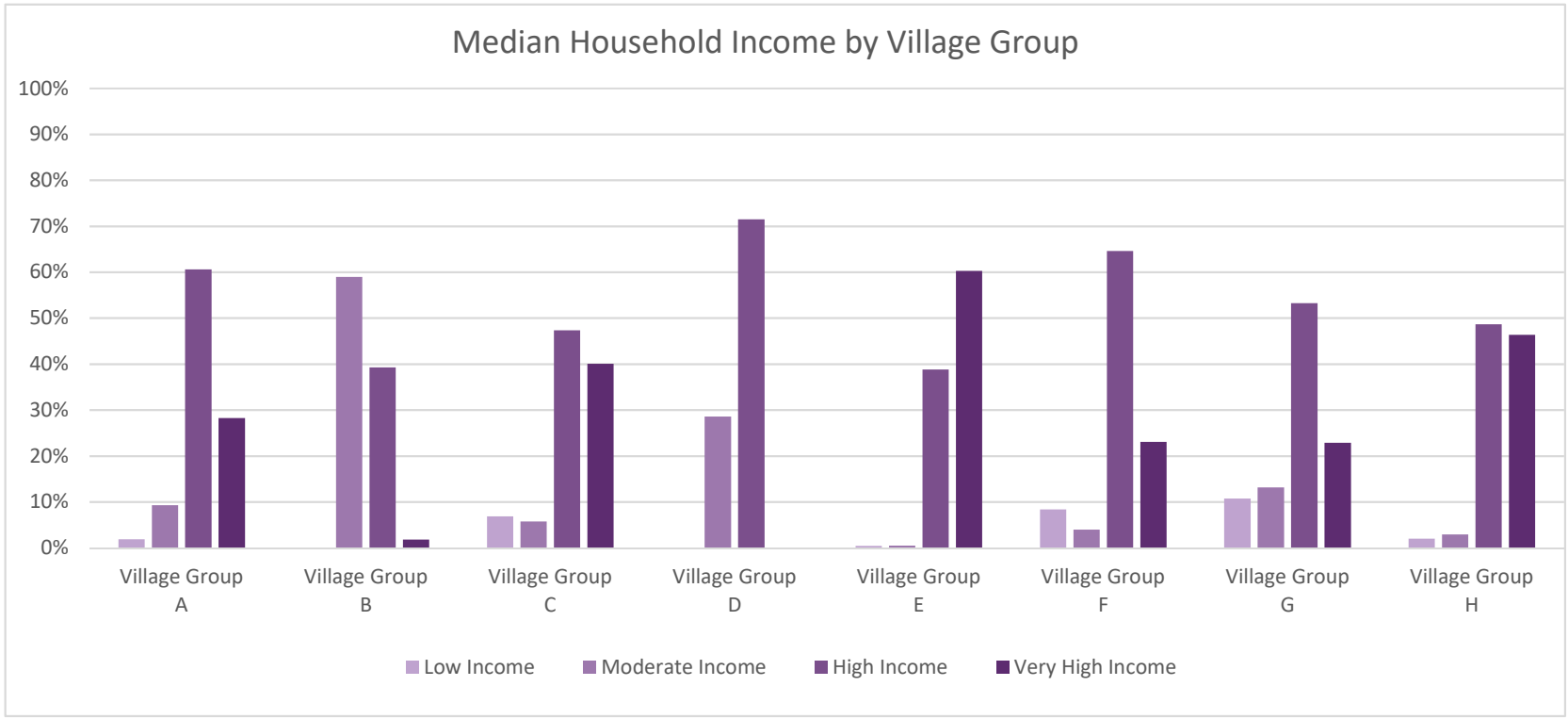


Table 3-13h
Median Household Income by Village Group
Irvine Ranch Water District

Abbreviations:

FY = fiscal year
HUD = United States Department of Housing and Urban Development
FMR = fair market rents
SPs = Service Points

Notes:

(a) Household income is based on estimated 2016 median household income by Census Block Group, per Census (2019). Income level groupings are based on the Income Level Summary for the Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area for a 3-person household in FY 2016 (HUD, 2017). Low income includes HUD extremely low income, and very low income classifications. Very high income is shown as greater than 1.5 times the Santa Ana-Anaheim-Irvine median household income.

(b) The overall percentage of residential service points by income group within the service area is calculated by dividing the service points of a village group that falls into the income category by the total service points of that village.

References:

HUD, 2017. Santa Ana-Anaheim-Irvine, CA HUD Metro FMR Area, income thresholds for 2016 downoaded from HUD webpage: https://www.huduser.gov/portal/datasets/il.html#2016

the West Irvine/Tustin Ranch and Canyons/OPA Village Groups and appears to be driving the majority of the income discrepancies observed at the District level. A notable disparity is seen in the Coast Village Group, where there has been a higher participation rate in the One-Stop-Shop programs by customers in high income areas, counter to the overall trend of higher participation by those in very high income areas. Given that the One-Stop-Shop program was a targeted program, with marketing and outreach specifically focused on customers with older homes, this illustrates the success of program targeting in reaching a different set of customers to participate than would otherwise participate without targeting.

3.3.3. Homeownership Trends

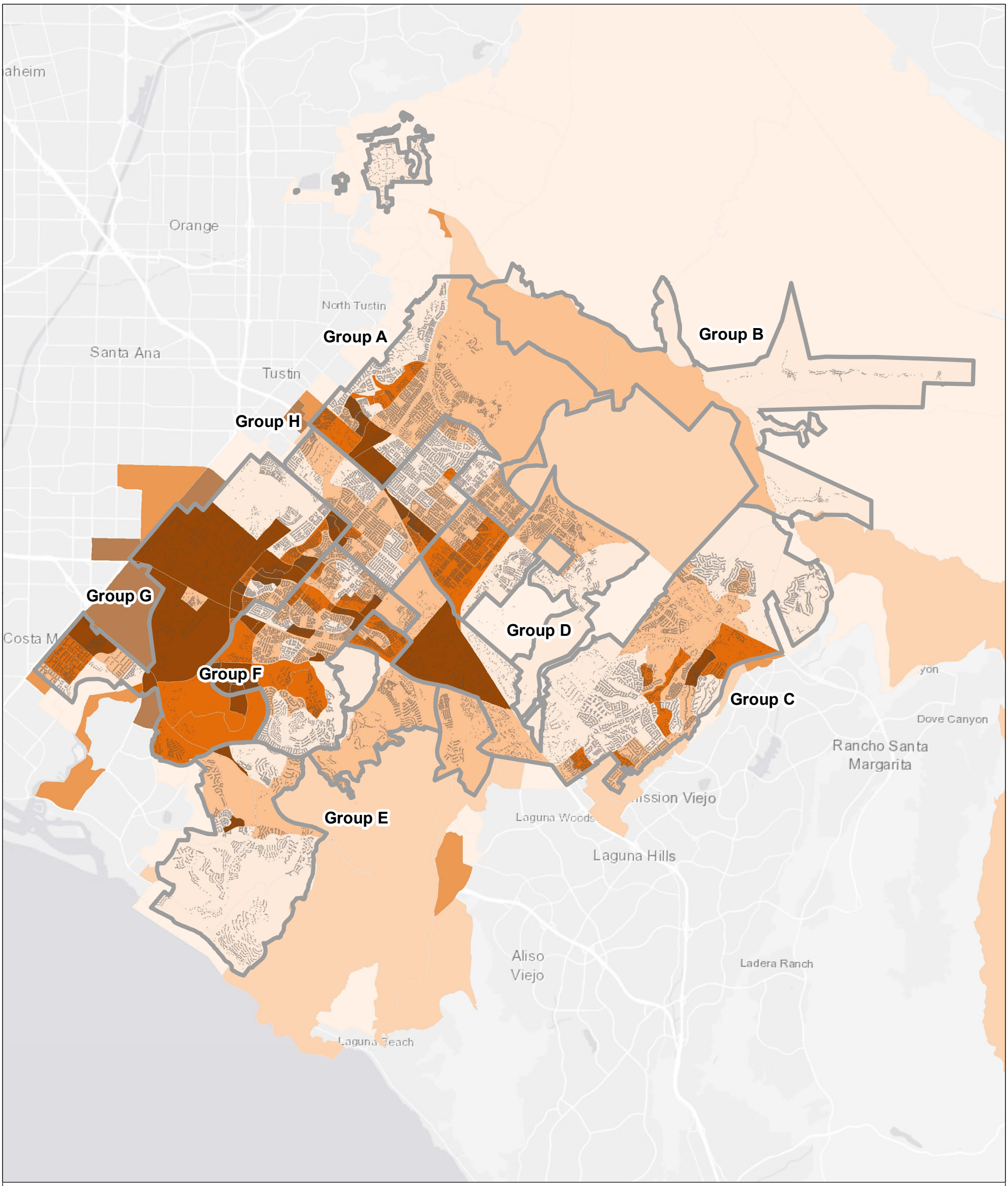
In order to evaluate whether home ownership appears to be a driving factor in program participation, SFR program participation was compared to the proportion of the population that live in renter-occupied homes, based on Census data. **Figure 3-13** shows the distribution of SFR homes by renter-occupancy rate across the District. **Table 3-14a** shows the distribution of residential WE program participation by the percentage of the population that live in renter-occupied homes ("rentership"). Nearly half of the SFR SPs are located in areas where more than 75% of the population own the home they occupy, and nearly 90% of SFR SPs are located in areas where 50% or more of the population own their homes.

The first chart in **Table 3-14a** shows the percentage of participants in each program that live in areas of each percent rentership grouping. For each WE program analyzed, close to half (46%-61%) of participants are from areas of predominantly owner-occupied homes (low rentership). This trend was consistent across all programs, but slightly less pronounced for the HECW Rebate program.

The second chart on **Table 3-14a** shows participation rates controlled for the number of SPs within the IRWD service area that fall within each rentership classification. When the relative proportion of number of SPs within each income group is controlled for, all programs except for the SFR HECW Rebate program show a clear trend that SFR customers in low rentership (high home ownership) areas are much more likely to participate than those in high rentership areas. The composition of participants in the SFR HECW Rebate program, however, is consistent with that of the distribution of SFR SPs across the District. That is, there is no correlation between home ownership and likelihood of participating in the HECW Rebate program. There is a very slightly higher tendency for those in very high rentership areas to participate in the no-cost, One-Stop-Shop programs.

Tables 3-14b through **3-14g** show a breakdown of each SFR WE program by rentership level and by Village Group, including total participation and relative percent difference in participation compared to the rentership composition of each Village Group. It should be noted that the rentership distributions are highly variable across different Village Groups, as illustrated in **Table 3-14h** . For example, 99% of the SFR SPs in the Canyons/OPA Village Group are located in low rentership (high home-ownership) areas, and no high rentership areas are present within the Canyons/OPA and Central Village Groups. To normalize the difference in participation rates for each program, relative percent differences in program participation are shown in the second chart on each of **Tables 3-14b** through **3-14g.** Therefore, the analysis on home ownership will focus on the relative percent difference instead of the total participation rate.

Rentership trends by Village Group are generally similar across programs, with the exception of the One-Stop-Shop program. Program participants from low to moderate rentership areas in the Central Village Group have a higher level of participation across programs, consistently showing a different trend than other Village Groups. Compared to the WBIC Rebate and HET Rebate programs, there is a much higher



Legend

Village Group Boundary

Percentage of Renters

- ≤25%
- 25.1% - 50%
- 50.1% - 75%
- ≥75%
- Service Point Location

Notes

1. All locations are approximate.
2. Percentage of renter-occupied housing units is based on the estimated 2016 number of renter-occupied housing units by Census Block Group, per Census (2019).

Sources

1. U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau.

N

0 2 4

(Scale in Miles)

Percentage of Renter-Occupied Housing Units

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure 3-13

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 3-13_Rentership.mxd

Table 3-14a
SFR Program Participation by Percent Rentership
Irvine Ranch Water District

Percent Rentership (a)		Percentage of SFR SPs	Percentage of Participating SFR SPs (b)					
			SFR Turf Removal	SFR WBIC Rebates	SFR One-Stop-Shop WBICs	SFR HET Rebates	SFR One-Stop-Shop HETs	SFR HECW Rebates
Low Rentership	≤25%	47%	61%	51%	56%	55%	51%	46%
Low to Moderate Rentership	25.1%-50%	41%	30%	39%	36%	35%	39%	41%
Moderate to High Rentership	50.1%-75%	11%	6.9%	8.7%	6.7%	8.1%	7.2%	11%
High Rentership	≥75%	1.8%	1.8%	1.4%	2.1%	1.9%	2.9%	1.8%

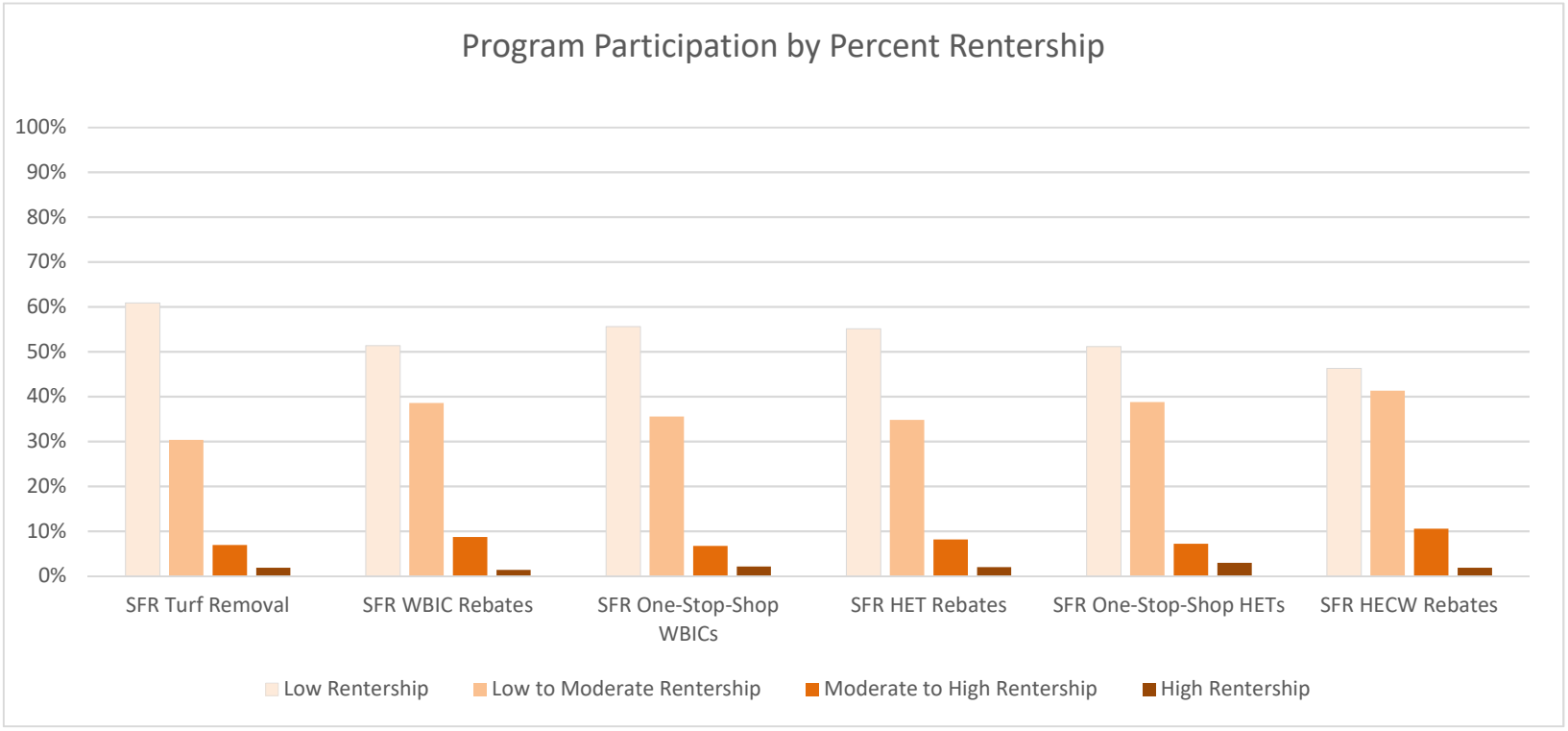
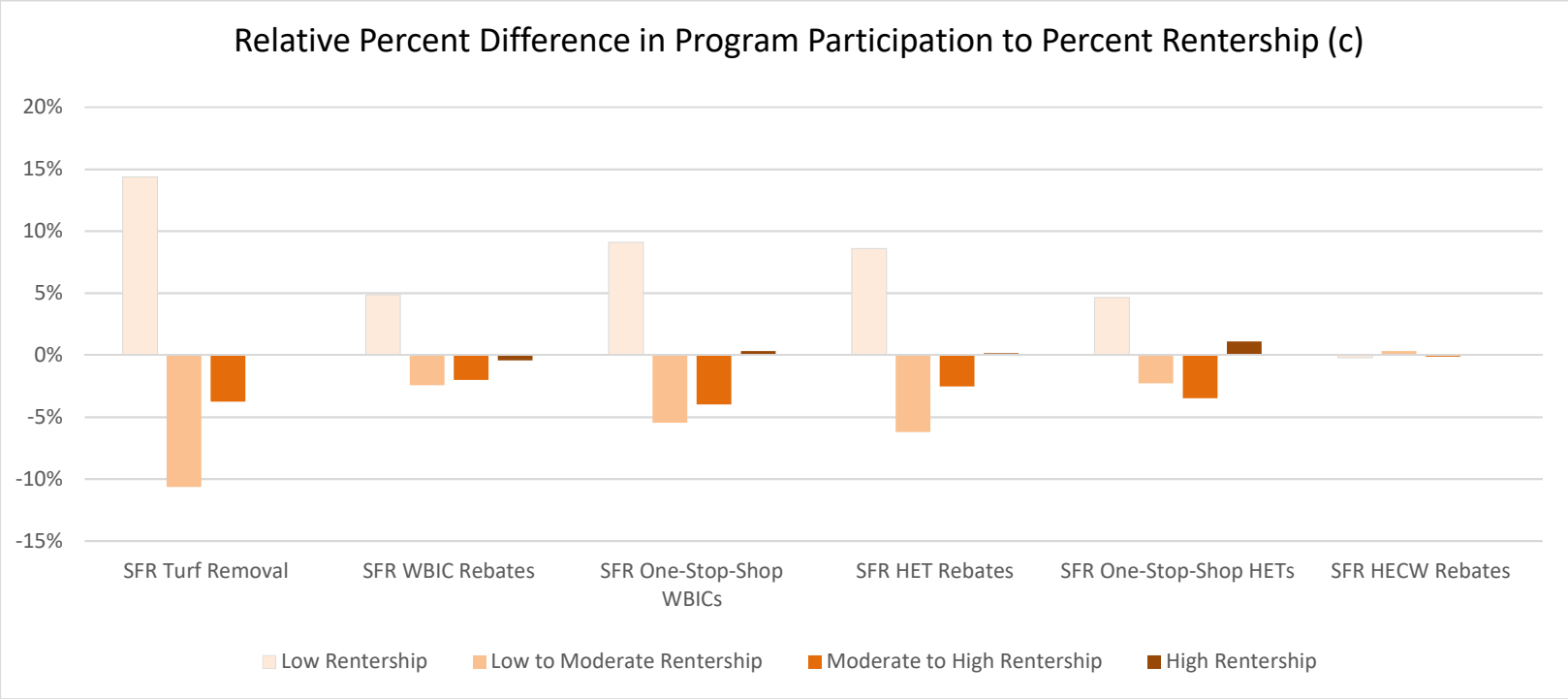


Table 3-14a
SFR Program Participation by Percent Rentership
Irvine Ranch Water District



Abbreviations:
HECW = high efficiency clothes washer
HET = high efficiency toilet
SFR = single-family residential
SPs = service points
WBIC = weather-based irrigation controller

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SFR service points by rentership within the service area.

Table 3-14a
SFR Program Participation by Percent Rentership
Irvine Ranch Water District

References:

(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14b
Turf Removal SFR Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	50%	100%	72%	0%	45%	52%	39%	64%
Low to Moderate Rentership	25.1%-50%	43%	0%	20%	69%	42%	43%	26%	34%
Moderate to High Rentership	50.1%-75%	4%	0%	7.6%	31%	13%	6%	22%	0%
High Rentership	≥75%	2.9%	0%	0.32%	0%	0%	0%	13%	1.5%

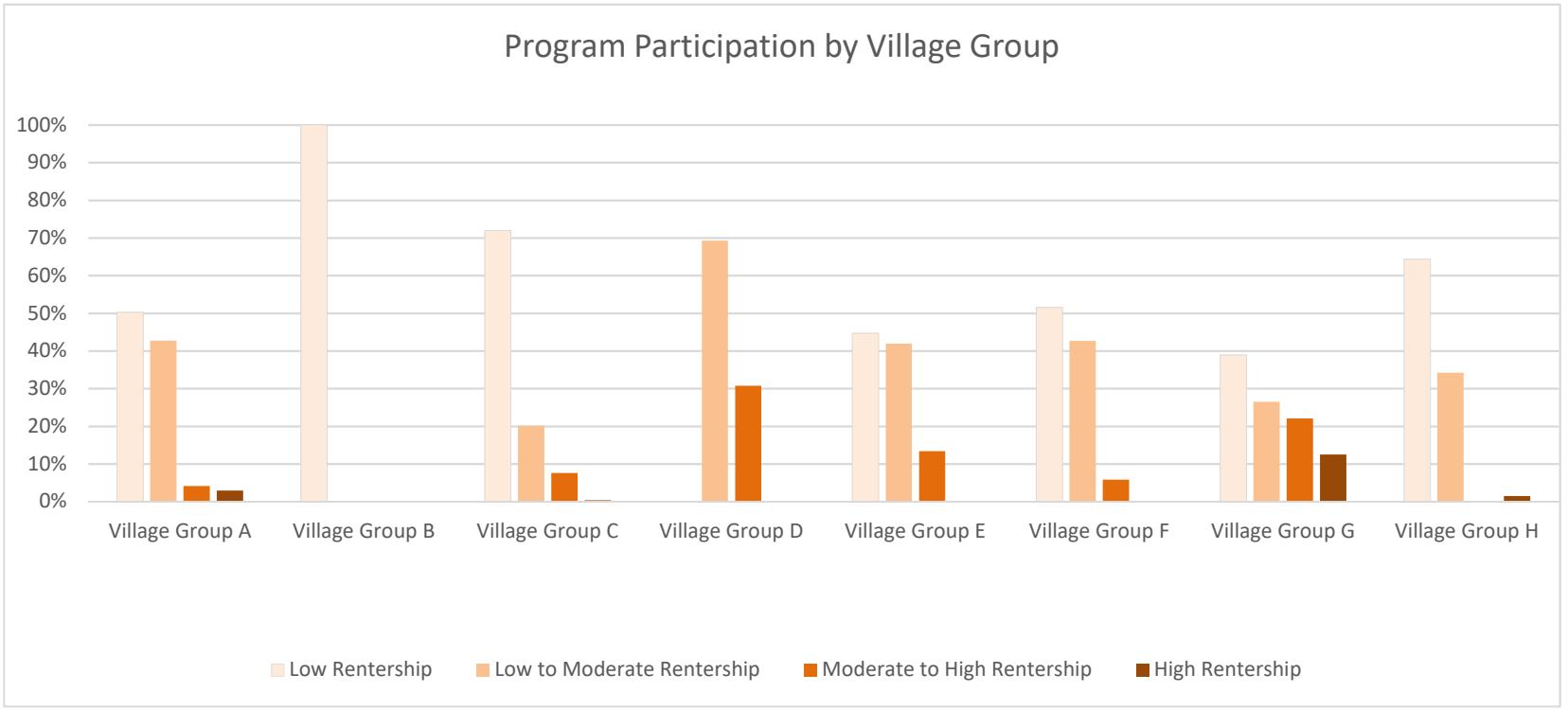
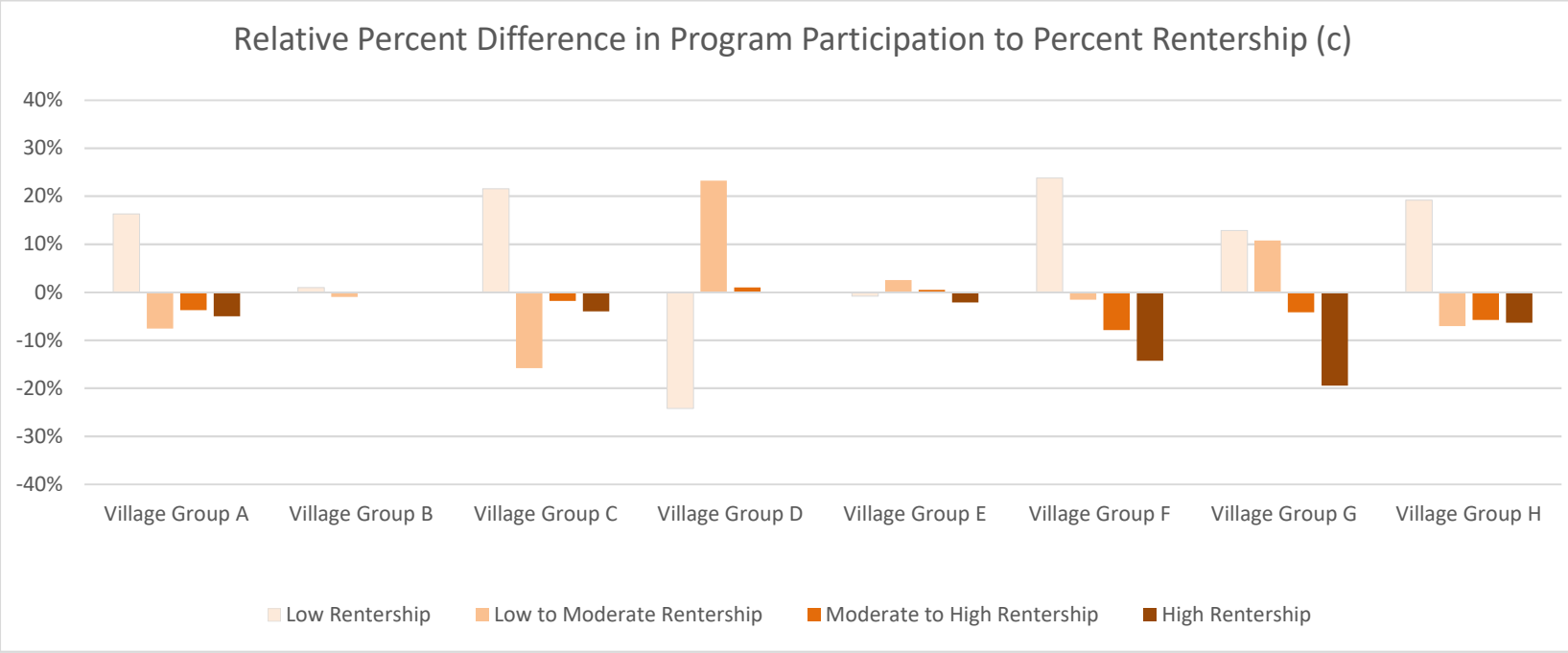


Table 3-14b
Turf Removal SFR Participation by Village Group
Irvine Ranch Water District



Abbreviations:
SFR = single-family residential
SPs = service points

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.

Table 3-14b
Turf Removal SFR Participation by Village Group
Irvine Ranch Water District

References:
(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14c
WBIC Rebate SFR Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	36%	100%	68%	13%	44%	46%	53%	61%
Low to Moderate Rentership	25.1%-50%	55%	0%	27%	64%	39%	46%	18%	37%
Moderate to High Rentership	50.1%-75%	6.1%	0%	5.0%	23%	17%	8.1%	23%	0.66%
High Rentership	≥75%	2.6%	0%	0.25%	0%	0%	0%	6.4%	1.3%

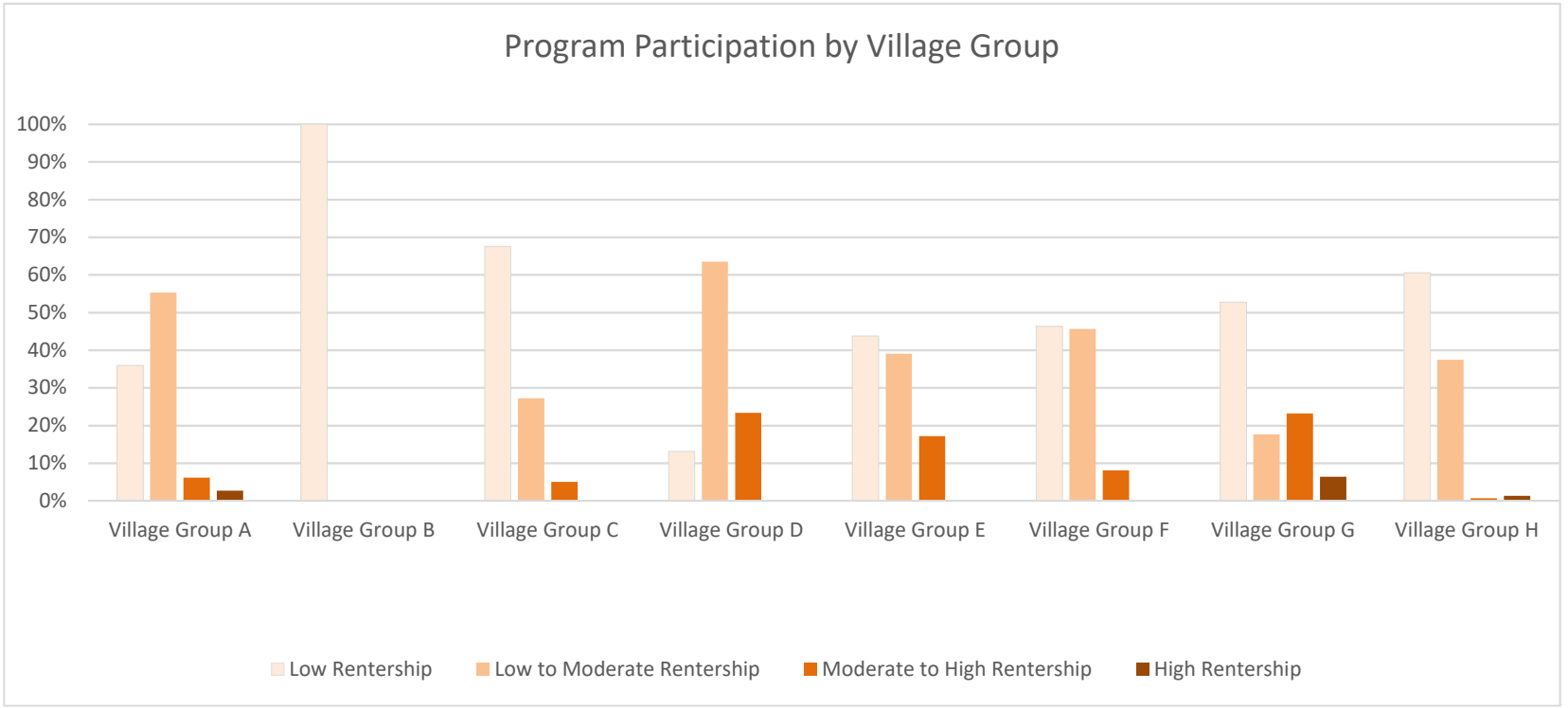
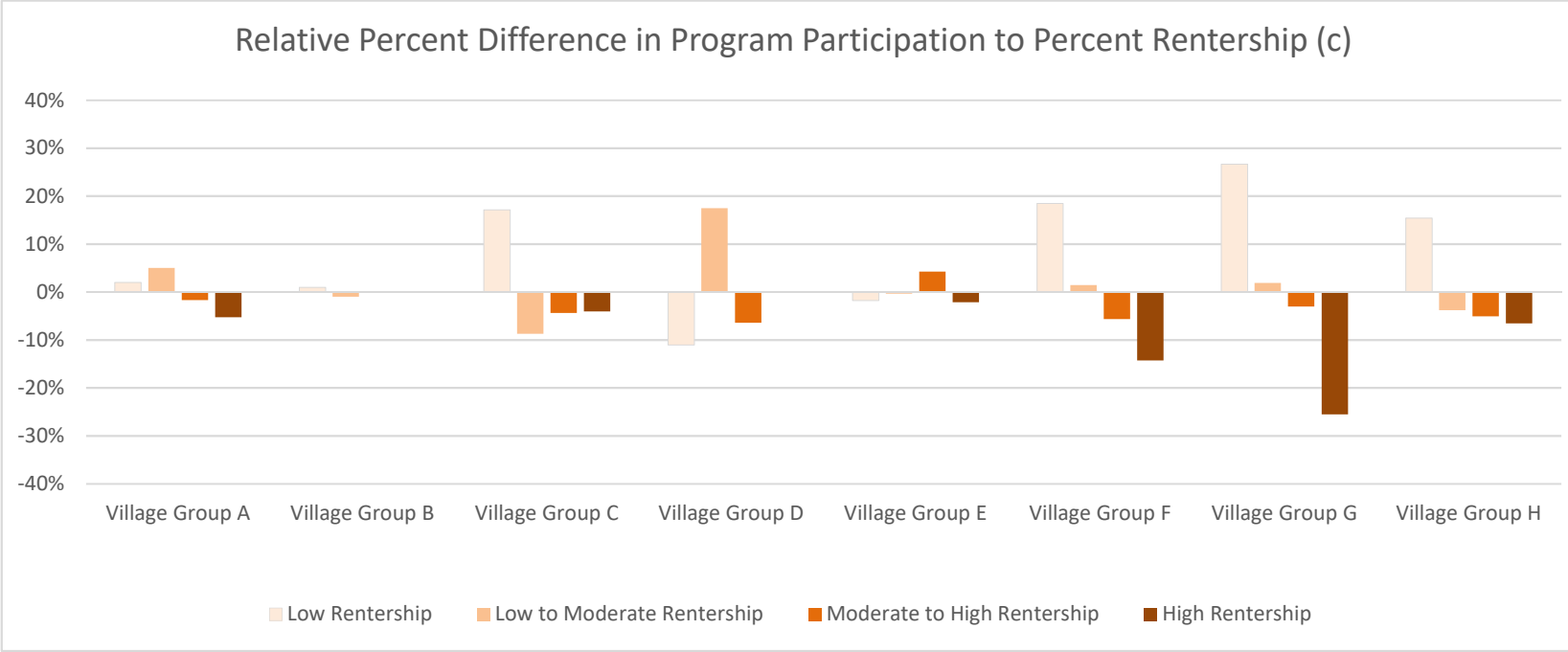


Table 3-14c
WBIC Rebate SFR Participation by Village Group
Irvine Ranch Water District



Abbreviations:
SFR = single-family residential
SPs = service points
WBIC = weather-based irrigation controller

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.

Table 3-14c
WBIC Rebate SFR Participation by Village Group
Irvine Ranch Water District

References:
(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14d
WBIC SFR One-Stop-Shop Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	63%	0%	80%	4.3%	7.7%	49%	40%	52%
Low to Moderate Rentership	25.1%-50%	27%	0%	15%	78%	46%	40%	27%	46%
Moderate to High Rentership	50.1%-75%	8.6%	0%	4.4%	17%	46%	9.6%	16%	0.87%
High Rentership	≥75%	1.2%	0%	0%	0%	0%	1.4%	16%	0.43%

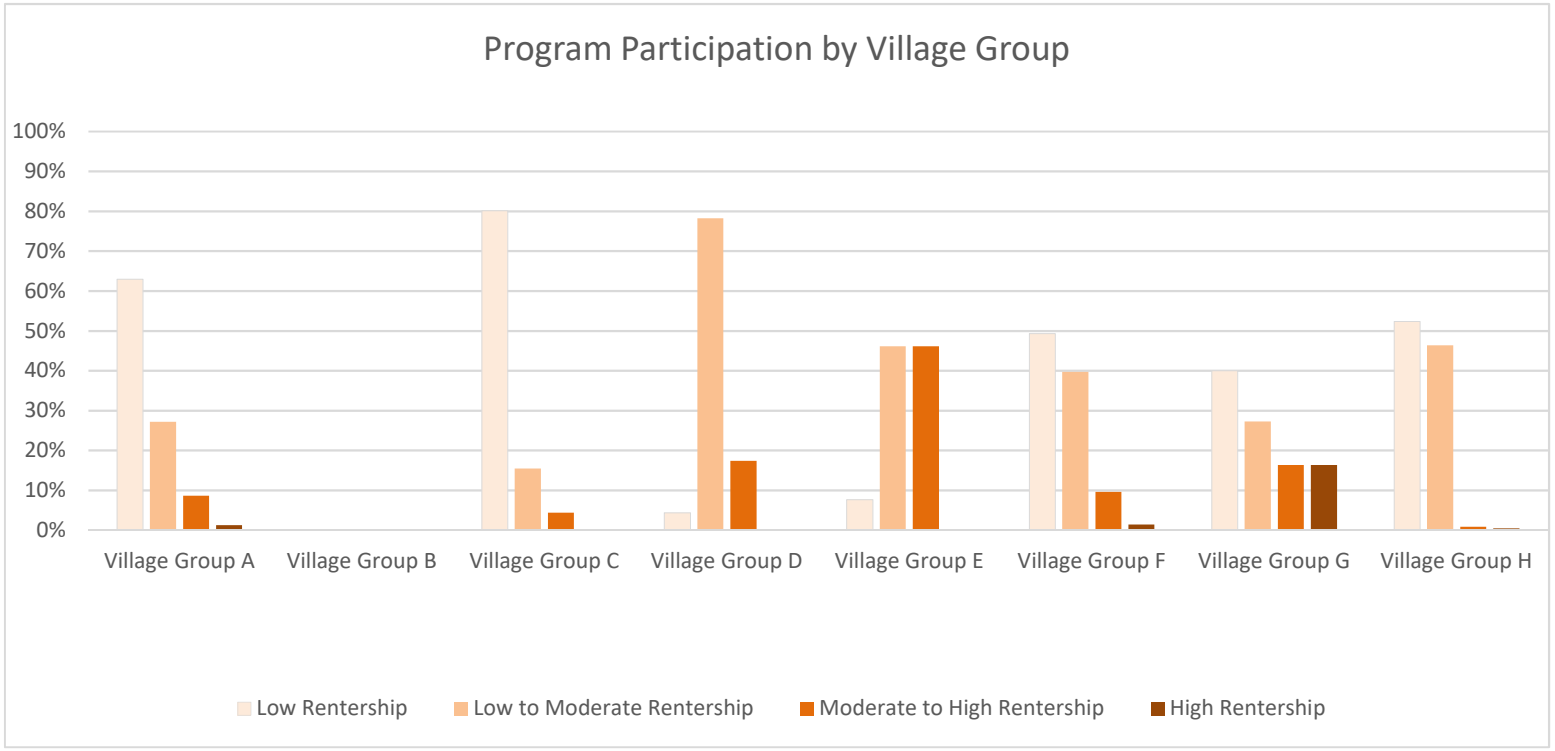
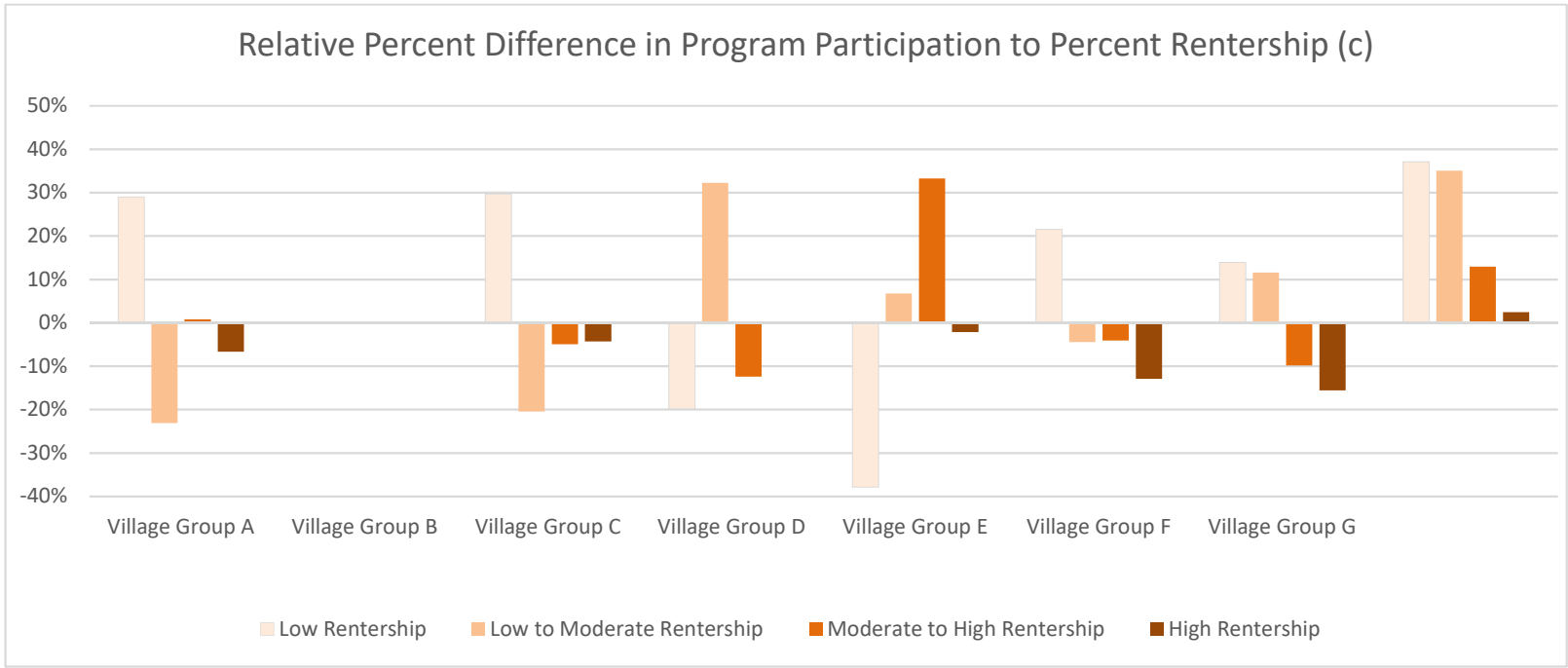


Table 3-14d
WBIC SFR One-Stop-Shop Participation by Village Group
Irvine Ranch Water District



Abbreviations:
SFR = single-family residential
SPs = service points
WBIC = weather-based irrigation controller

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.
(d) No SFR SPs from Village Group B participated in the WBIC SFR One-Stop-Shop program.

Table 3-14d
WBIC SFR One-Stop-Shop Participation by Village Group
Irvine Ranch Water District

References:

(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14e
SFR HET Rebate Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	49%	100%	68%	1.4%	37%	42%	46%	60%
Low to Moderate Rentership	25.1%-50%	35%	0%	24%	76%	43%	50%	22%	38%
Moderate to High Rentership	50.1%-75%	12%	0%	8.2%	23%	20.3%	8%	20%	0.88%
High Rentership	≥75%	4.6%	0%	0.23%	0%	0%	0%	12%	1.3%

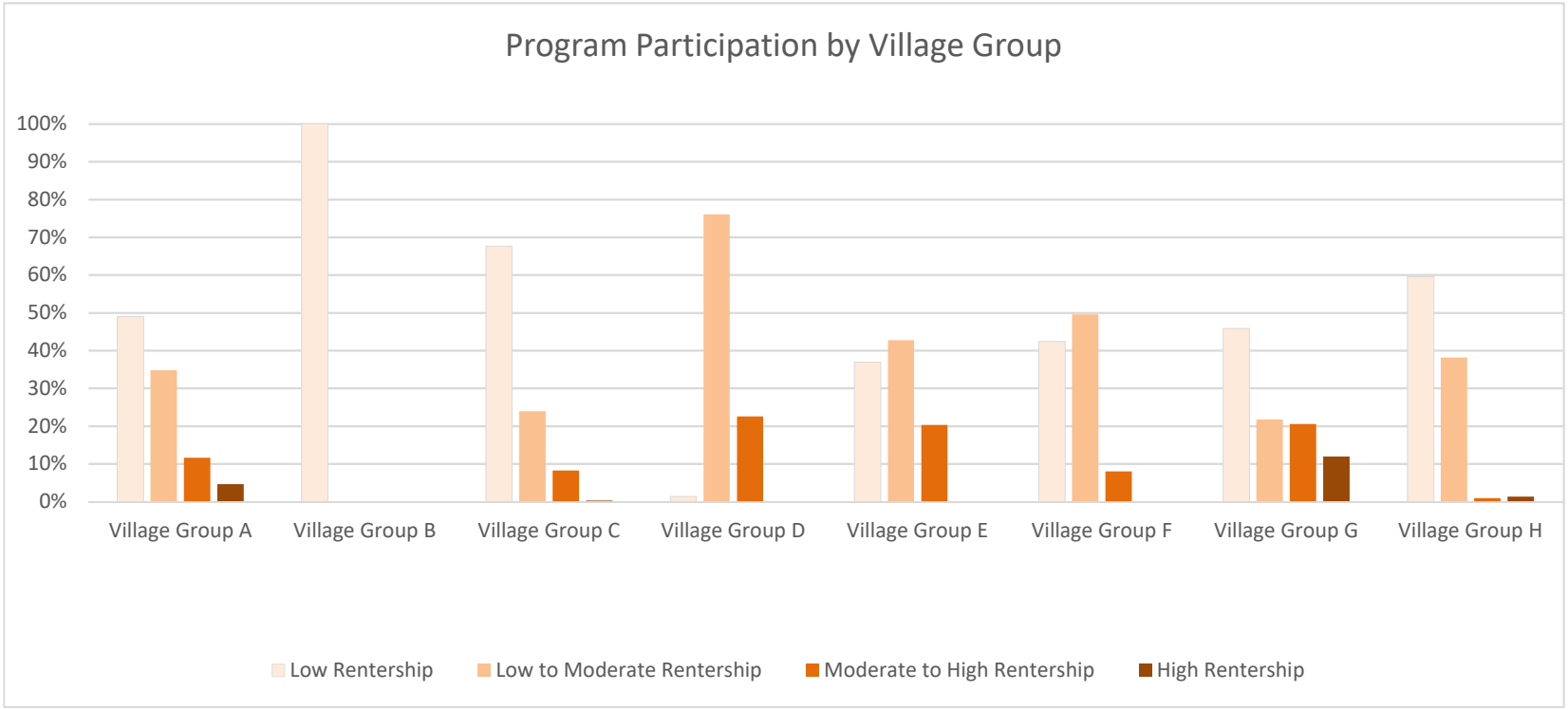
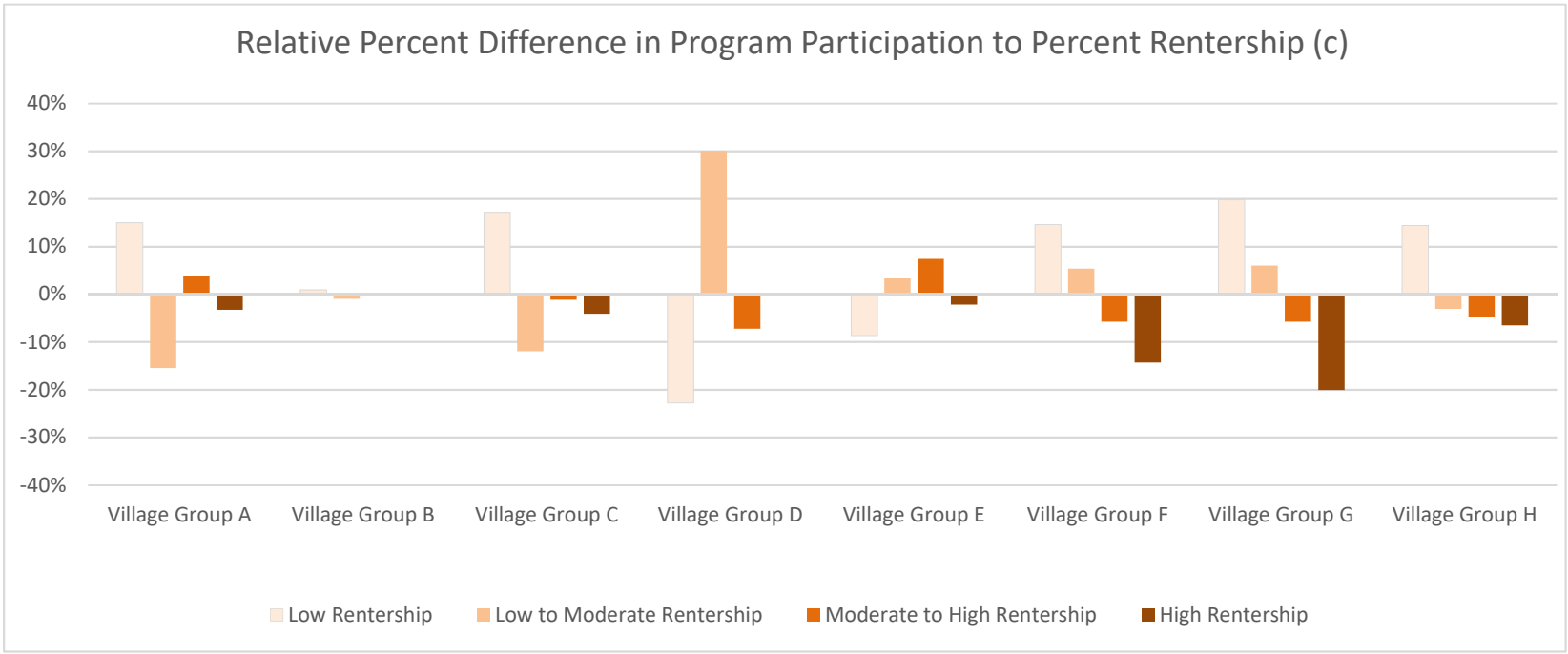


Table 3-14e
SFR HET Rebate Participation by Village Group
Irvine Ranch Water District



Abbreviations:
HET = high efficiency toilet
SFR = single-family residential
SPs = service points

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.

Table 3-14e
SFR HET Rebate Participation by Village Group
Irvine Ranch Water District

References:

(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14f
SFR One-Stop-Shop HET Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	43%	100%	73%	0%	15%	48%	42%	51%
Low to Moderate Rentership	25.1%-50%	48%	0%	18%	63%	53%	47%	22%	47%
Moderate to High Rentership	50.1%-75%	5.9%	0%	9.0%	37%	33%	4.6%	16%	1.2%
High Rentership	≥75%	3.0%	0%	0%	0%	0%	0.66%	20%	1.0%

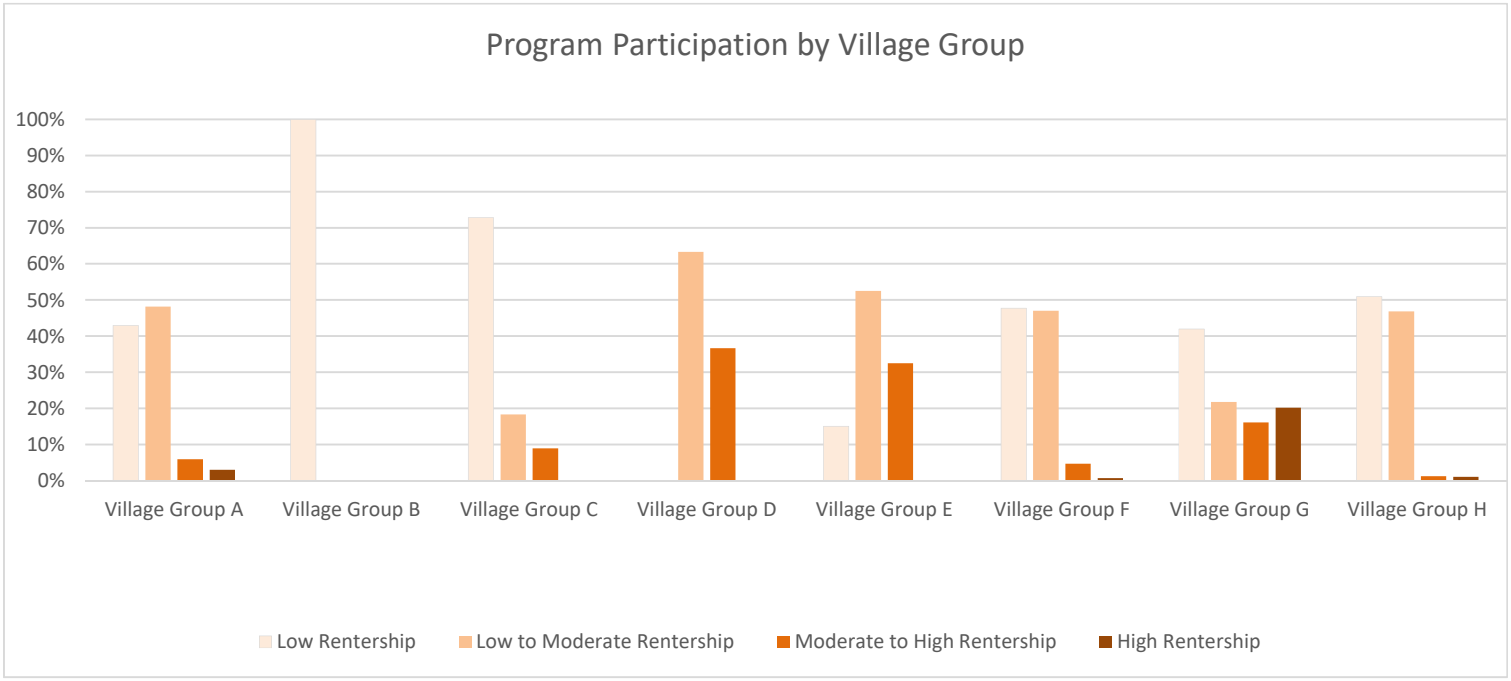
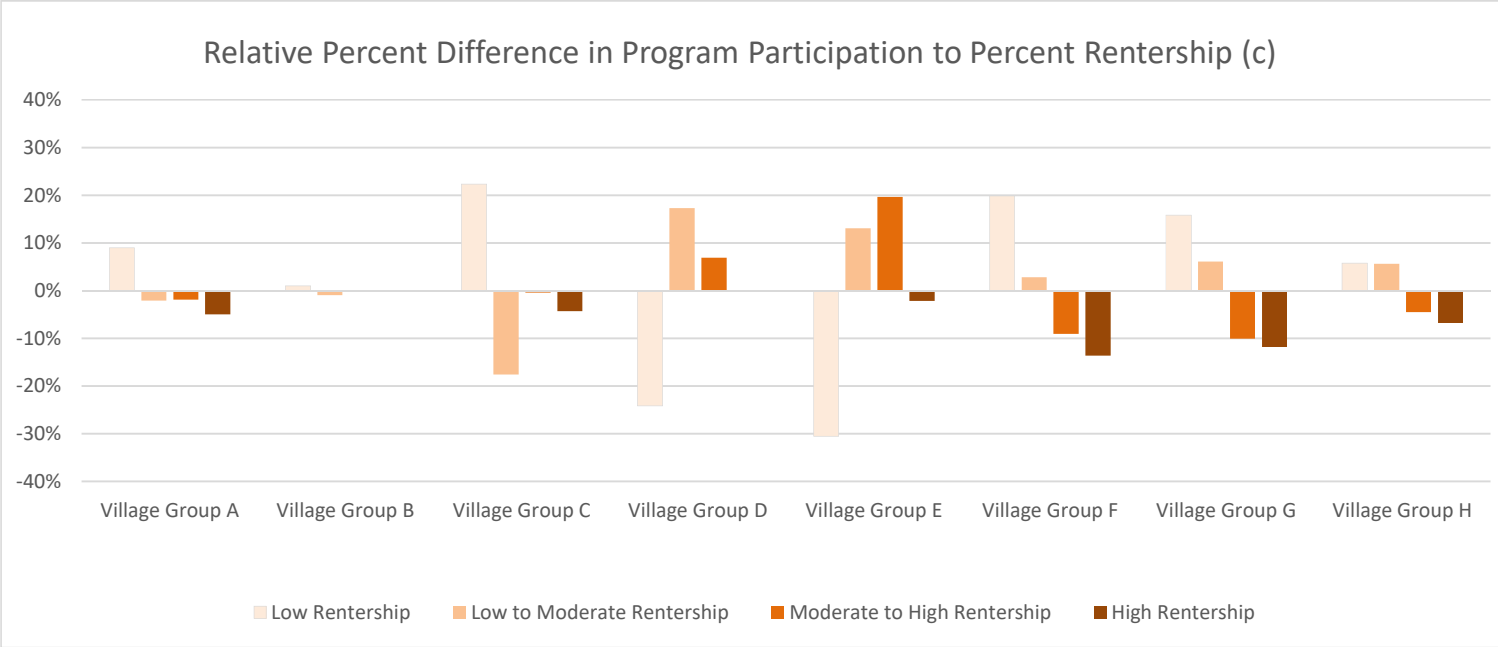


Table 3-14f
SFR One-Stop-Shop HET Participation by Village Group
Irvine Ranch Water District



Abbreviations:
HET = high efficiency toilet
SFR = single-family residential
SPs = service points

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.

References:
(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14g
SFR HECW Rebate Participation by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of Participation by Village Group (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	36%	100%	64%	3.9%	39%	40%	50%	59%
Low to Moderate Rentership	25.1%-50%	56%	0%	27%	63%	42%	52%	16%	39%
Moderate to High Rentership	50.1%-75%	6%	0%	7.8%	33%	19%	8%	24%	0.46%
High Rentership	≥75%	2.5%	0%	0.85%	0%	0%	0.08%	10%	1.3%

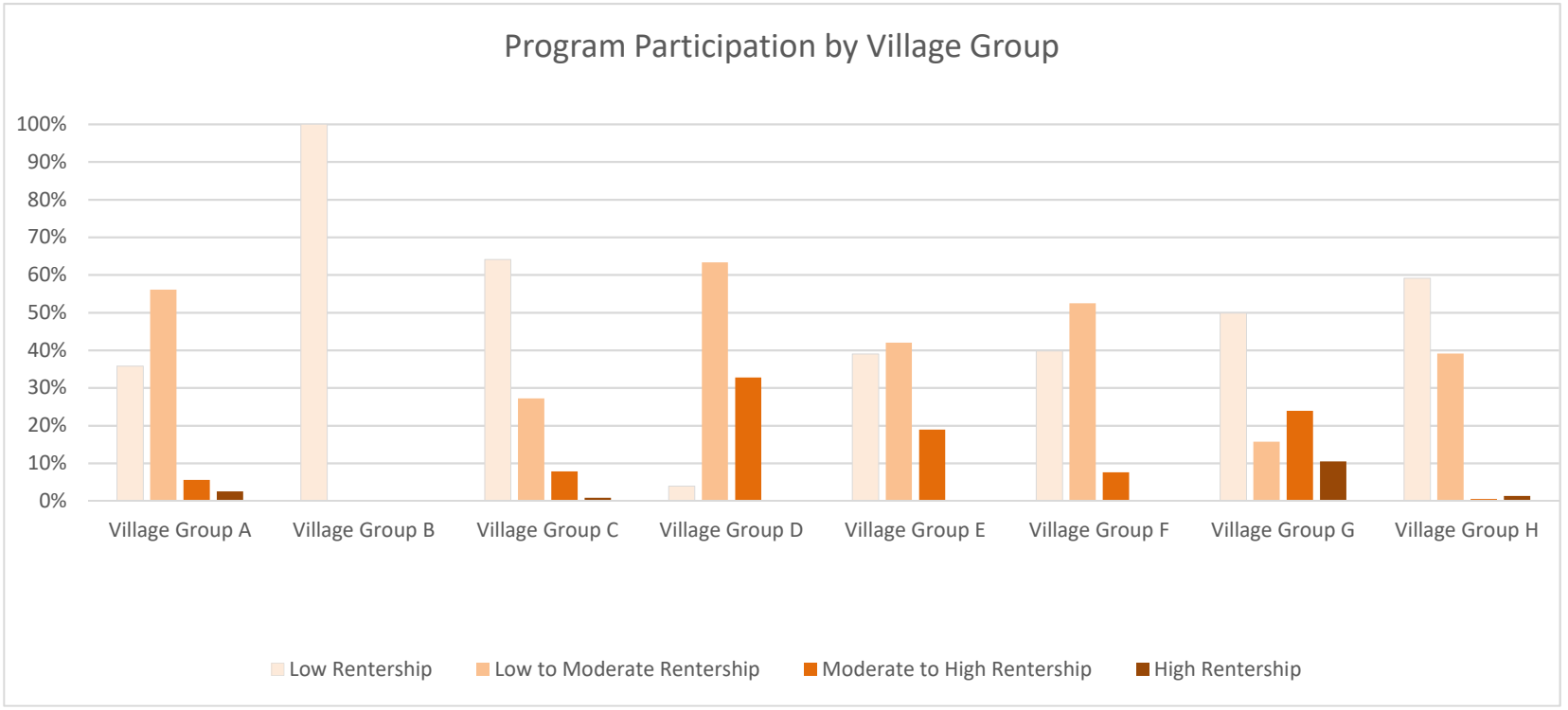
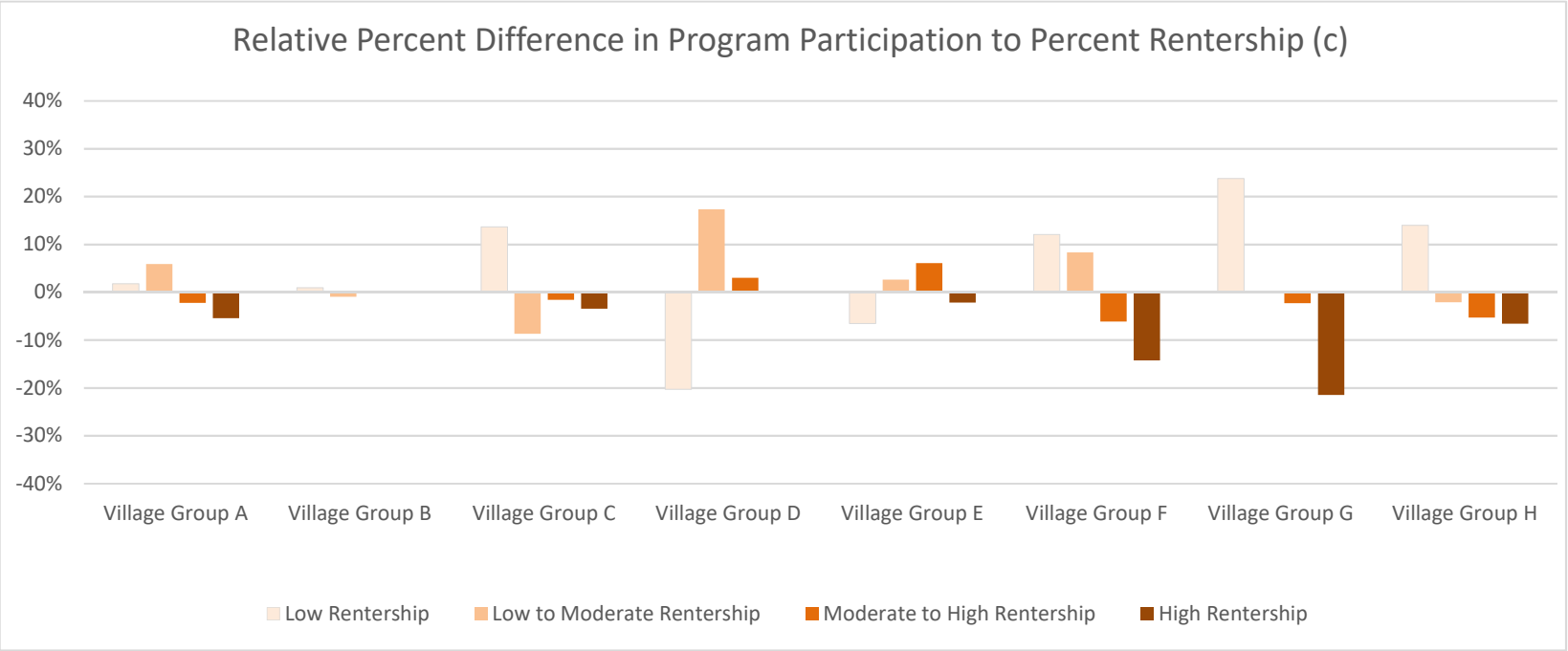


Table 3-14g
SFR HECW Rebate Participation by Village Group
Irvine Ranch Water District



Abbreviations:
HECW = high efficiency clothes washer
SFR = single-family residential
SPs = service points

Notes:
(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) Program participation rates are summarized in the report text.
(c) Relative difference is calculated as the percentage of program participation by percent rentership minus the overall percentage of SPR service points by income group within each village group detailed on Table TM2-14h.

Table 3-14g
SFR HECW Rebate Participation by Village Group
Irvine Ranch Water District

References:

(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

Table 3-14h
Percent Rentership by Village Group
Irvine Ranch Water District

Percent Rentership (a)		Percentage of SFR SPs (b)							
		Village Group A	Village Group B	Village Group C	Village Group D	Village Group E	Village Group F	Village Group G	Village Group H
Low Rentership	≤25%	34%	99%	50%	24%	46%	28%	26%	45%
Low to Moderate Rentership	25.1%-50%	50%	1.0%	36%	46%	39%	44%	16%	41%
Moderate to High Rentership	50.1%-75%	7.8%	0%	9.4%	30%	13%	14%	26%	5.8%
High Rentership	≥75%	7.9%	0%	4.3%	0%	2.2%	14%	32%	7.9%

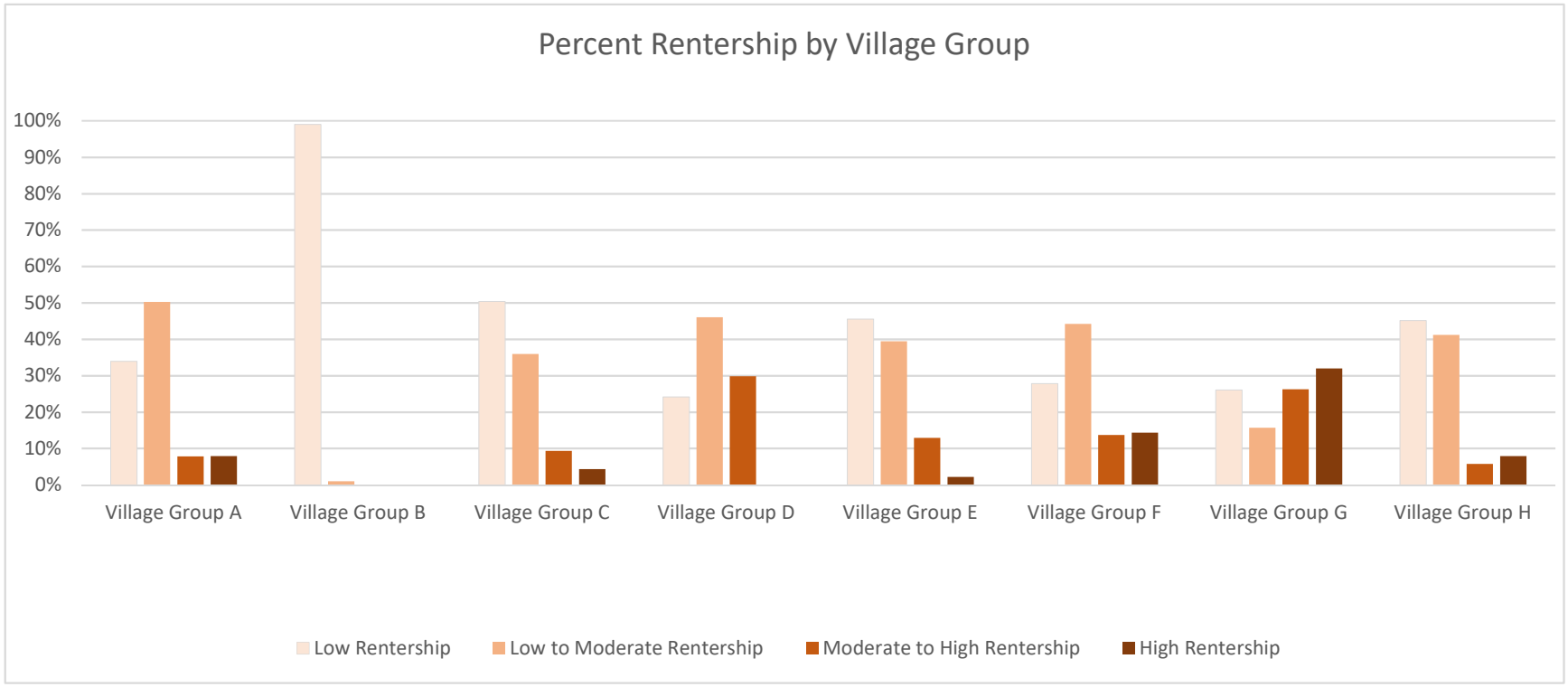


Table 3-14h
Percent Rentership by Village Group
Irvine Ranch Water District

Abbreviations:

SFR = single-family residential
SPs = service points

Notes:

(a) Percent rentership reflects the proportion of population within a given Census Block Group that lives in renter-occupied homes. Low rentership indicates an area consists predominantly of owner-occupied homes; high rentership indicates an area consists predominantly of renter-occupied homes. Rentership is based on estimated 2016 percentage of rentership by Census Block Group, per Census (2019).
(b) The overall percentage of residential service points by percent rentership group within the service area is calculated by dividing the service points of a village group that falls into the percent rentership category by the total service points of that village.

References:

(1) U.S. Census Bureau, 2019. 2012-2016 American Community Survey (ACS) 5-year estimates, TIGER/Line Shapefiles by Block Group, https://www.census.gov/geo/maps-data/data/tiger-data.html, United States Census Bureau, downloaded 14 February 2019.

level of participation by SFR SPs in moderate to high rentership areas in the Coast Village Group. There is also a less strong rentership trend observed in One-Stop-Shop program participants in the Central Irvine/University, Santa Ana Heights/UCI, and Central Irvine/ICD Village Groups than in the corresponding rebate programs.

3.4. Trends in Multiple Program Participation

Through a partnership with SoCalGas and Southern California Edison, IRWD residential customers were offered a suite of water- and energy-saving devices at no cost through the One-Stop-Shop program. Water-saving devices distributed through this program included faucet aerators, showerheads, HETs (standard HETs and premium high efficiency toilets [PHETs]), and WBICs. Depending on the existing devices in a customer's home, each customer was eligible to receive one or more type of device. **Table 3-15a** provides a summary of the number of SFR and multi-family residential (MFR) participants in this program, and the suite of devices they received. These same types of devices have been incentivized for IRWD customers through other programs, including rebate and other no-cost programs. **Table 3-15b** provides a summary of SFR and MFR participants who have received the same devices as offered through the One-Stop-Shop, but through other programs.

When IRWD customers are offered individual programs focused on just one type of device, 91% of SFR and 97% of MFR customers have participated in only one program. Through the One-Stop-Shop program, however, 61% of SFR and 57% of MFR customers received two or more different types of devices. By offering a program through which customers can receive multiple types of devices, the chances of that customer replacing multiple devices greatly increases. Therefore, it appears that the One-Stop-Shop has been much more successful at achieving greater water savings on a per-customer basis than through the traditional device-based programs. Trends in participation in multiple programs are further explored in Section 5.2.

3.5. Large Landscape and Commercial, Industrial, and Institutional Participant Characteristics

Within the ten programs evaluated, compared to programs offered to SFR customers, those aimed at CII and large landscape customers have had lower rates of participation, especially those for CII customers. This section provides a review of landscape and CII customer characteristics for key programs based on available data.

3.5.1. Large Landscape Participation and Irrigated Land Use Characteristics

Table 3-16 provides a summary of the total irrigated area within each Village Group, identified as irrigated lawn/turf area, irrigated non-turf landscape, and swimming pools, based on an aerial image processing land use classification study done by Quantum Spatial (2016).[24] In the District there is approximately 1,863 acres of irrigated turf area, 6,028 acres of irrigated non-turf landscaping, and 103 acres of swimming pool area, with irrigated turf area representing approximately 23% of the irrigated lands. The highest

[24] The Quantum Spatial study also identified irrigated lands in use as horse corrals/arenas, agriculture, irrigable, and non-irrigated classifications. For purposes of WE program assessment, this Study focuses on irrigated turf, irrigated non-turf, and swimming pools.

Table 3-15a
Summary of Residential SPs Receiving Multiple Devices
through One-Stop-Shop Program
Irvine Ranch Water District

	Single Family Residential					Multi-Family Residential				
		Measure					Measure			
Number of Measures	Number of SPs	HET	PHET	Shower-head	WBIC	Number of SPs	HET	PHET	Shower-head	WBIC
1	56	X				5	X			
	302		X			73		X		
	70			X		13			X	
	160				X	0				X
Subtotal	*588*	*56*	*302*	*70*	*160*	*91*	*5*	*73*	*13*	*0*
2	97	X	X			22	X	X		
	49	X		X		8	X		X	
	31	X			X	0	X			X
	231		X	X		49		X	X	
	145		X		X	0		X		X
	34			X	X	0			X	X
Subtotal	*587*	*177*	*473*	*314*	*210*	*79*	*30*	*71*	*57*	*0*
3	85	X	X	X		42	X	X	X	
	65	X	X		X	0	X	X		X
	18	X		X	X	0	X		X	X
	114		X	X	X	1		X	X	X
Subtotal	*282*	*168*	*264*	*217*	*197*	*43*	*42*	*43*	*43*	*1*
4	45	X	X	X	X	0	X	X	X	X
Subtotal	*45*	*45*	*45*	*45*	*45*	*0*	*0*	*0*	*0*	*0*
Total SPs	**1,502**	**446**	**1,084**	**646**	**612**	**213**	**77**	**187**	**113**	**1**

Abbreviations:

HET = high efficiency toilet
PHET = premium high efficiency toilet
SPs = service points
WBIC = weather-based irrigation controller

Notes:

a) The above table summarizes the number of residential service points that received water-saving devices through the One-Stop-Shop Program from January 2017 to February 2018. Faucet aerators were also distributed, but are not summarized herein.

Table 3-15b
Summary of Residential SPs Receiving Multiple Devices through Traditional Programs
Irvine Ranch Water District

Number of Measures	Single Family Residential					Multi-Family Residential				
		Measure					Measure			
	Number of SPs	HET	PHET	Shower-head	WBIC	Number of SPs	HET	PHET	Shower-head	WBIC
1	2,347	X				807	X			
	617		X			203		X		
	0			X		0			X	
	1,696				X	99				X
Subtotal	*4,660*	*2,347*	*617*	*0*	*1,696*	*1,109*	*807*	*203*	*0*	*99*
2	19	X	X			5	X	X		
	0	X		X		0	X		X	
	200	X			X	11	X			X
	190		X	X		13		X	X	
	54		X		X	3		X		X
	0			X	X	0			X	X
Subtotal	*463*	*219*	*263*	*190*	*254*	*32*	*16*	*21*	*13*	*14*
3	14	X	X	X		0	X	X	X	
	4	X	X		X	3	X	X		X
	0	X		X	X	0	X		X	X
	5		X	X	X	0		X	X	X
Subtotal	*23*	*18*	*23*	*19*	*9*	*3*	*3*	*3*	*0*	*3*
4	0	X	X	X	X	0	X	X	X	X
Subtotal	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total SPs	**5,146**	**2,584**	**903**	**209**	**1,959**	**1,144**	**826**	**227**	**13**	**116**

Abbreviations:

HET = high efficiency toilet
PHET = premium high efficiency toilet
SPs = service points
WBIC = weather-based irrigation controller

Notes:

a) The above table summarizes the number of residential service points that received water-saving devices through a variety of programs from 2008 to 2018, including the Water Smart Device Rebate program and other shorter-term efforts.

Table 3-16
Summary of Irrigated Landscape by Village Group
Irvine Ranch Water District

Village Group	Total Irrigated Area (ac)				Percentage Irrigated Area		
	Irrigated Landscape - Lawn/Turf	Irrigated Landscape - Non-Turf	Swimming Pools	Total	Irrigated Landscape - Lawn/Turf	Irrigated Landscape - Non-Turf	Swimming Pools
A - West Irvine/ Tustin Ranch	220	634	13	**867**	25%	73%	1.46%
B - Canyons/OPA	22	341	3	**366**	6%	93%	0.88%
C - Lake Forest/Foothills	280	1,452	24	**1,757**	16%	83%	1.38%
D - Central	65	289	4	**358**	18%	81%	1.23%
E - Coast	357	829	24	**1,210**	30%	69%	2.0%
F - Central Irvine/University	427	925	9	**1,361**	31%	68%	0.67%
G - Santa Ana Heights/UCI	240	900	8	**1,149**	21%	78%	0.74%
H - Central Irvine/ICD	250	657	17	**925**	27%	71%	1.9%
Total	**1,863**	**6,028**	**103**	**7,995**	23%	75%	1.29%

Abbreviations:

ac = acre
CII = commercial, industrial, institutional
SFR = single family residential
SPs = service points
WBIC = weather-based irrigation controller

Notes:

a) The above table summarizes the irrigated areas based on Reference 1, data processed by IRWD. Only Parcels that could be attributed to a SP ID are included in this dataset. The above summary does not include areas identified as irrigated horse corrals/arenas or agriculture, or irrigable and non-irrigated classifications.

References:

(1) Quantum Spatial, 2016. IRWD Land Use Classification Project, Technical data Report, prepared by Quantum Spatial and Eagle Aerial Solutions, dated 1 August 2017, as provided by IRWD on 27 November 2019.

proportion of turf to non-turf irrigated lands is in the Central Irvine/University, Coast, and Central Irvine/ICD Groups Village Groups, and the lowest proportion is in the Canyons/OPA, Lake Forest/Foothills, and Central Village Groups.

Of all of the WBIC and turf removal programs, the highest participation has been in the Lake Forest/Foothills and Central Irvine/ICD Village Groups, on both a total participant basis, and based on the number of participants per total irrigated land area. Similarly, the lowest level of participation relative to the total irrigated area has been in the Canyons/OPA and Santa Ana Heights/UCI Village Groups. While there are likely to be efficiencies gained through improved water management of swimming pools (e.g., increasing use of pool covers and encouraging cleaning method alternatives to draining), compared to irrigated turf area, the total pool area in the District is still comparatively very small (approximately 103 acres of pool area versus approximately 1,863 acres of turf area).

3.6. Commercial, Industrial, and Institutional Program Participation and Business Type Characteristics

Tables 3-17 and **3-18** list the participating SPs in the CII Turf Removal and CII Indoor Device Rebate programs, respectively, and include the associated water use sector, North American Industry Classification System (NAICs) Economic Subsector (3-digit level) designation, and the land use designation per parcel data.[25] The participants in the Device Rebate Programs receiving the most devices (typically more than 100) appear to be primarily hotels. Those receiving fewer devices (i.e., less than ten) appear to be businesses that are likely to have primarily office type operations.

Of the indoor devices offered through this program, the greatest number of rebates have been granted for plumbing flow control valves (1,942 rebates); however, these have gone to only two CII SPs. The second most popular rebated device is HETs, with 1,707 total rebates among 14 CII SPs. Thirty-one CII SPs participated in the CII Turf Removal program and includes a mix of commercial and industrial SPs. On average, each of the CII SPs participating in the CII Turf Removal program replaced approximately 0.3 acres of turf through the program. Substantial effort has gone into switching landscaped areas associated with CII SPs to dedicated irrigation meters, many of which are served by recycled water. Therefore, many CII SPs have no associated turf areas, and what turf areas they have are on whole much smaller than those associated with the dedicated irrigation SPs.

3.7. Funding Levels

Over time, the dollar amount of rebates offered to customers has varied for each WE program reviewed. In order to evaluate whether rebate amounts tend to be a strong driver of program participation, the change in rebate amount available to customers versus program participation are evaluated below. The rebate amounts reflected in **Figures 3-14** through **3-20** are the total amount available to the customer, which may be a combination of funds from IRWD, MWD, and/or MWDOC. **Figures 3-14** through **3-20** also show the number of SPs that have participated per month in a given WE program.

[25] The University of California at Irvine had a very high level of participation in these programs, but are excluded from this analysis primarily due to its uniqueness as a large institutional entity.

Table 3-17
Summary of Business and Land Use Classifications for CII Indoor Device Rebate Participants
Irvine Ranch Water District

Village Group	Sector	Water Source	Number of Devices					NAICS - Economic Subsector (3 Digit Level)		Land Use per Assessor Parcel Data
			HET/ PHET	ULWU/ ZWU	HECW	Cooling Tower	Plumbing Flow Control			
A	Commercial	Potable		1				713	Amusement, Gambling, and Recreation Industries	COMMERCIAL (GENERAL) COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE AGRICULTURAL / RURAL (GENERAL) COMMERCIAL-VACANT LAND AGRICULTURAL-UNIMPROVED VACANT LAND
A	Commercial	Potable		8				713	Amusement, Gambling, and Recreation Industries	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE COMMERCIAL (GENERAL) AGRICULTURAL / RURAL (GENERAL) COMMERCIAL-VACANT LAND AGRICULTURAL-UNIMPROVED VACANT LAND
A	Commercial	Potable		1				713	Amusement, Gambling, and Recreation Industries	COMMERCIAL (GENERAL) COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE AGRICULTURAL / RURAL (GENERAL) COMMERCIAL-VACANT LAND AGRICULTURAL-UNIMPROVED VACANT LAND
A	Commercial	Potable			1			531	Real Estate	MULTI-FAMILY DWELLINGS (GENERIC, ANY COMBINATION 2+)
A	Commercial	Potable		1				713	Amusement, Gambling, and Recreation Industries	COMMERCIAL-VACANT LAND AGRICULTURAL-UNIMPROVED VACANT LAND AGRICULTURAL / RURAL (GENERAL) COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE COMMERCIAL (GENERAL)
C	Commercial	Potable	3					813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	--
C	Commercial	Potable	120					721	Accommodation	COMMERCIAL (GENERAL)
C	Commercial	Potable					780	721 713 722	Accommodation Amusement, Gambling, and Recreation Industries Food Services and Drinking Places	COMMERCIAL (GENERAL) EXEMPT (FULL OR PARTIAL)
C	Commercial	Non-Potable		6				523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	COMMERCIAL (GENERAL)
C	Commercial	Potable			1			522	Credit Intermediation and Related Activities	CONDOMINIUMS (INDUSTRIAL)

Table 3-17

Summary of Business and Land Use Classifications for CII Indoor Device Rebate Participants

Irvine Ranch Water District

Village Group	Sector	Water Source	Number of Devices					NAICS - Economic Subsector (3 Digit Level)		Land Use per Assessor Parcel Data
			HET/ PHET	ULWU/ ZWU	HECW	Cooling Tower	Plumbing Flow Control			
C	Commercial	Non-Potable		6				523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	COMMERCIAL (GENERAL)
C	Commercial	Potable			1			531	Real Estate	MULTI-FAMILY DWELLINGS (GENERIC, ANY COMBINATION 2+)
C	Commercial	Non-Potable		6				523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	COMMERCIAL (GENERAL)
C	Commercial	Potable	160					--	--	COMMERCIAL (GENERAL)
F	Commercial	Potable	9					813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	COMMERCIAL (GENERAL)
F	Commercial	Potable	1					813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	RESIDENTIAL-VACANT LAND
G	Commercial	Potable		3				812	Personal and Laundry Services	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-
G	Commercial	Potable	1					561	Administrative and Support Services	LIGHT INDUSTRIAL (10% IMPROVED OFFICE SPACE; MACHINE SHOP)
G	Commercial	Potable	303					--	--	HOTEL
G	Commercial	Potable				1		531	Real Estate	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE COMMERCIAL-VACANT LAND
G	Commercial	Potable	45	9				561	Administrative and Support Services	COMMERCIAL (GENERAL)
G	Commercial	Potable	538					721 713	Accommodation Amusement, Gambling, and Recreation Industries	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable			1			541 236 541	Professional, Scientific, and Technical Services Construction of Buildings Professional, Scientific, and Technical Services	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable			1			813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	--
G	Commercial	Potable	204					721 561	Accommodation Administrative and Support Services	COMMERCIAL (GENERAL)
G	Commercial	Potable	171				1,162	561 236	Administrative and Support Services Construction of Buildings	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable	34					--	--	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable	3					541	Professional, Scientific, and Technical Services	COMMERCIAL (GENERAL)
G	Commercial	Potable	115					561 236	Administrative and Support Services Construction of Buildings	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
H	Commercial	Potable			1			812	Personal and Laundry Services	COMMERCIAL (GENERAL)

Table 3-17

Summary of Business and Land Use Classifications for CII Indoor Device Rebate Participants

Irvine Ranch Water District

Village Group	Sector	Water Source	Number of Devices					NAICS - Economic Subsector (3 Digit Level)	Land Use per Assessor Parcel Data
			HET/ PHET	ULWU/ ZWU	HECW	Cooling Tower	Plumbing Flow Control		
Total Participating SPs			14	9	6	1	2		
Total Devices Rebated			1,707	41	6	1	1,942		
Average Number of Device			**122**	**5**	**1**	**1**	**971**		

Abbreviations:

HECW = high efficiency clothes washer
HET = high efficiency toilet
PHET = Premium high efficiency toilet
ULWU/ ZWU = Zero and Ultra Low Water Urinals
SP = Service Points

Table 3-18
Summary of Business and Land Use Classifications for CII Turf Removal Rebate Participants
Irvine Ranch Water District

Village Group	Sector	Water Source	Turf Removed (ac)	NAICS - Economic Subsector (3 Digit Level)		Land Use per Assessor Parcel Data
C	Commercial	Potable	0.045	237 531	Heavy and Civil Engineering Construction Real Estate	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
C	Commercial	Potable	0.206	311	Food Manufacturing	INDUSTRIAL (GENERAL)
C	Commercial	Potable	0.438	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	INSTITUTIONAL-VACANT LAND
C	Commercial	Potable	6.268	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	--
G	Industrial	Potable	0.097	424	Merchant Wholesalers, Nondurable Goods	INDUSTRIAL (GENERAL)
G	Industrial	Potable	0.163	--	--	INDUSTRIAL (GENERAL)
G	Commercial	Potable	0.114	236	Construction of Buildings	COMMERCIAL (GENERAL)
G	Industrial	Potable	0.145	333	Machinery Manufacturing	WAREHOUSE (INDUSTRIAL)
G	Commercial	Potable	0.048	531	Real Estate	LIGHT INDUSTRIAL (10% IMPROVED OFFICE SPACE; MACHINE SHOP)
G	Commercial	Potable	0.129	561 236	Administrative and Support Services Construction of Buildings	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable	0.091	453	Miscellaneous Store Retailers	WAREHOUSE (INDUSTRIAL)
G	Industrial	Potable	0.162	335	Electrical Equipment, Appliance, and Component Manufacturing	INDUSTRIAL (GENERAL)
G	Commercial	Potable	0.037	531	Real Estate	WAREHOUSE (INDUSTRIAL)
G	Commercial	Potable	0.028	531	Real Estate	COMMERCIAL BUILDING, MAIL ORDER, SHOW ROOM (NON-AUTO), COMMERCIAL WHSE
G	Commercial	Potable	0.101	444 423	Building Material and Garden Equipment and Supplies Dealers Merchant Wholesalers, Durable Goods	WAREHOUSE (INDUSTRIAL)
G	Industrial	Potable	0.103	531	Real Estate	INDUSTRIAL (GENERAL)
G	Commercial	Potable	0.153	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	COMMERCIAL (GENERAL)
G	Commercial	Potable	0.112	531	Real Estate	INDUSTRIAL (GENERAL)
G	Industrial	Potable	0.409	--	--	INDUSTRIAL (GENERAL)
G	Industrial	Potable	0.043	--	--	LIGHT INDUSTRIAL (10% IMPROVED OFFICE SPACE; MACHINE SHOP)
G	Commercial	Potable	0.033	541	Professional, Scientific, and Technical Services	INDUSTRIAL (GENERAL)
G	Commercial	Potable	0.277	--	--	COMMERCIAL (GENERAL)
G	Industrial	Potable	0.099	--	--	WAREHOUSE (INDUSTRIAL)
G	Commercial	Potable	0.058	721	Accommodation	HOTEL
G	Commercial	Potable	0.052	423	Merchant Wholesalers, Durable Goods	WAREHOUSE (INDUSTRIAL)

Table 3-18
Summary of Business and Land Use Classifications for CII Turf Removal Rebate Participants
Irvine Ranch Water District

Village Group	Sector	Water Source	Turf Removed (ac)	NAICS - Economic Subsector (3 Digit Level)		Land Use per Assessor Parcel Data
H	Commercial	Potable		813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	RESIDENTIAL-VACANT LAND
H	Commercial	Potable	0.019	531	Real Estate	INDUSTRIAL (GENERAL)
H	Industrial	Potable	0.128	323	Printing and Related Support Activities	INDUSTRIAL (GENERAL)
H	Commercial	Potable	0.188	921	Executive, Legislative, and Other General Government Support	COMMERCIAL (GENERAL)
H	Institutional	Potable	0.041	611	Educational Services	COMMERCIAL (GENERAL)
H	Commercial	Potable	0.202	561 333	Administrative and Support Services Machinery Manufacturing	WAREHOUSE (INDUSTRIAL)
H	Commercial	Potable	0.021	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	COMMERCIAL (GENERAL)
Total			**9.759**			

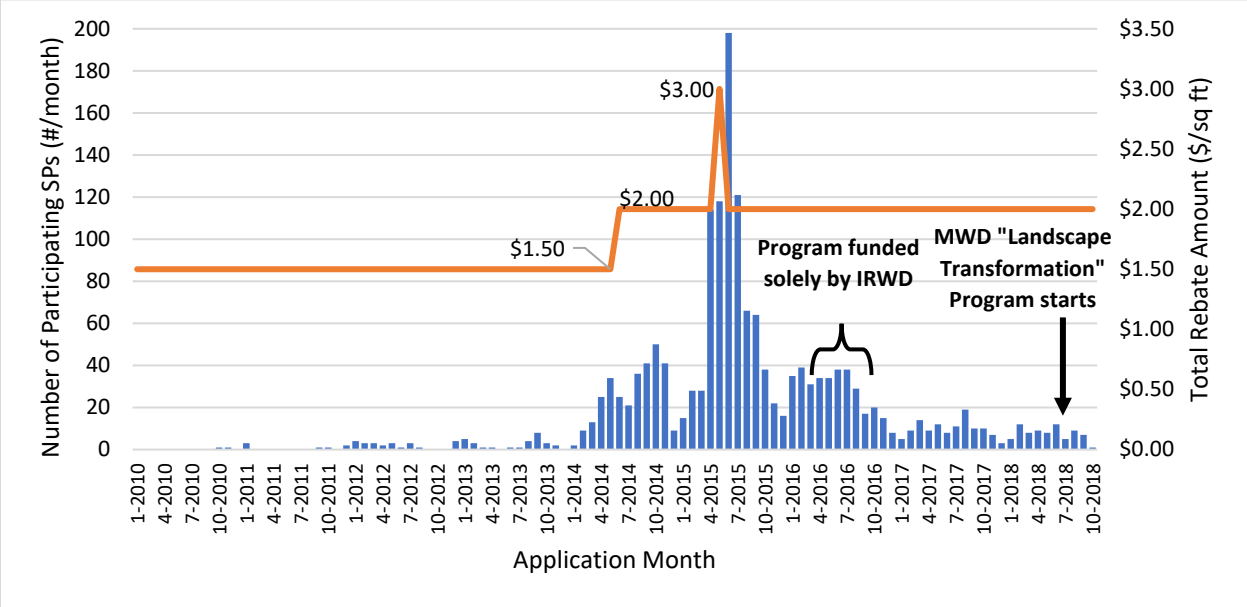
Abbreviations:
AC = acre
CII = Commercial, Industrial, and Institutional
NAICS = North American Industry Classification System
SP = Service Points

3.7.1. Outdoor Irrigation Programs for Single-Family Residential Customers

Figure 3-14 shows the level of participation by SFR customers in the Turf Removal program by rebate amount. In general, participation rates appear to have increased in 2014, which corresponds to when the rebate value increased from $1.50/sq ft to $2.00/sq ft. Another increase in participation rates was observed in summer 2015, which corresponds to the temporary increase in rebate value to $3.00/sq ft, but also to the time period where there was increased marketing and outreach for the program associated with the historic drought.

Given that, for the majority of the Turf Removal program, the rebate value has been $2.00/sq ft, and that participation rates in 2017 and 2018 are lower than those observed in 2014, it appears that marketing and promotion of the program has a more substantial effect on participation rates than just the rebate value. It should also be noted that there is a clear seasonal pattern to applications by SFR customers, wherein more applications are submitted in summer months compared to winter months.

Figure 3-14
SFR Turf Removal Rebate Program Participation by Rebate Level



Figures 3-15 and **3-16** below show the level of participation in the SFR WBIC rebate program for landscapes smaller than 1-acre and larger than 1-acre, respectively, along with the change in rebate amounts over time. The majority of participation by SFR customers in the WBIC rebate program has been by those SPs with landscapes smaller than 1-acre. When rebate amounts were increased from $80 to the cost of the device (up to $425) in July 2011, there was an increase in the rate of participation. The rebate amount was reduced to $150 in July 2014, but participation rates have continued increasing through 2018 despite the rebate amount remaining relatively low compared to the 2011-2013 levels. It should be noted that in this time frame, the overall costs of WBICs available on the market has trended downward as well. However, these data suggest that the rebate value does not appear to be the primary driver for participation by SFR customers in the WBIC rebate program.

Figure 3-15
SFR WBIC Rebate Program (<1-acre Landscape) Participation by Rebate Level

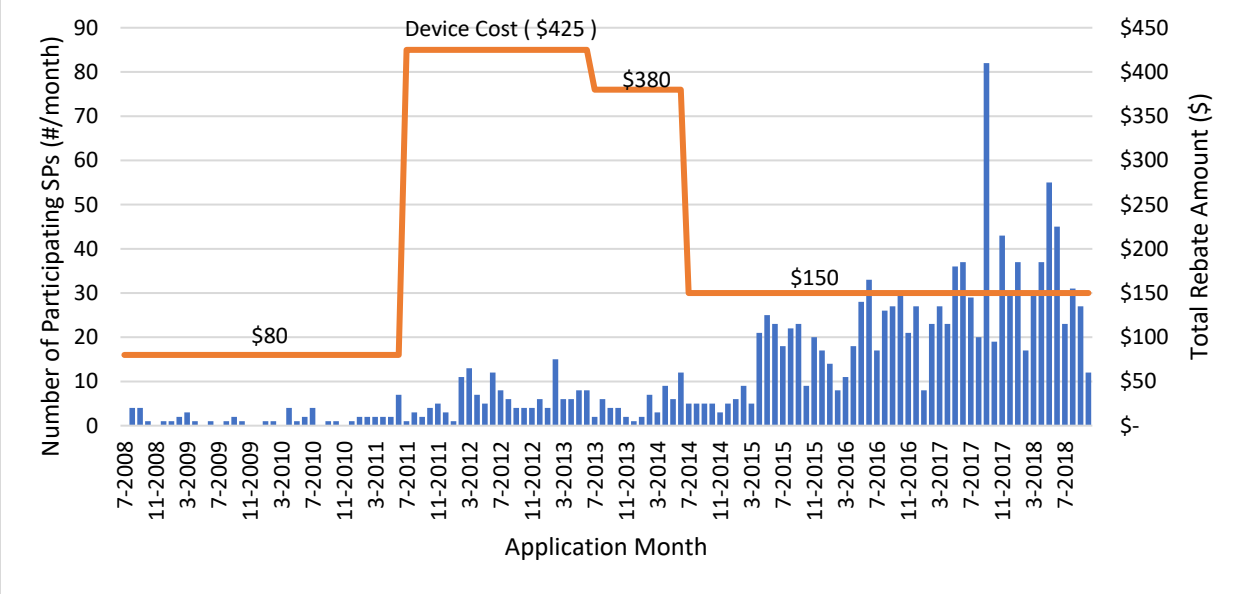
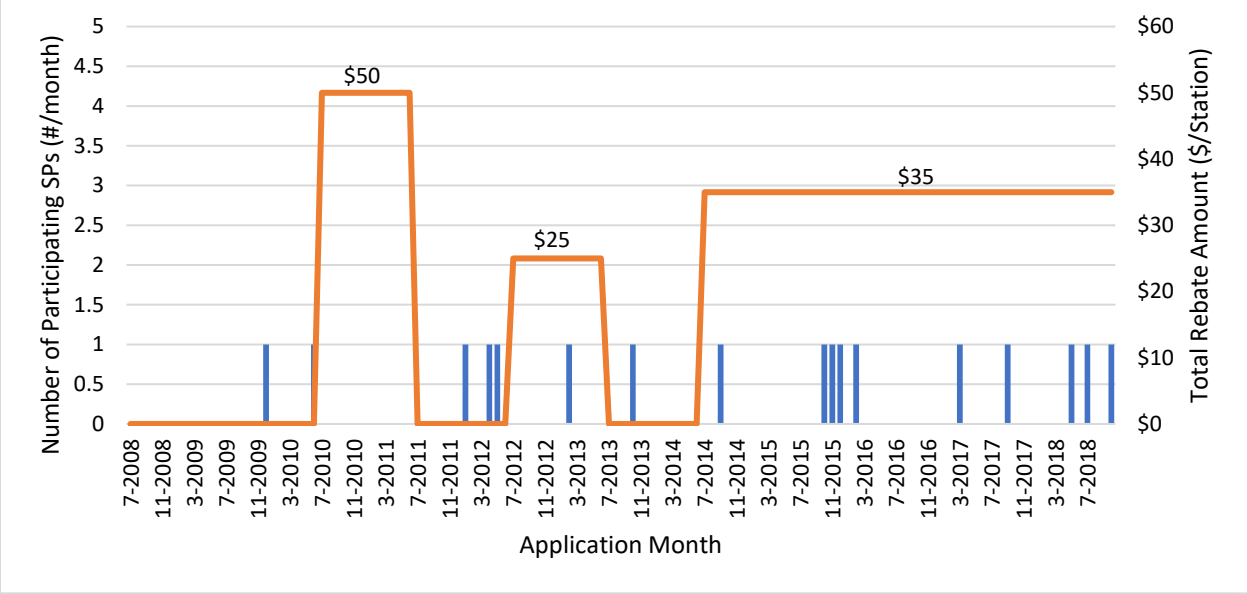


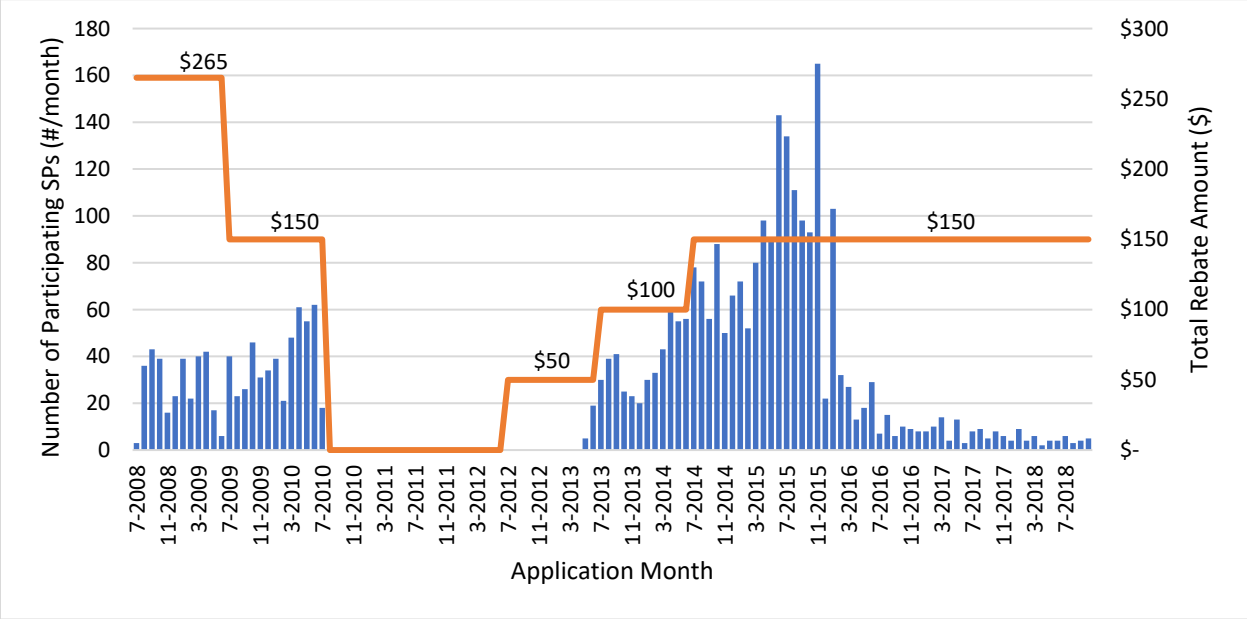
Figure 3-16
SFR WBIC Rebate Program (>1-acre Landscape) Participation by Rebate Level



3.7.2. Single-Family Residential High Efficiency Toilet Programs

Figure 3-17 shows participation by SFR customers in the HET rebate program by rebate amount. Overall participation rates generally increased from 2008 through 2010 (when the program was suspended), even though the rebate was reduced from $265 to $150 in July 2009. Once the program was re-instated, participation rates increased through 2015, with an apparent relationship to increases in rebate value. However, since 2016, participation in the program has declined, even though the rebate amount has remained the same at $150. As with the turf removal and WBIC rebates, it does not appear that the rebate amount for HETs is the primary driver for participation, especially in recent years.

Figure 3-17
SFR HET Rebate Program Participation by Rebate Level

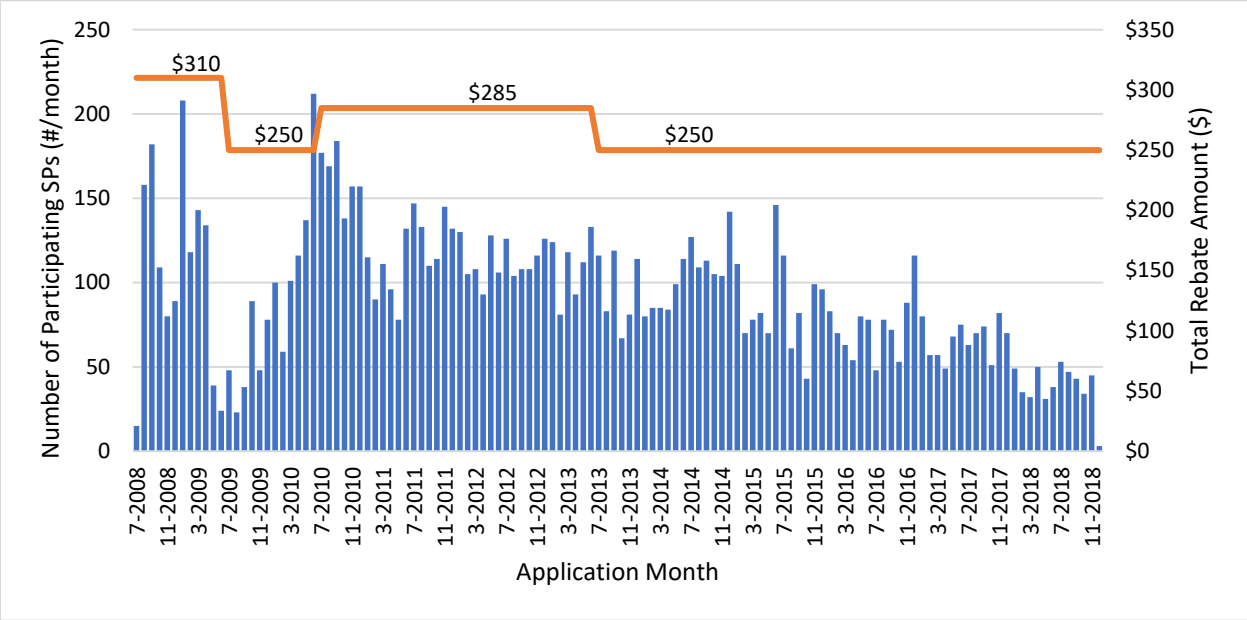


3.7.3. Single-Family Residential High Efficiency Clothes Washer Rebate Program

Figure 3-18 shows participation by SFR customers in the HECW rebate program by rebate amount. Compared to other programs, the rebate amount offered for HECWs has not varied as much. There does appear to have been a distinct, short-term drop in program participation corresponding with the decrease in rebate value from $310 to $250 in July 2009, but since that time, participation does not appear to have varied relative to the amount of rebate offered. Over time, the number of washer models on the market that meet the rebate eligibility criteria has varied. Rebate eligibility is based on washers meeting a minimum efficiency (i.e., WF[26] value) and the minimum qualifying efficiency has been increased over the course of the program. As fewer eligible washers are available, this may also play a factor in the observed participation rate decline.

[26] WF is measured as the number of gallons of water used to wash one cubic foot of laundry.

Figure 3-18
SFR HECW Rebate Program Participation by Rebate Level



3.7.4. Outdoor Irrigation Programs for Landscape Irrigation, Commercial, Industrial, and Institutional Service Points

Figure 3-19 shows the level of participation by CII and large landscape customers in the Turf Removal program by rebate amount. Participation rates increased in the summer of 2014, corresponding to a decrease in rebate amount from $2.50/sq ft to $2.00/sq ft, and an increase in program marketing. Following summer 2015 and corresponding with a drop in the rebate value to $1.00/sq ft, participation rates have dropped off. The increase in rebate amount to $2.00/sq ft in 2017, does not appear to have resulted in a corresponding increase in participation. Therefore, it appears that participation by CII and large landscape SPs is less influenced by rebate amount than it is by program marketing and outreach.

Figure 3-19
CII and Large Landscape Turf Removal Rebate Program Participation by Rebate Level

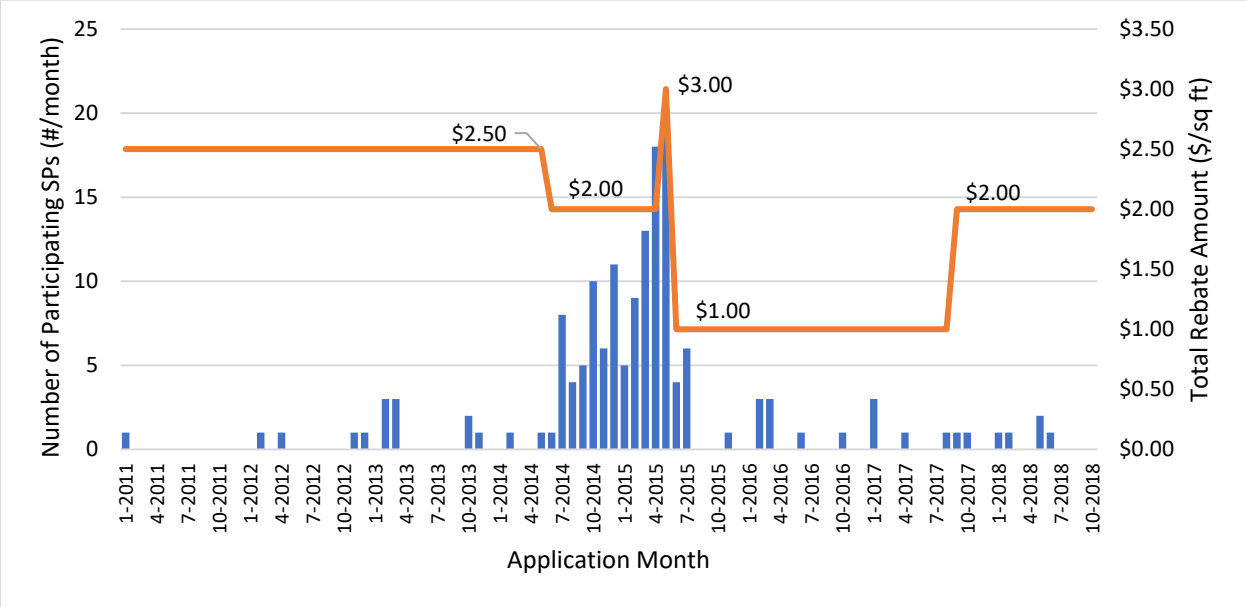
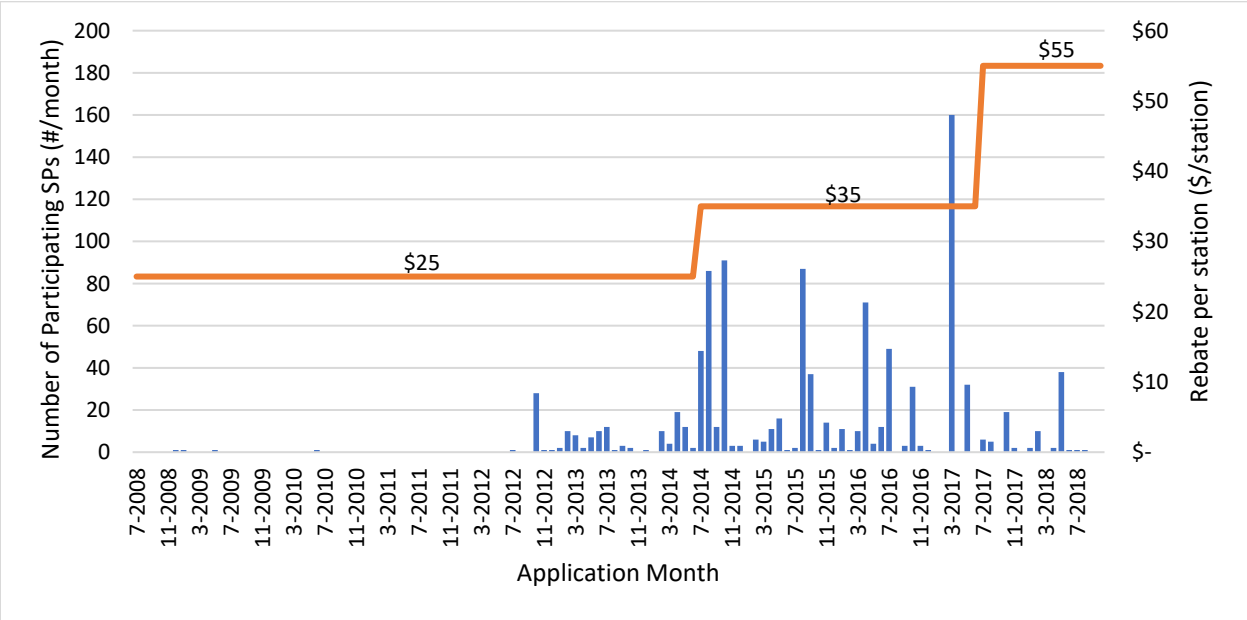


Figure 3-20 shows participation by large landscape accounts in the WBIC rebate program by rebate amount. As with SFR customers, the rebate amount does not appear to be the primary driver for participation. Participation rates were generally highest during the 2014 – 2016 period, when the rebate amount was $35/station. The rate of participation has decreased in recent years, even though the rebate was increased to $55/station.

Figure 3-20
Large Landscape WBIC Rebate Program Participation by Rebate Level



3.8. Summary of Program Participation Findings for Ten Selected WE Programs

By reviewing and analyzing past participation in ten selected WE programs, this Study provides insights on how and which IRWD customers tend to participate in various programs. These findings are summarized below, and were used to inform the program opportunity evaluation and approaches identified in Sections 6 and 7.

- **The WE programs appear to have effectively targeted customers with the most potential to achieve water savings** (i.e., SPs at older homes had a higher participation rate in indoor device replacement programs and SPs with larger-than-typical landscapes had a higher participation rate in irrigation efficiency device programs).
- **Program participation rates are not consistent throughout the District and reflect diverse demographic and property characteristics**, which can be generally correlated based on geographic location within the District (i.e., Village Groups). On the whole, the highest participation rates by SFR customers occurred in the Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD Village Groups, and the lowest participation rates have been in the Canyons/OPA and Coast Village Groups. In addition, SFR customers in predominantly high income areas (i.e., median household income between $85,000 and $128,000) tended to participate at lower rates than those in very high income areas (i.e., median household income >$128,000/year). As such, there appear to remain potential opportunities for more targeted outreach to encourage increased WE program participation in certain areas and across certain demographics.
- **Different program models can broaden/accelerate participation.** Although WE programs are made available to all customers, residential customers have generally tended to participate in only one program, typically replacing only one device. Of those customers that have participated in multiple programs, they have tended to do so over the course of multiple years with approximately half participating in both indoor and outdoor-focused programs. The One-Stop-Shop program was specifically targeted to a subset of SFR customers and, through a partnership with other entities, provided a suite of water and energy efficient devices to customers at no-cost. In its short lifetime, the One-Stop-Shop program was very successful at distributing a large number of devices and at reaching different subsets of customers. Specifically, participants in the One-Stop-Shop program tended to reflect a broader cross-section of SPs than was otherwise observed in the more traditional, primarily rebate-based, programs. While very successful, programs that are “no-cost” to the customer, like the One-Stop-Shop, are very costly and resource-intensive for the District. However, if the goal is to accelerate progression towards water efficiency in a short period of time, comprehensive no-cost programs such as the One-Stop-Shop have proven more effective at increasing the change out of multiple WE devices than relying on a series of rebate-based, single-device programs.
- **CII and landscape irrigation customers remain a potential untapped opportunity**. In general, the overall participation rates and trends between Village Groups by landscape irrigation customers are similar to those of SFR customers. The highest participation in WBIC and Turf Removal Programs has been in the Lake Forest/Foothills and Central Irvine/ICD Village Groups, while the lowest level of participation relative to the total irrigated area has been in the Canyons/OPA and Santa Ana Heights/UCI Village Groups. Overall there has been relatively little participation in programs by CII customers compared to that by SFR and landscape irrigation customers. What participation there

has been, has been primarily in West Irvine/Tustin Ranch Village Group for the Indoor Device Rebates and in Santa Ana Heights/UCI and Central Irvine/ICD Village Groups for the Turf Removal Rebates. As such, these areas of lower participation remain a potential opportunity for more targeted outreach to encourage increased WE program participation.

- **Opportunities have been identified for increased water savings through strategic WE program planning,** including strategic targeting based on program type, key customer demographics, and SP location within the District. Taken together, the analyses conducted as part of this Study suggest that, depending on IRWD's goals for its future WE programs, there remain large portions of the District for which there may be a substantial benefit in terms of WE program participation rates and associated water savings. Depending on IRWD's goals, these WE results can be achieved by modifying program design and/or focusing outreach in areas of the District and to customers that have had comparatively low levels of WE program participation to date, but for which opportunities for increased WE remain.
- **Unless a rebate increase is coupled with a substantial marketing and outreach effort, the actual rebate value does not appear to be a substantial driver for customer participation.** Given this finding, in order to increase WE program participation, increased marketing and outreach should be considered as well as the rebate value when considering WE program development and implementation.

4. ESTIMATED WATER EFFICIENCY PROGRAM WATER SAVINGS FOR SELECTED PROGRAMS

Water use by Irvine Ranch Water District (IRWD) customers has declined in recent years (i.e., approximately 27% of total potable use on a per capita basis since 2013).[27] While the water efficiency (WE) programs provided to IRWD customers have certainly contributed to this reduction in water use, other factors including passive water conservation, regulatory requirements, drought conditions, economic influences, and a greater public awareness of responsible water use are likely also contributing to this reduction, to varying degrees. In order to isolate and quantify the impact of IRWD's WE programs, the amount of water savings directly resulting from participation in ten selected WE programs was estimated. The values derived for IRWD customers were used in the cost-benefit assessment of potential WE program scenarios in Section 7.

IRWD-Specific Water Savings Factors

Sector	Measure	IRWD-Specific Savings Factors
SFR	Turf Removal	3.0 AFY/ ac
SFR	WBIC	0.017 AFY/unit
SFR	HET	0.014 AFY/unit
SFR	PHET	0.013 AFY/unit
SFR	HECW	0.012 AFY/unit
SFR	One-Stop-Shop	0.046 AFY/SP
Landscape Irrigation, Potable	Turf Removal	0.38 – 0.77 AFY/ac based on size of landscape area
Landscape Irrigation, Potable	WBIC	0 – 0.017 AFY/ac based on size of landscape area

Using IRWD-specific savings rates that reflect participation trends and intra-District customer variability can be used to improve local planning estimates and inform program prioritization, funding, targeting, and marketing.

4.1. Water Savings Analysis Methodology

In order to estimate the water savings associated with participation in each WE program, water use by program participants was compared to water use by a representative cohort. Water use savings were estimated for the ten WE programs identified below.

1. Single-Family Residential (SFR) Turf Removal Rebates;
2. SFR Weather-Based Irrigation Controller (WBIC) Rebates;
3. SFR High Efficiency Toilet (HET) Rebates;
4. SFR Premium High Efficiency Toilet (PHET) Rebates;
5. SFR High Efficiency Clothes Washer (HECW) Rebates;
6. SFR One-Stop-Shop Program (all devices);
7. WBIC Rebates for Potable Landscape Irrigation service points (SPs);
8. WBIC Rebates for Non-Potable Landscape Irrigation SPs;

[27] This estimate is based on monthly reporting to the State Water Resources Control Board.

9. Turf Removal Rebates for Potable Landscape Irrigation SPs; and
10. Turf Removal Rebates for Non-Potable Landscape Irrigation SPs.

This selected list of WE programs is similar to those analyzed in Section 3 with the following modifications: (1) water savings by HET and PHET rebates are evaluated separately;[28] (2) water savings for participants in the One-Stop-Shop program is evaluated regardless of which or how many devices were installed in order to evaluate the water saved by the One-Stop-Shop approach as a whole; and (3) water savings by commercial, industrial, and institutional (CII) customers are not evaluated due to the limited amount of available data.

In order to estimate the water savings associated with participation in each WE program, water use by program participants was compared to water use by a representative cohort over the same time period, that was stratified based on key criteria. Specifically, water use before and after implementation of a given WE measure (e.g., device or turf removal) by program participants is compared to the water use by a cohort of accounts who have not participated in the same or other WE programs in the given time frame. The incremental volume of water saved by program participants compared to that of the cohort group can then be attributed to program participation, as other factors have been normalized. This analytical technique is also known as a "Difference-in-Differences Estimation". The Difference-in-Difference method is a standard method used in economics and social science for quantitatively evaluating observational study data by studying the differential effect of a treatment, or in this case participation in a given WE program as compared to a "control group," when a true controlled experiment cannot be performed.

By comparing water use over time to a cohort group and identifying just the incremental change in water use due to program participation, this methodology controls for variation in water use due to climate, economic, and other temporally related factors. By stratifying (or weighting) the cohort group based on key factors (i.e., village or landscape size), this method also effectively controls for geographic-linked water use influencing factors, such as house and yard size, housing age, general socio-economic factors, general landscape management factors, etc. The results of these savings analyses are compared to industry standard values in Section 4.7.

Participant Sample Groups: In order to estimate the water saving attributable to a single WE program, participant sample groups for this analysis were limited to SPs that participated in only one WE program, and who participated in that program in only one year (e.g., did not receive several HET rebates over several years). The participant sample groups were further limited to just those SPs that had active water use over the study period.[29] Active SPs were identified as those who received 12 or more water bills in a given year. Further, in order to reasonably screen out residential SPs that are not fully occupied (e.g., partially occupied rental properties or a part-time residence), SFR SPs were further considered to be active only if they used 20 one-hundred cubic feet (CCF) or more in a given year (approximately 42 gallons per day [gpd]).[30,31]

[28] HET refers to toilets that are 1.28 gallons per flush (gpf) or less. PHET refers to toilets that are 1.1 gpf or less.
[29] For purposes of the saturation analysis in Section 5.2.1, all program participants are considered.
[30] 20 CCF, or 42 gpd was selected as this threshold because this represents the lowest 10% of water use by accounts.
[31] IRWD customers received one extra bill in 2015 due to a change in water billing system. For purposes of active account screening, a full year of water bills was considered to be 13 water bills in 2015.

Given that landscape irrigation SPs do not have the same occupancy issues, landscape irrigation SPs were considered to be active if they received 12 or more water bills and used at least 1 CCF per year of water. Due to these sample group "eligibility" limitations, the total number of participants in each participant sample group evaluated herein is lower than the total number of program participants identified in Section 3.

Comparison Cohort Sample Groups: SPs included in the cohort groups are limited to those SPs that had not participated in any WE program based on available data and that meet the same active account thresholds as described above for the participant sample groups (i.e., received 12 bills per year and had a minimum level of annual water use). It is possible that members of the cohort group participated in a program prior to 2009;[32] however, given the large number of SPs included in these groups the effect of participation prior to 2009 would be expected to be minimal. Although not participants in a specific WE program, a portion of the cohort group members would be expected to have changed out water using devices with more efficient ones through natural replacement. Given this, the WE program savings identified by this method may actually be somewhat higher. Therefore, this approach results in a conservative WE program savings estimate.

Study Periods: **Table 4-1** below shows the selected study periods (shown in blue shading) for each of the WE programs and the number of SPs meeting the above criteria. The study periods are generally selected to incorporate the most recent three to four years of available data, in order to represent the most current water use characteristics and devices available on the market. Water savings cannot be calculated for participants in 2018 because no water use data are available to represent a period following the WE program implementation. As shown in **Table 4-1**, these selected time periods generally capture the majority of the overall program participants in the most recent years. In each case, the study period spans a portion of the 2013-2017 drought. Given that both the participant and cohort populations were subject to the same drought-related factors over this period, the effect of the drought on the analyses would be expected to be relatively minimal. Including the drought in the study period would be expected to have a larger effect on the results of savings for outdoor programs than indoor programs, and may be a factor particularly in the variation and minimal savings observed in WBIC programs.

[32] Between 1993 and 2008, IRWD customers received over 21,000 WE devices through WE programs, including HETs, HECWs, WBICs, and other devices.

Table 4-1
Selected WE Program Study Period

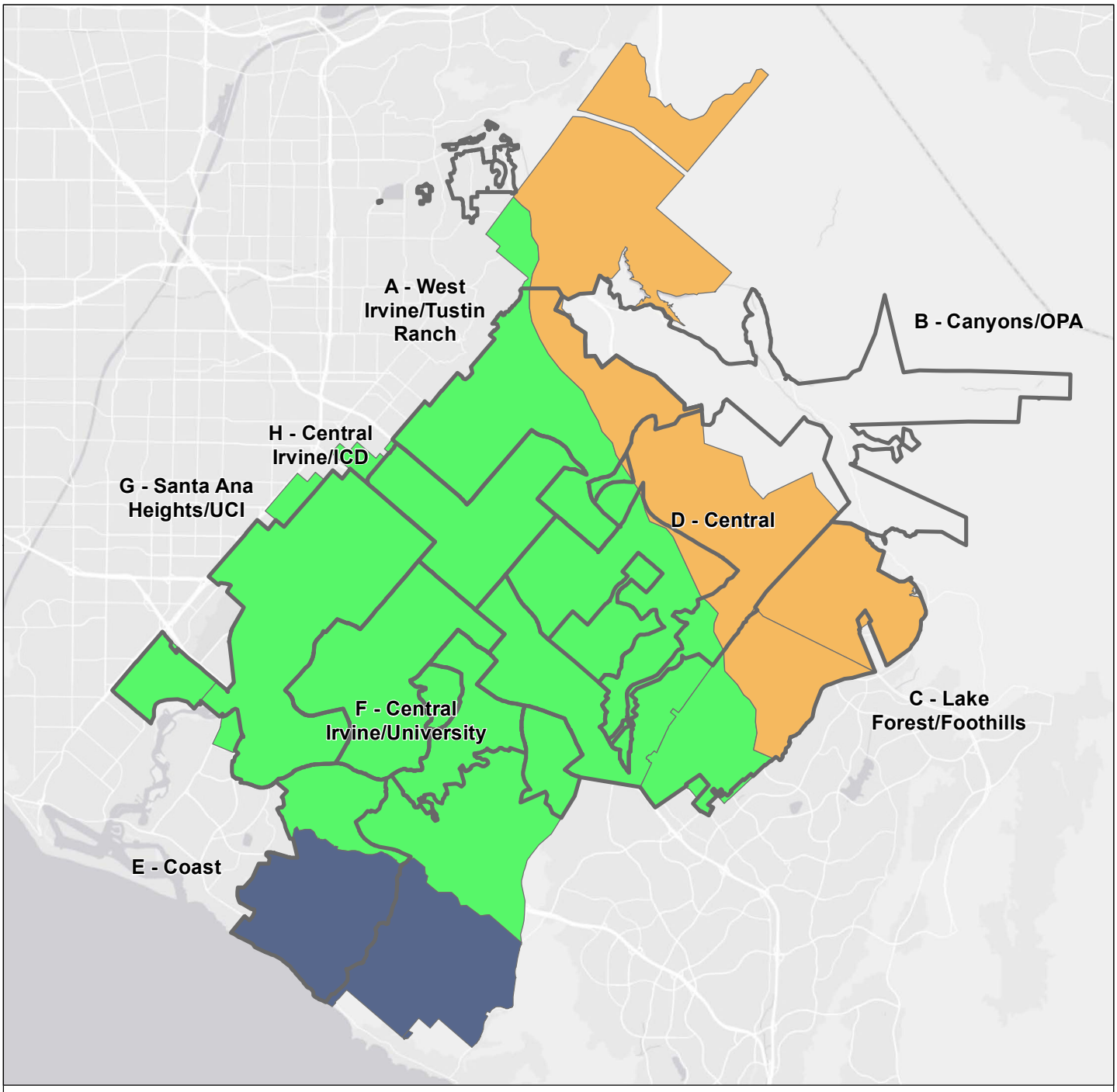
WE Program	Number of SPs Participating in a Single WE Program[33,34]											Total SPs in Study Period	Percent of Participant SPs
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
Single-Family Residential SPs													
Turf Removal Rebates	--	--	--	--	7	15	130	378	232	96	48	836	92%
WBIC Rebates	3	4	8	12	30	28	19	78	116	173	182	367	56%
HET Rebates	73	187	145	--	--	60	204	357	--	--	19	621	59%
PHET Rebates	--	--	--	--	--	--	--	55	117	32	6	204	97%
HECW Rebates	500	720	1,253	1,088	1,043	941	889	712	638	568	312	2,807	32%
One-Stop-Shop	--	--	--	--	--	--	--	--	--	884	9	884	99%
Landscape Irrigation SPs													
Turf Removal Rebates													
Non-Potable	--	--	--	--	--	1	10	36	--	--	2	46	94%
Potable	--	--	--	1	2	3	5	26	3	2	2	36	82%
WBIC Rebates													
Non-Potable	1	1	--	--	13	36	128	49	106	158	38	441	83%
Potable	--	--	--	--	1	4	31	13	9	5	--	58	92%

Stratification: For the SFR WE programs, the water savings calculations were stratified (or weighted) based on villages as shown in **Figure 2-1**, as a way to control for geographically linked variables such as house and yard size, housing age, general socio-economic factors, etc. **Table 4-2** shows a comparison of key characteristics for the SFR program participants and the cohort group SPs, as grouped by Villages. Based on this assessment, the characteristics of the cohort group members are consistent with the program participant sample group members and thus the cohorts are appropriately representative of the program participants for purposes of this analysis.

For landscape irrigation WE programs, water savings calculations were stratified based on evapotranspiration (ET) zone (**Figure 4-1**) and based on the size of the irrigated area per SP. That is, all landscape irrigation SPs were categorized to control for the general differences in landscape management

[33] The SPs included here includes SPs that did not have active water use for the analysis period before and/or after participation. Thus, the actual number of SPs included in the participant sample groups are further reduced by 2% to 25% depending on the program. Approximately 25% of the SFR HECW rebate recipient SPs lacked sufficient water use data, reflecting the fact that rebates can be used to purchase HECWs for new homes, rather than only replacing existing older washers.

[34] Selected study periods are shown with blue shading. Total SPs in a study period refers to the number of SPs participating in a program in a given year within the selected study period. Percent of Participant SPs is based on the total number of SPs participating in a given year since 2009.



Legend

Village Group Boundary

Evapotranspiration Zone

Central

Coastal

Foothill

N

0 3 6

(Scale in Miles)

Evapotranspiration Zones

Notes

1. All locations are approximate.
2. Evapotranspiration zone boundaries and naming are defined by Irvine Ranch Water District.

Sources

1. Evapotranspiration zone boundaries received from Irvine Ranch Water District on 09 January 2019.

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Irvine Ranch Water District
December 2019
B80129.00

Figure 4-1

Path: X:\B80129\Maps\2019\12_Final\Fig 4-1 ET.mxd

Table 4-2
Housing Stock Characteristic of Cohort Group and SFR Program Participants
Irvine Ranch Water District

		Comparision Cohort Members				SFR Turf Removal					SFR WBIC Rebates					SFR HET Rebates				
Village and Village Group		Number of SPs	Median Year Built	Median Lot Size (sq ft)	Median Interior Size (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Lot Size (sq ft)	Lot Size Range (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Lot Size (sq ft)	Lot Size Range (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Interior Size (sq ft)	Interior Size Range (sq ft)
A	Northpark	1,213	2001	5,265	2,486	19	2001	1999 - 2003	5,053	3,684 - 207,968	12	2001	2000 - 2003	5,711	4,053 - 8,288	11	2001	1999 - 2005	2,971	1,491 - 3,902
	Orchard Hills	395	2015	6,196	3,628	–	–	–	–	–	3	2015	2014 - 2015	6,900	5,781 - 7,925	–	–	–	–	–
	Stone Gate	913	2013	7,318	2,291	2	2011	2010 - 2012	4,008	4,008 - 4,008	7	2014	2013 - 2015	4,836	3,317 - 165,307	–	–	–	–	–
	Tustin Ranch	1,290	1994	6,683	2,476	28	1994	1989 - 1999	9,875	2,434 - 489,566	9	1994	1989 - 1999	9,660	2,424 - 489,566	18	1993	1989 - 1997	2,057	1,281 - 3,467
	Tustin Ranch North	810	1998	5,300	2,526	18	1998	1993 - 2002	5,728	2,450 - 36,982	9	1998	1993 - 2001	4,929	4,310 - 16,989	15	1998	1992 - 2001	2,117	1,788 - 4,333
	West Irvine	878	1999	4,433	2,140	16	2000	1997 - 2001	4,860	3,690 - 6,841	10	1998	1997 - 2001	4,709	3,083 - 699,962	19	1999	1997 - 2001	2,246	1,649 - 3,114
B	Modjeska Canyon	168	1964	–	1,208	4	1990	1941 - 2000	–	3,643 - 43,560	–	–	–	–	–	4	1965	1948 - 1980	1,625	654 - 2,582
	Orange Park Acres	397	1966	–	1,913	14	1966	1936 - 1992	–	4,128 - 47,916	3	1992	1979 - 2007	–	43,560 - 43,560	3	1955	1918 - 1966	1,978	1,664 - 2,025
	Silverado Canyon	336	1945	6,338	1,032	4	1961	1933 - 1999	8,198	5,500 - 32,000	3	2000	1976 - 2002	–	8,676 - 34,100	2	1959	1940 - 1977	1,104	781 - 1,427
	Williams Canyon	35	2000	–	810	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C	Baker Ranch	358	2015	3,980	2,252	1	2014	2014 - 2014	4,439	4,439 - 4,439	4	2014	2014 - 2015	3,476	2,257 - 6,915	–	–	–	–	–
	Foothill Ranch	1,690	1994	4,800	2,004	55	1994	1991 - 1997	5,280	3,125 - 10,400	22	1994	1990 - 1996	4,815	3,500 - 7,475	34	1993	1990 - 1998	1,995	1,086 - 2,684
	Lake Forest	5,603	1976	6,000	2,105	220	1977	1964 - 2013	6,225	3,000 - 18,000	69	1977	1968 - 2012	5,912	3,000 - 13,340	137	1976	1928 - 1990	2,110	945 - 3,569
	Portola Hills	641	1992	6,300	2,513	36	1992	1987 - 1995	6,188	3,180 - 16,875	9	1994	1988 - 1996	6,360	3,030 - 19,800	11	1992	1987 - 1994	2,513	1,788 - 3,246
D	Cypress Village	499	2014	3,691	2,448	–	–	–	–	–	1	2014	2014 - 2014	3,659	3,659 - 3,659	–	–	–	–	–
	Heritage Fields	630	2014	6,515	2,696	1	2014	2014 - 2014	4,550	4,550 - 4,550	8	2014	2013 - 2015	5,497	4,680 - 7,067	–	–	–	–	–
	Hidden Canyon	21	2015	8,026	5,039	–	–	–	–	–	1	2015	2015 - 2015	7,394	7,394 - 7,394	–	–	–	–	–
	Laguna Altura	484	2012	–	2,075	1	2012	2012 - 2012	4,235	4,235 - 4,235	1	2011	2011 - 2011	4,231	4,231 - 4,231	1	2013	2013 - 2013	2,075	2,075 - 2,075
	Lambert Ranch	137	2013	6,325	3,937	–	–	–	–	–	3	2013	2013 - 2013	5,643	5,009 - 8,669	–	–	–	–	–
	Portola Springs	294	2010	–	2,095	1	2012	2012 - 2012	–	–	2	2011	2009 - 2013	–	–	–	–	–	–	–
	Portola Springs North	492	2012	7,188	2,398	2	2008	2007 - 2009	8,174	5,881 - 10,466	3	2011	2010 - 2013	4,312	3,118 - 5,634	–	–	–	–	–
	Woodbury	1,046	2005	5,986	2,414	5	2009	2005 - 2013	5,000	3,600 - 7,083	14	2006	2005 - 2013	5,304	3,668 - 99,000	8	2005	2005 - 2007	1,691	957 - 2,299
	Woodbury East	130	2009	8,287	2,313	–	–	–	–	–	1	2010	2010 - 2010	–	–	–	–	–	–	–
E	Crystal Cove	444	2003	–	3,997	3	2007	2003 - 2008	–	9,844 - 18,644	–	–	–	–	–	–	–	–	–	–
	Newport Coast	1,898	1998	9,569	3,495	20	1998	1992 - 2006	8,101	3,800 - 26,400	13	1998	1993 - 2006	7,150	3,840 - 11,660	8	1998	1993 - 2003	2,936	1,919 - 4,176
	Oak Creek	770	2000	–	1,750	15	1999	1998 - 2001	5,104	3,373 - 259,393	8	1999	1998 - 2000	8,415	3,804 - 356,957	6	1999	1999 - 2002	2,186	1,166 - 3,023
	Quail Hill	809	2003	–	1,930	6	2004	2003 - 2006	7,000	4,328 - 381,432	7	2004	2003 - 2006	8,843	5,870 - 381,432	2	2004	2003 - 2004	2,155	1,775 - 2,535
	Shady Canyon	317	2005	–	6,909	1	2005	2005 - 2005	–	25,962 - 25,962	–	–	–	–	–	–	–	–	–	–
	Turtle Ridge	693	2003	–	2,921	10	2004	2003 - 2006	9,697	5,477 - 386,998	7	2005	2003 - 2006	7,242	6,438 - 10,535	2	2003	2003 - 2003	3,258	3,184 - 3,331
F	Culverdale	326	1970	5,457	1,807	8	1971	1969 - 1971	6,222	4,956 - 8,250	3	1969	1969 - 1970	5,135	4,980 - 5,525	5	1970	1969 - 1971	1,273	1,075 - 2,311
	Deane Homes	216	1974	4,607	2,275	7	1974	1973 - 2013	4,494	4,050 - 5,729	2	1994	1975 - 2013	3,487	3,373 - 3,600	4	1974	1974 - 1996	2,591	1,841 - 2,762
	Orangetree	205	1977	2,739	1,133	–	–	–	–	–	–	–	–	–	–	4	1977	1977 - 1977	916	867 - 964
	Turtle Rock	1,561	1976	7,076	2,516	29	1977	1968 - 1996	7,500	5,000 - 19,800	19	1977	1968 - 2006	8,000	5,500 - 47,916	25	1973	1968 - 1994	2,384	1,702 - 4,676
	University Park	430	1969	5,100	1,916	11	1968	1965 - 1973	5,500	4,144 - 6,750	2	1970	1968 - 1971	4,500	3,000 - 6,000	6	1970	1965 - 1973	1,841	1,495 - 2,294
	Woodbridge	2,229	1980	5,000	1,946	30	1980	1976 - 1986	4,760	3,024 - 679,775	17	1980	1976 - 2013	5,000	3,024 - 334,253	43	1979	1976 - 1990	2,007	1,440 - 3,847
G	Newport Beach	352	1998	6,807	2,951	3	1998	1986 - 1998	7,269	3,500 - 11,503	–	–	–	–	–	3	1986	1986 - 1986	1,217	1,191 - 2,105
	Riviera	127	1964	1,766	1,780	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Santa Ana Heights	1,530	1963	7,390	1,789	29	1961	1907 - 2004	7,560	2,483 - 25,500	7	1960	1949 - 2013	7,425	3,640 - 9,479	8	1954	1949 - 1966	1,554	1,162 - 5,872
	Tustin Legacy	770	2007	5,084	2,921	6	2006	2005 - 2009	5,098	3,042 - 6,891	15	2007	2005 - 2009	5,014	3,042 - 7,144	3	2007	2005 - 2007	2,921	2,526 - 3,360
	Westpark	1,553	1989	4,050	2,013	28	1989	1986 - 1997	4,225	3,300 - 7,500	7	1989	1987 - 1996	4,050	2,850 - 5,400	24	1991	1987 - 1997	1,988	1,085 - 3,107
	Windwood	201	1984	913	1,096	1	1984	1984 - 1984	–	–	–	–	–	–	–	2	2004	2004 - 2004	1,607	1,607 - 1,607
H	Cal Homes	432	1971	5,500	1,480	15	1971	1970 - 2007	5,600	5,000 - 6,600	4	1971	1970 - 1971	5,300	5,000 - 6,440	7	1970	1970 - 1971	1,200	975 - 1,967
	College Park	674	1973	5,200	1,970	14	1974	1971 - 1975	5,000	4,500 - 6,700	5	1974	1972 - 1974	5,300	5,000 - 6,300	11	1974	1971 - 2001	1,970	1,420 - 2,318
	Deerfield	408	1975	5,400	2,122	7	1975	1974 - 1976	5,400	5,400 - 7,200	4	1976	1975 - 1976	5,400	5,390 - 7,840	2	1976	1975 - 1976	2,358	2,125 - 2,591
	Greentree	412	1973	5,406	1,762	8	1971	1971 - 1974	5,545	5,000 - 5,624	5	1974	1972 - 2004	5,002	4,896 - 5,467	5	1971	1971 - 1974	1,611	1,448 - 2,089
	Irvine Grove	13	2005	3,200	2,004	2	2005	2005 - 2005	3,616	3,616 - 3,616	–	–	–	–	–	2	1991	1976 - 2005	2,041	2,004 - 2,078
	Laurelwood	181	1973	3,822	1,576	3	1973	1973 - 1973	4,000	3,720 - 4,140	1	1973	1973 - 1973	3,500	3,500 - 3,500	3	1973	1973 - 1974	1,801	1,242 - 1,801
	Northwood	4,056	1980	5,029	2,251	85	1979	1977 - 2005	5,296	3,150 - 394,711	42	1985	1977 - 2004	5,493	3,360 - 364,959	94	1979	1977 - 2004	2,287	1,063 - 4,345
	Peppertree	248	1973	5,940	2,232	10	1973	1973 - 1976	5,463	5,310 - 6,024	1	1973	1973 - 1973	6,000	6,000 - 6,000	5	1973	1973 - 1976	2,235	2,232 - 2,539
	Raquet Club	188	1970	5,605	2,255	5	1970	1970 - 1971	5,500	413 - 6,300	3	1970	1970 - 1971	6,000	5,500 - 6,500	4	1971	1970 - 1978	2,192	2,039 - 2,508
	The Colony	608	1974	5,050	2,206	11	1998	1973 - 2000	5,000	4,450 - 7,439	3	1998	1997 - 1999	5,353	5,064 - 6,893	10	1985	1972 - 1998	2,169	1,403 - 3,309
	The Ranch	482	1970	6,240	2,086	18	1970	1969 - 1971	6,255	5,952 - 7,623	5	1969	1969 - 1971	6,400	6,072 - 6,450	14	1971	1969 - 1972	1,910	1,400 - 3,120
	Willows	342	1971	5,000	1,307	2	1981	1970 - 1992	5,000	5,000 - 5,000	2	1971	1971 - 1971	4,975	4,950 - 5,000	3	1971	1971 - 1972	1,116	1,116 - 1,205

Table 4-2
Housing Stock Characteristic of Cohort Group and SFR Program Participants
Irvine Ranch Water District

		Comparision Cohort Members				SFR PHET Rebates					SFR HECW Rebates					SFR One-Stop-Shop				
	Village and Village Group	Number of SPs	Median Year Built	Median Lot Size (sq ft)	Median Interior Size (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Interior Size (sq ft)	Interior Size Range (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Interior Size (sq ft)	Interior Size Range (sq ft)	Number of SPs	Median Year Built	Year Built Range	Median Interior Size (sq ft)	Interior Size Range (sq ft)
A	Northpark	1,213	2001	5,265	2,486	2	2003	2000 - 2005	1,884	1,491 - 2,277	106	2001	1999 - 2006	2,704	1,491 - 4,640	21	2001	1999 - 2006	2,201	1,491 - 4,315
	Orchard Hills	395	2015	6,196	3,628	–	–	–	–	–	7	2014	2014 - 2014	4,047	2,709 - 5,396	2	2014	2014 - 2014	3,377	3,145
	Stone Gate	913	2013	7,318	2,291	2	2014	2013 - 2014	3,114	2,613 - 3,614	26	2013	2011 - 2015	2,117	1,685 - 3,794	4	2013	2012 - 2013	2,627	1,918
	Tustin Ranch	1,290	1994	6,683	2,476	8	1994	1989 - 1998	2,405	1,876 - 3,337	104	1994	1987 - 2006	2,539	1,213 - 4,468	28	1993	1987 - 2000	3,030	1,213 - 4,879
	Tustin Ranch North	810	1998	5,300	2,526	4	1995	1993 - 1998	2,071	1,830 - 2,276	65	1997	1992 - 2002	2,575	1,510 - 5,240	20	1998	1992 - 1999	2,400	1,788 - 2,768
	West Irvine	878	1999	4,433	2,140	6	1999	1997 - 2000	2,277	1,649 - 3,393	99	2000	1997 - 2001	2,140	1,489 - 3,748	20	1999	1997 - 2001	2,072	1,649 - 3,748
B	Modjeska Canyon	168	1964	–	1,208	–	–	–	–	–	4	1949	1932 - 2000	667	190	–	–	–	–	–
	Orange Park Acres	397	1966	–	1,913	–	–	–	–	–	7	1962	1950 - 1988	2,719	1,256 - 8,169	1	1978	1978 - 1978	3,446	3,446 - 3,446
	Silverado Canyon	336	1945	6,338	1,032	2	1931	1930 - 1932	736	512 - 960	11	1948	1927 - 1996	848	480 - 2,601	–	–	–	–	–
	Williams Canyon	35	2000	–	810	–	–	–	–	–	–	–	–	–	–	1	1978	1978 - 1978	2,600	2,600
C	Baker Ranch	358	2015	3,980	2,252	–	–	–	–	–	6	2015	2014 - 2015	2,422	1,537 - 3,401	–	–	–	–	–
	Foothill Ranch	1,690	1994	4,800	2,004	14	1994	1992 - 1998	1,838	1,086 - 2,882	161	1994	1990 - 1998	2,004	1,086 - 3,607	40	1993	1990 - 1998	2,148	1,086 - 3,607
	Lake Forest	5,603	1976	6,000	2,105	32	1977	1969 - 1999	2,225	1,124 - 3,456	399	1977	1964 - 2012	2,136	945 - 4,752	137	1976	1952 - 1999	2,124	1,144 - 3,809
	Portola Hills	641	1992	6,300	2,513	3	1992	1987 - 1993	3,208	2,513 - 3,383	38	1992	1987 - 1996	2,378	1,210 - 3,642	17	1991	1987 - 1996	2,009	1,154 - 3,938
D	Cypress Village	499	2014	3,691	2,448	–	–	–	–	–	16	2013	2013 - 2015	2,762	1,745 - 2,923	2	2014	2013 - 2014	2,340	2,284
	Heritage Fields	630	2014	6,515	2,696	1	2014	2014 - 2014	1,746	1,746 - 1,746	17	2014	2012 - 2014	2,448	1,971 - 3,018	5	2014	2013 - 2015	2,925	2,206
	Hidden Canyon	21	2015	8,026	5,039	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Laguna Altura	484	2012	–	2,075	–	–	–	–	–	9	2012	2012 - 2013	2,075	1,775 - 3,236	1	2013	2013 - 2013	2,827	2,827 - 2,827
	Lambert Ranch	137	2013	6,325	3,937	–	–	–	–	–	7	2012	2012 - 2013	3,848	3,458 - 4,935	–	–	–	–	–
	Portola Springs	294	2010	–	2,095	–	–	–	–	–	16	2010	2007 - 2013	2,095	1,621 - 2,495	3	2007	2007 - 2012	2,495	2,095
	Portola Springs North	492	2012	7,188	2,398	5	2010	2006 - 2013	3,322	2,339 - 4,271	28	2012	2006 - 2015	2,339	1,753 - 4,134	–	–	–	–	–
	Woodbury	1,046	2005	5,986	2,414	3	2005	2005 - 2009	2,347	2,299 - 3,285	85	2005	2005 - 2013	2,429	957 - 4,606	12	2007	2005 - 2013	2,479	1,223 - 4,389
	Woodbury East	130	2009	8,287	2,313	–	–	–	–	–	8	2010	2009 - 2010	1,904	1,904 - 2,313	1	2010	2010 - 2010	1,904	1,904
E	Crystal Cove	444	2003	–	3,997	–	–	–	–	–	17	2004	2000 - 2008	3,838	3,162	–	–	–	–	–
	Newport Coast	1,898	1998	9,569	3,495	2	1997	1994 - 1999	2,172	1,912 - 2,432	67	1999	1993 - 2006	3,435	1,459 - 10,379	5	1997	1994 - 2004	2,916	2,185 - 4,948
	Oak Creek	770	2000	–	1,750	4	1999	1998 - 2000	2,212	1,656 - 2,500	73	2000	1998 - 2002	1,750	1,166 - 3,328	9	1999	1998 - 2000	2,269	1,585 - 3,554
	Quail Hill	809	2003	–	1,930	4	2004	2003 - 2004	2,287	1,904 - 2,919	61	2003	2003 - 2006	2,407	1,534 - 4,761	8	2004	2003 - 2004	2,030	1,534 - 2,445
	Shady Canyon	317	2005	–	6,909	–	–	–	–	–	16	2004	2002 - 2009	5,991	3,954	1	2005	2005 - 2005	7,899	7,899
	Turtle Ridge	693	2003	–	2,921	1	2004	2004 - 2004	3,469	3,469 - 3,469	41	2003	2003 - 2006	2,032	1,850 - 6,141	3	2004	2004 - 2006	3,224	3,214 - 3,902
F	Culverdale	326	1970	5,457	1,807	1	1969	1969 - 1969	1,449	1,449 - 1,449	18	1971	1969 - 2011	1,939	1,273 - 3,381	13	1969	1969 - 1971	2,067	1,054 - 2,376
	Deane Homes	216	1974	4,607	2,275	2	1974	1974 - 1974	2,838	2,577 - 3,099	12	1975	1974 - 2013	2,232	1,663 - 2,862	5	1996	1974 - 1996	2,480	2,122 - 2,779
	Orangetree	205	1977	2,739	1,133	1	1976	1976 - 1976	964	964	12	1977	1976 - 1977	1,289	867	6	1977	1976 - 2004	1,220	964 - 2,036
	Turtle Rock	1,561	1976	7,076	2,516	2	1992	1992 - 1992	5,019	4,676 - 5,361	101	1977	1968 - 2015	2,519	1,442 - 4,198	35	1973	1968 - 1996	2,248	1,442 - 4,675
	University Park	430	1969	5,100	1,916	4	1971	1965 - 1973	2,501	1,714 - 2,810	32	1970	1965 - 2006	2,143	1,309 - 4,557	13	1971	1965 - 1973	1,916	1,215 - 2,304
	Woodbridge	2,229	1980	5,000	1,946	10	1981	1976 - 1986	1,923	971 - 3,212	172	1980	1976 - 2013	1,946	971 - 4,512	41	1979	1976 - 1999	2,135	1,332 - 4,275
G	Newport Beach	352	1998	6,807	2,951	–	–	–	–	–	14	1998	1986 - 1999	3,367	1,739	6	1986	1986 - 1998	1,836	1,217 - 2,911
	Riviera	127	1964	1,766	1,780	–	–	–	–	–	3	1964	1964 - 1964	1,574	1,574	–	–	–	–	–
	Santa Ana Heights	1,530	1963	7,390	1,789	2	1967	1963 - 1970	2,067	1,571 - 2,563	40	1966	1949 - 2014	2,163	759 - 5,973	8	1964	1953 - 2015	1,993	1,574 - 2,386
	Tustin Legacy	770	2007	5,084	2,921	2	2007	2007 - 2007	2,680	2,640 - 2,719	49	2007	2005 - 2012	2,878	1,342 - 5,014	9	2005	2005 - 2008	3,270	1,871 - 4,326
	Westpark	1,553	1989	4,050	2,013	12	1988	1986 - 1995	1,934	919 - 2,914	99	1989	1986 - 1998	2,153	919 - 3,432	55	1989	1986 - 1997	1,868	1,157 - 3,595
	Windwood	201	1984	913	1,096	1	2004	2004 - 2004	1,607	1,607 - 1,607	10	2004	1984 - 2005	1,459	1,096	7	1984	1984 - 2005	1,096	1,096 - 1,607
H	Cal Homes	432	1971	5,500	1,480	5	1971	1970 - 1971	1,489	1,200 - 2,648	25	1971	1970 - 1971	1,540	963 - 2,757	17	1971	1970 - 1972	1,480	963 - 2,332
	College Park	674	1973	5,200	1,970	4	1973	1971 - 1974	1,973	1,552 - 2,729	34	1973	1971 - 2001	1,970	1,400 - 2,579	25	1973	1971 - 2001	1,970	1,420 - 3,413
	Deerfield	408	1975	5,400	2,122	3	1974	1974 - 1976	1,903	1,305 - 2,592	26	1975	1974 - 1976	2,125	1,587 - 3,023	17	1975	1974 - 1976	2,564	1,305 - 2,597
	Greentree	412	1973	5,406	1,762	10	1973	1972 - 1974	1,782	1,192 - 2,274	19	1973	1971 - 2003	1,785	1,448 - 2,840	22	1973	1971 - 1974	1,703	1,192 - 2,732
	Irvine Grove	13	2005	3,200	2,004	–	–	–	–	–	1	2005	2005 - 2005	2,078	2,078	–	–	–	–	–
	Laurelwood	181	1973	3,822	1,576	2	1973	1973 - 1973	1,522	1,242 - 1,801	8	1973	1973 - 1974	1,624	1,576 - 1,801	4	1974	1973 - 1974	1,689	1,242 - 1,801
	Northwood	4,056	1980	5,029	2,251	35	1979	1977 - 2004	2,364	1,323 - 3,913	352	1980	1977 - 2015	2,382	948 - 4,345	149	1984	1977 - 2005	2,337	1,054 - 4,412
	Peppertree	248	1973	5,940	2,232	1	1973	1973 - 1973	1,649	1,649 - 1,649	10	1974	1973 - 1976	1,942	1,320 - 2,419	6	1973	1973 - 1975	1,605	1,346 - 3,227
	Raquet Club	188	1970	5,605	2,255	–	–	–	–	–	11	1970	1970 - 1971	2,344	1,464 - 2,610	7	1970	1970 - 1971	2,514	1,470 - 3,178
	The Colony	608	1974	5,050	2,206	3	1973	1972 - 1974	1,614	1,403 - 2,268	45	1997	1970 - 2008	2,206	1,228 - 3,246	19	1998	1970 - 1999	2,239	1,238 - 3,309
	The Ranch	482	1970	6,240	2,086	3	1971	1971 - 1972	2,160	1,950 - 2,479	25	1971	1969 - 1971	2,039	1,400 - 3,086	17	1971	1969 - 1972	2,086	1,400 - 2,659
	Willows	342	1971	5,000	1,307	4	1971	1971 - 1972	1,292	1,116 - 1,588	23	1971	1970 - 2006	1,156	780 - 4,051	39	1971	1970 - 1972	1,200	976 - 2,640

Table 4-2
Housing Stock Characteristic of Cohort Group and SFR Program Participants
Irvine Ranch Water District

Abbreviations:

HECW = high efficiency clothes washer	SPs = service points
HET = high efficiency toilet	WBIC = weather-based irrigation controller
PHET = premium hight efficiency toilet	sq ft = square feet
SFR = single-family residential	-- = not available

Notes:
(a) Housing stock characteristics are based on available parcel and billing data. At the time of this analysis, some MFR SPs were miscategorized as SFR SPs in the billing system. Thus, the maximum lot sizes for some villages may not reflect SFR SPs, and the median and lot sizes may be skewed somewhat higher. However, these data did not factor into the water savings analyses, and the SFR/MFR error rate is expected to be the same between the participant and cohort groups.
(b) Only villages with SFR SPs participating in specified programs are summarized herein.

practices related to landscape size by dividing the SPs into the following irrigated landscape area classifications: <0.25 acres, 0.25-0.49 acres; 0.5-0.99 acres; 1.0-1.99 acres; and ≥2 acres.[35]

Water Savings Calculation: For each active account, the average annual water use for a period of three years prior to WE program participation is compared to the average annual water use in the one to three years following WE program participation, dependent on available data. The change in water use by WE program participants is then compared to that of the cohort group over the same time period. As discussed below, the resultant WE program-specific water savings is calculated for the District as a whole, as well as by Village Group for SFR accounts and by landscape size for landscape irrigation accounts.[36]

Population Variation: Box-plots illustrating the population variation for both participant and program sample groups, as well as the resultant water savings estimates are presented in **Appendix C**. Based on this, the sample and cohort populations appear to reflect a similar level of variability, and do not appear to be skewed by outliers. By using the largest participant and cohort group population sizes available, this analysis minimizes the effects of individual outlier results and instead reflects the inherent variability associated with people's behaviors, habits, and needs.

4.2. Outdoor Irrigation Programs for Single-Family Residential Customers

Tables 4-3 and **4-4** below summarize the estimated water savings associated with participation in the SFR Turf Removal Rebate[37] and WBIC Rebate programs by Village Group and across the District. **Tables 4-5** and **4-6** present the comparison of water use by the program participants and the cohorts over the selected study periods.

Participation in the SFR Turf Removal program results in approximately 0.055 acre feet per year (AFY) of reduced water use per participating SP, or approximately 3 acre-feet per year per acre (AFY/ac) of turf replaced. The amount of water saved by a participant varies between Village Group. Notably, the highest savings was observed in the Coast Village Group, which is primarily located in the Coastal ET zone. This result is somewhat counterintuitive, as homes located in an area with the lowest ET rate would be expected to use less water for irrigation to start with and therefore experience less of a reduction in water use through this landscape change. However, in this area, homes often have larger lots, serviced by professional gardeners, and/or the homeowners are generally less price sensitive than in other areas of the District.[38]

The water savings results for WBIC rebates, shown in **Table 4-4**, show a similar trend. Annual water savings resulting from a WBIC rebate is approximately 0.17 AFY, or roughly one-third the savings observed by Turf Removal Rebate participants.

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[35] As discussed in Section 4.6, landscape water use on a per acre basis decreases as the overall landscape area increases. The landscape size ranges selected for each group were chosen to provide a rough grouping of similar-sized landscapes in order to control for such variations.

[36] Potable and non-potable landscape irrigation accounts are assessed separately.

[37] It should be noted that some SPs in the participant group may have participated in the program prior to 2009, which may result in a lower savings estimate.

[38] As discussed further below in Section 4.6, this result is supported by the fact that in practice, landscape irrigation usage by dedicated irrigation accounts is actually highest by SPs in the Coastal ET zone, and lowest in the Foothill ET zone.

Table 4-3
Summary of Water Savings for SFR Turf Removal Rebate Participants, Based on 2014 – 2017 Participation

Village Group	Predominant ET Zone	Number of Participant SPs	Average Turf Area Removed (sq ft)	Annual Water Savings per SP (AFY)	Annual Water Savings per Acre (AFY/ac)
A - West Irvine/Tustin Ranch	Central	82	715	0.053	3.2
B - Canyons/OPA	Foothill	20	2,308	0.14	2.7
C - Lake Forest/Foothills	Foothill/ Central	305	882	0.064	3.2
D - Central	Central	9	421	-0.0085[39]	-0.88[39]
E - Coast	Coastal/ Central	55	825	0.076	4.0
F - Central Irvine/University	Central	81	602	0.037	2.7
G - Santa Ana Heights/UCI	Central	65	767	0.057	3.3
H - Central Irvine/ICD	Central	173	673	0.039	2.5
Weighted Total	**n/a**	**790**	**808**	**0.055**	**3.0**

Table 4-4
Summary of Water Savings for SFR WBIC Rebate Participants, Based on 2015 – 2017 Participation

Village Group	Predominant ET Zone	Number of Participant SPs	Annual Water Savings per SP (AFY)
A - West Irvine/Tustin Ranch	Central	46	0.0083
B - Canyons/OPA	Foothill	5	0.090[40]
C - Lake Forest/Foothills	Foothill/Central	86	0.12
D - Central	Central	34	0.025
E - Coast	Coastal/Central	32	0.032
F - Central Irvine/University	Central	43	0.019
G - Santa Ana Heights/UCI	Central	28	-0.014
H - Central Irvine/ICD	Central	61	0.025
Weighted Total	**n/a**	**335**	**0.017**

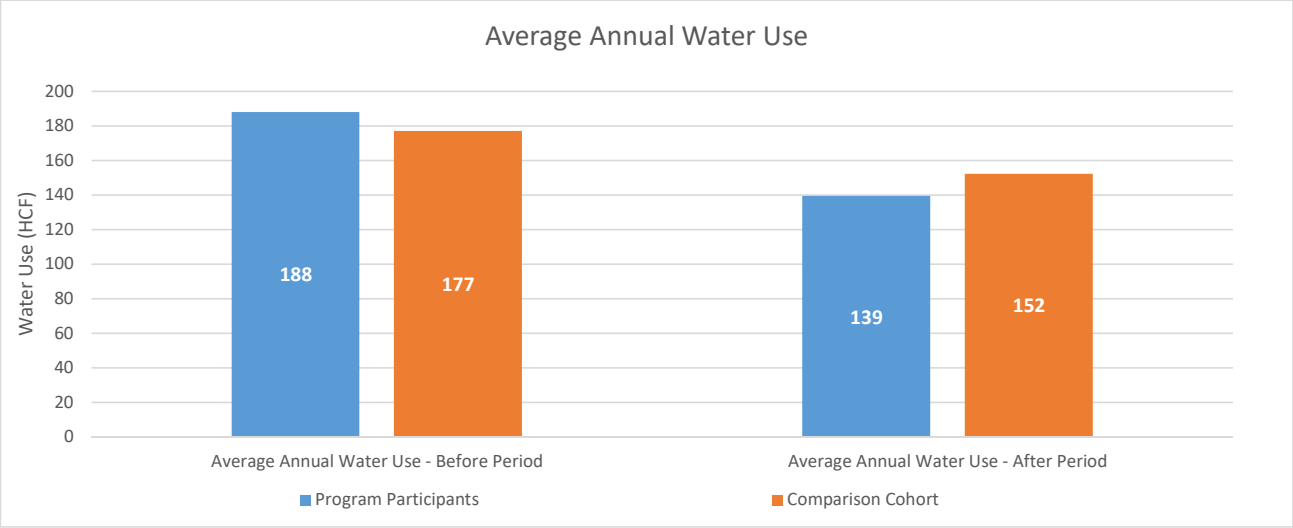
4.3. Single-Family Residential High Efficiency Toilet Rebate Program

Tables 4-7 and **4-8** below summarize the estimated water savings associated with replacement of older toilets with HETs and PHETs, respectively. **Tables 4-9** and **4-10** present the comparison of water use by the program participants and the cohorts for the selected study periods.

[39] Due to the small sample size the resultant estimate is a negative value. Total savings calculated for the District are weighted by number of SPs.
[40] Due to the small sample size, the resultant estimate is much higher than for other Village Groups. Total savings calculated for the District are weighted by number of SPs.

Table 4-5
Water Savings Analysis for SFR Turf Removal Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Parctication									
Number of SPs	--	119	26,762	360	33,902	217	34,968	94	28,462
Total Area of Turf Replaced	sq ft	85,240	n/a	287,219	n/a	195,135	n/a	70,392	n/a
Average Area of Turf Replaced per SP	sq ft	716	n/a	798	n/a	899	n/a	749	n/a
Water Use									
Average Annual Water Use - Before Period	CCF	206	194	202	186	183	175	160	152
Average Annual Water Use - After Period	CCF	140	155	138	150	144	155	136	149
Annual Water Use Reduction per SP	CCF	67	39	64	37	39	21	24	3
Estimated Water Savings									
Reduction in Water Use per SP due to the Turf Removal Program (c)	CCF	28		28		18		21	
Annual Water Savings per 1,000 sq ft Removal Project (c) (d)	CCF	39		35		20		28	
	AFY	0.090		0.080		0.047		0.065	
	gal	29,234		25,990		15,191		21,229	

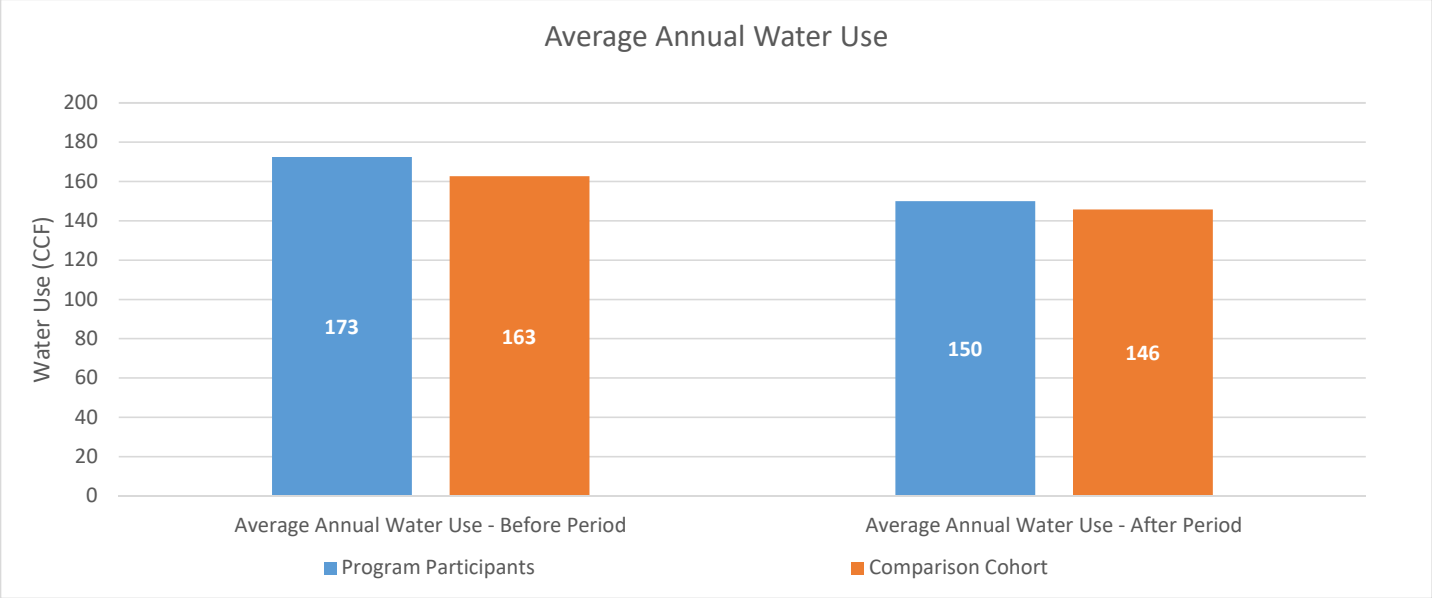


Abbreviations
CCF = one hundred cubic feet
gal = gallons
n/a = not applicable
SFR = single-family residential
SP = service point
sq ft = square feet

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Annual Water Savings per 1,000 sq ft Removal Project = (reduction in water use per SP X number of SPs)/(total area of turf replaced/1,000) Rebate cost per gallon of water saved over a ten-year period is calculated as the total dollar value of rebates issued divided by the annual water savings per average turf removal project (assumed to be 947 sq ft) extended over a ten-year period. Rebate cost does not include the cost of program administration.
(e) Totals may not sum exactly due to rounding.

Table 4-6
Water Savings Analysis for SFR WBIC Rebate Program
Irvine Ranch Water District

	Units	2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation							
Number of SPs	--	71	26,664	110	34,919	154	36,591
Total Number of Rebates Issued	--	71	n/a	116	n/a	165	n/a
Water Use							
Average Annual Water Use - Before Period	CCF	182	181	173	161	162	146
Average Annual Water Use - After Period	CCF	151	148	151	144	148	145
Annual Water Use Reduction per SP	CCF	31	33	22	17	14	1
Estimated Water Savings							
Annual Water Savings due to Program Participation per SP (c)	CCF	-2		5		13	
	gal	-1,441		3,999		10,002	
Annual Water Savings per Rebate Issued (c) (d)	CCF	-2		5		12	
	AFY	-0.004		0.012		0.029	
	gal	-1,441		3,792		9,335	



Abbreviations
CCF = one hundred cubic feet; 748 gallons
gal = gallons
n/a = not applicable
SFR = single-family residential
SP = service point
WBIC = weather-Based Irrigation Controller

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Totals may not sum exactly due to rounding.

The term HET generally refers to toilets with a flush rate of 1.28 gallons per flush (gpf) or less, while PHETs have a flush rate of 1.1 gpf or less. Based on this analysis, the water savings associated with a HET is approximately 0.014 AFY, while that of a PHET is approximately 0.013 AFY. Given that PHETs have lower water usage rates than HETs, it would be expected that PHETs would result in a greater overall savings. However, based on the results broken down by year (**Tables 4-9** and **4-10**), it appears that greater water savings were achieved through HET rebates in 2015 than in 2013 or 2014. Thus, the toilets installed under the HET rebate likely included more efficient toilets (i.e., PHETs) as they become available on the market, and thus the savings results for HET and PHET rebates are very similar. Given that rebates are only currently offered for PHETs, water savings associated with future rebates would be expected to be similar to that shown in **Table 4-8**. On average, two rebates were issued per SP, resulting in a savings of approximately 0.028 AFY per home through this program.

Table 4-7
Summary of Water Savings for SFR HET Rebate Participants, Based on 2013 – 2015 Participation

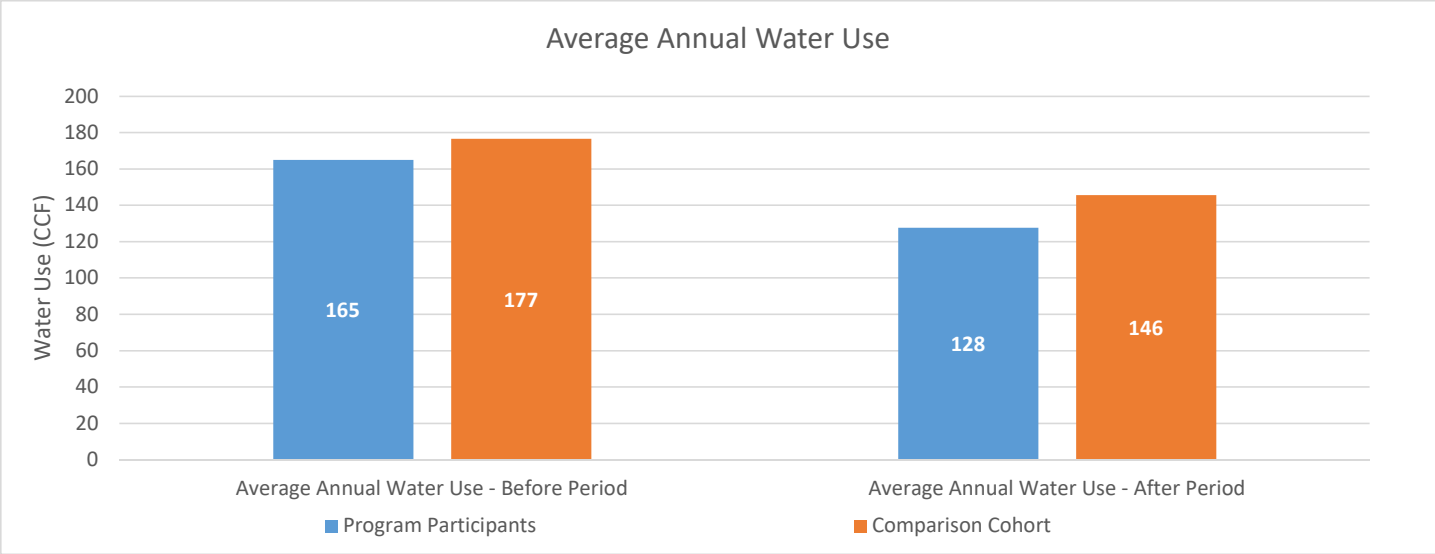
Village Group	Number of Participant SPs	Number of Rebates	Annual Water Savings per SP (AFY)	Annual Water Savings per Rebate (AFY)
A - West Irvine/Tustin Ranch	63	107	0.0032	0.0018
B - Canyons/OPA	9	11	0.019	0.016
C - Lake Forest/Foothills	182	276	0.0087	0.057
D - Central	9	21	-0.014[39]	-0.0060[39]
E - Coast	18	28	0.039	0.025
F - Central Irvine/University	87	142	0.021	0.013
G - Santa Ana Heights/UCI	40	67	0.16	0.096
H - Central Irvine/ICD	160	253	0.010	0.0062
Weighted Total	**568**	**905**	**0.022**	**0.014**

Table 4-8
Summary of Water Savings for SFR PHET Rebate Participants, Based on 2015 – 2017 Participation

Village Group	Number of Participant SPs	Number of Rebates	Annual Water Savings per SP (AFY)	Annual Water Savings per Rebate (AFY)
A - West Irvine/Tustin Ranch	22	51	0.018	0.0078
B - Canyons/OPA	2	2	0.0023	0.0023
C - Lake Forest/Foothills	48	93	0.034	0.017
D - Central	9	23	0.011	0.0041
E - Coast	10	20	0.025	0.012
F - Central Irvine/University	20	43	0.064	0.030
G - Santa Ana Heights/UCI	17	45	0.023	0.0087
H - Central Irvine/ICD	70	149	0.019	0.0087
Weighted Total	**198**	**426**	**0.028**	**0.013**

Table TM4-9
Water Savings Analysis for SFR HET Rebate Program
Irvine Ranch Water District

	Units	2013 Participation		2014 Participation		2015 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation							
Number of SPs	--	47	18,713	176	28,539	345	32,988
Total Number of Rebates Issued	--	72	n/a	249	n/a	584	n/a
Number of SPs Receiving 1 Rebate	--	29	n/a	129	n/a	195	n/a
Number of SPs Receiving 2 Rebates	--	11	n/a	25	n/a	70	n/a
Number of SPs Receiving more than 2 Rebates	--	7	n/a	22	n/a	80	n/a
Water Use							
Average Annual Water Use - Before Period	CCF	152	176	161	178	182	176
Average Annual Water Use - After Period	CCF	130	153	118	142	136	142
Annual Water Use Reduction per SP	CCF	22	23	43	36	46	34
Estimated Water Savings							
Annual Water Savings due to Program Participation per SP (c)	CCF	-0.20		7		12	
	gal	-151		5,382		8,973	
Annual Water Savings per Rebate Issued (c) (d)	CCF	-0.13		5		7	
	AFY	-0.0003		0.012		0.016	
	gal	-99		3,804		5,301	

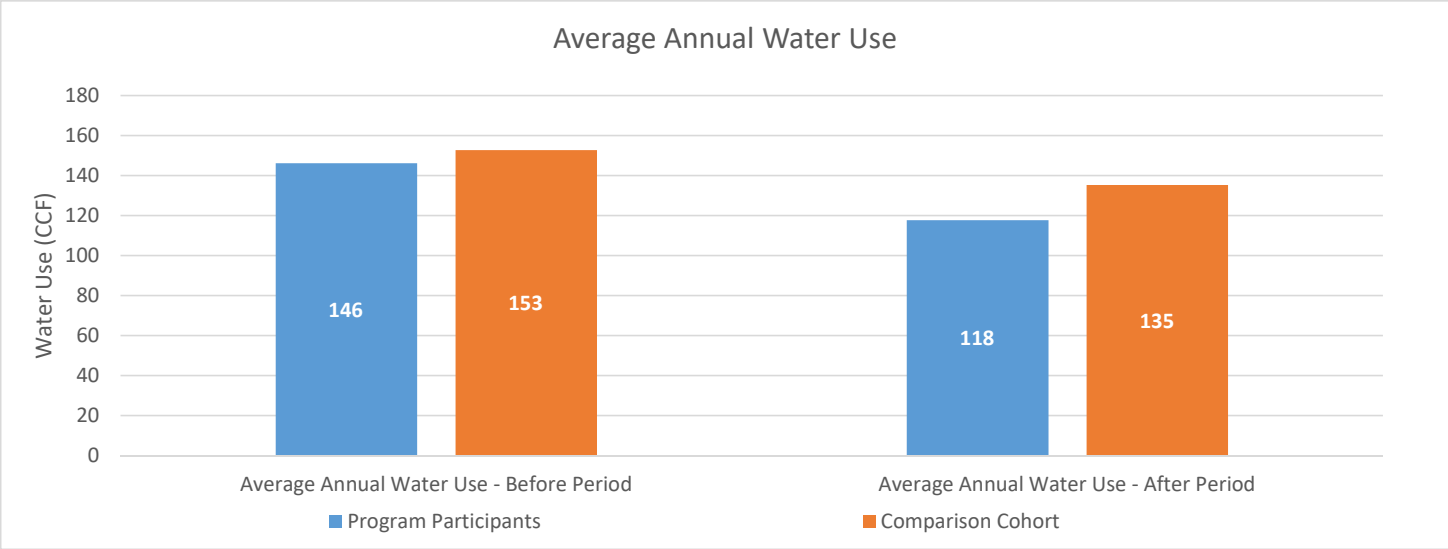


Abbreviations
CCF = one hundred cubic feet; 748 gallons
gal = gallons
HET = high efficiency toilet
n/a = not applicable
SFR = single-family residential
SP = service point

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Totals may not sum exactly due to rounding.

Table 4-10
Water Savings Analysis for SFR PHET Rebate Program
Irvine Ranch Water District

	Units	2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation							
Number of SPs	--	52	21,743	115	33,021	31	22,157
Total Number of Rebates Issued	--	111	n/a	244	n/a	71	n/a
Number of SPs Receiving 1 Rebate	--	16	n/a	38	n/a	7	n/a
Number of SPs Receiving 2 Rebates	--	17	n/a	36	n/a	10	n/a
Number of SPs Receiving more than 2 Rebates	--	19	n/a	41	n/a	14	n/a
Water Use							
Average Annual Water Use - Before Period	CCF	160	168	159	154	119	136
Average Annual Water Use - After Period	CCF	121	136	129	138	104	133
Annual Water Use Reduction per SP	CCF	39	32	30	17	16	3
Estimated Water Savings							
Annual Water Savings due to Program Participation per SP (c)	CCF	7		14		12	
	gal	5,450		10,157		9,271	
Annual Water Savings per Rebate Issued (c) (d)	CCF	3		6		5	
	AFY	0.0078		0.015		0.012	
	gal	2,553		4,787		4,048	



Abbreviations
CCF = one hundred cubic feet; 748 gallons
gal = gallons
PHET = premium high efficiency toilet
n/a = not applicable
SFR = single-family residential
SP = service point

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Totals may not sum exactly due to rounding.

4.4. Single-Family Residential High Efficiency Clothes Washer Rebate Program

Table 4-11 below summarizes the estimated water savings associated with replacement of older clothes washers with HECWs.[41] **Table 4-12** presents the comparison of water use by the program participants and the cohorts over the selected study periods.

Overall, replacement of a clothes washer with an HECW saves approximately 0.012 AFY. Notably, no savings are observed from participation in this program by SPs in the Santa Ana Heights/UCI Village Group. In general, the highest rates of savings are observed in the Central, Coast, and Central Irvine/ICD Village Groups. The Central Irvine/ICD Village Group is dominated by older homes, and thus a higher rate of savings would be expected. It should be noted that while the highest per-SP savings was observed in the Canyons/OPA Village Group, this result may be less accurate because it is based on such a small sample size (i.e., only 17 program participants).

Table 4-11
Summary of Water Savings for SFR HECW Rebate Participants, Based on 2014 – 2017 Participation

Village Group	Number of Participant SPs	Annual Water Savings per SP (AFY)
A - West Irvine/Tustin Ranch	316	0.0078
B - Canyons/OPA	17	0.046
C - Lake Forest/Foothills	477	0.012
D - Central	169	0.016
E - Coast	228	0.023
F - Central Irvine/University	261	0.0078
G - Santa Ana Heights/UCI	188	-0.00030[42]
H - Central Irvine/ICD	448	0.017
Weighted Total	**2,104**	**0.012**

4.5. One-Stop-Shop Program for Single-Family Residential Customers

Table 4-13 below summarizes the estimated water savings associated with participation in the One-Stop-Shop program, and **Table 4-14** presents the comparison of water use by program participants and the cohorts over the study period.

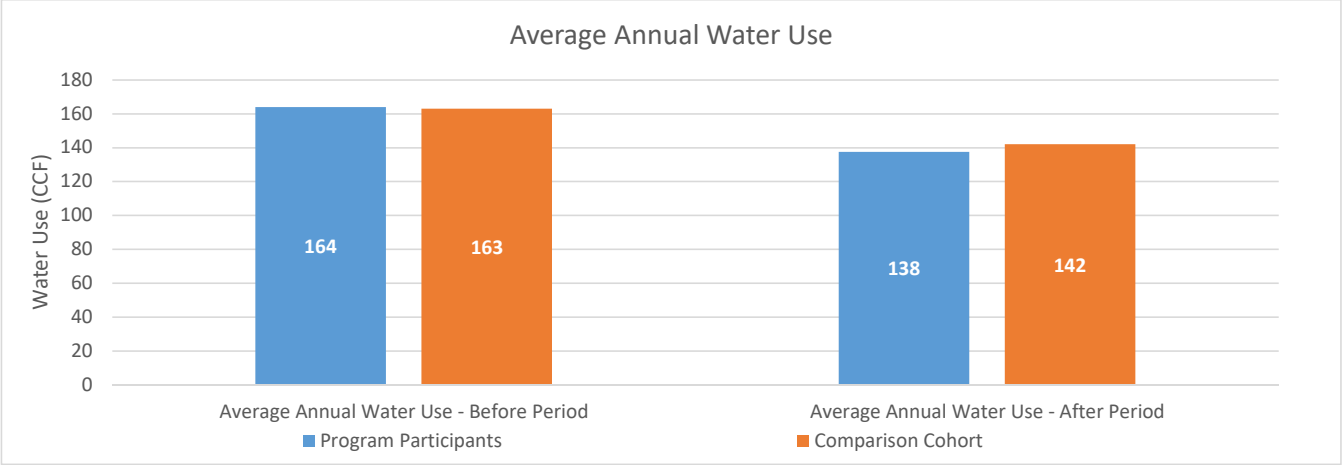
Depending on the need and preferences of the individual household, devices installed through this program included a combination of HETs, PHETs, faucet aerators, showerheads, and WBICs. On average, this resulted in a savings of 0.046 AFY per SP. As shown in **Table 4-14**, half of the water-saving devices

[41] Water use by clothes washers is measured by "water factor," or the number of gallons of water used per cycle per cubic foot of washer capacity. The lower the water factor, the more efficient a washer is. Clothes washers historically and currently available on the market have a wide range of water factors, and the market has been trending towards more efficient washers over time.

[42] This negative value may be the result of more SPs in this Village Group not having had a clothes washer in the home prior to participation in this program than in other Village Groups. This value is included in the weighted average total for the District, and thus may result in a more conservative savings estimate.

Table 4-12
Water Savings Analysis for SFR HECW Rebate Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation									
Number of SPs	--	552	31,535	552	35,618	515	38,436	485	39,662
Total Number of Rebates Issued	--	552	n/a	552	n/a	515	n/a	485	n/a
Water Use									
Average Annual Water Use - Before Period	CCF	177	175	177	174	152	158	148	145
Average Annual Water Use - After Period	CCF	139	142	138	142	133	141	140	143
Annual Water Use Reduction per SP	CCF	38	33	40	32	20	16	8	2
Estimated Water Savings									
Annual Water Savings due to Program Participation per SP (c)	CCF	5		8		3		6	
	AFY	0.012		0.017		0.008		0.013	
	gal	3,799		5,675		2,489		4,395	

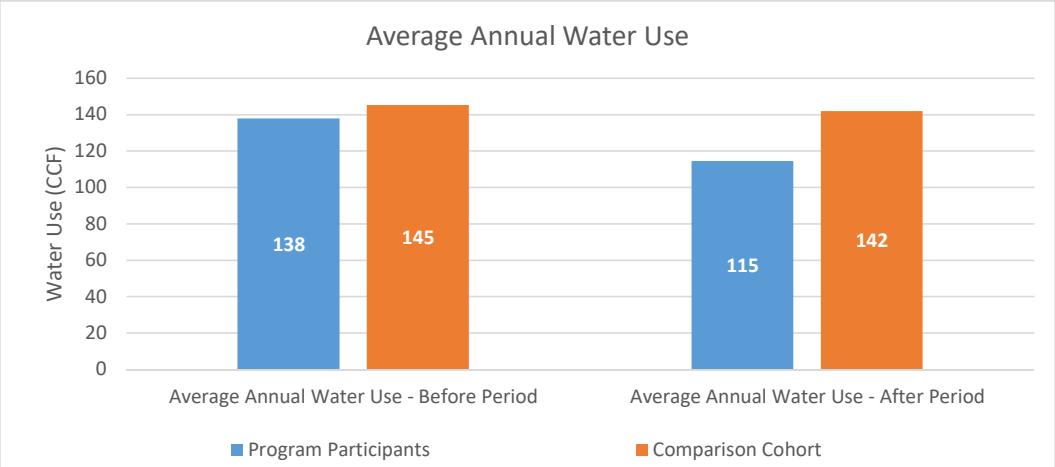


Abbreviations
CCF = one hundred cubic feet; 748 gallons
gal = gallons
HECW = high efficiency clothes washer
n/a = not applicable
SFR = single-family residential
SP = service point

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Totals may not sum exactly due to rounding.

Table 4-14
Water Savings Analysis for One-Stop-Shop Programs
Irvine Ranch Water District

	Units	2017 Participation	
		Participants (a)	Cohort (b)
SP Participation			
Number of SPs	--	861	38,008
Total Number of Devices Installed	--	3,558	n/a
PHETs Installed	--	1,363	n/a
HETs Installed	--	400	n/a
Faucet Aerators Installed	--	737	n/a
Showerheads Installed	--	720	n/a
WBICs Installed	--	338	n/a
Water Use			
Average Annual Water Use - Before Period	CCF	138	145
Average Annual Water Use - After Period	CCF	115	142
Annual Water Use Reduction per SP	CCF	23	3
Estimated Savings			
Annual Water Savings due to One Stop Shop Program Participation per SP (c)	CCF	20	
	gal	15,252	
Annual Water Savings per Device Installed (c) (d)	CCF	5	
	AFY	0.011	
	gal	3,691	



Abbreviations

CCF = one hundred cubic feet; 748 gallons
gal = gallons
HET = high efficiency toilet
PHET = premium high efficiency toilet
SP = service point
WBIC = weather-Based Irrigation Controller

Notes

(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on Village.
(d) Totals may not sum exactly due to rounding.

installed were HETs or PHETs, 21% of the installed devices were faucet aerators, 20% were showerheads, and only 9% were WBICs.

Table 4-13
Summary of Water Savings for SFR One-Stop-Shop Participants, Based on 2017 Participation

Village Group	Number of Participant SPs	Number of Devices Installed	Annual Water Savings per SP (AFY)
A - West Irvine/Tustin Ranch	218	457	0.064
B - Canyons/OPA	2	4	0.083
C - Lake Forest/Foothills	443	788	0.048
D - Central	34	72	0.053
E - Coast	50	111	0.020
F - Central Irvine/University	234	418	0.069
G - Santa Ana Heights/UCI	207	403	0.048
H - Central Irvine/ICD	741	1,305	0.046
Weighted Total	**1,929**	**3,558**	**0.046**

4.6. Outdoor Irrigation Programs for Landscape Irrigation and Commercial, Industrial, and Institutional Service Points

Tables 4-15 and **4-16** below summarize the estimated water savings associated with participation in the Turf Removal Rebate[43] and WBIC Rebate programs by landscape irrigation SPs. Given that landscape management practices differ depending on the overall size of the landscape, participants were compared against a cohort of similar sized landscapes within the same ET zone. Water savings results are summarized below by landscape size. **Tables 4-17a,b** and **4-18a,b** present the comparison of water use by program participants and the cohorts over the selected study periods.

In reviewing the cohort data for landscape irrigation accounts, several trends were identified. The attached **Table 4-19** summarizes water use by landscape irrigation SPs, by landscape size, water source, and ET zone. In general, more water per acre is used by non-potable irrigation SPs than by potable irrigation SPs, and the larger the total landscape size, the more efficient the water use is. These findings could be the result of higher water budgets for non-potable SPs and the tendency for large landscapes to be managed by professional landscape contractors. Although counterintuitive based on ET rates, SPs located in the Coastal ET zone consistently used more water per acre than those in the Central ET zone, and those in the Foothill ET zone consistently used the least water per acre.

On average, the Turf Removal Rebate program results in approximately 0.77 AFY/ac water savings for potable irrigation accounts and 0.38 AFY/ac for non-potable irrigation accounts. Participation in the WBIC Rebate program results in far less savings, with no savings observed by potable water landscape irrigation SPs and approximately 0.017 AFY/ac savings for non-potable irrigation SPs. It is noted that the relatively

[43] It should be noted that some SPs in the participant group may have participated in the program prior to 2009, which may result in a lower savings estimate.

small sample size of program participants in the Turf Removal Rebate program and the potable water SPs in the WBIC Rebate program results in a lower level of confidence in the accuracy of the water savings results for those programs relative to the other programs evaluated herein. That being said, in general, it appears that the WBIC Rebates tend to save more water at larger landscapes than they do at smaller landscapes, while the Turf Removal Rebate program appears to result in more savings per acre for smaller landscapes.

Table 4-15
Summary of Water Savings for Landscape Irrigation Turf Removal Rebate Participants, Based on 2014 – 2015 Participation

Total Landscape Area (ac)	Potable Water SPs			Non-Potable Water SPs		
	Number of Participant SPs	Total Turf Area Removed (ac)	Annual Water Savings (AFY/ac)	Number of Participant SPs	Total Turf Area Removed (ac)	Annual Water Savings (AFY/ac)
<0.25	4	0.59	0.15	1	0.02	-1.7[44]
0.25-0.49	3	0.31	1.2	7	1.2	0.70
0.5-0.99	11	1.9	1.4	12	5.0	0.61
1.0-1.99	6	0.51	0.11	14	8.9	0.10
≥2	3	1.2	0.41	10	12	0.49
Total	**27**	**4.6**	**0.77**	**44**	**27**	**0.38**

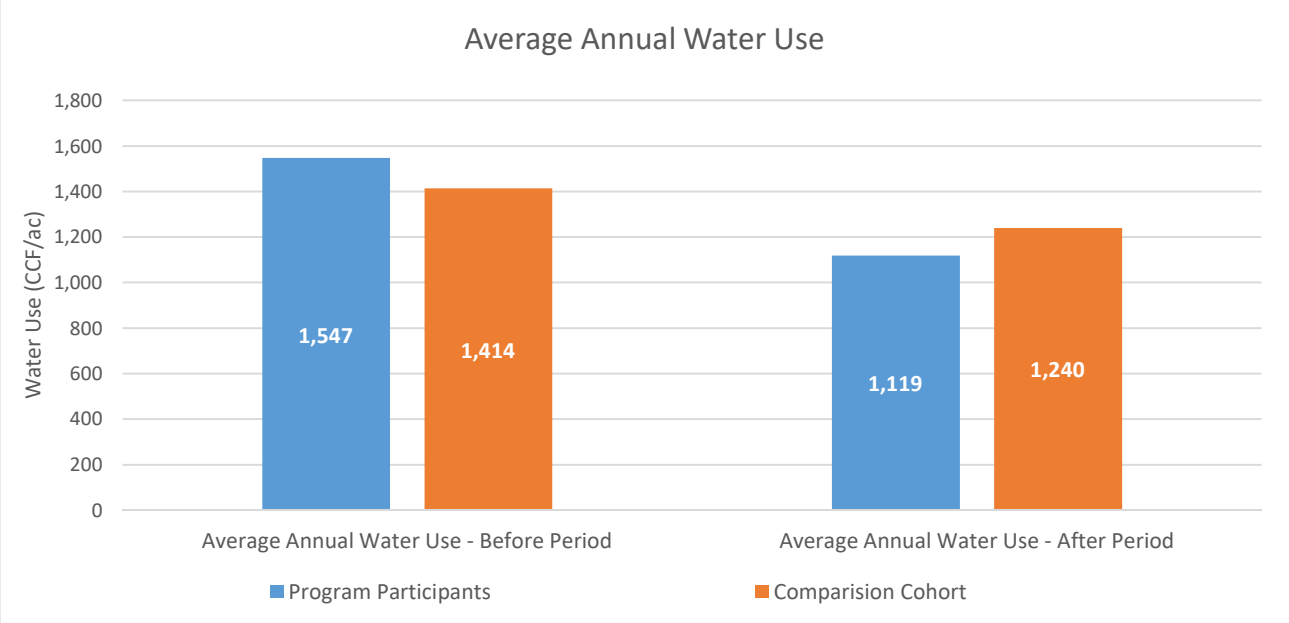
Table 4-16
Summary of Water Savings for Landscape Irrigation WBIC Rebate Participants, Based on 2014 – 2017 Participation

Total Landscape Area (ac)	Potable Water SPs		Non-Potable Water SPs	
	Number of Participant SPs	Annual Water Savings (AFY/ac)	Number of Participant SPs	Annual Water Savings (AFY/ac)
<0.25	12	-0.61	12	-0.49
0.25-0.49	9	-1.5	26	-0.10
0.5-0.99	10	0.085	86	-0.0021
1.0-1.99	6	0.041	137	0.028
≥2	21	-0.75	171	0.071
Total	**58**	**-0.61**	**432**	**0.017**

[44] Due to the small sample size the resultant estimate is a negative value. Total savings calculated for the District are weighted by number of SPs.

Table 4-17a
Water Savings Analysis for Potable Water Landscape Irrigation Account Turf Removal Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation					
Number of SPs	--	5	291	17	1,104
Total Area of Turf Replaced Under Rebate	ac	0.51	n/a	2.6	n/a
Average Area of Turf Replaced per SPs	ac	0.10	n/a	0.15	n/a
Water Use					
Average Annual Water Use - Before Period	CCF/ac	1,315	1,260	1,779	1,569
Average Annual Water Use - After Period	CCF/ac	1,184	1,154	1,053	1,326
Annual Water Use Reduction per SP	CCF/ac	131	106	726	243
Estimated Water Savings					
Reduction in Water Use per SP due to the Turf Removal Program (c) (d)	AFY/ac	0.057		1.11	
	CCF/ac	25		483	

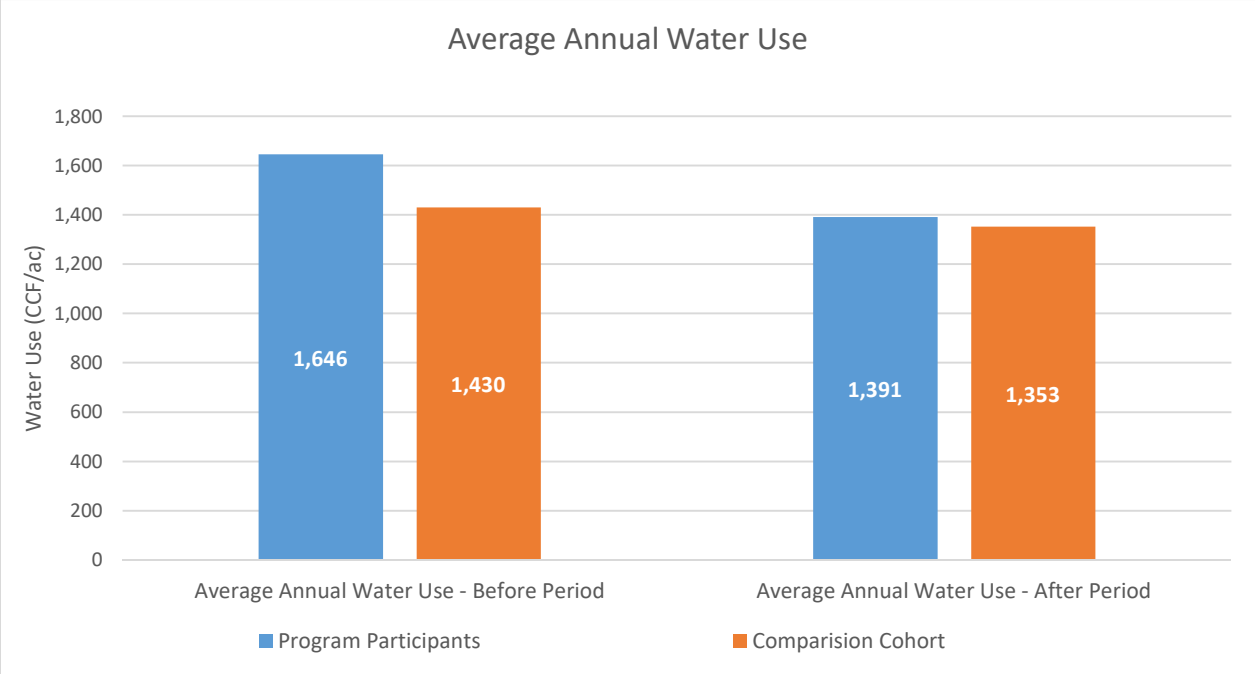


Abbreviations
CCF/ac = one hundred cubic feet per acre
n/a = not applicable

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on size of total landscaped area and evapotranspiration zone.
(d) Totals may not sum exactly due to rounding.

Table 4-17b
Water Savings Analysis for Non-Potable Water Landscape Irrigation Account Turf Removal Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Particpation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation					
Number of SPs	--	9	2,228	35	3,545
Total Area of Turf Replaced Under Rebate	ac	2.3	n/a	25	n/a
Average Area of Turf Replaced per SP	ac	0.26	n/a	0.71	n/a
Water Use					
Average Annual Water Use - Before Period	CCF/ac	1,556	1,472	1,736	1,387
Average Annual Water Use - After Period	CCF/ac	1,331	1,448	1,450	1,258
Annual Water Use Reduction per SP	CCF/ac	225	25	286	129
Estimated Water Savings					
Reduction in Water Use per SP due to the Turf	AFY/ac	0.460		0.36	
Removal Program (c) (d)	CCF/ac	200		157	

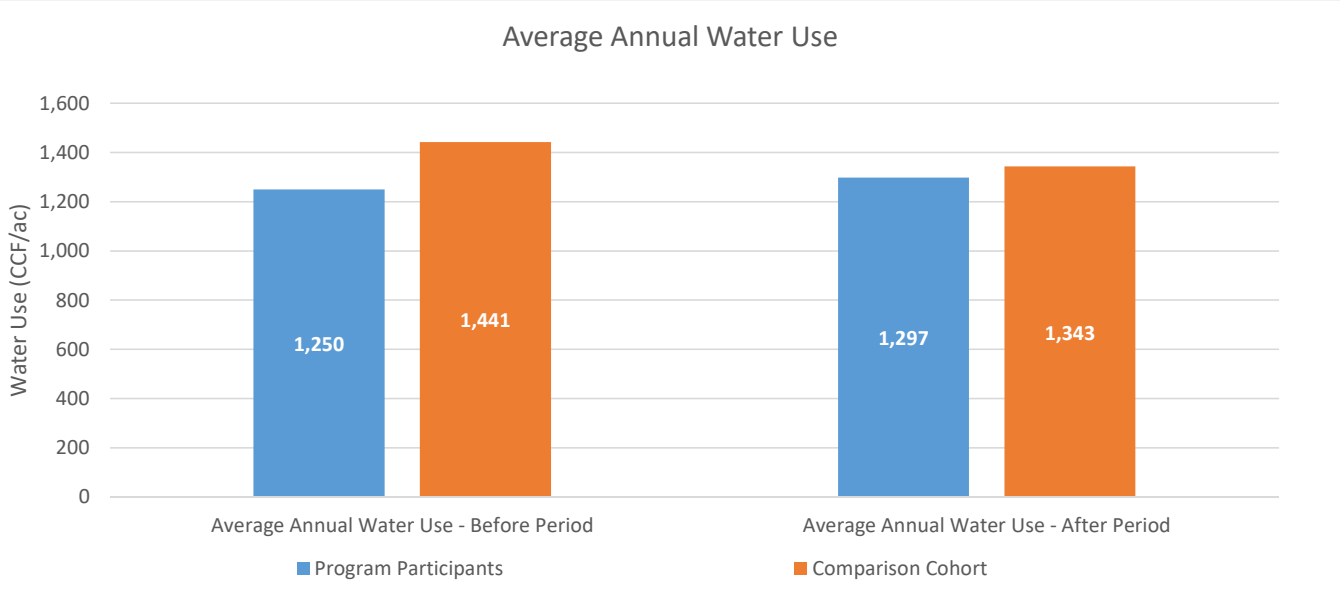


Abbreviations
CCF/ac = one hundred cubic feet per acre
SP = service point

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on size of total landscaped area and evapotranspiration zone.
(d) Totals may not sum exactly due to rounding.

Table 4-18a
Water Savings Analysis for Potable Water Landscape Irrigation Account WBIC Rebate Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation									
Number of SPs	--	31	2,228	13	1,147	9	861	5	832
Average Lot Size	sq ft	135,992	n/a	25,533	n/a	25,120	n/a	24,568	n/a
Total Number of Rebates Issued	--	52	n/a	99	n/a	12	n/a	5	n/a
Water Use									
Average Annual Water Use - Before Period	CCF/ac	833	1,155	1,434	1,585	1,413	1,600	1,319	1,423
Average Annual Water Use - After Period	CCF/ac	1,099	1,006	1,504	1,354	1,127	1,472	1,459	1,541
Annual Water Use Reduction per SP	CCF/ac	-266	149	-70	232	286	128	-141	-117
Estimated Water Savings									
Annual Water Savings due to WBIC Rebate Program Participation per SP (c) (d)	AFY/ac	-0.95		-0.69		0.36		-0.05	
	CCF/ac	-415		-301		159		-23	

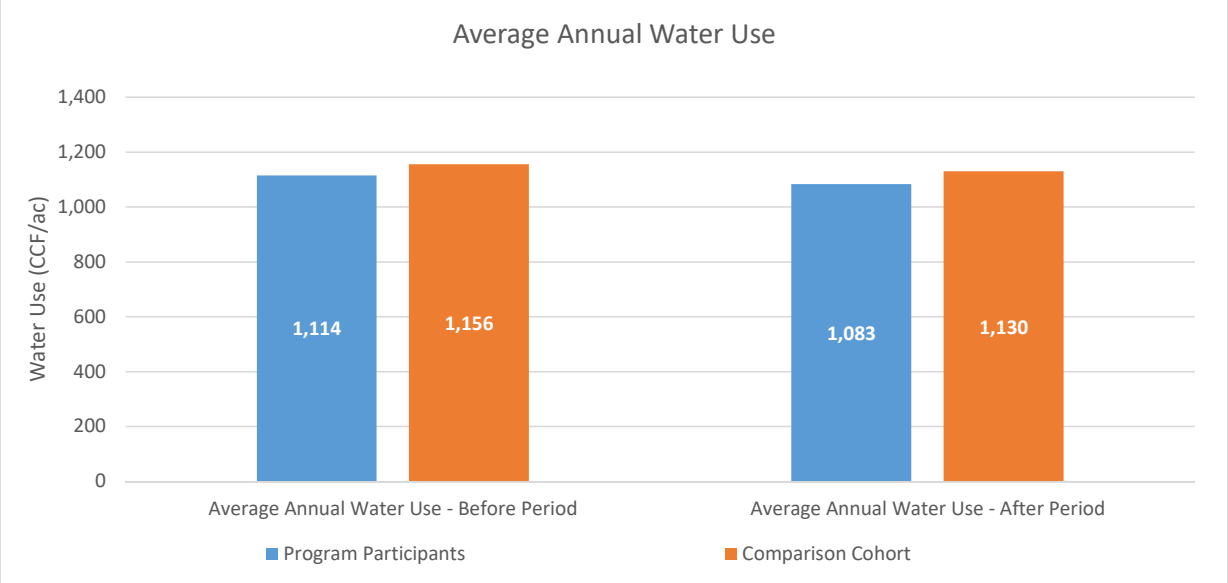


Abbreviations
CCF/ac = one hundred cubic feet per acre
SP = service point
WBIC = weather-Based Irrigation Controller

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on size of total landscaped area and evapotranspiration zone.
(d) Totals may not sum exactly due to rounding.

Table 4-18b
Water Savings Analysis for Non-Potable Water Landscape Irrigation Account WBIC Rebate Program
Irvine Ranch Water District

	Units	2014 Participation		2015 Participation		2016 Participation		2017 Participation	
		Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)	Participants (a)	Cohort (b)
SP Participation									
Number of SPs	--	126	2,900	49	3,600	105	3,996	152	4,245
Total Number of Rebates Issued	--	230	n/a	61	n/a	158	n/a	167	n/a
Water Use									
Average Annual Water Use - Before Period	CCF/ac	1,284	1,244	1,059	1,146	1,282	1,229	832	1,004
Average Annual Water Use - After Period	CCF/ac	1,272	1,224	983	1,043	1,165	1,174	913	1,079
Annual Water Use Reduction per SP	CCF/ac	13	20	76	103	117	55	-81	-75
Estimated Water Savings									
Annual Water Savings due to WBIC Rebate Program Participation per SP (c) (d)	AFY/ac	-0.018		-0.061		0.14		-0.015	
	CCF/ac	-8		-27		62		-7	



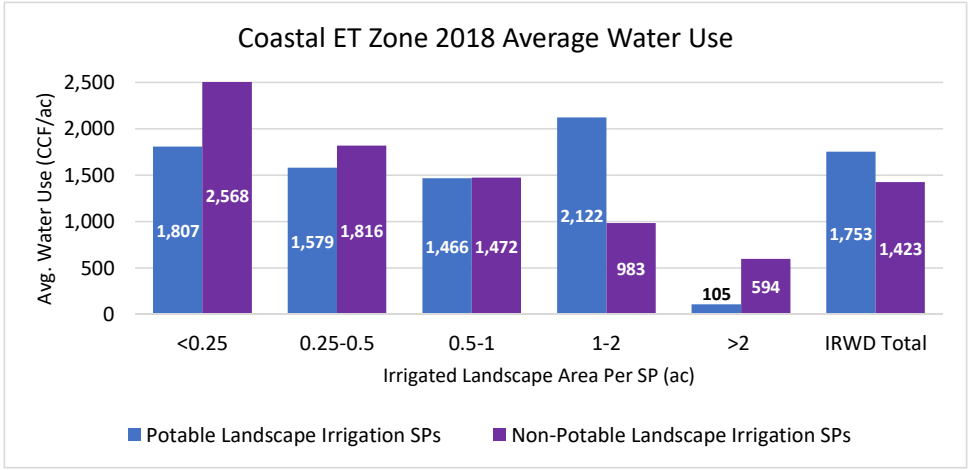
Abbreviations
CCF/ac = one hundred cubic feet per acre
SP = service point
WBIC = weather-Based Irrigation Controller

Notes
(a) Program participants included in this analysis are limited to those that: (1) have only participated in the specified program, (2) have only participated in the program in the specified year, and (3) have sufficient water use data within the study periods.
(b) SPs included in the comparison cohort sample groups are limited to those that: (1) have not participated in any water efficiency program based on available data and (2) have sufficient water use data within the study periods.
(c) Estimated annual water savings associated with the program are calculated as the incremental amount of water saved by the program participants over that of the comparison cohort SPs. Water savings for program participants relative to the cohort is stratified based on size of total landscaped area and evapotranspiration zone.
(d) Totals may not sum exactly due to rounding.

Table 4-19
Average Water Use by Landscape Irrigation Accounts by ET Zone and Landscape Area Size
Irvine Ranch Water District

Coastal ET Zone

Irrigated Landscape Area Per SP (ac)	Average Water Use (CCF/ac)						
	2012	2013	2014	2015	2016	2017	2018
Potable Landscape Irrigation SPs							
<0.25	1,903	2,136	2,127	1,622	1,420	1,602	1,807
0.25-0.5	1,577	1,856	2,042	1,245	1,187	1,312	1,579
0.5-1	1,231	1,315	1,376	1,049	1,150	1,295	1,466
1-2	1,243	938	1,636	1,163	1,335	1,613	2,122
>2	116	125	174	84	109	105	105
IRWD Total	1,774	1,977	2,030	1,505	1,359	1,534	1,753
Non-Potable Landscape Irrigation SPs							
<0.25	2,066	2,020	2,515	2,149	2,105	2,244	2,568
0.25-0.5	1,581	1,583	1,913	1,522	1,541	1,618	1,816
0.5-1	1,159	1,204	1,386	1,199	1,199	1,271	1,472
1-2	825	819	970	787	806	760	983
>2	533	551	636	515	505	454	594
IRWD Total	1,117	1,146	1,398	1,159	1,169	1,204	1,423



Central ET Zone

Irrigated Landscape Area Per SP (ac)	Average Water Use (CCF/ac)						
	2012	2013	2014	2015	2016	2017	2018
Potable Landscape Irrigation SPs							
<0.25	1,714	1,961	1,911	1,408	1,394	1,587	1,824
0.25-0.5	1,527	1,589	1,730	1,273	1,226	1,379	1,506
0.5-1	1,460	1,523	1,664	1,239	1,157	1,376	1,453
1-2	1,293	1,375	1,510	1,119	1,052	1,158	1,250
>2	998	1,108	1,199	894	824	899	965
IRWD Total	1,472	1,607	1,676	1,240	1,192	1,357	1,499
Non-Potable Landscape Irrigation SPs							
<0.25	2,095	2,092	2,361	2,083	1,900	1,964	2,303
0.25-0.5	1,563	1,636	1,828	1,447	1,533	1,615	1,747
0.5-1	1,418	1,457	1,668	1,314	1,362	1,413	1,515
1-2	1,297	1,382	1,492	1,165	1,197	1,240	1,311
>2	953	998	1,153	904	887	909	962
IRWD Total	1,354	1,413	1,587	1,265	1,282	1,329	1,432

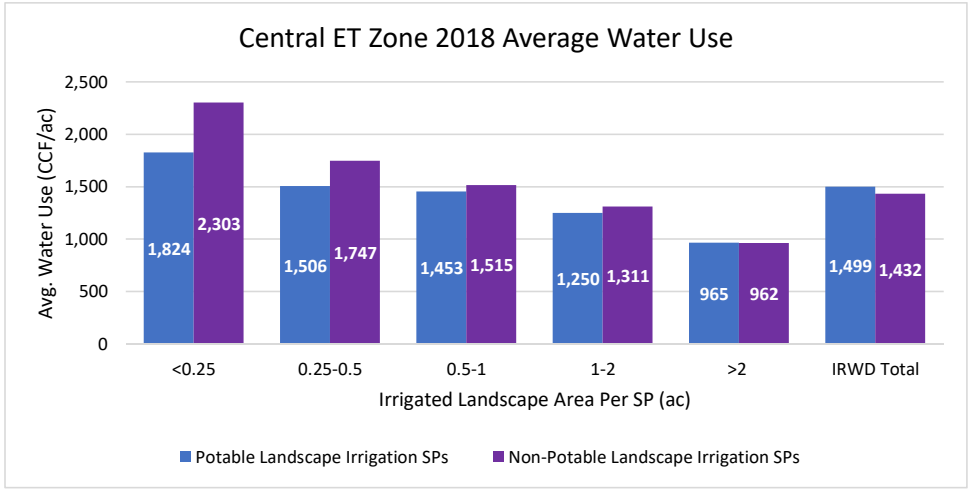
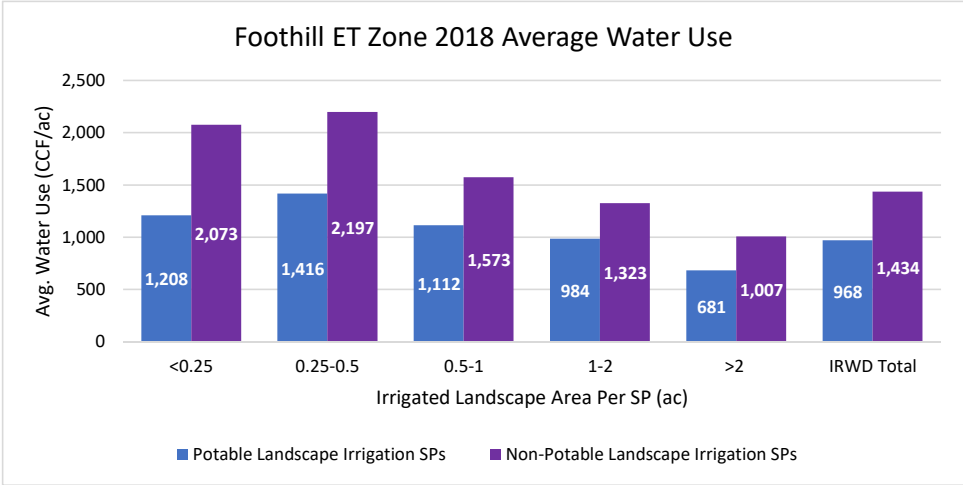


Table 4-19
Average Water Use by Landscape Irrigation Accounts by ET Zone and Landscape Area Size
Irvine Ranch Water District

Foothill ET Zone

Irrigated Landscape Area Per SP (ac)	Average Water Use (CCF/ac)						
	2012	2013	2014	2015	2016	2017	2018
Potable Landscape Irrigation SPs							
<0.25	1,230	1,259	1,254	1,139	1,073	1,126	1,208
0.25-0.5	1,423	1,571	1,599	1,298	1,270	1,566	1,416
0.5-1	1,145	1,322	1,262	1,040	1,027	1,141	1,112
1-2	906	995	1,032	866	927	1,003	984
>2	695	762	781	590	621	707	681
IRWD Total	967	1,062	1,058	870	881	990	968
Non-Potable Landscape Irrigation SPs							
<0.25	1,409	1,166	1,730	1,778	1,953	2,133	2,073
0.25-0.5	1,347	1,331	1,617	1,449	1,732	2,021	2,197
0.5-1	1,256	1,314	1,484	1,470	1,611	1,591	1,573
1-2	1,214	1,215	1,295	1,052	1,106	1,251	1,323
>2	908	943	987	897	973	975	1,007
IRWD Total	1,177	1,170	1,323	1,206	1,315	1,396	1,434



Abbreviations

CCF/ac = one hundred cubic feet per acre
ET = evapotranspiration zone
SP = service point

4.7. Comparison of IRWD Savings to Industry Standard Estimates

Table 4-20 summarizes the District-specific estimated water savings calculated based on the above analysis, as well as the water savings utilized by the Alliance for Water Efficiency (AWE) Tracking Tool Version 3 and as planning numbers for MWD customer agencies. Of the SFR WE programs considered, the Turf Removal Rebate and One-Stop-Shop programs resulted in the largest savings for individual participation, but it is noted that these are among the highest cost programs to implement. Overall, it appears that the WE programs implemented within the District save less water than the default values contained in the AWE Tracking Tool. This result is important for planning purposes, as it likely represents a conservative (i.e., lower) estimate of the benefit of WE programs and/or IRWD customers are generally more efficient to begin with as a result of budget-based water rates. The values derived for IRWD customers were used in the cost-benefit assessment of potential WE program scenarios in Section 7.

Table 4-20
Summary of Estimated Annual Water Savings Factors

Sector	Measure	Units	Estimated IRWD-Specific Savings Factors	AWE Tracking Tool Default Savings Factors	MWD Savings Factors
SFR	Turf Removal	AFY/ac	3.0	2.8	5.7
SFR	WBIC	AFY/unit	0.017	0.023	0.041
SFR	HET	AFY/unit	0.014	0.032	0.025
SFR	PHET	AFY/unit	0.013	0.028	0.025
SFR	HECW	AFY/unit	0.012	0.015	0.034
SFR	One-Stop-Shop	AFY/SP	0.046	n/a	n/a
Large Landscape	Turf Removal	AFY/ac	0.38 – 0.77	2.8	5.7
Large Landscape	WBIC	AFY/ac	-0.61 – 0.017	2.3	0.013 AFY/unit

5. DEVICE SATURATION ASSESSMENT

In order to evaluate the saturation of key water efficient devices in the District and to understand the remaining potential water savings, this section provides:

1. A review of regulatory and market place changes that drive water efficiency;
2. A summary of total participation in all available device-based water efficiency (WE) programs; and
3. An estimate of the natural replacement of fixtures.

In addition, an evaluation of property turnover rates and self-reported rates of device saturation for a subset of Irvine Ranch Water District (IRWD) customers are summarized in **Appendix D.** This assessment includes all WE programs for which implementation data were made available, including and beyond those evaluated in Sections 3 and 4. Due to data availability, these analyses were limited to WE program implementation between 2009 and 2018. These findings were used to support the identification of potential future WE program opportunities in Section 6.

Key Saturation Assessment Findings

The key findings relative to device saturation are briefly summarized below and further described in Section 5.5:

- **Toilet Saturation** – Based on this assessment, very few pre-1994 toilets appear to remain within the District. It is estimated, however, that the majority (i.e., 70%) of the toilets installed in the 1994 to 2009 period remain; these present a potential opportunity for increased water efficiency through replacement with a premium high efficiency toilet (PHET).
- **Clothes Washer Saturation** – It is estimated that between 35% and 56% of pre-2010 era clothes washers remain in the District.
- **Turf Removal** – Approximately 20% of the irrigated area (excluding agricultural and horse corral areas) within the District consist of turf areas. To date, turf removal programs have removed over 100 acres of turf, which amounts to approximately 5.6% of the irrigated turf area, where the total irrigated turf is estimated to be 1,863 acres (**Table 3-16)**. Commercial and SFR uses comprise approximately 44% and 21% of irrigated turf area in the District, respectively, and represent an opportunity to reduce overall turf area and associated irrigation water use.

5.1. Key Regulatory and Market Place Changes

Over the last three decades, several major regulations and shifts in market availability have occurred, which resulted in considerable increases in the water efficiency of devices available on the market. Key regulations and changes are summarized in **Table 5-1** below.[45] As a result of these regulations and market changes, newly constructed buildings are typically more water efficient than older buildings. Older building stock can become increasingly more efficient over time as older devices are replaced, with changes often driven by renovation and remodeling activities.

[45] Nearly all water using devices have become more efficient over time. The selected technologies identified here generally reflect the most common devices and technologies that are considered at the Federal level to be some of the more promising water- and energy-efficient technologies.

Table 5-1
Summary of Key Device Efficiency Market Changes and Newer Technologies

Regulation/ Market Change	Key Changes
Regulation	
1992 Federal Energy Policy Act (H.R. 776; Toilets, Showerheads, Faucets) *effective 1 January 1994*	• Requires maximum water use of new toilets sold in the U.S. be 1.6 gallons per flush (gpf). • Requires maximum flow rate of new showerheads sold in the U.S. be 2.5 gallons per minute (gpm). • Requires maximum flow rate of faucets and aerators sold in the U.S. be 2.5 gpm.
Model Water Efficient Landscape Ordinance (CCR Title 23, §490-495; Landscaping) *Initially effective 1993, key updates effective 2010 and 2015*	• Requires local agencies to adopt ordinances setting minimum water efficiency standards for new and rehabilitated landscapes. Landscape size and other thresholds and requirements were updated in 2010 and 2015.
California Energy Commission (CEC) Clothes Washer Standards *Effective 2007, updated 2010*	• Sets a minimum water efficiency standard for clothes washers sold in California. In 2007 the standard was set at 8.5 gallons per cubic foot of washload (a water factor of 8.5), and in 2010 the standard was tightened to a water factor of 6.0.
California Green Building Standards Code (CalGreen) *Effective 1 August 2009, updated every 3 years thereafter*	• Requires newly constructed and renovated buildings to comply with a 20% reduced indoor water use through either a prescriptive or a performance method. Current efficiency standards under the prescriptive method require the following minimum efficiency standards: ≤2.0 gpm at 80 pounds per square inch (psi) showerheads [to be reduced to ≤1.8 gpm at 80 in January 2020]; ≤1.2 gpm lavatory faucets at 60 psi; ≤1.8 gpm kitchen faucets at 60 psi; ≤1.28 gpf toilets; and ≤0.5 gpf urinals. This is an optional program.
AB 715 (Toilets and Urinals) *effective 1 January 2014*	• Requires 100% of toilets and urinals sold or installed in California be high efficiency (maximum of 1.28 gallons per flush for toilets and 0.5 gallons per flush for urinals).
SB 407 (Toilets, Urinals, Showerheads and Interior Faucets) *compliance by 1 January 2017 for SFR properties, 1 January 2019 for MFR and CII properties*	• Requires all residential and commercial property constructed before January 1994 to replace "non-compliant" plumbing fixtures with fixtures that meet or exceed current plumbing standards. • Requires that a seller of transferor of property disclose in writing the requirements, and whether or not the property includes non-compliant plumbing. There is currently no enforcement of this requirement.
Selected New Water Efficiency Technology	
Weather-Based Irrigation Controllers (WBICs) / Smart Irrigation Controllers	• WBICs are a newer technology that are gaining popularity and availability in recent years as part of the "smart home" movement. WBICs allow for automatic and remote adjustment of watering schedules to adapt to real-time weather changes. First generation WBICs used historical evapotranspiration data and were not widely available for the residential market.
Irrigation Sprinkler Nozzles and Drip Irrigation	• New sprinkler nozzle designs and drip irrigation systems result in increased irrigation water efficiency over the traditional fixed-spray irrigation nozzles. Newer multi-stream rotational sprinklers, for

Table 5-1
Summary of Key Device Efficiency Market Changes and Newer Technologies

Regulation/ Market Change	Key Changes
	example, are widely available on the market and can reduce water use by over 50% with increased coverage.[46]
Premium HETs	• Premium HETs (PHETs) with water usage as low as 0.8 gpf are broadly available on the market to consumers. Toilets available on the market today typically range from 0.8 to 1.28 gpf. PHETs have become readily available to the general public primarily over the last five years.
Clothes Washers	• Clothes washers of higher efficiency than that set by the CEC are available on the market. The EPA Energy Star Program certifies high efficiency clothes washers available on the market. Clothes washers currently on the market must have a water factor of 3.2 or less for front-loading washers and a water factor of 4.3 or less for top-loading washers, for washers with a capacity of greater than 2.5 cubic feet.[47] Current certified washers have water factors as low as 2.7.

5.2. WE Program Participation Patterns

5.2.1. Overall Program Participation

A wide variety of WE programs have been offered to IRWD customers over the years, including and in addition to the selected programs analyzed in Section 4 above. **Tables 5-2** and **5-3** show the total number of devices provided and area of turf removed through these programs by customer sector, year, and by Village Group between 2009 and 2018. From 1993 to 2008, IRWD customers received over 21,000 WE devices through WE programs, including HETs, HECWs, WBICs, and other devices. These older data, however, are not included in the counts of WE program participation or saturation assessment herein.[48]

Table 5-4 provides an estimate of the amount of water savings associated with the implementation of the devices provided from 2009 through 2018, based on the IRWD-specific savings rates calculated and described in Section 4. Based on this rough assessment, these programs have resulted in over 2,300 AF of water savings per year.

5.2.2. Participation in Multiple Programs

Section 3 evaluated customer participation in the One-Stop-Shop program as compared to customer participation in other rebate and no-cost programs that include the same devices. This analysis found that IRWD customers tended to change out one type of device (i.e., participate in only one program) if water

[46] https://www.energy.gov/eere/femp/water-efficient-technology-opportunity-multi-stream-rotational-sprinkler-heads
[47] https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%208.0%20Clothes%20Washer%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf
[48] The older data were not available until following the completion of this analysis. The inclusion of these data would not have substantively changed the overall findings of a high rate of saturation of HETs and HECWs.

Table 5-2
Summary of Devices Installed through WE Programs by Year and Program
Irvine Ranch Water District

Measure	Program	Units	Number of Devices / Area of Turf Replaced											Total
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Residential - Single Family														
Faucet Aerator	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	1,253	16	1,269
Faucet Aerator	Stealth Toilet Direct Installation	qty	--	--	--	--	--	473	--	--	--	--	--	473
HECW	WaterSmart Rebate	qty	633	991	1,707	1,403	1,359	1,244	1,247	1,055	883	796	460	11,778
HET	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	679	5	684
HET	WaterSmart Rebate	qty	272	654	566	--	--	366	1,199	1,911	--	--	91	5,059
PHET	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	2,286	28	2,314
PHET	Stealth Toilet Direct Installation	qty	--	--	--	--	--	662	--	--	--	--	--	662
PHET	WaterSmart Rebate	qty	--	--	--	--	--	--	--	248	563	206	16	1,033
Showerhead	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	1,278	16	1,294
Showerhead	Stealth Toilet Direct Installation	qty	--	--	--	--	--	320	--	--	--	--	--	320
Cistern	WaterSmart Rebate	qty	--	--	--	--	--	--	--	1	--	1	1	3
Moisture Sensor	WaterSmart Rebate	qty	--	--	--	--	--	--	1	2	2	--	--	5
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	8,777	--	--	--	--	--	--	8,777
Precision Spray Nozzle	prop84	qty	--	--	--	478	31,664	4,368	--	--	--	--	--	36,510
Rain Barrel	WaterSmart Rebate	qty	--	--	--	--	--	7	71	357	479	29	13	956
Rotating Nozzle	WaterSmart Rebate	qty	1,083	1,249	1,546	1,561	907	449	1,408	1,643	477	410	70	10,803
WBIC/Smart Controller	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	665	--	665
WBIC/Smart Controller	prop84	qty	--	--	--	8	459	51	--	--	--	--	--	518
WBIC/Smart Controller	watersage	qty	--	--	--	--	--	--	--	--	--	--	--	48
WBIC/Smart Controller	WaterSmart Rebate	qty	10	15	19	39	87	71	71	214	284	399	346	1,555
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	4,031	19,840	34,733	161,146	542,322	413,153	135,652	75,255	1,387,050
Turf Removal	Turnkey WaterSmart Rebate	sq ft	--	--	--	--	--	--	--	--	16,138	6,588	--	23,901
Turf Removal (Synthetic Turf)	WaterSmart Rebate	sq ft	10,727	2,570	--	--	--	--	--	--	--	--	--	13,297
Residential - Multi Family														
Faucet Aerator	Stealth Toilet Direct Installation	qty	--	--	--	--	630	2,124	1,772	--	--	--	--	4,526
Faucet Aerator	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	182	16	198
Faucet Aerator	Stealth Toilet Direct Installation	qty	--	--	--	--	--	14	--	--	--	--	--	14
HECW	WaterSmart Rebate	qty	118	244	655	624	566	523	590	500	469	476	309	5,074
HET	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	100	6	106
HET	WaterSmart Rebate	qty	28	127	120	--	--	137	455	673	--	--	45	1,585
PHET	Stealth Toilet Direct Installation	qty	--	--	--	--	443	1,429	192	--	--	--	--	2,064
PHET	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	346	16	362
PHET	Stealth Toilet Direct Installation	qty	--	--	--	--	--	21	--	--	--	--	--	21
PHET	WaterSmart Rebate	qty	--	--	--	--	--	--	--	9,993	727	2,388	998	14,106
Showerhead	Stealth Toilet Direct Installation	qty	--	--	--	--	260	1,111	52	--	--	--	--	1,423
Showerhead	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	197	4	201
Showerhead	Stealth Toilet Direct Installation	qty	--	--	--	--	--	17	--	--	--	--	--	17
Moisture Sensor	WaterSmart Rebate	qty	--	--	--	--	--	--	--	--	1	--	--	1
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	550	--	--	--	--	--	--	550
Rain Barrel	WaterSmart Rebate	qty	--	--	--	--	--	--	6	26	23	8	--	63
Rotating Nozzle	WaterSmart Rebate	qty	39	10	--	--	--	38	430	2,856	1,227	--	--	4,600

Table 5-2
Summary of Devices Installed through WE Programs by Year and Program
Irvine Ranch Water District

Measure	Program	Units	Number of Devices / Area of Turf Replaced											Total
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
WBIC/Smart Controller	One-Stop-Shop Direct Installation	qty	--	--	--	--	--	--	--	--	--	1	--	1
WBIC/Smart Controller	WaterSmart Rebate	qty	--	--	--	4	1	8	9	21	22	29	36	130
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	1,392	424	1,461	7,390	44,920	75,948	1,443	4,083	137,061
Turf Removal (Synthetic Turf)	WaterSmart Rebate	sq ft	575	240	250	--	--	--	--	--	--	--	--	1,065
Landscape Irrigation, Potable														
Flow Regulator (Sprinkler)	WaterSmart Rebate	qty	--	--	--	--	--	--	--	750	--	--	--	750
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	100	--	--	--	--	--	--	100
Rotating Nozzle	WaterSmart Rebate	qty	--	--	--	--	--	1,884	--	3,045	471	--	--	5,400
WBIC/Smart Controller	WaterSmart Rebate	qty	--	--	--	--	1	13	54	107	19	6	--	200
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	12,794	3,916	39,879	25,135	551,700	202,462	80,580	45,075	1,037,395
Landscape Irrigation, Non-Potable														
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	25	--	--	--	--	--	--	25
Precision Spray Nozzle	prop84	qty	--	--	--	--	6,693	2,383	--	--	--	--	--	9,076
Rotating Nozzle	WaterSmart Rebate	qty	--	96	606	--	70	890	116	7,436	320	--	--	9,534
WBIC/Smart Controller	prop84	qty	--	--	--	--	47	11	--	--	--	--	--	58
WBIC/Smart Controller	WaterSmart Rebate	qty	1	2	--	--	30	47	238	74	176	218	52	838
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	--	--	20,334	108,625	1,151,725	197,000	--	91,119	1,568,803
Turf Removal (Synthetic Turf)	WaterSmart Rebate	sq ft	871	--	--	--	--	--	--	--	--	--	--	871
Institutional														
Faucet Aerator	CII Aerators	qty	--	--	--	--	--	--	--	--	25	--	--	25
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	100	--	--	--	--	--	--	100
WBIC/Smart Controller	WaterSmart Rebate	qty	--	--	--	--	--	--	--	--	1	--	1	2
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	--	--	--	--	1,800	--	--	--	1,800
Industrial														
Faucet Aerator	CII Aerators	qty	--	--	--	--	--	--	--	--	--	18	10	28
Faucet Aerator	Stealth Toilet Direct Installation	qty	--	--	--	--	--	7	--	--	--	--	--	7
PHET	Stealth Toilet Direct Installation	qty	--	--	--	--	--	7	--	--	--	--	--	7
Showerhead	CII Showerheads	qty	--	--	--	--	--	--	--	--	--	11	--	11
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	--	--	17,798	4,244	32,416	--	--	4,311	58,769
Commercial														
Cooling Tower	WaterSmart Rebate	qty	--	--	--	--	--	--	--	1	--	--	--	1
Faucet Aerator	CII Aerators	qty	--	--	--	--	--	--	--	--	10	--	130	140
Faucet Aerator	Stealth Toilet Direct Installation	qty	--	--	--	--	--	106	--	--	--	--	--	106
HECW	WaterSmart Rebate	qty	--	--	--	2	1	--	--	2	1	--	--	6
HET	WaterSmart Rebate	qty	--	--	--	--	--	426	639	718	--	--	--	1,783
PHET	Stealth Toilet Direct Installation	qty	--	--	--	--	--	10	26	--	--	--	--	36
PHET	WaterSmart Rebate	qty	--	--	--	--	--	--	--	--	2	1	--	3
Plumbing Flow Control	WaterSmart Rebate	qty	--	--	--	--	--	--	--	780	--	1,162	--	1,942

Table 5-2
Summary of Devices Installed through WE Programs by Year and Program
Irvine Ranch Water District

Measure	Program	Units	Number of Devices / Area of Turf Replaced											Total
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Showerhead	CII Showerheads	qty	--	--	--	--	--	--	--	--	--	--	10	10
Showerhead	Stealth Toilet Direct Installation	qty	--	--	--	--	--	97	--	--	--	--	--	97
Ultra Low Water Urinal	WaterSmart Rebate	qty	--	--	--	--	--	--	18	--	--	--	--	18
Zero Water Urinal	WaterSmart Rebate	qty	--	--	--	--	18	3	--	11	--	--	--	32
Precision Spray Nozzle	Free Sprinkler Nozzle	qty	--	--	--	--	200	--	--	--	--	--	--	200
Rotating Nozzle	WaterSmart Rebate	qty	--	--	--	--	--	--	--	185	--	535	--	720
WBIC/Smart Controller	WaterSmart Rebate	qty	--	--	--	--	1	--	3	--	--	3	1	8
Turf Removal	WaterSmart Rebate	sq ft	--	--	--	--	--	6,504	8,201	316,897	28,406	15,445	--	375,453

Abbreviations

CII = commercial, industrial, institutional
HECW = high efficiency clothes washer
HET = high efficiency toilet
PHET = premium high efficiency toilet
qty = quantity
SFR = single-family residential
SP = service point
sq ft = square feet
WBIC = weather-Based Irrigation Controller

Notes

(a) Devices installed at University of California Irvine properties are not included in this summary. Data provided by IRWD.

Table 5-3
Summary of Devices Installed through WE Programs by Village Group
Irvine Ranch Water District

Measure	Units	Number of Devices / Area of Turf Replaced by Village Group								Total
		A - West Irvine/ Tustin Ranch	B - Canyons/ OPA	C - Lake Forest/ Foothills	D - Central	E - Coast	F - Central Irvine/ University	G - Santa Ana Heights/ UCI	H - Central Irvine/ ICD	
Residential - Single Family										
Faucet Aerator	qty	192	8	348	34	57	240	168	694	1,741
HECW	qty	2,018	100	2,409	1,151	1,093	1,314	1,025	2,652	11,762
HET	qty	702	59	1,528	156	276	837	517	1,665	5,740
PHET	qty	467	42	766	124	167	504	341	1,597	4,008
Showerhead	qty	161	7	314	37	64	219	137	674	1,613
Cistern	qty	--	1	--	--	--	2	--	--	3
Moisture Sensor	qty	--	--	--	--	1	--	2	2	5
Precision Spray Nozzle	qty	849	156	2,313	232	37,432	1,320	599	2,386	45,287
Rain Barrel	qty	107	42	281	30	24	80	101	291	956
Rotating Nozzle	qty	1,323	1,257	3,071	101	1,744	702	1,251	1,354	10,803
WBIC/Smart Controller	qty	325	76	575	161	644	245	185	568	2,779
Turf Removal	sq ft	126,752	94,162	547,998	12,261	86,940	134,571	118,981	283,500	1,405,165
Turf Removal (Synthetic Turf)	sq ft	1,904	1,798	6,290	260	188	271	1,624	962	13,297
Residential - Multi Family										
Faucet Aerator	qty	39	--	2,712	2	3	46	104	1,770	4,676
HECW	qty	991	--	632	795	249	1,239	594	541	5,041
HET	qty	225	--	280	70	52	597	187	280	1,691
PHET	qty	1,259	--	2,858	255	199	3,869	6,314	1,617	16,371
Showerhead	qty	34	--	1,336	14	6	55	83	61	1,589
Moisture Sensor	qty	--	--	--	--	--	--	--	1	1
Precision Spray Nozzle	qty	15	--	75	--	50	210	150	50	550
Rain Barrel	qty	5	--	6	1	4	27	12	8	63
Rotating Nozzle	qty	--	--	1,227	--	10	2,910	78	375	4,600
WBIC/Smart Controller	qty	29	--	8	25	5	45	6	13	131
Turf Removal	sq ft	1,849	--	35,916	836	724	48,445	19,037	29,674	136,481
Turf Removal (Synthetic Turf)	sq ft	--	--	--	--	--	815	250	--	1,065

Table 5-3
Summary of Devices Installed through WE Programs by Village Group
Irvine Ranch Water District

Measure	Units	Number of Devices / Area of Turf Replaced by Village Group								Total
		A - West Irvine/ Tustin Ranch	B - Canyons/ OPA	C - Lake Forest/ Foothills	D - Central	E - Coast	F - Central Irvine/ University	G - Santa Ana Heights/ UCI	H - Central Irvine/ ICD	
Landscape Irrigation, Potable										
Flow Regulator	qty	--	--	750	--	--	--	--	--	750
Precision Spray Nozzle	qty	--	--	--	--	--	--	--	100	100
Rotating Nozzle	qty	--	--	2,495	--	--	2,466	139	--	5,100
WBIC/Smart Controller	qty	1	--	51	--	37	95	11	4	199
Turf Removal	sq ft	805	--	499,708	--	--	19,594	480,823	17,663	1,018,593
Landscape Irrigation, Non-Potable										
Precision Spray Nozzle	qty	--	--	--	--	9,101	--	--	--	9,101
Rotating Nozzle	qty	583	--	4,804	--	1,477	202	2,468	--	9,534
WBIC/Smart Controller	qty	67	--	59	90	502	65	60	62	905
Turf Removal	sq ft	410,116	--	47,856	--	19,619	590,777	266,684	233,751	1,568,803
Turf Removal (Synthetic Turf)	sq ft	--	--	--	--	871	--	--	--	871
Institutional										
Faucet Aerator	qty	--	--	--	--	--	--	25	--	25
Precision Spray Nozzle	qty	--	--	100	--	--	--	--	--	100
WBIC/Smart Controller	qty	1	--	--	1	--	--	--	--	2
Turf Removal	sq ft	--	--	--	--	--	--	--	1,800	1,800
Industrial										
Faucet Aerator	qty	--	--	23	--	--	--	12	--	35
PHET	qty	--	--	--	--	--	--	7	--	7
Showerhead	qty	--	--	11	--	--	--	--	--	11
Turf Removal	sq ft	--	--	--	--	--	--	53,179	5,590	58,769
Commercial										
Cooling Tower	qty	--	--	--	--	--	--	1	--	1
Faucet Aerator	qty	--	--	70	--	--	--	12	67	149
HECW	qty	1	--	2	--	--	--	2	1	6
HET	qty	--	--	281	--	--	9	1,493	--	1,783
PHET	qty	--	--	7	--	--	1	6	15	29
Plumbing Flow Control	qty	--	--	780	--	--	--	1,162	--	1,942

Table 5-3
Summary of Devices Installed through WE Programs by Village Group
Irvine Ranch Water District

Measure	Units	Number of Devices / Area of Turf Replaced by Village Group								Total
		A - West Irvine/ Tustin Ranch	B - Canyons/ OPA	C - Lake Forest/ Foothills	D - Central	E - Coast	F - Central Irvine/ University	G - Santa Ana Heights/ UCI	H - Central Irvine/ ICD	
Showerhead	qty	--	--	10	--	--	--	--	--	10
Ultra Low Water Urinal	qty	--	--	--	--	--	--	18	--	18
Zero Water Urinal	qty	11	--	18	--	--	--	3	--	32
Precision Spray Nozzle	qty	100	--	100	--	--	--	--	--	200
Rotating Nozzle	qty	--	--	--	--	--	185	535	--	720
WBIC/Smart Controller	qty	1	--	1	--	3	1	2	--	8
Turf Removal	sq ft	--	--	303,006	--	--	--	53,690	18,757	375,453

Abbreviations

CII = commercial, industrial, institutional
HECW = high efficiency clothes washer
HET = high efficiency toilet
PHET = premium high efficiency toilet
qty = quantity
SFR = single-family residential
SP = service point
sq ft = square feet
WBIC = weather-Based Irrigation Controller

Notes

(a) Devices installed at University of California Irvine properties are not included in this summary. Data provided by IRWD.

Table 5-4
Summary of Water Savings Assumptions for Devices Installed through Past WE Program Participation
Irvine Ranch Water District

Measure	Indoor/ Outdoor Use	Units	Devices Replaced	Estimated Savings per Unit		Savings Basis	Estimated Total Annual Savings (AFY)
				gpy	AFY		
Residential - Single Family							
Faucet Aerator	Indoor	qty	1,741	n/a	n/a		n/a
HECW	Indoor	qty	11,762	4,039	0.0124	IRWD-specific estimate	146
HET	Indoor	qty	5,740	4,413	0.0135	IRWD-specific estimate	78
PHET	Indoor	qty	4,008	4,114	0.0126	IRWD-specific estimate	51
Showerhead	Indoor	qty	1,613	2,062	0.0063	AWE Model default value	10
Cistern	Outdoor	qty	3	n/a	n/a		n/a
Moisture Sensor	Outdoor	qty	5	n/a	n/a		n/a
Precision Spray Nozzle	Outdoor	qty	45,287	1,434	0.0044	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	199
Rain Barrel	Outdoor	qty	956	n/a	n/a		n/a
Rotating Nozzle	Outdoor	qty	10,803	1,434	0.0044	Planning numbers provided by IRWD	48
WBIC/Smart Controller	Outdoor	qty	2,779	5,610	0.0172	IRWD-specific estimate	48
Turf Removal	Outdoor	sq ft	1,405,165	23	0.0001	IRWD-specific estimate	97
Turf Removal (Synthetic Turf)	Outdoor	sq ft	13,297	23	0.0001	IRWD-specific estimate	1
						Total	**677**
Residential - Multi Family							
Faucet Aerator	Indoor	qty	4,676	n/a	n/a		n/a
HECW	Indoor	qty	5,041	9,290	0.0285	IRWD-specific estimate for SFR; scaled relative to the number of MFR dwelling units/SP (2.3)	144
HET	Indoor	qty	1,691	4,413	0.0135	IRWD-specific estimate	23
PHET	Indoor	qty	16,371	4,114	0.0126	IRWD-specific estimate	207
Showerhead	Indoor	qty	1,589	1,898	0.0058	AWE Model default value	9
Moisture Sensor	Outdoor	qty	1	n/a	n/a		n/a
Precision Spray Nozzle	Outdoor	qty	550	1,434	1.9	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	1,054
Rain Barrel	Outdoor	qty	63	n/a	n/a		n/a
Rotating Nozzle	Outdoor	qty	4,600	1,434	0.0044	Planning numbers provided by IRWD	20

Table 5-4
Summary of Water Savings Assumptions for Devices Installed through Past WE Program Participation
Irvine Ranch Water District

Measure	Indoor/ Outdoor Use	Units	Devices Replaced	Estimated Savings per Unit		Savings Basis	Estimated Total Annual Savings (AFY)
				gpy	AFY		
WBIC/Smart Controller	Outdoor	qty	131	3,653	0.0112	IRWD-specific estimate; assumed 2/3 of non-potable landscape irrigation savings	1
Turf Removal	Outdoor	sq ft	136,481	23	0.0001	IRWD-specific estimate	9
Turf Removal (Synthetic Turf)	Outdoor	sq ft	1,065	23	0.0001	IRWD-specific estimate	0
						Total	**1,468**
Landscape Irrigation, Potable							
Flow Regulator (Sprinkler)	Outdoor	qty	750	n/a	n/a		n/a
Precision Spray Nozzle	Outdoor	qty	100	1,434	0.0044	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	0
Rotating Nozzle	Outdoor	qty	5,100	1,434	0.0044	Planning numbers provided by IRWD	22
WBIC/Smart Controller	Outdoor	qty	199	0	0	IRWD-specific estimate	0
Turf Removal	Outdoor	sq ft	1,018,593	5.8	0.00002	IRWD-specific estimate	18
						Total	**41**
Landscape Irrigation, Non-Potable							
Precision Spray Nozzle	Outdoor	qty	9,101	1,434	0.0044	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	40
Rotating Nozzle	Outdoor	qty	9,534	1,434	0.0044	Planning numbers provided by IRWD	42
WBIC/Smart Controller	Outdoor	qty	905	5,535	0.0170	IRWD-specific estimate	15
Turf Removal	Outdoor	sq ft	1,568,803	2.9	0.00001	IRWD-specific estimate	14
Turf Removal (Synthetic Turf)	Outdoor	sq ft	871	2.9	0.00001	IRWD-specific estimate	0
						Total	**111**
Institutional							
Faucet Aerator	Indoor	qty	25	n/a	n/a		n/a
Precision Spray Nozzle	Outdoor	qty	100	1,434	0.0044	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	0
WBIC/Smart Controller	Outdoor	qty	2	3,653	0.0112	IRWD-specific estimate; assumed 2/3 of non-potable landscape irrigation savings	0
Turf Removal	Outdoor	sq ft	1,800	5.8	0.00002	IRWD-specific estimate; assumed same as potable-landscape irrigation	0
						Total	**0**

Table 5-4
Summary of Water Savings Assumptions for Devices Installed through Past WE Program Participation
Irvine Ranch Water District

Measure	Indoor/ Outdoor Use	Units	Devices Replaced	Estimated Savings per Unit		Savings Basis	Estimated Total Annual Savings (AFY)
				gpy	AFY		
Industrial							
Faucet Aerator	Indoor	qty	35	n/a	n/a		n/a
PHET	Indoor	qty	7	5,760	0.0177	IRWD-specific estimate' assume to be 1.4X that of SFR savings based on ratio in AWE model default	0
Showerhead	Indoor	qty	11	n/a	n/a		n/a
Turf Removal	Outdoor	sq ft	58,769	5.8	0.00002	IRWD-specific estimate; assumed same as potable-landscape irrigation	1
						Total	**1**
Commercial							
Cooling Tower	Indoor	qty	1	210,188	0.6450	Planning numbers provided by IRWD	1
Faucet Aerator	Indoor	qty	149	n/a	n/a		n/a
HECW	Indoor	qty	6	24,235	0	Assumes use is 6x that of SFR use per AWE model assumption; uses IRWD-specific estimate	0
HET	Indoor	qty	1,783	6,178	0.0190	IRWD-specific estimate' assume to be 1.4x that of SFR savings based on ratio in AWE model default	34
PHET	Indoor	qty	29	5,760	0.0177	IRWD-specific estimate' assume to be 1.4x that of SFR savings based on ratio in AWE model default	1
Plumbing Flow Control	Indoor	qty	1,942	n/a	n/a		n/a
Showerhead	Indoor	qty	10	n/a	n/a		n/a
Ultra Low Water Urinal	Indoor	qty	18	39,943	0.1226	Planning numbers provided by IRWD	2
Zero Water Urinal	Indoor	qty	32	39,943	0.1226	Planning numbers provided by IRWD	4
Precision Spray Nozzle	Outdoor	qty	200	1,434	0.0044	Planning numbers provided by IRWD, assumed same as Rotating Nozzle	1
Rotating Nozzle	Outdoor	qty	720	1,434	0.0044	Planning numbers provided by IRWD	3
WBIC/Smart Controller	Outdoor	qty	8	3,653	0.0112	IRWD-specific estimate; assumed 2/3 of non-potable landscape irrigation savings	0
Turf Removal	Outdoor	sq ft	375,453	5.8	0.00002	IRWD-specific estimate; assumed same as potable-landscape irrigation	7
						Total	**52**

Table 5-4
Summary of Water Savings Assumptions for Devices Installed through Past WE Program Participation
Irvine Ranch Water District

Abbreviations

AWE = Alliance for Water Efficiency
CCF = hundred cubic feet, 748 gallons
CII = commercial, industrial, institutional
gpy = gallons per year
HECW = high efficiency clothes washer
HET = high efficiency toilet
MFR = multi-family residential
PHET = premium high efficiency toilet
n/a = not available
qty = quantity
SFR = single-family residential
SP = service point
sq ft = square feet
WBIC = weather-Based Irrigation Controller

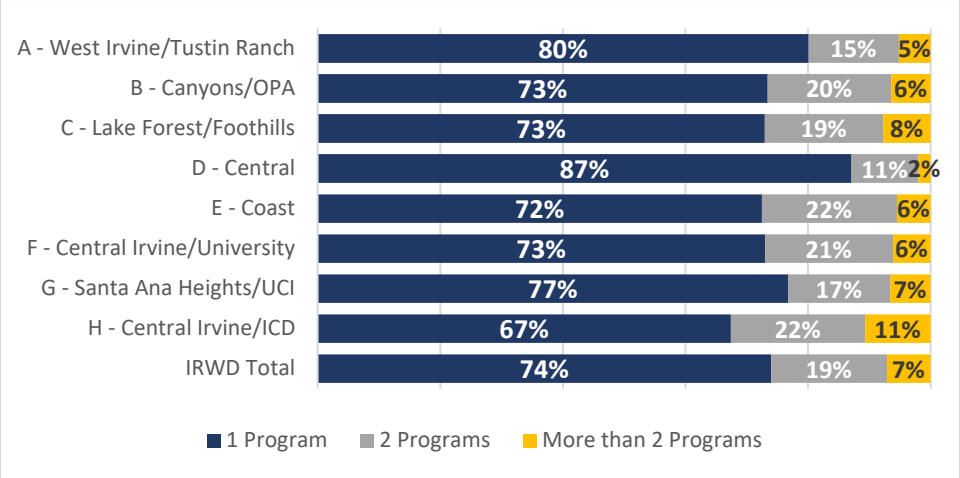
Notes

(a) Devices installed at University of California Irvine properties are not included in this summary. Data provided by IRWD.

efficient devices were offered as part of separate programs, whereas they were more likely to change out multiple device types if they were offered as a "bundle". In order to understand program saturation on the "whole home-level", as well as consider the water savings achieved by WE program no-cost "bundles," multiple-program participation is further evaluated below. **Figures 5-1** through **5-6** below show the relative percentage of participants and attached **Table 5-5** presents the total number of participants.

As shown in **Figure 5-1**, 74% of the total single-family residential (SFR) participants only participated in one WE program, 19% participated in two programs, and the remaining 7% participated in more than two programs. Some variation is observed between Village Groups. For example, only 13% of participating service points (SPs) from the Central Village Group participated in more than one program, while 33% of participating SPs from the Central Irvine/ICD Village Group participated in more than one program. The Central Village Group tends to have newer homes (which might limit their participation rates), while the Central Irvine/ICD Village Group has much older homes.

Figure 5-1
SFR Participation in Multiple Programs



As shown in **Figure 5-2**, 89% of the multi-family residential (MFR) SPs only participated in one program, 10% of them participated in two programs, and the remaining 1% participated in more than two programs. The MFR SPs have been less likely to participate in multiple programs to date. One possible explanation is many MFR participants tend not to have private devices (such as washers) or turf at their properties.

Participation rates in multiple programs are similar across different Village Groups. Similar to the SFR participation, MFR participants in the Central Irvine/ICD Village Group have been more likely to participate in multiple programs while those in the Central Village Group have been less likely to do so.

Table 5-5
Summary of Participation in Multiple Programs
Irvine Ranch Water District

Participation in Multiple Programs

	SFR				MFR			
Village Group	Total SPs Participating in WE Programs	1 Program	2 Programs	> 2 Programs	Total SPs Participating in WE Programs	1 Program	2 Programs	> 2 Programs
A - West Irvine/Tustin Ranch	2,519	2,018	370	131	1,060	968	79	13
B - Canyons/OPA	218	160	44	14	0	0	0	0
C - Lake Forest/Foothills	3,839	2,801	741	297	731	645	81	5
D - Central	1,293	1,126	141	26	797	736	59	2
E - Coast	1,721	1,247	379	95	271	245	26	0
F - Central Irvine/University	2,050	1,496	428	126	1,577	1,363	199	15
G - Santa Ana Heights/UCI	1,429	1,097	238	94	673	603	63	7
H - Central Irvine/ICD	4,181	2,819	916	446	610	512	82	16
Total	**17,250**	**12,764**	**3,257**	**1,229**	**5,719**	**5,072**	**589**	**58**

Timing of SPs Participating in More than 1 Program

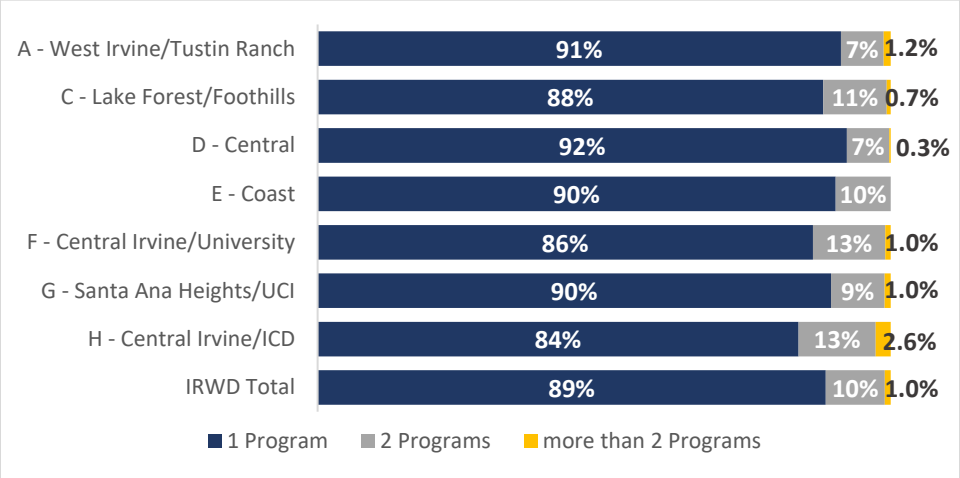
	SFR				MFR		
Village Group	SPs Particpating in >1 Program	1 year	Multiple Years		SPs Particpating in >1 Program	1 year	Multiple Years
A - West Irvine/Tustin Ranch	501	135	366		92	28	64
B - Canyons/OPA	58	30	28		0	0	0
C - Lake Forest/Foothills	1,038	296	742		86	41	45
D - Central	167	54	113		61	21	40
E - Coast	474	264	210		26	5	21
F - Central Irvine/University	554	207	347		214	62	152
G - Santa Ana Heights/UCI	332	110	222		70	22	48
H - Central Irvine/ICD	1,362	544	818		98	29	69
Total	**4,486**	**1,640**	**2,846**		**647**	**208**	**439**

Participation in Indoor vs. Outdoor Programs

	SFR				MFR			
Village Group	SPs Particpating in >1 Program	Indoor Only	Outdoor Only	Indoor & Outdoor	SPs Particpating in >1 Program	Indoor Only	Outdoor Only	Indoor & Outdoor
A - West Irvine/Tustin Ranch	501	210	25	266	92	79	1	12
B - Canyons/OPA	58	20	9	29	0	0	0	0
C - Lake Forest/Foothills	1,038	377	68	593	86	76	1	9
D - Central	167	65	5	97	61	51	0	10
E - Coast	474	90	220	164	26	23	1	2
F - Central Irvine/University	554	301	21	232	214	175	2	37
G - Santa Ana Heights/UCI	332	152	24	156	70	58	1	11
H - Central Irvine/ICD	1,362	722	38	602	98	83	1	14
Total	**4,486**	**1,937**	**410**	**2,139**	**647**	**545**	**7**	**95**

Abbreviations
MFR = multi-family residential
SFR = single-family residential
SP = service point

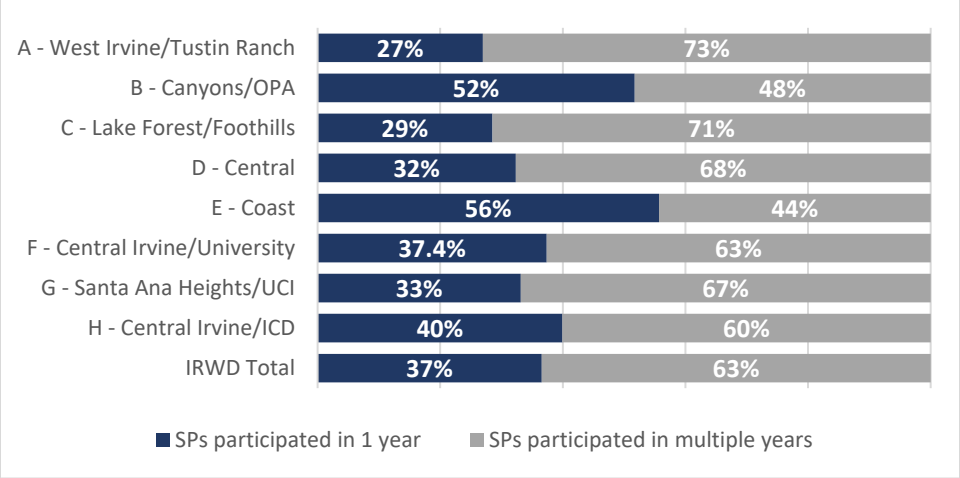
Figure 5-2
MFR Participation in Multiple Programs



5.2.3. Participation in Multiple Programs Over Multiple Years

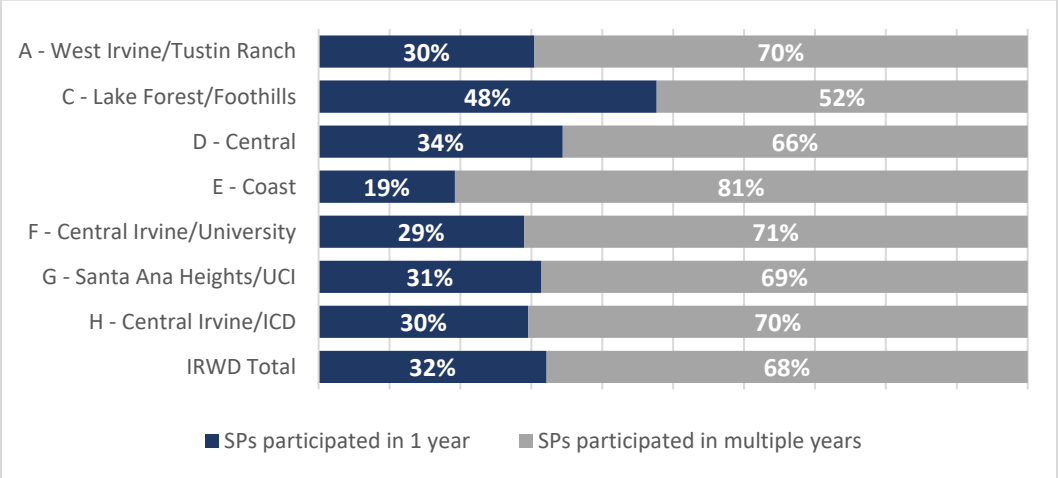
As shown in **Figure 5-3**, more than half of the SFR participants participated in multiple programs over multiple years, except the Canyons/OPA Village Group and the Coast Village Group.

Figure 5-3
Timing of SFR SPs that Participated in More than One Program



As shown in **Figure 5-4**, in general, MFR participants that participated in multiple programs were more likely to participate over multiple years. About two thirds of participants that participated in multiple programs participated in multiple years except for the Lake Forest/Foothills Village Group.

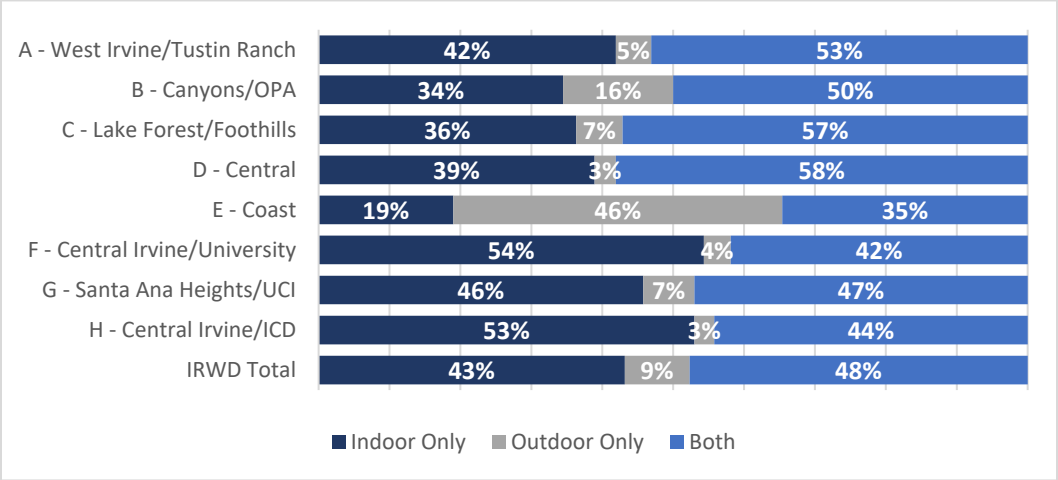
Figure 5-4
Timing MFR SPs that Participated in More than One Program



5.2.4. Participation in Multiple Programs – Indoor vs. Outdoor

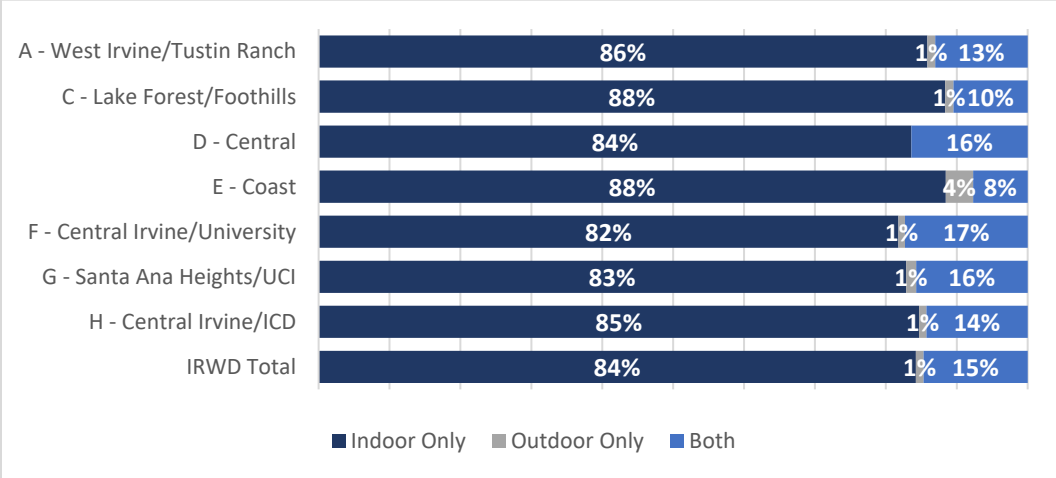
As shown in **Figure 5-5**, for SFR SPs, the preference for indoor or outdoor programs varies between Village Groups. In general, SFR participants have participated at higher rates in indoor programs, except for those in the Coast Village Group, where homes tend to be larger with larger lots. Most SFR SPs that participated in multiple programs either participated in indoor programs only or both indoor and outdoor programs; less than 10% participated in outdoor programs only.

Figure 5-5
Preference for Indoor/Outdoor for SFR SPs that Participated in More than One Program



As shown in **Figure 5-6**, MFR customers participate in indoor programs at a much higher rate than outdoor programs, which is expected given that many MFR customers have little to no private outdoor space (yards). However, among MFR customers that have participated in multiple programs, those that participated in an outdoor program typically also participated in an indoor program.

Figure 5-6
Preference for Indoor/Outdoor for MFR SPs that Participated in More than One Program



5.3. Natural Replacement of Devices

Toilets and clothes washers are typically the highest water using devices within a residential home and therefore have the greatest potential for water efficiency savings.

In order to evaluate the remaining potential for additional water savings through replacement of indoor devices, the saturation of high efficiency toilets and clothes washers were evaluated. The results of this assessment are presented in attached **Tables 5-6** and **5-7**, respectively.

Given the increased water efficiency standards and requirements for new construction and new devices (Section 4.1), and at IRWD's direction, this assessment focuses only on homes that were constructed prior to 2010.[49] Indoor devices in homes built after 2010 are assumed to be "fully efficient" due to plumbing code requirements.

5.3.1. Toilets

Table 5-6 presents the total number of toilets at SFR and MFR SPs constructed before 2010 by Village Group, based on the number of bathrooms identified by available parcel data. On average, SFR homes tend to have 3.1 bathrooms per unit and MFR homes tend to have 1.9 per unit, with some variation between Village Groups. The first toilet efficiency standard went into effect in 1994, and required all toilets sold to have a minimum efficiency of at least 1.6 gpf.

For toilets in homes built before 1994, it is assumed that they are replaced at a rate of 4% per year, per the natural replacement rate in the Alliance for Water Efficiency (AWE) Tracking Tool. This natural

[49] Home construction date is estimated based on parcel data, where available. Where date of construction is not available in parcel data, construction date is assumed to be the earliest of the date of SP install and service agreement start date.

Table 5-6
Estimated Saturation of High Efficiency Toilets for SFR and MFR SPs Constructed Prior to 2010
Irvine Ranch Water District

Village Group	Number of Dwelling Units Constructed Prior to 2010	Bathrooms per Unit	Total Estimated No. of Toilets	Estimated Number of Toilets in Homes Built Before 1994				Estimated Number of Toilets in Homes Built 1994-2009			
				Toilets In Homes Built before 1994	Replaced through WE Programs	Replaced through Natural Replacement	Remaining Pre-1994 Toilets	Toilets In Homes Built 1994-2009	Replaced through WE Programs	Replaced through Natural Replacement	Remaining 1994-2009 Toilets
Single-Family Residential											
A - West Irvine/Tustin Ranch	6,219	3.3	20,333	3,570	274	3,570	0 - 0	16,763	831	6,690	9,242 - 10,073
B - Canyons/OPA	1,212	1.8	2,228	1,803	99	1,803	0 - 0	425	6	134	284 - 290
C - Lake Forest/Foothills	11,528	2.8	32,678	27,865	1,955	27,865	0 - 0	4,813	329	2,579	1,905 - 2,234
D - Central	1,526	3.5	5,385	0	0	0	0 - 0	5,385	145	550	4,690 - 4,835
E - Coast	6,590	4.2	27,458	1,221	20	1,221	0 - 0	26,237	423	8,149	17,666 - 18,089
F - Central Irvine/University	6,874	2.8	19,247	18,082	1,276	18,082	0 - 0	1,165	61	525	579 - 640
G - Santa Ana Heights/UCI	5,718	3.0	16,929	9,042	465	9,042	0 - 0	7,887	386	2,614	4,887 - 5,273
H - Central Irvine/ICD	12,222	2.8	34,643	27,426	2,674	27,426	0 - 0	7,217	586	2,900	3,731 - 4,317
Total	**51,889**	**3.1**	**158,901**	**89,010**	**6,763**	**89,010**	**0 - 0**	**69,891**	**2,767**	**24,141**	**42,984 - 45,751**
Percentage	**--**	**--**	**--**	**--**	**7.6%**	**100%**	**- 0%**	**--**	**4.0%**	**35%**	**62% - 65%**
Multi-Family Residential											
A - West Irvine/Tustin Ranch	10,790	1.8	19,029	6,034	132	5,911	0 - 122	12,995	865	3,747	8,383 - 9,248
B - Canyons/OPA	--	--	--		--	--	--	--	--	--	--
C - Lake Forest/Foothills	13,046	1.8	23,454	16,063	468	16,063	0 - 0	7,391	73	1,286	6,031 - 6,104
D - Central	3,436	2.3	7,978	0	0	0	0 - 0	7,978	246	826	6,905 - 7,151
E - Coast	5,648	2.3	12,912	117	2	117	0 - 0	12,795	80	4,223	8,492 - 8,572
F - Central Irvine/University	15,266	2.0	30,745	30,481	833	30,481	0 - 0	264	0	136	128 - 128
G - Santa Ana Heights/UCI	17,532	1.6	28,761	12,916	1,627	12,916	0 - 0	15,846	1,159	4,172	10,514 - 11,673
H - Central Irvine/ICD	6,211	1.8	10,878	9,715	430	9,715	0 - 0	1,163	174	383	605 - 779
Total	**71,929**	**1.9**	**133,756**	**75,325**	**3,492**	**75,202**	**0 - 122**	**58,431**	**2,597**	**14,774**	**41,060 - 43,657**
Percentage	**--**	**--**	**--**	**--**	**4.6%**	**99.8%**	**0% - 0.2%**	**--**	**4.4%**	**25%**	**70% - 75%**

replacement rate is based on assumed average device lifetime of 25 years.[50] For homes built between 1994 and 2010, it is assumed that no toilets are replaced for the first 10 years and thereafter toilets are replaced at a rate of 4% per year.

Table 5-6 shows the estimated number of toilets replaced through natural replacement as well as those replaced in conjunction with a WE program such as rebates and direct installation programs. Based on this assessment, all SFR toilets and nearly all MFR toilets (99.8%) for homes built before 1994 are estimated to have been replaced through natural replacement. Approximately 7.6% of SFR and 4.6% of MFR toilets have been replaced through participation in a WE program such as a rebate or direct installation program. While this is an estimate based on assumed change-out rates, and not an inventory of individual homes, based on this assessment, very few pre-1994 toilets are expected to remain within the IRWD service area (i.e., the estimates would suggest that more than 100% of the pre-1994 toilets "should have" been replaced by now through active or passive means).

Beginning in 2014, all new toilets sold in California were required to have a minimum efficiency of 1.28 gpf or better, but these higher efficiency toilets penetrated the market well before the mandatory change. At IRWD's direction, for purposes of this assessment, 2010 is used as the transition period. Therefore, toilets installed between 1994 and 2009 are more efficient than pre-1994 toilets, but still present a potential for increased water efficiency. As shown in **Table 5-6**, it is estimated that approximately 35% of SFR and 25% of MFR toilets in homes constructed during this period have been replaced through natural replacement. Approximately 4% of toilets in homes constructed during this period were replaced in conjunction with a WE program. It is unknown how many program participants would have replaced a toilet if an incentive was not provided (known as "free ridership"). Based on this assessment, it is estimated that between 62% and 65% of SFR toilets have not been replaced and between 70% and 75% of MFR toilets have not been replaced. Therefore, while some potential opportunity for increased efficiency remains, the potential savings that would be achieved would be less than was achieved historically by changing out the older pre-1994 toilets.

As shown in **Table 5-7** below, the majority of the remaining potential for toilet change-outs at SFR SPs (over 60%) is located in the West Irvine/Tustin Ranch and Coast Village Groups. For MFR accounts, nearly 70% of the remaining potential for toilet change-outs is located in the West Irvine/Tustin Ranch, Coast, and Central Irvine/ICD Village Groups.

[50] Property turnover is often a driver for device changeouts. As a check for general appropriateness of the assumed rate, property transfer rates were evaluated and discussed in Attachment A. SFR properties built prior to 2010 have been transferred at a rate of approximately 3.4% per year over the last 10 years, and MFR properties built prior to 2010 have been transferred at a rate of approximately 1.8% per year over this period. Given that these rates are on the same order of magnitude, these rates are in general agreement.

Table 5-7
Estimated Remaining 1994-2009 Toilets (1.6 gpf)

Village Group	SFR Toilets		MFR Toilets	
	Remaining	Percentage	Remaining	Percentage
A - West Irvine/Tustin Ranch	9,242 - 10,073	22%	8,383 - 9,248	21%
B - Canyons/OPA	284 - 290	1%	--	--
C - Lake Forest/Foothills	1,905 - 2,234	5%	6,031 - 6,104	14%
D - Central	4,690 - 4,835	11%	6,905 - 7,151	17%
E - Coast	17,666 - 18,089	40%	8,492 - 8,572	20%
F - Central Irvine/University	579 - 640	1%	128 - 128	0%
G - Santa Ana Heights/UCI	4,887 - 5,273	11%	10,514 - 11,673	26%
H - Central Irvine/ICD	3,731 - 4,317	9%	605 - 779	2%
Total	**42,984 - 45,751**	**n/a**	**41,060 - 43,657**	**n/a**

5.3.2. Clothes Washers

Table 5-8 presents the total number of clothes washers for SFR and MFR homes constructed before 2010 by Village Group, based on the number of dwelling units. Based on information included in the AWE Tracking Tool, it is assumed that 95% of SFR SPs have a clothes washer. For MFR SPs, it is assumed that 95% of condominium homes have a clothes washer and 39% of apartment homes have a clothes washer. Based on the split between types of MFR units, the effective rate of washers per dwelling unit for the MFR sector within the District is therefore 67%.

It is assumed that clothes washers are replaced at a rate of 7% per year at SFR homes and condominiums and 13% per year for apartments, based on values provided in the AWE Tracking Tool. This equates to an average lifetime of 14 years for SFR and condominium clothes washers, and 8 years for apartment clothes washers. Regulatory changes have required increased minimum efficiencies for clothes washers; however, there are many clothes washer options that exceed these minimum efficiency standards. The AWE Tracking Tool provides an estimate of the market share of Environmental Protection Agency (EPA) Energy Star-rated clothes washers from 1998 onward. Therefore, it is assumed that the number of washers replaced by high efficiency clothes washers (HECWs) in a given year is proportionate to the market share of Energy Star washers in that year.

Table 5-8 shows the estimated number of clothes washers replaced through natural replacement as well as those replaced in conjunction with a WE program from 2009 onward. In addition to this, many customers participated in the HECW rebate program prior to 2009, although the data are not currently available. Based on this assessment, approximately 44% of SFR clothes washers and 50% of MFR clothes washers have been replaced with HECWs through natural replacement. Approximately 21% of SFR clothes washers and 19% of MFR clothes washers have been replaced with HECWs in conjunction with a WE program. Given that the rate of free ridership is unknown, it is therefore estimated that between 35% and 56% of SFR clothes washers are not HECW and between 37% and 50% of MFR clothes washers are not HECW.

Table 5-8
Estimated Saturation of High Efficiency Clothes Washers for SFR and MFR SPs Constructed Prior to 2010
Irvine Ranch Water District

Village Group	Number of Dwelling Units Constructed Prior to 2010	Estimated Number of Clothes Washers			
		Total No. Washers	Replaced with HECW through WE Programs	Replaced with HECW through Natural Replacement	Remaining Non-HECWs
Single-Family Residential					
A - West Irvine/Tustin Ranch	6,219	5,908	1,569	3,015	1,324 - 2,893
B - Canyons/OPA	1,212	1,151	109	590	452 - 561
C - Lake Forest/Foothills	11,528	10,952	2,264	2,331	6,356 - 8,620
D - Central	1,526	1,450	397	598	454 - 851
E - Coast	6,590	6,261	1,088	3,073	2,099 - 3,187
F - Central Irvine/University	6,874	6,530	1,291	3,382	1,858 - 3,149
G - Santa Ana Heights/UCI	5,718	5,432	984	2,705	1,743 - 2,727
H - Central Irvine/ICD	12,222	11,611	2,658	5,994	2,959 - 5,617
Total	**51,889**	**49,295**	**10,360**	**21,689**	**17,245 - 27,605**
Percentage	**--**	**--**	**21%**	**44%**	**35% - 56%**
Multi-Family Residential					
A - West Irvine/Tustin Ranch	10,790	6,492	660	3,216	2,616 - 3,276
B - Canyons/OPA	--	--	--	--	-- - --
C - Lake Forest/Foothills	13,046	8,969	597	4,495	3,877 - 4,474
D - Central	3,436	1,975	211	818	945 - 1,156
E - Coast	5,648	3,320	249	1,640	1,431 - 1,680
F - Central Irvine/University	15,266	11,798	1,281	6,122	4,395 - 5,676
G - Santa Ana Heights/UCI	17,532	10,371	680	5,014	4,677 - 5,357
H - Central Irvine/ICD	6,211	4,976	5,238	2,571	0 - 2,405
Total	**71,929**	**47,900**	**8,916**	**23,877**	**17,940 - 24,023**
Percentage	**--**	**--**	**19%**	**50%**	**37% - 50%**

Abbreviations
HECW = high efficiency clothes washer
WE = water efficiency

As shown in **Table 5-9** below, the majority of the remaining potential for clothes washer change-outs at SFR SPs (over 50%) is located in the Lake Forest/Foothills and Central Irvine/ICD Village Groups. For MFR accounts, nearly 70% of the remaining potential for clothes washer change-outs is located in the Lake Forest/Foothills, Central Irvine/University, and Santa Ana Heights/UCI Village Groups.

Table 5-9
Estimated Remaining Non-High Efficiency Clothes Washers

Village Group	SFR		MFR	
	Remaining	Percentage	Remaining	Percentage
A - West Irvine/Tustin Ranch	1,324 - 2,893	9%	2,616 - 3,276	14%
B - Canyons/OPA	452 - 561	2%	--	--
C - Lake Forest/Foothills	6,356 - 8,620	34%	3,877 - 4,474	20%
D - Central	454 - 851	3%	945 - 1,156	5%
E - Coast	2,099 - 3,187	12%	1,431 - 1,680	7%
F - Central Irvine/University	1,858 - 3,149	11%	4,395 - 5,676	24%
G - Santa Ana Heights/UCI	1,743 - 2,727	10%	4,677 - 5,357	24%
H - Central Irvine/ICD	2,959 - 5,617	19%	0 - 2,405	5%
Total	**17,245 - 27,605**	**na**	**17,940 - 24,023**	**na**

5.3.3. Turf Removal

As discussed in Section 4.6, installation of WBICs does not appear to save a substantial amount of water and may potentially even increase the overall amount of water used for irrigation.[51] Therefore, this evaluation of outdoor water savings program potential focuses on turf removal programs. **Table 5-10** below provides a summary of the total irrigated area within each Village Group, identified as lawn/ turf area, irrigated non-turf landscape, and swimming pools, based on an aerial image processing land use classification study done by Quantum Spatial (2016) and data processing performed by IRWD.[52] Key data limitations associated with this dataset are discussed in Section 2.2.5. **Table 5-10** also shows the amount of turf area removed through the Turf Removal Rebate program through 2018 by Village Group.

Approximately 23% of the irrigated area (excluding agricultural and horse corral areas) within the District consists of turf areas. To date, turf removal programs have directly removed 105 acres of turf, which amounts to approximately 5.6% of the irrigated lands.[53] The Village Groups with the largest proportions of turf include the Central Irvine/University and Coast areas, which amounts to nearly 800 acres of turf.

[51] It should be noted that some SPs in the participant group may have participated in the program prior to 2009, which may result in a lower savings estimate.
[52] The Quantum Spatial study also identified irrigated lands in use as horse corrals/arenas, agriculture, irrigable, and non-irrigated classifications, which are not summarized herein.
[53] In addition to the turf removed directly through these programs, a "multiplier effect" has been observed among SFR customers, wherein additional SFR customers in the vicinity of a participating SFR customer also replace their lawns (IRWD, 2016). Accounting for the multiplier effect, an additional 86 acres of turf may also have been removed in relation to the program.

Table 5-10, **Table 5-11**, and **Figure 5-7** below, show an estimate of irrigated turf area by land use sector and by Village Group. Because data are not yet available to link the geospatial irrigation land use data to specific customer meters and sector types, certain assumptions were made in the processing of this dataset. The data limitations associated with this processing is discussed in Section 2.2.5.

Table 5-10
Estimated Irrigated Turf Area and Turf Removal through Programs by Village Group[54]

	Irrigated Area (ac)				Turf Removed through Programs (ac)					
Village Group	Lawn/ Turf	Non-Turf	Swim. Pools	Lawn/ Turf as Percent. of Irrigation Area	SFR	MFR	Landscape Irrigation, Non-Potable	Landscape Irrigation, Potable	CII	Total All Sectors
A - West Irvine/ Tustin Ranch	220	634	13	25%	3.0	0.042	9.4	0.018	0	12
B - Canyons/ OPA	22	341	3.2	6%	2.2	0	0	0	0	2.2
C - Lake Forest/ Foothills	280	1,452	24	16%	13	0.82	1.1	11	7.0	33
D - Central	65	289	4.4	18%	0.29	0.019	0	0	0	0.31
E - Coast	358	829	24	30%	2.0	0.017	0.47	0	0	2.5
F - Central Irvine/University	427	925	9.1	31%	3.1	1.1	14	0.45	0	18
G - Santa Ana Heights/UCI	240	900	8.5	21%	2.8	0.44	6.1	11	2.5	23
H - Central Irvine/ICD	250	657	17	27%	6.5	0.68	5.4	0.41	0.60	14
Total	**1,863**	**6,028**	**103**	**23%**	**33**	**3.1**	**36**	**23**	**10**	**105**

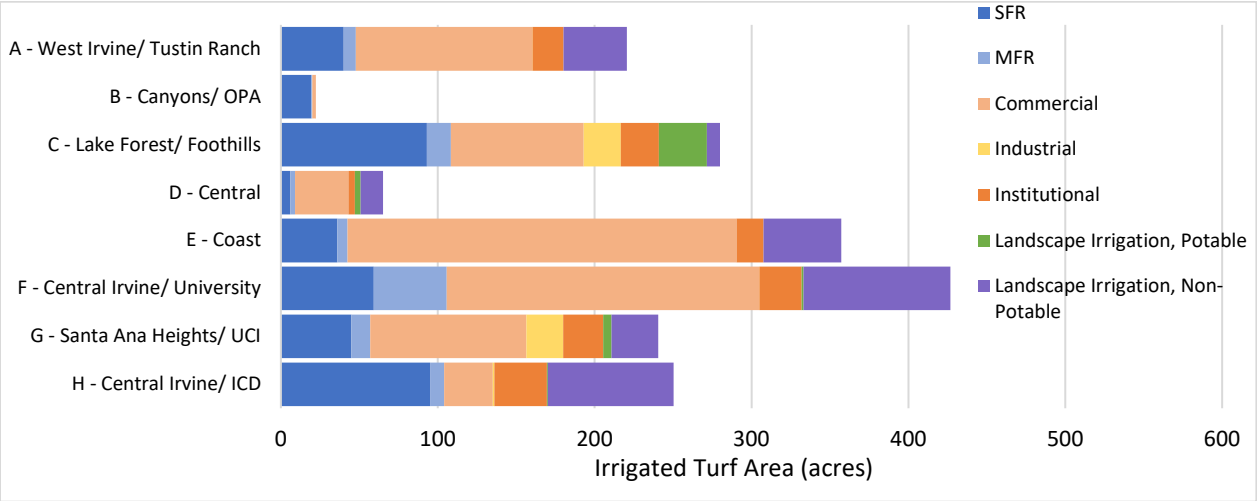
Commercial and SFR uses comprise approximately 44% and 21% of turf area in the District, respectively, as shown in **Table 5-11**, and represent an opportunity to reduce overall irrigated turf area and associated irrigation water use. Over 800 acres of turf are associated with commercial land uses, with the majority located in the Coast, Central Irvine/University, and West Irvine/ Tustin Ranch Village Groups. It is important to note that some of these areas may include functional turf such as golf courses and parks, and thus would not be included as eligible for turf removal or the associated water savings. Nearly 400 acres of turf are associated with SFR SPs, with the majority located in the Central Irvine/ICD and Lake Forest/Foothills Village Groups.

[54] See Section 2.2.5 for a discussion of data limitations associated with the turf area estimates.
Totals may not sum exactly due to rounding.

Table 5-11
Turf Area by Sector and Village Group[54]

Village Group	SFR	MFR	Commercial	Industrial	Institutional	Landscape Irrigation, Potable	Landscape Irrigation, Non-Potable	Total
	Turf Area (ac)							
A - West Irvine/ Tustin Ranch	40	7.8	113	0.03	20	0	40	**220**
B - Canyons/ OPA	20	0.6	2.0	0	0.23	0	0	**22**
C - Lake Forest/ Foothills	93	15	85	24	24	31	8.4	**280**
D - Central	5.9	3.2	34	0	4.0	3.7	14	**65**
E - Coast	36	6.5	248	0	17	0	50	**358**
F - Central Irvine/ University	59	47	199	0.16	27	1.2	94	**427**
G - Santa Ana Heights/ UCI	45	12	99	24	25	5.3	30	**240**
H - Central Irvine/ ICD	95	8.8	31	1.0	34	0.6	80	**250**
Total	**394**	**101**	**811**	**48**	**151**	**41**	**316**	**1,863**
	Proportion of Turf Area (%)							
A - West Irvine/ Tustin Ranch	2.1%	0.42%	6.0%	0.002%	1.1%	na	2.2%	12%
B - Canyons/ OPA	1.0%	0.03%	0.11%	na	0.01%	na	na	1.2%
C - Lake Forest/ Foothills	5.0%	0.83%	4.5%	1.3%	1.3%	1.6%	0.45%	15%
D - Central	0.31%	0.17%	1.8%	na	0.22%	0.20%	0.76%	3.5%
E - Coast	1.9%	0.35%	13%	na	0.92%	0%	2.7%	19%
F - Central Irvine/ University	3.2%	2.5%	11%	0.01%	1.4%	0.06%	5.0%	23%
G - Santa Ana Heights/ UCI	2.4%	0.65%	5.3%	1.3%	1.4%	0.29%	1.6%	13%
H - Central Irvine/ ICD	5.1%	0.47%	1.7%	0.05%	1.8%	0.03%	4.3%	13%
Total	**21%**	**5%**	**44%**	**2.6%**	**8.1%**	**17%**	**2.2%**	**100%**

Figure 5-7
Turf Area by Land Use and Village Group



5.4. Estimation of Water Saved Through Active and Passive Device Replacement

Overall, water use by IRWD customers has declined approximately 27% on a per capita basis since 2013.[55] The reduction in water use is due to a combination of factors, including WE program participation, passive water conservation due to device change-outs, regulatory requirements, drought conditions, economic influences, budget based rates, IRWD's consistent outreach campaigns and a greater public awareness of responsible water use, all to varying degrees.

The total water savings associated with toilet and clothes washer replacements are estimated and shown in **Table 5-12** below. These estimates of indoor water savings are based on the IRWD-specific water savings factors identified in Sections 4.1 and 4.4 and the total indoor device replacement estimates from 2009 to 2018 discussed in Section 5.3. It should be noted that from 1993 to 2008, IRWD customers received over 21,000 WE devices through WE programs, including HETs, HECWs, WBICs, and other devices. These older data, however, are not included in the counts of WE program participation or saturation assessment herein.[56] The total savings associated with these device replacements for SFR customers is estimated to be between approximately 1,800 acre feet per year (AFY) and 2,100 AFY through the lifetime of the device. The total savings associated with toilet and clothes washer device replacements for MFR customers is estimated to be between approximately 1,500 AFY and 1,700 AFY through the lifetime of the device.

[55] This estimate is based on monthly reporting to the State Water Resources Control Board.
[56] The older data were not included in the completion of this analysis. The inclusion of these data would not have substantively changed the overall findings of a high rate of saturation of HETs and HECWs.

Table 5-12
Estimated Indoor Water Savings for Homes Built before 2010 Based on Toilet and Clothes Washer Replacements

Village Group	Estimated Annual Indoor Savings for Homes Built Before 2010 (AFY)					
	Savings from Toilets		Savings from Clothes Washers		Total	
	WE Programs Implemented 2009-2018	Natural Replacement	WE Programs Implemented 2009-2018	Natural Replacement		
Single-Family Residential						
A - West Irvine/Tustin Ranch	15	139	19	37	176 -	211
B - Canyons/OPA	1	26	1	7	34 -	36
C - Lake Forest/Foothills	31	412	28	29	441 -	500
D - Central	2	7	5	7	15 -	22
E - Coast	6	127	13	38	165 -	184
F - Central Irvine/University	18	252	16	42	294 -	328
G - Santa Ana Heights/UCI	12	158	12	34	191 -	215
H - Central Irvine/ICD	44	411	33	74	485 -	562
Total	**129**	**1,533**	**128**	**269**	**1,801 -**	**2,059**
Multi-Family Residential						
A - West Irvine/Tustin Ranch	14	131	8	40	171 -	192
B - Canyons/OPA	--	--	--	--	-	
C - Lake Forest/Foothills	7	235	7	56	291 -	305
D - Central	3	11	3	10	21 -	27
E - Coast	1	59	3	20	79 -	83
F - Central Irvine/University	11	415	16	76	491 -	518
G - Santa Ana Heights/UCI	38	231	8	62	294 -	340
H - Central Irvine/ICD	8	137	65	32	169 -	242
Total	**82**	**1,219**	**111**	**296**	**1,515 -**	**1,708**

The total water savings associated with Turf Removal programs for potable water SPs is estimated and shown in **Table 5-13** below. These estimates of outdoor water savings are based on the IRWD-specific water savings factors identified in Section 4.2 and the total area of turf replaced through WE programs. The total savings is estimated to be approximately 99 AFY for SFR SPs and 2.4 AFY for MFR SPs. The savings associated with landscape irrigation and CII accounts is estimated to be 18 AFY and 7.7 AFY, respectively. Accounting for the SFR multiplier effect, the total estimated potable water savings across all sectors is estimated to be 383 AFY.

Table 5-13
Estimated Outdoor Potable Water Savings Based on Turf Removal Rebates

Village Group	Turf Removed through WE Program (acres)[57]	Estimated Annual Outdoor Savings (AFY)[58]	Estimated Total Savings, Incorporating SFR Multiplier Effect (AFY)
Single-Family Residential			
A - West Irvine/Tustin Ranch	3.0	9.0	32
B - Canyons/OPA	2.2	6.6	24
C - Lake Forest/Foothills	13	39	140
D - Central	0.29	0.90	3.2
E - Coast	2.0	6.0	22
F - Central Irvine/University	3.1	9.3	33
G - Santa Ana Heights/UCI	2.8	8.4	30
H - Central Irvine/ICD	6.5	19.5	70
SFR Total	**33**	**99**	**355**
Multi-Family Residential			
A - West Irvine/Tustin Ranch	0.042	0.032	0.032
B - Canyons/OPA	--	--	--
C - Lake Forest/Foothills	0.82	0.63	0.63
D - Central	0.019	0.015	0.015
E - Coast	0.017	0.013	0.013
F - Central Irvine/University	1.1	0.85	0.85
G - Santa Ana Heights/UCI	0.44	0.34	0.34
H - Central Irvine/ICD	0.68	0.52	0.52
MFR Total	**3.1**	**2.4**	**2.4**
Landscape Irrigation, Potable			
A - West Irvine/Tustin Ranch	0.018	0.014	0.014
B - Canyons/OPA	--	--	--
C - Lake Forest/Foothills	11	8.5	8.5
D - Central	--	--	--
E - Coast	--	--	--
F - Central Irvine/University	0.45	0.35	0.35
G - Santa Ana Heights/UCI	11	8.5	8.5
H - Central Irvine/ICD	0.41	0.32	0.32
Landscape Irrigation, Potable Total	**23**	**18**	**18**
Commercial, Industrial, and Institutional			
A - West Irvine/Tustin Ranch	0	0	0
B - Canyons/OPA	0	0	0
C - Lake Forest/Foothills	7	5.4	5.4

[57] Turf removed is based on implementation records provided by IRWD.
[58] The annual outdoor saving based on turf removal is calculated based on 3.0 AFY/ac, which is estimated in Section 4.2.

Table 5-13
Estimated Outdoor Potable Water Savings Based on Turf Removal Rebates

Village Group	Turf Removed through WE Program (acres)[57]	Estimated Annual Outdoor Savings (AFY)[58]	Estimated Total Savings, Incorporating SFR Multiplier Effect (AFY)
D - Central	0	0	0
E - Coast	0	0	0
F - Central Irvine/University	0	0	0
G - Santa Ana Heights/UCI	2.5	1.9	1.9
H - Central Irvine/ICD	0.6	0.46	0.46
CII Total	**10**	**7.7**	**7.7**
Potable Water Total	***69***	***127***	***383***

5.5. Summary of WE Program and Natural Replacement Savings

The WE programs implemented within the District have had a measurable impact on reducing customer water use, resulting in water savings of over 2,300 AFY (Table 5-4). Based on device saturation rate estimates, up to 3,800 AFY of indoor savings were achieved through toilet and clothes washer change-outs (natural replacement and WE programs) by SFR and MFR customers for the same period.

Outdoor water use by SFR and MFR customers has been reduced by approximately 23% and 17%, respectively, between 2009 and 2018. During this time, approximately 36 acres of turf has been replaced by SFR and MFR customers (excluding dedicated irrigation SPs associated with MFR), resulting in an estimated savings of 99 AFY and 9.3 AFY, respectively. Accounting for the SFR multiplier effect and potable dedicated irrigation and CII SPs, the annual savings associated with the turf removal programs are estimated to be 383 AFY.

Based on this assessment, it appears that the remaining potential opportunities for savings through indoor WE programs is limited. Given the observed trends in program participation, it is likely that including targeted replacement of indoor devices through a bundle program like the One-Stop-Shop is likely to have greater success than targeting such devices individually. Greater savings potential for outdoor irrigation water use remains, particularly through Turf Removal programs. Over 1,300 acres of irrigated turf area associated with SFR, MFR, commercial, and industrial SPs remain in the District (**Table 5-11**), which represent a theoretical upper-bound potential savings of 1,900 AFY.[59] These findings were used to support the identification of potential future WE program opportunities under Section 6.

[59] It is noted that it is not realistic to replace all residential and commercial turf. However, this number is provided as an upper estimate of the savings potential for the purposes of evaluating potential future WE program strategies. The water savings associated with residential turf removal program are estimated based on the saving factor for SFR turf removal program, as discussed in Section 4.2, while the water savings associated with the commercial turf removal are based on the weighted average saving factor of various size of turf areas for the turf removal program for potable landscape irrigation accounts, as discussed in Section 4.6.

6. OPPORTUNITIES FOR INCREASED WATER EFFICIENCY

This section evaluates the remaining opportunities for water efficiency in the District and identifies potential water efficiency (WE) program opportunities. Given the high levels of indoor device saturation identified in Section 5, water use by the residential sector was further evaluated to confirm that limited potential savings remain indoors. Based on this analysis, and informed by the findings presented in previous sections, four potential WE program opportunities were identified. The estimated water and cost savings for these potential WE program opportunities are evaluated in Section 7.

Increased Water Efficiency Opportunities

Overall, indoor water use has decreased throughout the IRWD service area over the last several decades and, based on the analysis conducted as part of this Study, is approaching the apparent "maximum reasonable efficiency" based on current technology and practices. When indoor water use by SFR homes is compared relative to the age of the home, the newest constructed homes appear to be inherently more efficient than older homes, and that due to WE program efforts and natural replacement of fixtures, the oldest homes (pre 1994 homes) in the District have become more efficient over time. These findings suggest that limited cost-effective potential remains to further reduce indoor water use through implementation of WE programs.

While outdoor water use has also decreased throughout the IRWD service area, potential appears to remain to reduce outdoor water use through implementation of WE programs, especially in some Village Groups where outdoor water use still accounts for 70% of total water use. As such, four potential programs were evaluated to assess potential for increased outdoor water use efficiency:

1. SFR Turf Removal Rebate Prioritized by Turf Size
2. SFR Turf Removal Rebate Targeted at Customers That Reduced Water Use During the Drought
3. Targeted Non-Residential Turf Removal Rebate Program
4. Potential Pressure Regulating Valve Program

6.1. Residential Indoor and Outdoor Water Use

There are a variety of methodologies to calculate and differentiate indoor and outdoor usage for single-family homes and none are perfect. The results from any calculated indoor or outdoor value should be accompanied with the caveat that each home has many unknown variables. Unknown variables may include the number of occupants, size of landscape, swimming pools, spas, fountains, lakes or ponds, animals or livestock, water softeners, whole house reverse osmosis, or other special equipment. It is not possible to take all of these variables into consideration when attempting to calculate the ratio of indoor to outdoor water use.

Indoor versus outdoor water use by single-family residential (SFR) and multi-family residential (MFR) mixed meter accounts was estimated using the methodology described in **Appendix E**, and the results of this assessment are described below. This method uses an annual irrigation scaling factor to better estimate the amount of water used for irrigation in winter months. For service points (SPs) with dedicated outdoor irrigation meters, the potable meter is assumed to be all indoor water use.

Given the variety of possible methods and assumptions for estimating indoor versus outdoor water use, in an effort to understand device saturation for indoor plumbing fixtures, Irvine Ranch Water District (IRWD) also calculated indoor and outdoor water use using an alternative methodology. This approach sought to identify fully occupied homes grouped together based on years of significant changes to the plumbing code. The IRWD methodology and results are described in detail in **Appendix E**, and highlights

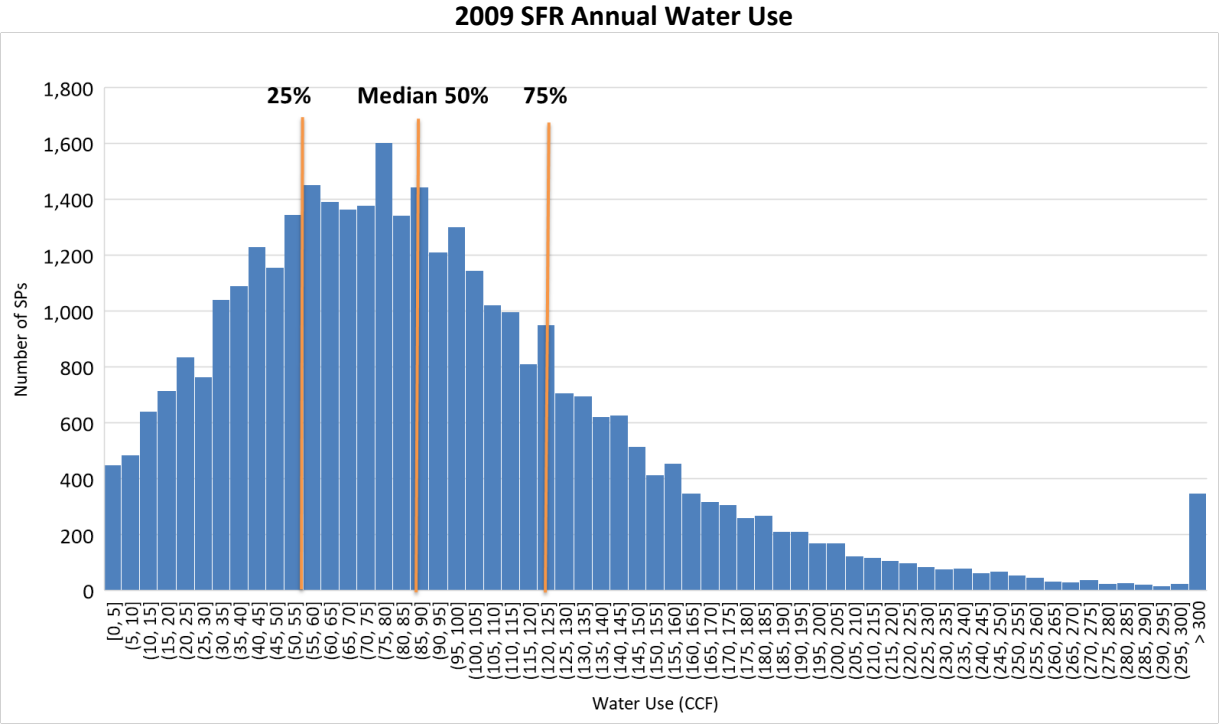
the uncertainty inherent in such estimation methods. While the estimated indoor usage below is helpful for relative comparisons and for use as a planning metric, these values should not be taken as absolute.

6.1.1. Estimated Indoor Water Use

Figure 6-1 below presents histograms showing the change in estimated indoor water use between 2009 and 2018 for SFR customers. The majority of customers have reduced their water use -- the median indoor water use dropped by 30% from approximately 176 gallons per day (gpd) per SP in 2009 to 123 gpd per SP in 2018.[60] The same analysis is shown for MFR SPs, presented on a per dwelling unit (DU) basis in **Figure 6-2.** Similarly, the median indoor water use dropped by 14% from approximately 107 gpd per DU in 2009 to 92 gpd/DU in 2018.

[60] These estimates are done on a per household (per SP) basis. Based on census data, there are typically less than three persons per household within the IRWD service area. https://www.census.gov/quickfacts/fact/table/lakeforestcitycalifornia,santaanacitycalifornia,tustincitycalifornia,irvinecitycalifornia/PST045218

Figure 6-1
Histograms of Estimated Annual Indoor Water Use for SFR SPs – 2009 and 2018



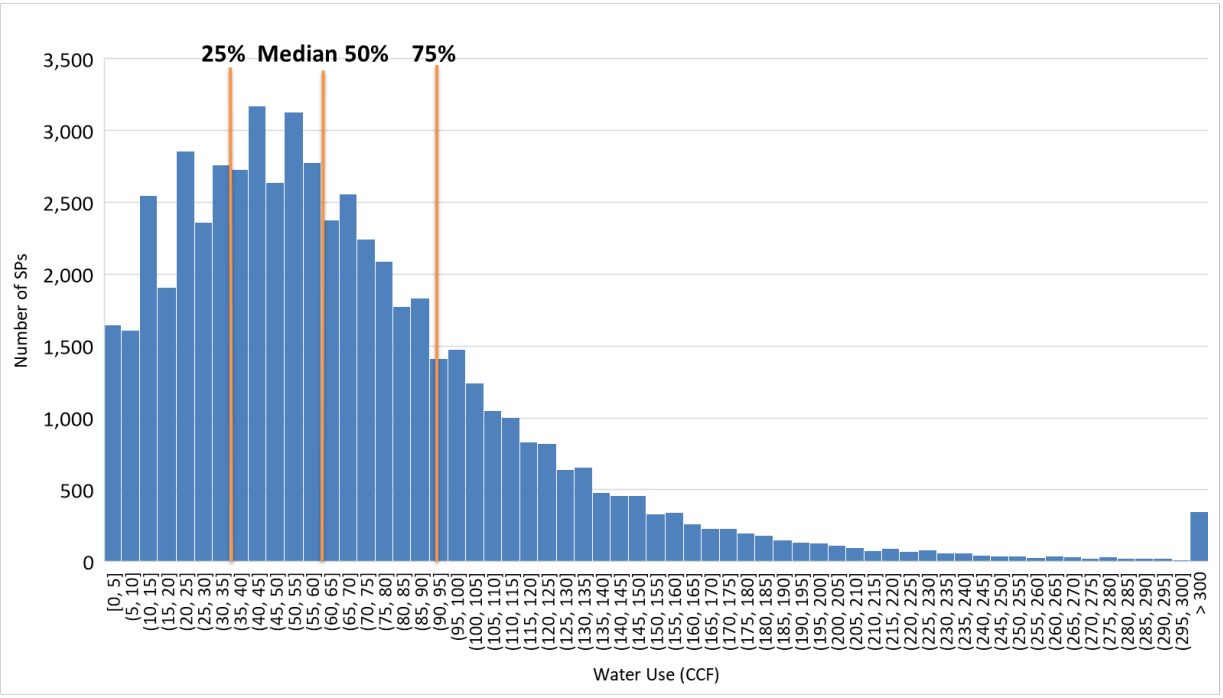
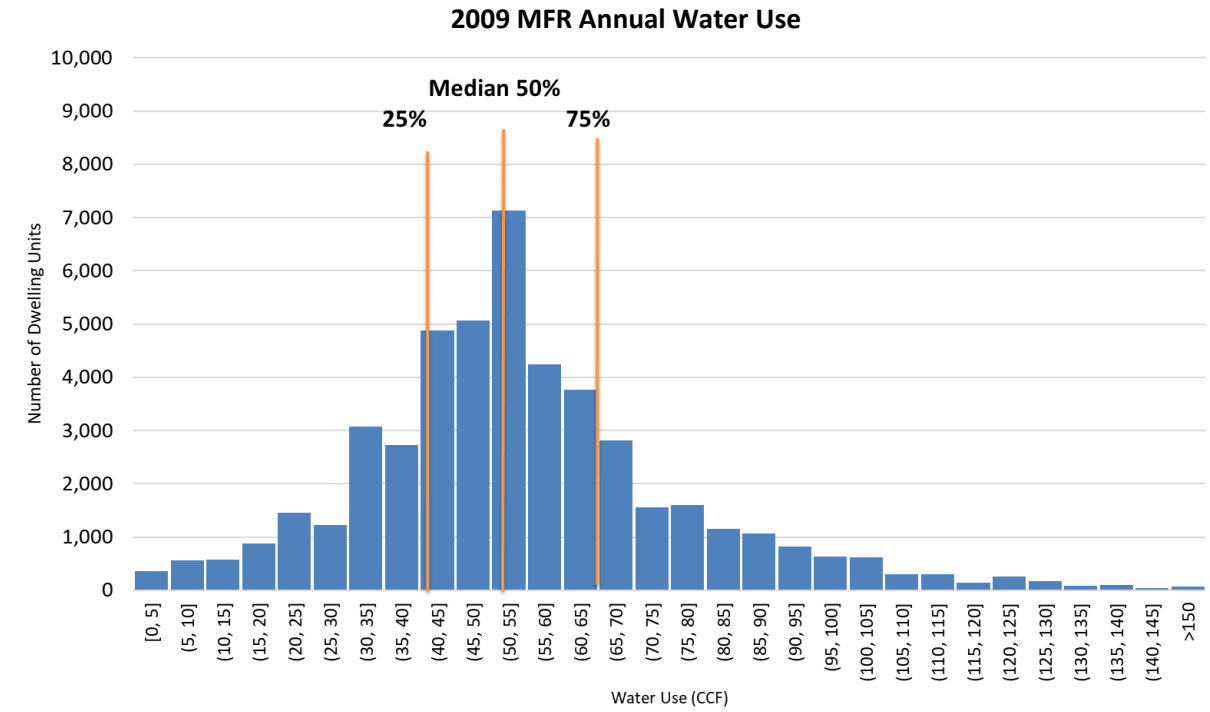


Figure 6-2
Histogram of Estimated Annual Indoor Water Use for MFR DUs – 2009 and 2018



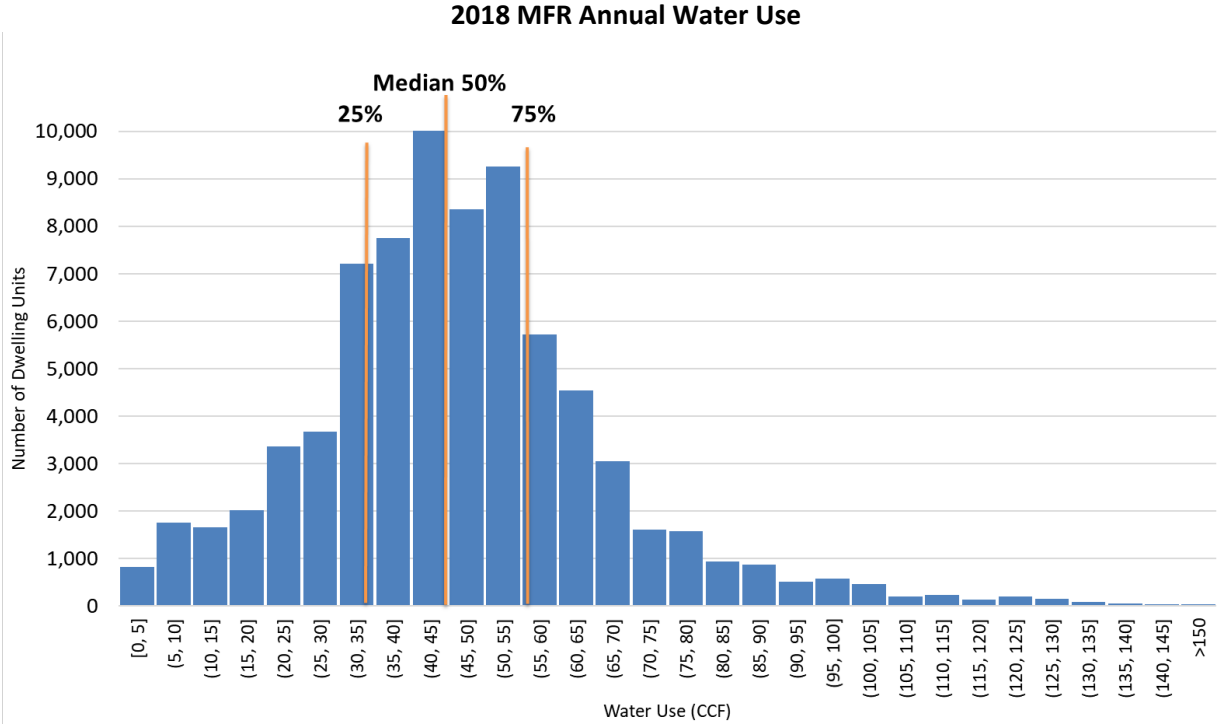
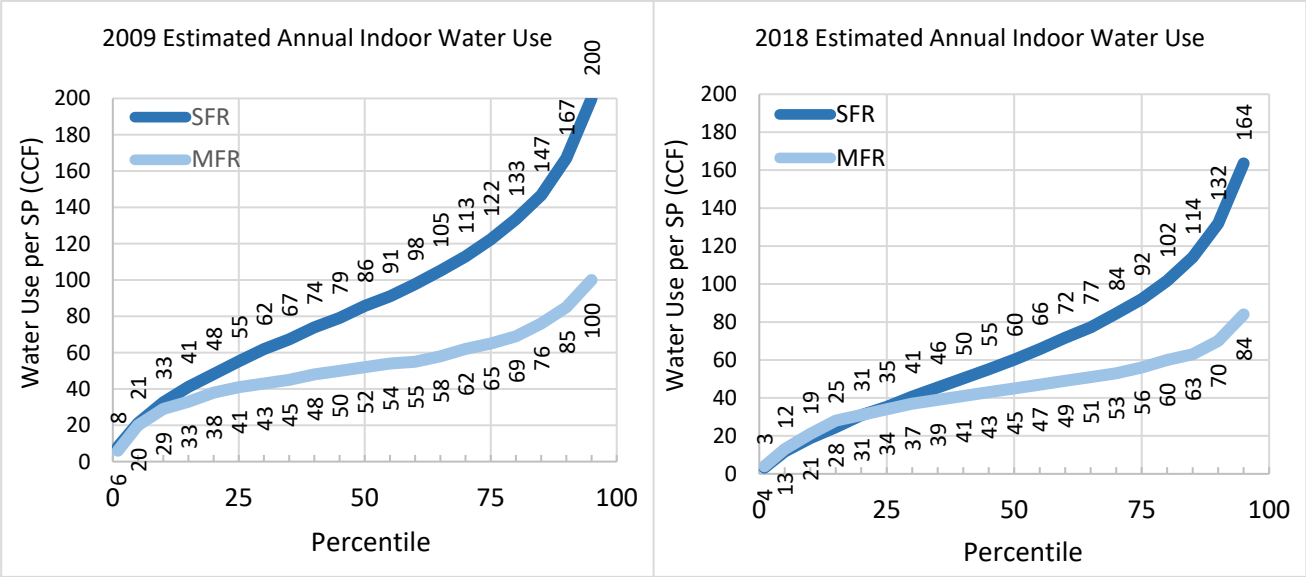


Figure 6-3 shows how estimated indoor water use by SFR and MFR customers has changed over the period 2009-2018. This shift reflects the increased efficiency due to IRWD's WE program success as well as passive savings due to natural changeout of fixtures and appliances, more proactive identification and repair of leaks, and changes in customer behavior, among other things. SFR customers tend to have a higher estimated indoor water use[61] than MFR customers.[62] However, as shown in **Figure 6-3** below, estimated indoor water use within the two sectors appears to have converged for the lowest 30% of water users, and the gap appears to have narrowed for the remaining 70% of residential customers. This convergence is likely reflective of the large portions of the population that have reached a "maximum reasonable efficiency" based on current technology and practices.

Figure 6-3
Population Shift in Estimated Annual Indoor Water Use for SFR and MFR SPs – 2009 and 2018



Based on this analysis, along with the results of the saturation study documented in Section 5 it appears that there is limited opportunity for readily-obtainable increased indoor water efficiency for much of the residential sector through WE incentive programs.

6.1.2. Estimated Outdoor Water Use

The results of the analysis of estimated indoor versus outdoor water use are presented for selected years in **Figures 6-4** and **6-5** for SFR and MFR SPs, respectively, by evapotranspiration (ET) zone.

Overall, outdoor water use makes up just over 50% of total water use by SFR SPs. Customers in the Coastal and Foothill ET zones tend to use a higher proportion of water for outdoor irrigation than those in the

[61] Since most MFR SPs have outdoor water use separately metered and data were not available to match the outdoor water use to the MFR SPs, only estimated indoor water use is discussed here and the outdoor water use of MFR SPs might be underestimated.
[62] Estimation of indoor versus outdoor water use was only applied to MFR accounts with mixed use (indoor and outdoor combined) meters. Indoor water use for MFR SPs with indoor-only meters is included without adjustment.

Figure 6-4
Estimated Monthly Indoor and Outdoor Water Use by SFR SPs

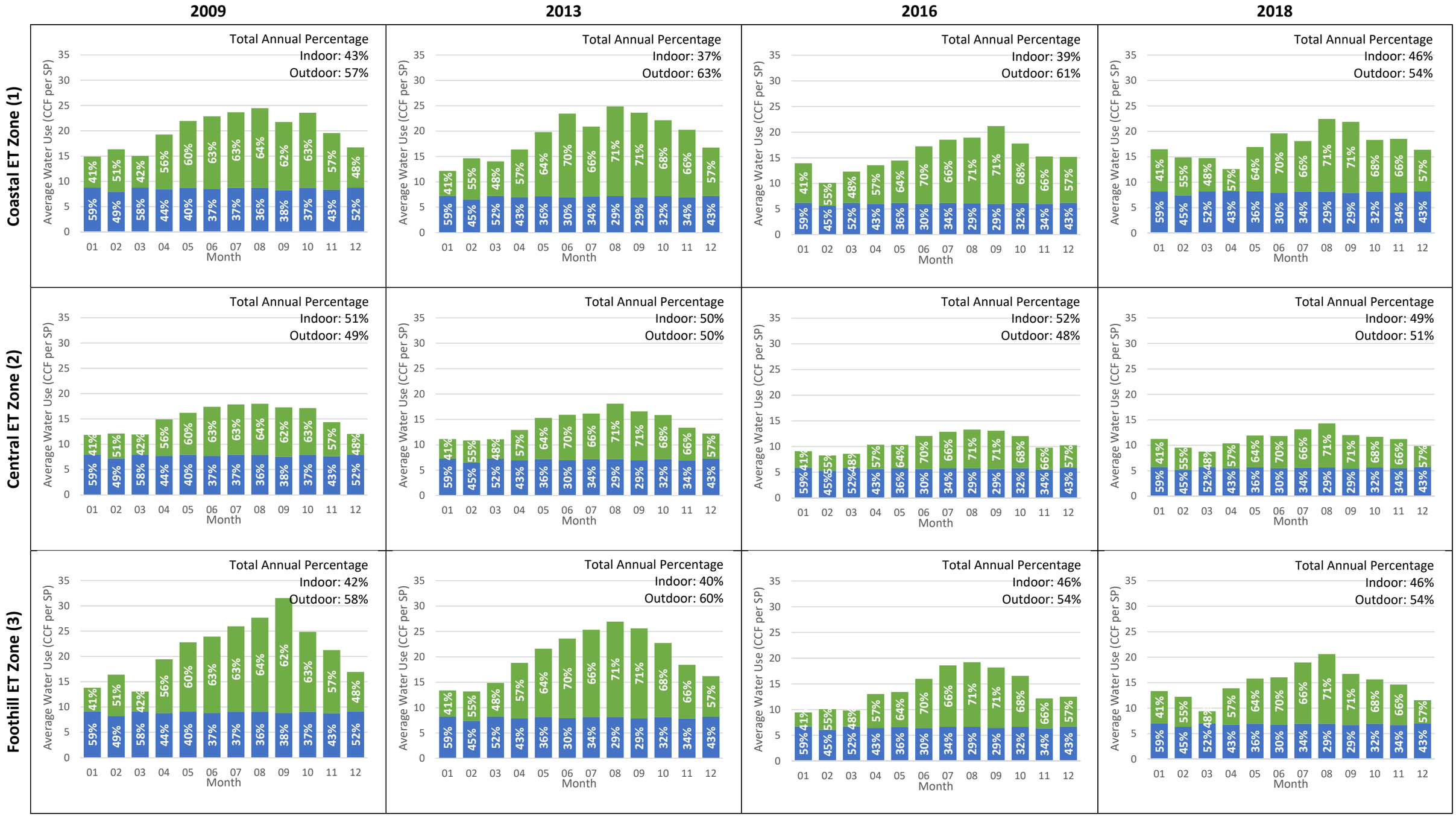
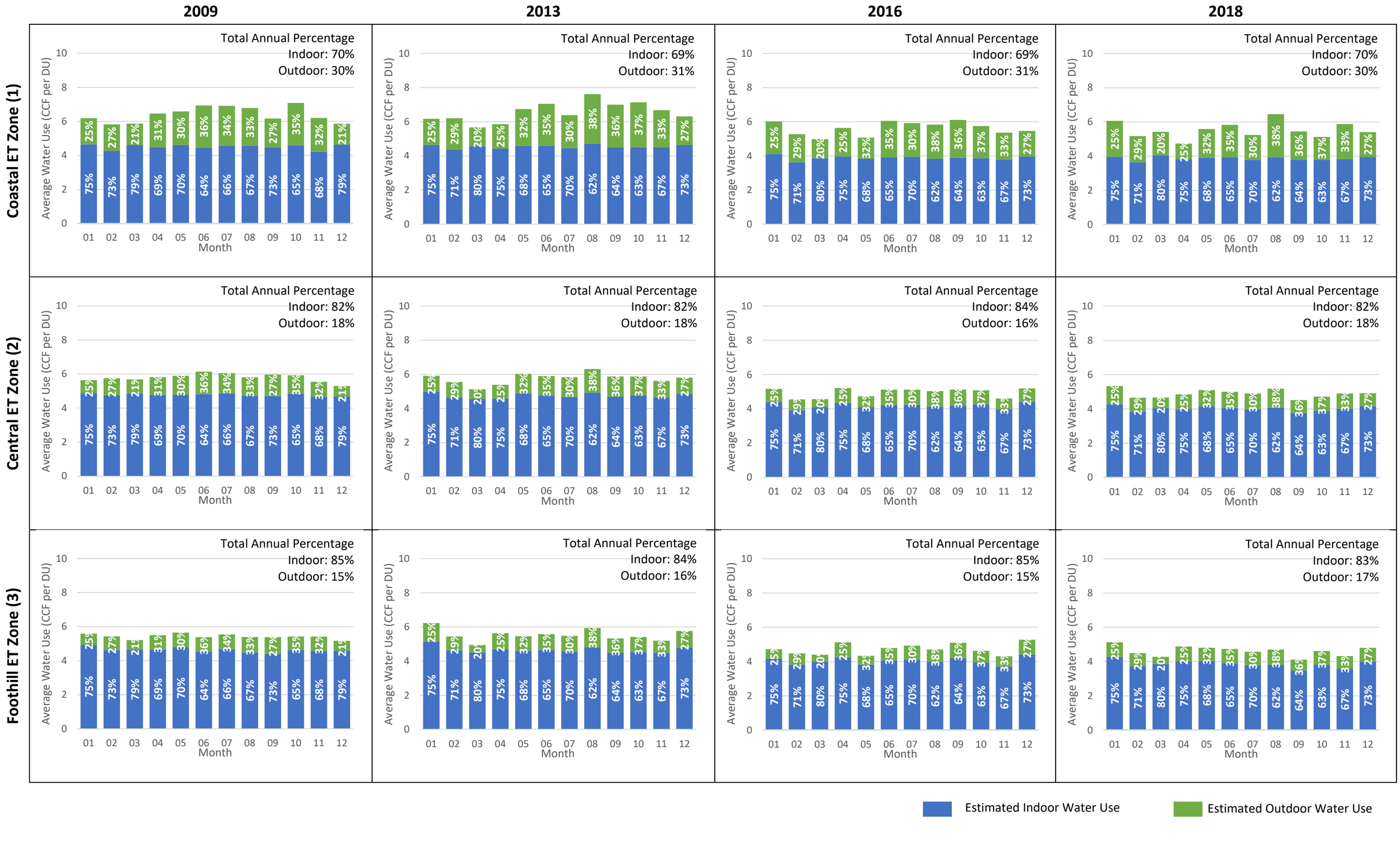


Figure 6-5
Estimated Monthly Indoor and Outdoor Water Use by MFR SPs



Central zone, with larger peaks observed in the summer. The SFR lot sizes in the Coastal and Foothill ET zones tend to be larger than the lot sizes in the majority of the District, which likely accounts for the higher proportion of outdoor water use at those SPs. In addition, within the District, the Foothill ET Zone consistently has the highest ET rate, as shown in **Table 6-1** below; this would be expected to increase irrigation demand. For all three ET zones, summer water use appears to have decreased since 2009. This effect is clearly pronounced in 2016; however, this summer-time reduction appears to have largely persisted through 2018.

Table 6-1
Annual ET by ET Zone

	ET per Year (in)		
Year	Coastal	Central	Foothills
2008	43.1	47.3	53.3
2009	43.0	47.2	53.1
2010	43.0	47.2	53.1
2011	43.0	47.2	53.2
2012	43.1	47.3	53.3
2013	43.0	47.2	53.2
2014	43.0	47.2	53.2
2015	43.0	47.2	53.1
2016	43.1	47.3	53.2
2017	43.0	47.2	53.2
2018	43.0	47.2	53.2

Outdoor water use makes up a much smaller proportion of water use within the MFR sector because many SPs have little or no irrigated outdoor areas. Common landscape areas associated with MFR developments are typically metered separately as dedicated irrigation accounts. The water use estimates shown in **Figure 6-5** are shown on an average per DU basis within a given ET zone and include SPs without outdoor areas. Outdoor water use by MFR customers in the Coastal ET zone accounts for approximately 30% of total water use, but only about 18% of total MFR water use in the Central and Foothill ET zones. The proportion of outdoor water use has remained generally consistent for MFR customers, even during the recent drought (2013-2017).

The reduction in outdoor water use for SFR customers during the drought indicates that customers are willing and able to reduce their irrigation water use in response to drought messaging and marketing. Rebound in water use since the drought appears to have been minimal thus far. However, despite this, a substantial amount of water appears to still be used for outdoor irrigation purposes, especially at SFR SPs. As discussed in Section 5, residential areas of the District still have a lot of acreage developed as turf, which requires more water to irrigate than drought-tolerant and native landscapes. Therefore, it appears there is still some opportunity for turf removal WE programs or other means to incentivize the reduction in outdoor water use.

6.1.3. Water Use by Village Group

Figure 6-6 below shows the change in water use by Village Group between 2009 and 2018 for SFR SPs. While overall water use on a per SP basis has declined across the District, as illustrated in this chart, the change in water use by SFR customers has not been consistent in all Village Groups. The SFR customers in the Central Village Group have the lowest overall water use in the District, and their use has remained consistent over this ten-year analysis period. The SFR customers in the Lake Forest/ Foothills, West Irvine/Tustin Ranch, and Canyons/OPA areas have reduced their water use, with reductions of 31%, 30%, and 25%, respectively. However, despite this reduction, SFR customers in the Canyons/OPA Village Group have the highest overall water usage and a greater than average proportion of outdoor water use (approximately 73%), likely due to a combination of having a higher ET rate as well as generally much larger lot sizes than most of the District. Every other Village Group appears to have a roughly 50:50 split between indoor and outdoor water usage in 2018.

Figure 6-6
Change in Water Use by Village Group for SFR SPs – 2009 and 2018

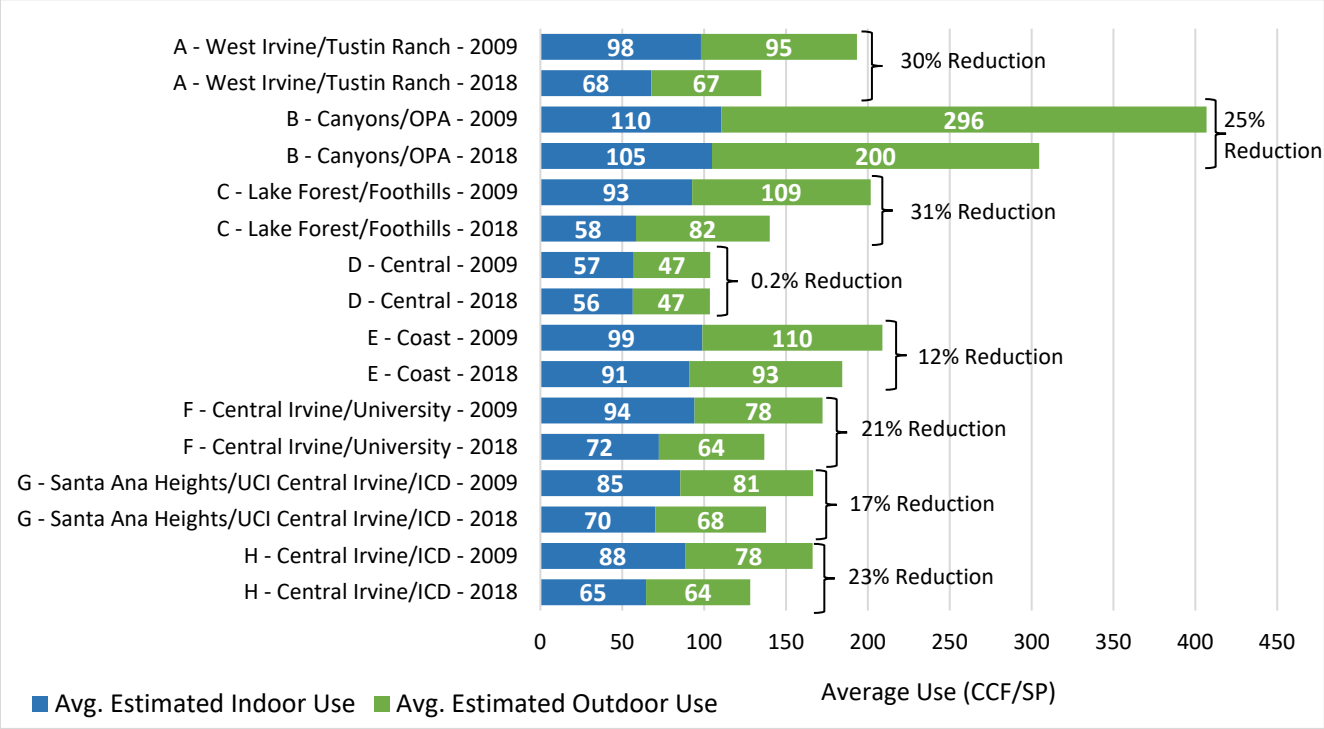
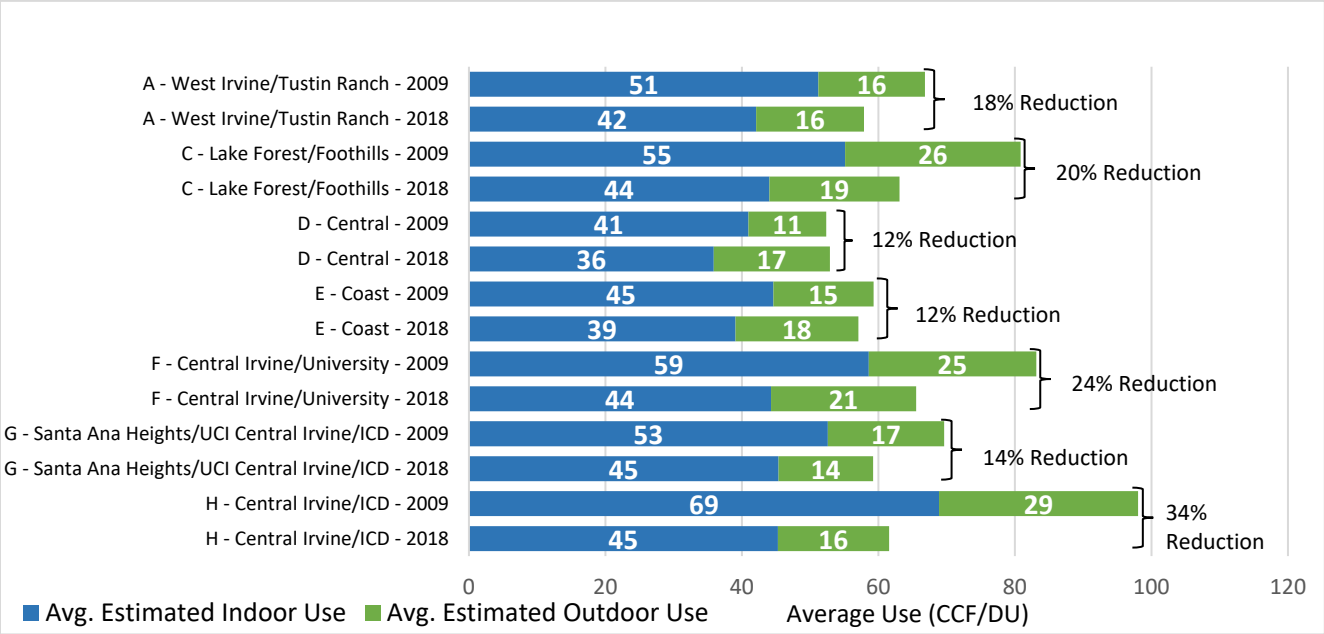


Figure 6-7 below shows the change in water use by Village Group between 2009 and 2018 for MFR SPs, estimated on a per DU basis. Water use by MFR customers is substantially less than for SFR customers, and as discussed above, includes less outdoor water use associated with individual MFR SPs. As observed with SFR customers, MFR customers have reduced their water use over the last ten years, and this reduction has differed between different areas of the District. The greatest reduction in water use over this period was observed in the Central Irvine/ICD Village Group, with an approximately 34% reduction. In 2009, MFR customers in this area had the highest water use, but are now using water at consistent rates as compared to the other Village Groups.

Figure 6-7
Change in Water Use by Village Group for MFR SPs – 2009 and 2018



6.1.4. SFR Water Use by Age of Construction

Appendix E presents the results of a water use analysis developed by IRWD using an alternative indoor versus outdoor estimation methodology, and presented separately by SFR homes that were constructed: (1) in 1993 and earlier, (2) from 1994 to 2009, and (3) in 2010 or later. This analysis showed that among the three age classes, homes constructed in 2010 or later are substantially more water efficient than older homes, and that homes constructed from 1994 to 2009 are on average the least efficient. Thus, it appears that the newest constructed SFR homes are inherently more efficient than older homes, and that due to WE program efforts and natural replacement of fixtures, the oldest homes in the District have become more efficient over time.

6.2. Future Water Efficiency Program Opportunities

EKI worked with IRWD staff to identify potential WE programs and approaches that could be implemented based on the opportunities identified above and through the analyses documented in the previous sections. As discussed below, these opportunities include increased and tailored marketing for existing or similar programs (i.e., a "Target Opportunity") as well as a potential new WE program. The estimated water and energy savings and benefit-cost ratios for each of these programs are estimated in Section 7.

1. SFR Turf Removal Rebate Prioritized by Turf Size
2. SFR Turf Removal Rebate Targeted at Customers That Reduced Water Use During the Drought
3. Targeted Non-Residential Turf Removal Rebate Program
4. Potential Pressure Regulating Valve Program

6.2.1. Target Opportunity – SFR Turf Removal Rebate Prioritized by Turf Size

An aerial imagery study of land use in the District was previously conducted by Quantum Spatial (2016). This study identified irrigated and non-irrigated areas within the District, and specifically identified areas planted as turf/lawn. As discussed previously in Section 4.2, to date approximately 33 acres of SFR turf area have been replaced through IRWD turf rebate programs. The District also conducted a study of the "multiplier effect" experienced when customers/SPs that did not receive a turf rebate also completed a landscape transformation from turf to drought-tolerant landscapes (IRWD, 2016). This *Multiplier Effect Study*, which was conducted on a limited portion of the District, suggests that the multiplier effect may be as high as 2.6 (i.e., for every acre of turf transformed through a regional rebate program, another 2.6 acres is also transformed). Thus, the effective area of SFR turf replaced to date may be as high as 86 acres. Based on the aerial imagery study, roughly 400 acres of turf were associated with SFR SPs in 2016; thus, a substantial amount of turf still remains within the District and represents a potential water savings opportunity.

Per the analysis conducted in Section 4.2, the water savings benefits associated with this WE program vary with the amount of turf area replaced. For example, the smaller the turf area, the less efficient the irrigation tends to be, and the higher the per square footage savings. However, the larger the turf area the larger the potential for total water savings, irrespective of irrigation efficiency. In addition, additional staff time and resources are necessary to administer a given rebate for larger turf removal areas. Given this, the size of turf areas per SFR SP were identified and quantified across the District, with larger turf areas identified as a priority for WE program implementation.

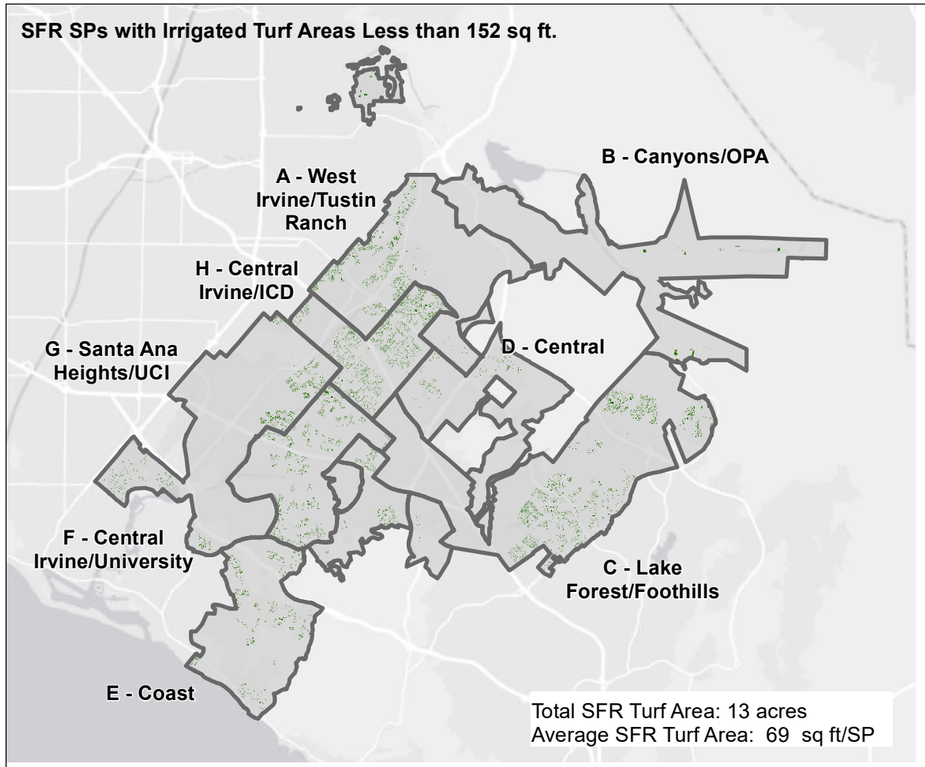
Using the APN-specific shapefile developed as part of the Quantum Spatial (2016) study, turf area associated with SFR SPs was identified and classified into quartiles.[63] Based on this:

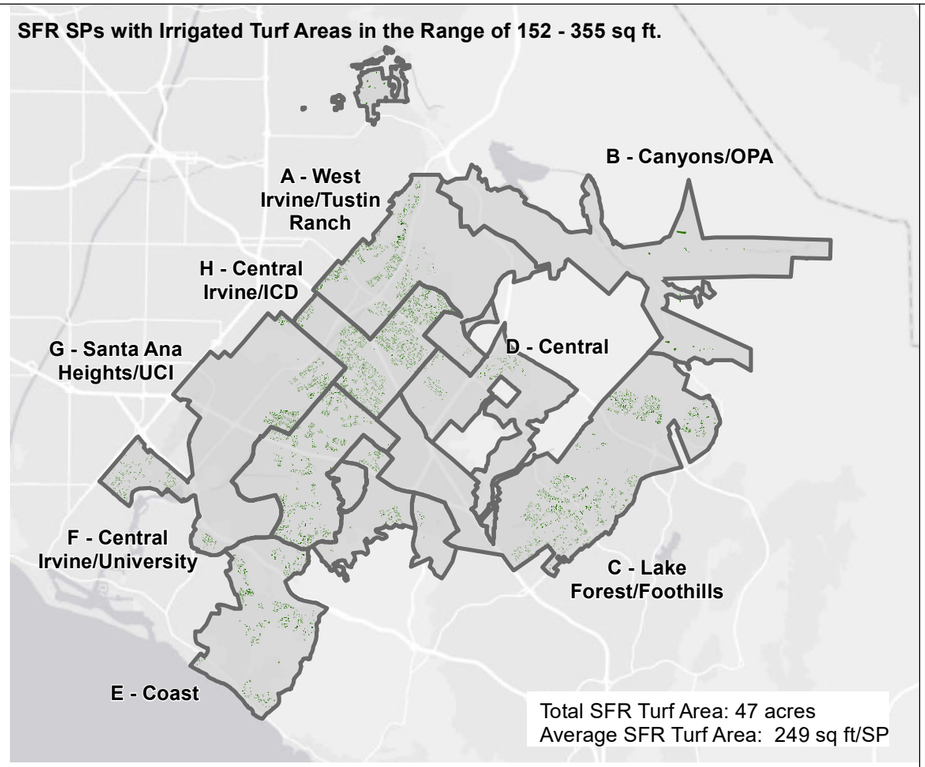
- 25% of SFR SPs have turf areas of less than 152 square feet (sq ft), which amounts to a total of 13 acres;
- 25% have turf areas ranging from 152 sq ft to 355 sq ft, which amounts to a total of 47 acres;
- 25 % have turf areas ranging from 356 sq ft to 682 sq ft, which amounts to a total of 94 acres; and
- 25% have turf areas greater than 682 sq ft, which amounts to a total of 239 acres.

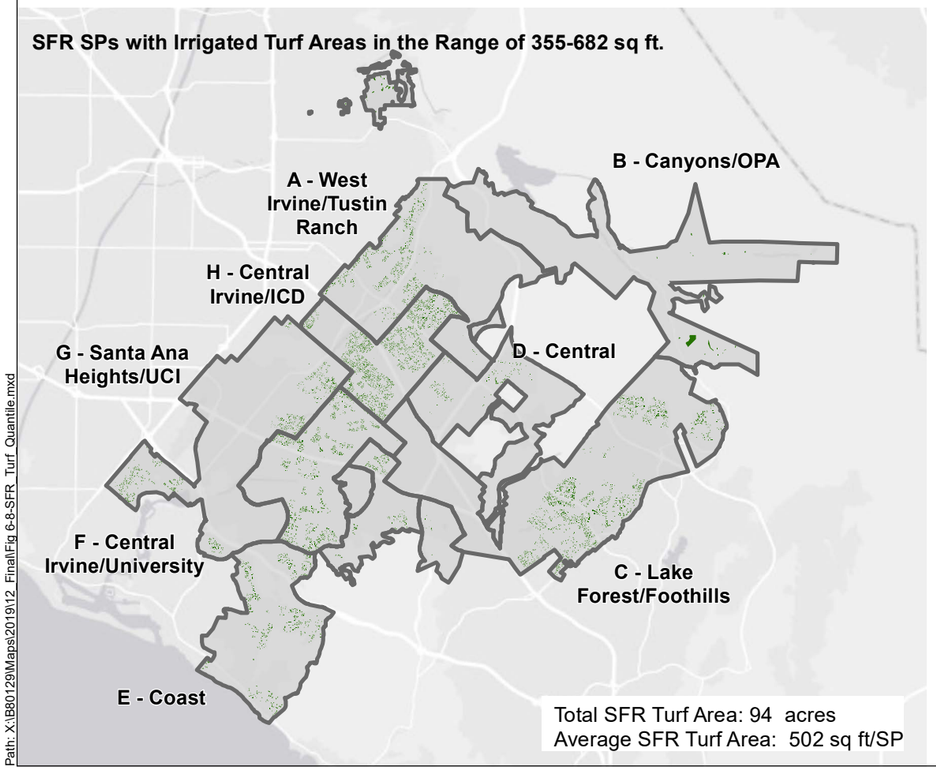
Figure 6-8 shows the location of SFR turf areas by size class (quartile). **Table 6-2** below shows the breakdown of number of SPs and total turf acreage by Village Group and turf size class. The Lake Forest/Foothills and Central Irvine/ICD Village Groups have the largest amount of SFR turf in the District, and a fairly even distribution of turf sizes between the four categories. Turf areas in the West Irvine/Tustin Ranch, Central, and Santa Ana Heights/UCI Village Groups tend to be on the smaller size, while turf areas in the Canyons/OPA Village Group are predominantly in the largest turf size category.

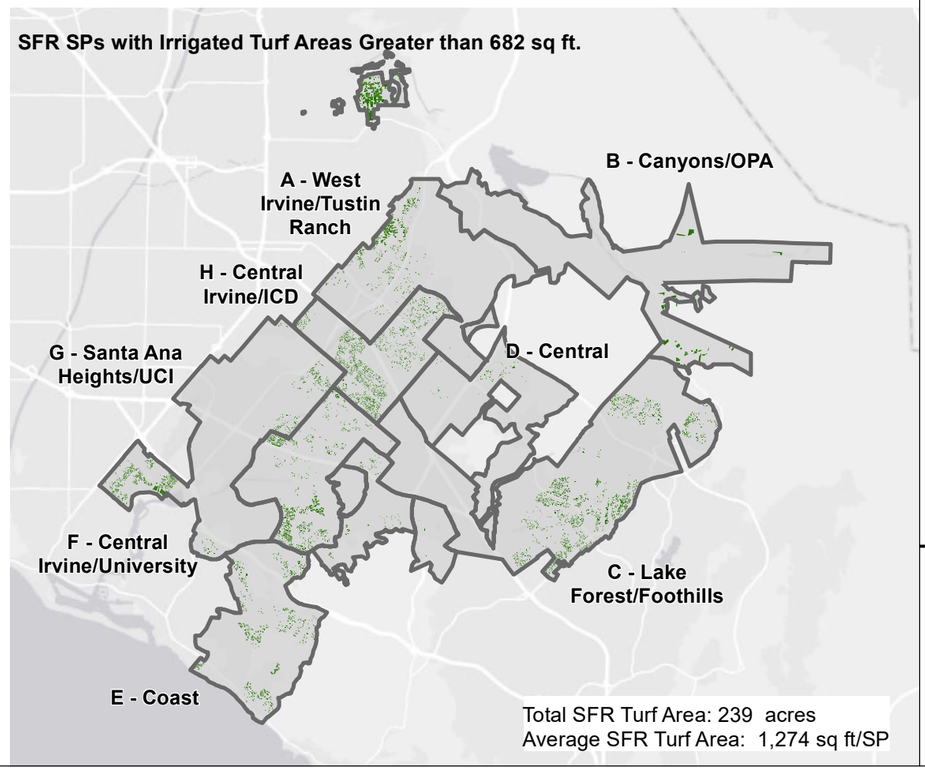
Based on past participation in the Turf Removal program, the average size of turf area replaced by SFR customers was approximately 800 square feet (Section 4.2). Per the assessment below, which is based on

[63] Per IRWD staff, a number of SPs identified in the billing system as SFR are actually MFR accounts. These SPs were excluded for purposes of this analysis. Only SPs located within Village Groups and with irrigated turf as identified through APN matching were included in this analysis.









Legend

- Village Group Boundary
- LUCParcel
- Village Group

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single-family residential
SP = service point
sq = square foot

Notes

1. All locations are approximate.
2. Only SFR SPs with irrigated turf areas are presented. Map reflects the entire parcel associated wit the turf area, and not the turf footprint, for visualization purposes.
3. Turf size ranges are based on a quantile breakdown of SFR SPs with irrigated turf area.
4. Only parcels that could be attributed to a SP ID are included in the dataset (Source 1). Thus, the parcels presented in the map do not capture all SFR SPs that with irrigated turf areas.

Sources

1. Quantum Spatial, 2016. IRWD Land Use Classification Project, Technical data Report, prepared by Quantum Spatial and Eagle Aerial Solutions, dated 1 August 2017, as provided by IRWD on 27 November 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

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(Scale in Miles)

Summary of Irrigated Turf Size for SFR SPs

Irvine Ranch Water District

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Figure 6-8

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data from the Quantum Spatial study (2016), the majority of SFR customers appear to have less than 800 square feet of total turf area. However, it should be noted that the aerial imagery study is prone to underestimating the actual amount of turf area for a property. One source of error is that when using aerial imagery, one cannot see landscape beneath a tree canopy. In addition, the Quantum Spatial (2016) study is based off of aerial imagery taken in the summer of 2016, and thus lawns that went brown during the 2013-2017 drought would not have been identified by the study as having been irrigated turf areas. EKI has not done a quality control review of the aerial imagery study, but by doing a brief spot-check review, it appears that, in addition, some irrigated turf areas have been classified as other land use types. Thus, the actual amount of turf area in the District is likely to be greater than that presented in **Table 6-2**, and the total turf areas by SFR SP are likely to be larger.

Table 6-2
SFR Turf Area Distribution by Village Group

Village Group	Irrigated Turf Area Size				Total
	<152 sq ft	152-355 sq ft	355-682 sq ft	>682 sq ft	
Number of SFR SPs					
A - West Irvine/Tustin Ranch	1,166	1,093	857	716	**3,832**
B - Canyons/OPA	36	37	40	254	**367**
C - Lake Forest/Foothills	1,909	1,610	1,869	2,137	**7,525**
D - Central	231	245	169	93	**738**
E - Coast	676	773	724	704	**2,877**
F - Central Irvine/University	1,073	1,183	1,311	1,280	**4,847**
G - Santa Ana Heights/UCI	1,092	1,038	766	874	**3,770**
H - Central Irvine/ICD	2,028	2,193	2,442	2,129	**8,792**
Total[64]	**8,211**	**8,172**	**8,178**	**8,187**	**32,748**
Total Turf Area (acres)					
A - West Irvine/Tustin Ranch	2.0	6.2	10	22	**40**
B - Canyons/OPA	0.06	0.23	0.47	19	**20**
C - Lake Forest/Foothills	3	9	22	59	**93**
D - Central	0.36	1.41	1.88	2.21	**6**
E - Coast	1.2	4.4	8.4	22	**36**
F - Central Irvine/University	1.7	6.8	15	35	**59**
G - Santa Ana Heights/UCI	1.8	5.8	8.8	29	**45**
H - Central Irvine/ICD	3.1	13	28	51	**95**
Total	**13**	**47**	**94**	**239**	**393**
Turf Area (Percentage)					
A - West Irvine/Tustin Ranch	0.5%	1.6%	2.5%	5.6%	**10%**
B - Canyons/OPA	0.02%	0.06%	0.12%	4.77%	**5%**
C - Lake Forest/Foothills	0.68%	2.3%	5.5%	15%	**24%**
D - Central	0.09%	0.36%	0.48%	0.56%	**1%**
E - Coast	0.32%	1.12%	2.12%	5.57%	**9%**
F - Central Irvine/University	0.44%	1.74%	3.86%	8.99%	**15%**
G - Santa Ana Heights/UCI	0.46%	1.48%	2.23%	7.26%	**11%**
H - Central Irvine/ICD	0.80%	3.21%	7.13%	13.05%	**24%**
Total	**3%**	**12%**	**24%**	**61%**	**100%**

[64] Because the quartile cut offs are whole numbers and there are many SPs with the same turf size, the number of SPs are not exactly the same for each quartile.

6.2.2. Target Opportunity – SFR Turf Removal Rebate Targeted at Customers That Reduced Water Use During Drought

Many SFR customers chose to let their lawn go brown to reduce water use during the drought. Based on the 2016 update of the *Multiplier Effect Study*, which evaluated a limited area of the District, approximately 6.6% of SFR customer lawns were found to be brown in 2016 (IRWD, 2016). The customers who let their lawn go brown during the drought, but have since increased their water use to pre-drought usage rates represent a customer sector that could be good targets for participation in a Turf Removal program.

The following methodology was used to identify the customers who, based on water use data, likely let their lawns (or other landscaping) go brown during the drought but have rebounded to a similar level of pre-drought water usage. The potential targets were identified as SFR SPs where the difference between 2013 (pre-drought) and 2018 (post-drought) outdoor water use was less than 15%, and where water use in 2016 (the surrogate for drought water use) was at least 25% lower than the average of the 2013 and 2018 water use.[65]

The difference between 2013 and 2018 outdoor water use was calculated as follows:

$$change\ in\ water\ use\ (2013\&2018) = \frac{Outdoor\ Water\ Use\ in\ 2018 - Outdoor\ Water\ Use\ in\ 2013}{\frac{1}{2} * \ (Outdoor\ Water\ Use\ in\ 2018 + Outdoor\ Water\ Use\ in\ 2013)} * 100\%$$

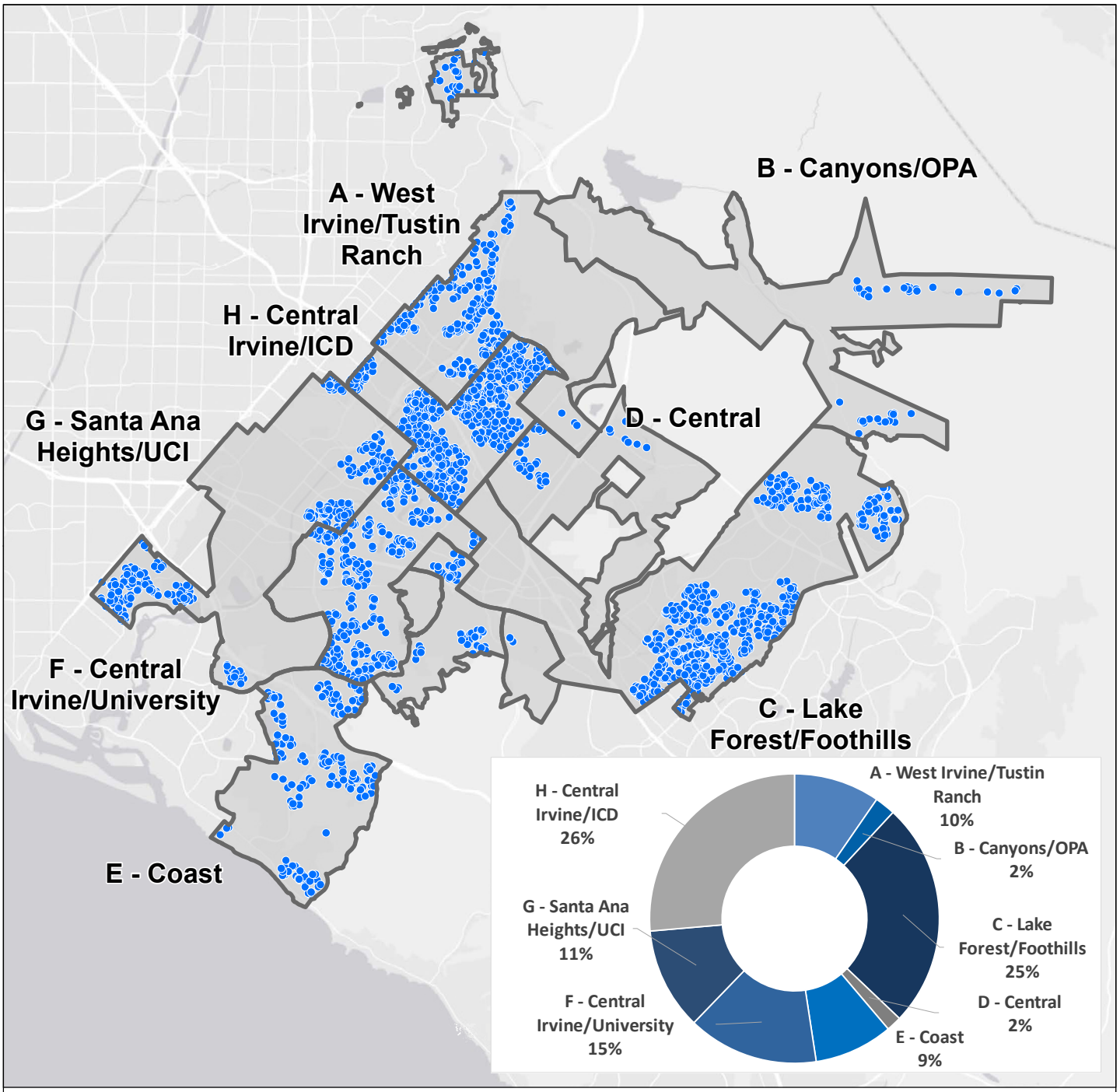
The difference between 2016 outdoor water use and the average of 2013 and 2018 outdoor water use was calculated as follows:

$$change\ in\ water\ use\ in\ 2016 = \frac{Outdoor\ Water\ Use\ in\ 2016 - \frac{1}{2} * \ (Outdoor\ Water\ Use\ in\ 2018 + Outdoor\ Water\ Use\ in\ 2013)}{\frac{1}{2} * \ (Outdoor\ Water\ Use\ in\ 2018 + Outdoor\ Water\ Use\ in\ 2013)} * 100$$

The results of this analysis are shown in **Figure 6-9** and summarized in **Table 6-3** below. In total, more than 2,800 SFR SPs were identified, representing approximately 23.1 acres of turf.[66] This represents approximately 5% of SFR SPs, and is consistent with the findings of the 2016 update of the *Multiplier Effect Study* (IRWD, 2016). The majority of these customers are located in the Central Irvine/ICD, Lake Forest/Foothills, and Central Irvine/University Village Groups. The identified SFR SPs in these areas represent approximately 23 acres of turf and 136 acres of total irrigated landscape, based on the data from Quantum Spatial (2016) study and processed by IRWD.

[65] The change in water use patterns calculation was normalized by ET zone but not explicitly normalized by annual ET. As shown in **Table 6-1** above, the evapotranspiration rate has been consistent each year, and between 2013, 2016, and 2018 has varied at most by 0.1 inch within each of the three ET zones. The method applied controls for the variation between ET zones, which over the period evaluated varied by more than 10 inches.

[66] See Section 2.2.5 for a discussion of data limitations associated with the turf area estimates.



Legend

- Village Group Boundary
- SFR SPs that Reduced Water Use in 2016

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single-family residential
SP = service point

Notes

1. All locations are approximate.

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0 3 6

(Scale in Miles)

SFR SPs that Reduced Water Use During Drought and Experienced Post-Drought Rebound

Irvine Ranch Water District
December 2019
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Figure 6-9

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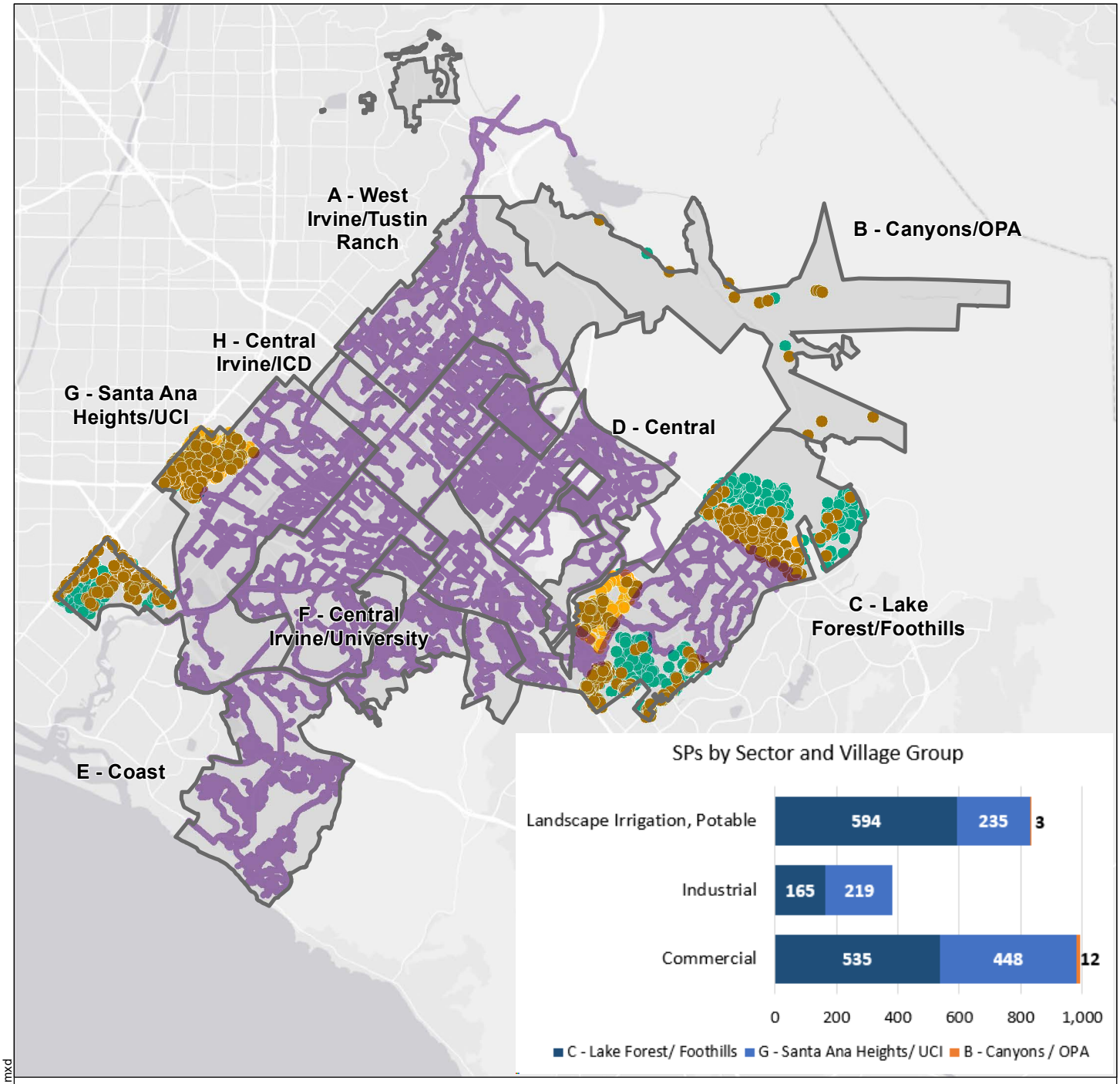
Table 6-3
Summary of SFR SPs that Reduced Water Use during the Drought and Rebounded

Village Group	Number of SPs	Irrigated Area (acres)		
		Landscape - Turf	Landscape - Non-Turf	Total
A - West Irvine/Tustin Ranch	272	2.07	12.5	**14.5**
B - Canyons/OPA	65	1.35	20.9	**22.2**
C - Lake Forest/Foothills	714	4.93	29.0	**34.0**
D - Central	48	0.07	1.30	**1.37**
E - Coast	249	1.97	14.6	**16.6**
F - Central Irvine/University	414	3.99	19.0	**23.0**
G - Santa Ana Heights/UCI	323	2.94	14.4	**17.4**
H - Central Irvine/ICD	747	5.82	23.9	**29.7**
Total	**2,832**	**23.1**	**136**	**159**

6.2.3. Target Opportunity – Non-Residential Turf Removal Rebate

In addition to SFR customers, a substantial amount of turf remains in non-residential areas. Potential non-residential candidates for Turf Removal programs include those commercial, industrial, and potable landscape irrigation SPs that are located in areas of the District that are not currently served by recycled water. Since customers in these areas do not have access to recycled water, the only water source for irrigation is potable water. Targeting these customers for turf removal opportunities will maximize potable water conservation. While institutional SPs often have a lot of irrigated turf area, turf tends to be more functional for institutional users (such as schools and parks); thus, institutional SPs are not considered likely targets for a Turf Removal program.

The commercial, industrial, and potable landscape irrigation SPs located outside of areas served by recycled water are shown on **Figure 6-10**. These SPs are located in three distinct areas within the District, primarily within the Santa Ana Heights/UCI and Lake Forest/Foothills Village Groups, and include approximately 955 SPs. **Figure 6-10** also shows a breakdown of the number of SP types by area. The estimated irrigated acreage associated with these SPs is summarized in **Table 6-4** below. As discussed in Section 2.2.5, the inherent limitations in the available data result in a lower level of certainty as to what specific turf areas are associated with a given SP and customer sector, and thus these acreages should not be taken as exact. Based on this, it is estimated that more than 100 acres of turf likely associated with commercial and industrial customers in these areas, the majority of which is located within the Lake Forest/Foothills Village Group. Also as discussed in Section 2.2.5, the actual turf areas measured by this method are likely to be underestimated.



Legend

- Village Group Boundary
- Recycled Water Service
- Commercial
- Industrial
- Landscape Irrigation, Potable

Sources

1. Basemap provided by ESRI.
2. Recycled water lines provided by IRWD on August 2019.

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0 3 6

(Scale in Miles)

Abbreviations

IRWD = Irvine Ranch Water District
SP = service points

Notes

1. All locations are approximate.

Non-Residential SPs with No Recycled Water Service

Irvine Ranch Water District
December 2019
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Figure 6-10

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Path: X:\B80129\Maps\2019\12_Final\Fig 6-10-Non-residential Turf Opportunities.mxd

Table 6-4
Non-Residential SPs in Areas Not Served by Recycled Water and Estimated Associated Irrigated Landscape

Village Group	Number of SPs			Irrigated Area (acres)		
	Commercial	Industrial	Landscape Irrigation	Lawn/ Turf	Landscape – Non-Turf	Total
B - Canyons/OPA	10	--	--	2	13	**15**
C - Lake Forest/Foothills	314	121	13	65	244	**309**
G - Santa Ana Heights/UCI	317	162	18	52	147	**199**
Total	**641**	**283**	**31**	**118**	**405**	**523**

6.2.4. Potential New Program – Pressure Regulating Valve (Pressure Reducing Valve) Program

Water pressure within the IRWD potable water distribution system varies depending on a number of factors including elevation, proximity to pumping station, and distribution pipe size, among other things. Based on pressure contours of the average potable water system conditions provided by IRWD, system pressure within the District ranges from 30 to 180 pounds per square inch (psi)[67] (see **Figure 6-11a**). The California Plumbing Code §608.2 requires that a pressure regulating valve or pressure reducing valve (PRV) be installed at service connections where the system water pressure exceeds 80 psi, to reduce the water service pressure to 80 psi.[68] This responsibility falls to the homeowner, and it is possible that SPs in some areas with high water pressure do not have such a PRV, or that the PRV they have may not be functioning as intended.

Systems with higher pressure have been demonstrated to have higher leakage rates (Lambert, 2001). In addition, without a pressure regulator, sprinklers and other irrigation devices used by customers with higher water pressure would be expected to use more water and result in a greater degree of irrigation overspray (inefficiency) than those in lower pressure areas. If that is the case, providing PRVs to customers in high pressure areas could result in water savings by increasing irrigation efficiency, in addition to reduced leakage losses. In order to begin to evaluate the potential benefit of a new WE program to incentivize and increase the use of PRVs, the relationship between irrigation water use and system water pressure within IRWD was evaluated.

Because there is much less variability in water use by landscape irrigation SPs (and thus less "noise" in the data to complicate results) this evaluation looked at water use by potable landscape irrigation SPs. To further focus the analysis, only water use during the high-use summer months (i.e., July, August, and September water bills) was evaluated. Summer water use was normalized based on landscape area, and the analysis was performed separately for each of the three ET zones in the District.

[67] Based on the contours of average potable water system pressure provided by IRWD, the water pressure in the distribution systems ranges from 30 to 180 psi. Data provided by IRWD, Potable water system average water pressure, 10-psi contour shapefile, on 9 August 2019.
[68] https://up.codes/viewer/california/ca-plumbing-code-2016/chapter/6/water-supply-and-distribution#6

Figure 6-12 below shows a linear regression analysis of normalized summer water use and system pressure for the Coastal ET zone. Based on this, water use is positively correlated with water pressure (i.e., there is more water use at accounts in the higher pressure zones), and the relationship is statistically significant within a 99% confidence interval.[69] However, less than 10% of the variation in normalized water use can be explained by the variation in water pressure.[70]

Figure 6-12
Water Use and Water Pressure by Potable Water Irrigation SPs in the Coastal ET Zone

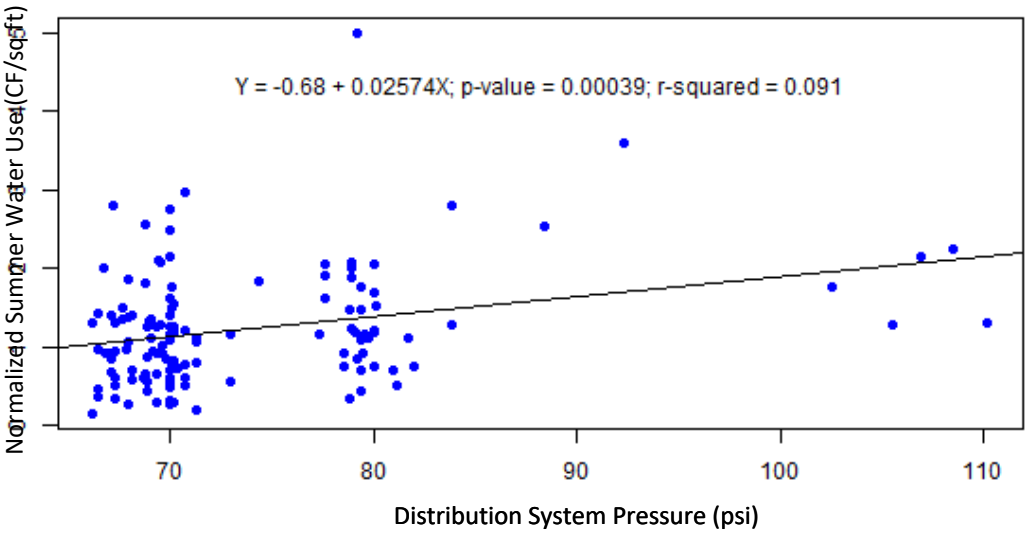


Figure 6-13 below shows the linear regression analysis of normalized summer water use and system pressure for the Foothill ET zone. The results are very similar to that for the Coastal ET zone. Water use shows a statistically significant positive correlation (within a 99% confidence interval) with water pressure and the same amount of variability in water use is explained by water pressure (i.e., less than 10%, with an r-squared value of 0.09).

Figure 6-14 below shows the results of the linear regression analysis for the Central ET zone. Within the Central ET zone, the relationship between irrigation water use and water pressure is statistically significant within a 90% confidence interval. While the correlation is similar, the statistical significance of this result is much less than that for the Coastal and Foothill ET zones. The Central ET zone has far more SPs than either the Foothill or Central ET zones, and thus more natural variation among water use. The Central ET zone also tends to be fairly flat and therefore has less localized variability than the other ET zones. It is possible that the same relationship exists among all three zones, but that more confounding variables are present among potable irrigation SPs in Central zone.

The low level of variability with pressure explained by these analyses is likely related to the fact that most landscape irrigation SPs in the higher pressure areas would already be expected to have PRVs installed.

[69] Statistical significance is identified by the p-value. A p-value of 0.01 or less indicates a confidence level within 99%.
[70] The R-squared value quantifies how much variation in the dependent variable can be explained by the independent variable. Regression with R-squared values closer to 1 indicate higher correlation.

The fact that there is still a strong correlation and increase in water use relative to pressure suggests that the PRVs may not be functioning entirely as intended.

Figure 6-13
Water Use and Water Pressure by Potable Water Irrigation SPs in the Foothill ET Zone

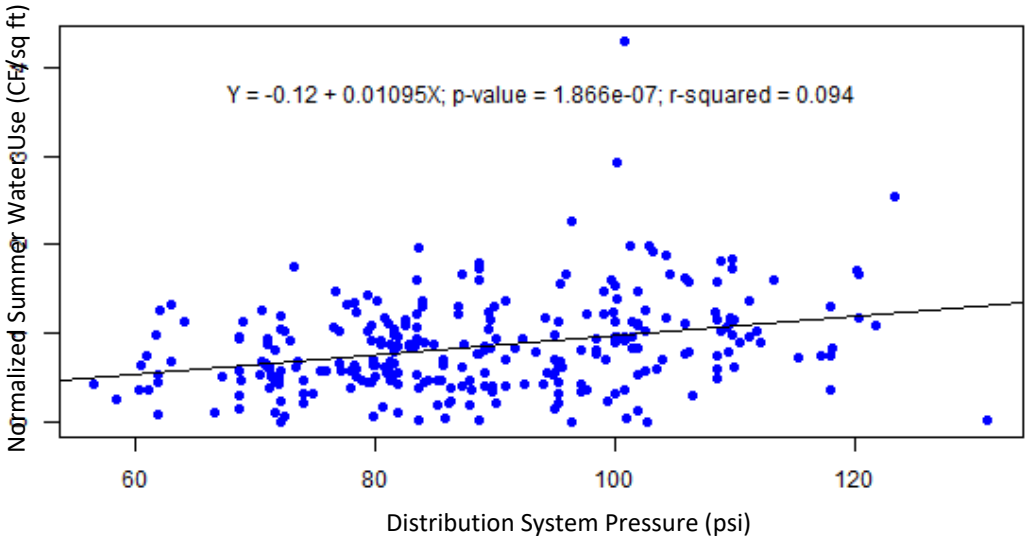
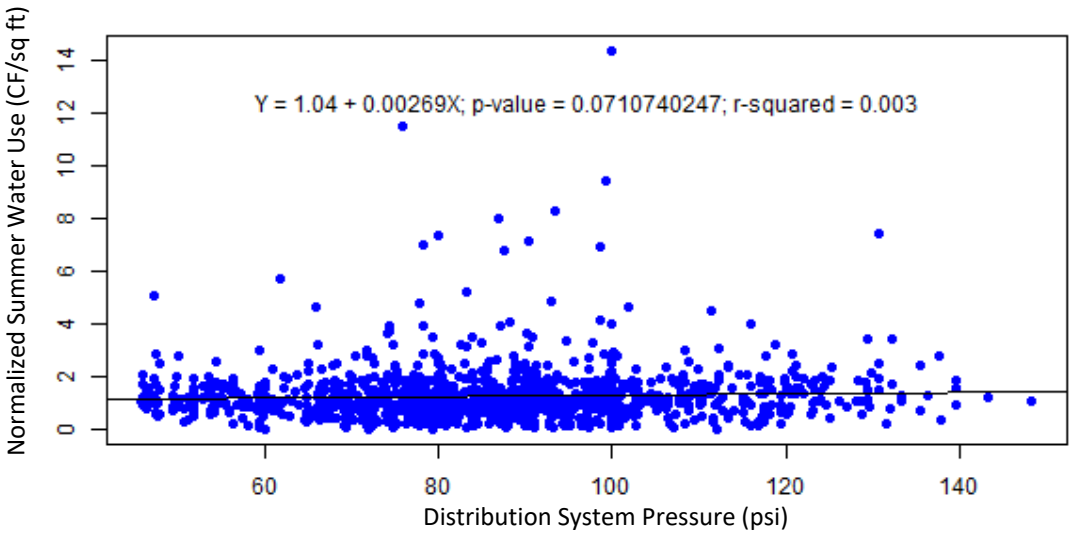


Figure 6-14
Water Use and Water Pressure by Potable Water Irrigation SPs in the Central ET Zone

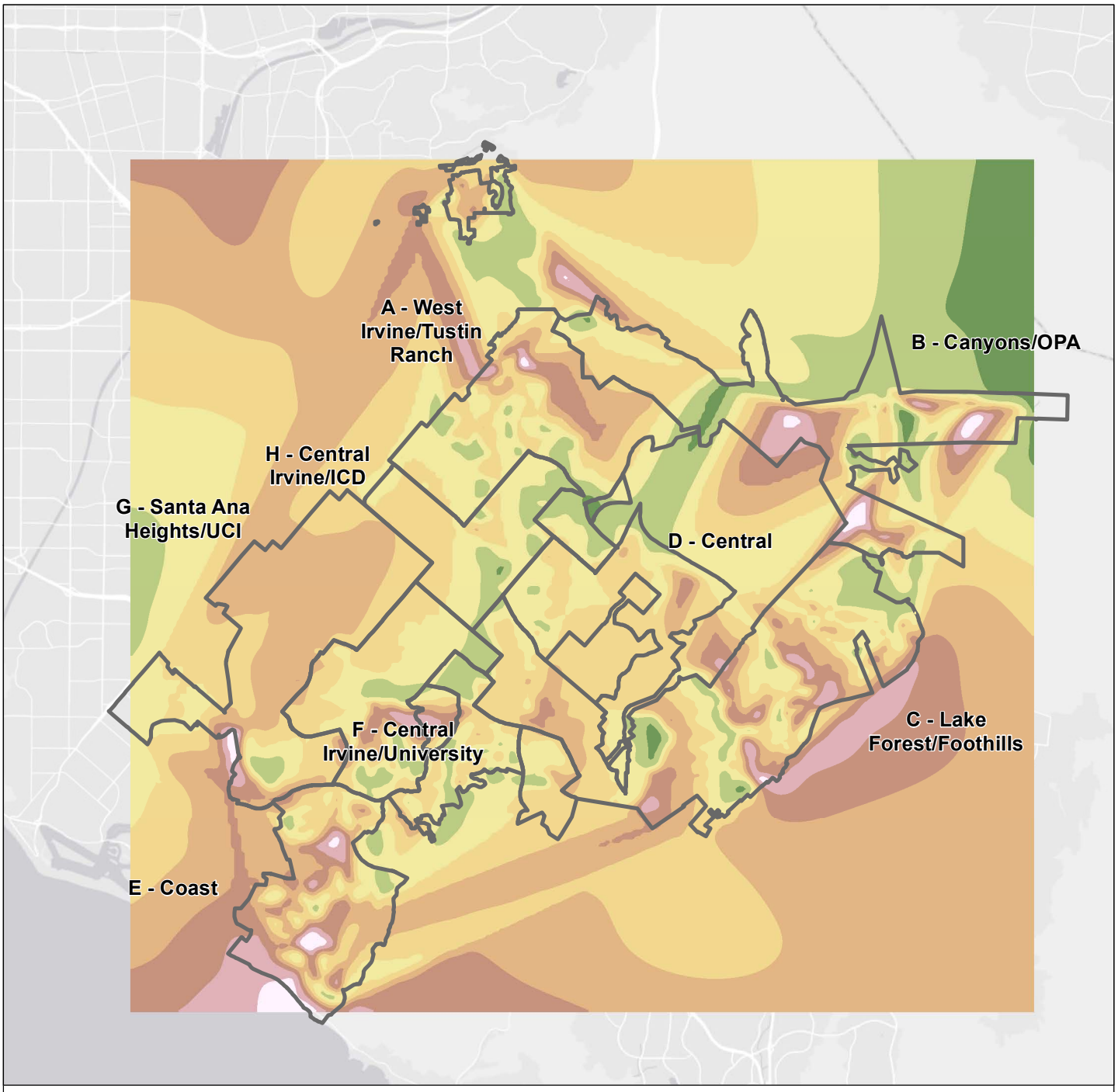


Based on the results from the Coastal and Foothill zones, an increase in water pressure of 10 psi is correlated with approximately 0.8 to 1.9 gallons of increased water use per square foot of landscape area during the summer months.[71]

In order to identify which customers could benefit from a PRV installation or replacement program, the location and sectors of customers in high pressure zones were evaluated. SPs in areas with pressure higher than 80 psi are summarized in **Table 6-5**, by sector and Village Group. These SPs are broken out further into three groups: (1) areas of pressure from 80 to 90 psi, (2) areas of pressure from 90 to 100 psi, and (3) areas of pressure exceeding 100 psi. These SPs are identified on **Figure 6-11b**.

Roughly one-half of SFR and MFR SPs are located in areas with a distribution system pressure over 80 psi. Approximately 60% of potable landscape irrigation SPs and 70% of CII SPs are also located in areas of high pressure. While the SPs with high pressure are geographically clustered in limited areas, such areas exist within all Village Groups. While a statistically significant relationship between water use and water pressure was not established for other sectors, as it was for landscape irrigation, as shown in **Table 6-5,** the areas of the District with the highest pressure tend to have higher water use on average compared to the same Village Group and sector with lower pressure. Based on this, there is potential benefit to implementing a PRV installation and/or replacement program in the District with the intention of decreasing water losses due to leakage and irrigation inefficiency; see also **Appendix F**. As discussed further in Section 0, the best potential targets for such a program are customers with a pressure between 80 psi and 90 psi. SFR customers in this range are identified in **Figure 6-11c**.

[71] The relationship between system water pressure and total water use and outdoor water use was evaluated for other water sectors, including SFR, and was not found to be statistically significant. This may be a combination of existing installed PRVs and the increased variability of water uses among non-irrigation-only customers.



Legend

- Village Group Boundary

Potable Water System Average Pressure (psi)

- ≤ 50
- 51 - 65
- 66 - 80
- 81 - 95
- 96 - 110
- 111 - 125
- 126 - 140
- > 140

Abbreviations

IRWD = Irvine Ranch Water District
psi = pounds per square inch
SP = service points

Notes

1. All locations are approximate.

Sources

1. Basemap provided by ESRI.
2. Potable water system pressure contour provided by IRWD on August 2019.

N

0 3 6

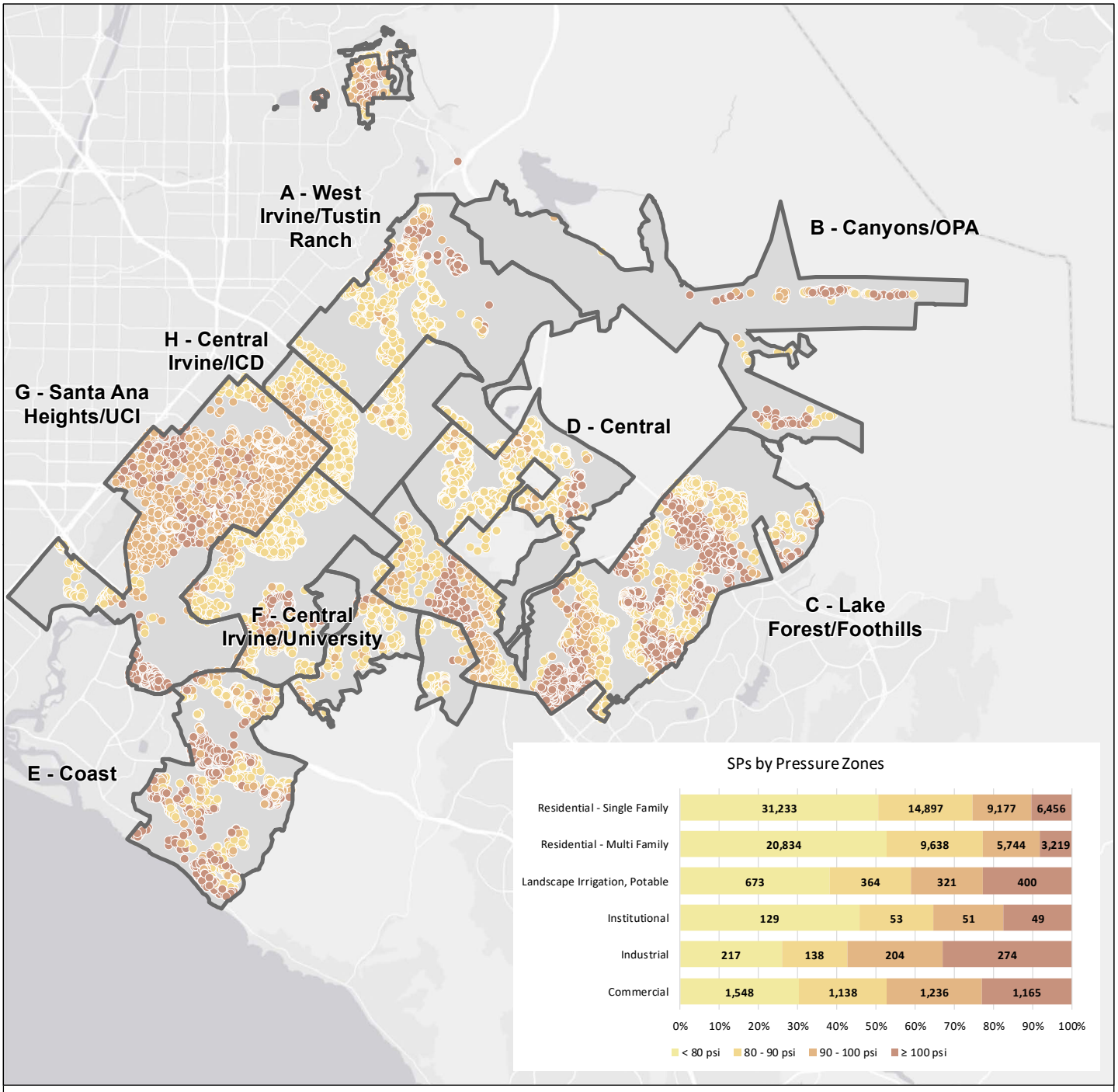
(Scale in Miles)

Potable Water System Average Pressure

Irvine Ranch Water District
December 2019
B80129.00

Figure 6-11a

Path: X:\B80129\Maps\2019\12_Final\Fig 6-11a-Pressure_SPs.mxd



Legend

Village Group Boundary

SPs in Areas Exceeding 80 psi

- 80 - 90 psi
- 90 - 100 psi
- ≥ 100 psi

Abbreviations

IRWD = Irvine Ranch Water District
psi = pounds per square inch
SP = service points

Notes

1. All locations are approximate.
2. Potable SPs from all sectors exceeding 80 psi are shown.

Sources

1. Basemap provided by ESRI.
2. Potable water system pressure contour provided by IRWD on August 2019.

N

0 3 6

(Scale in Miles)

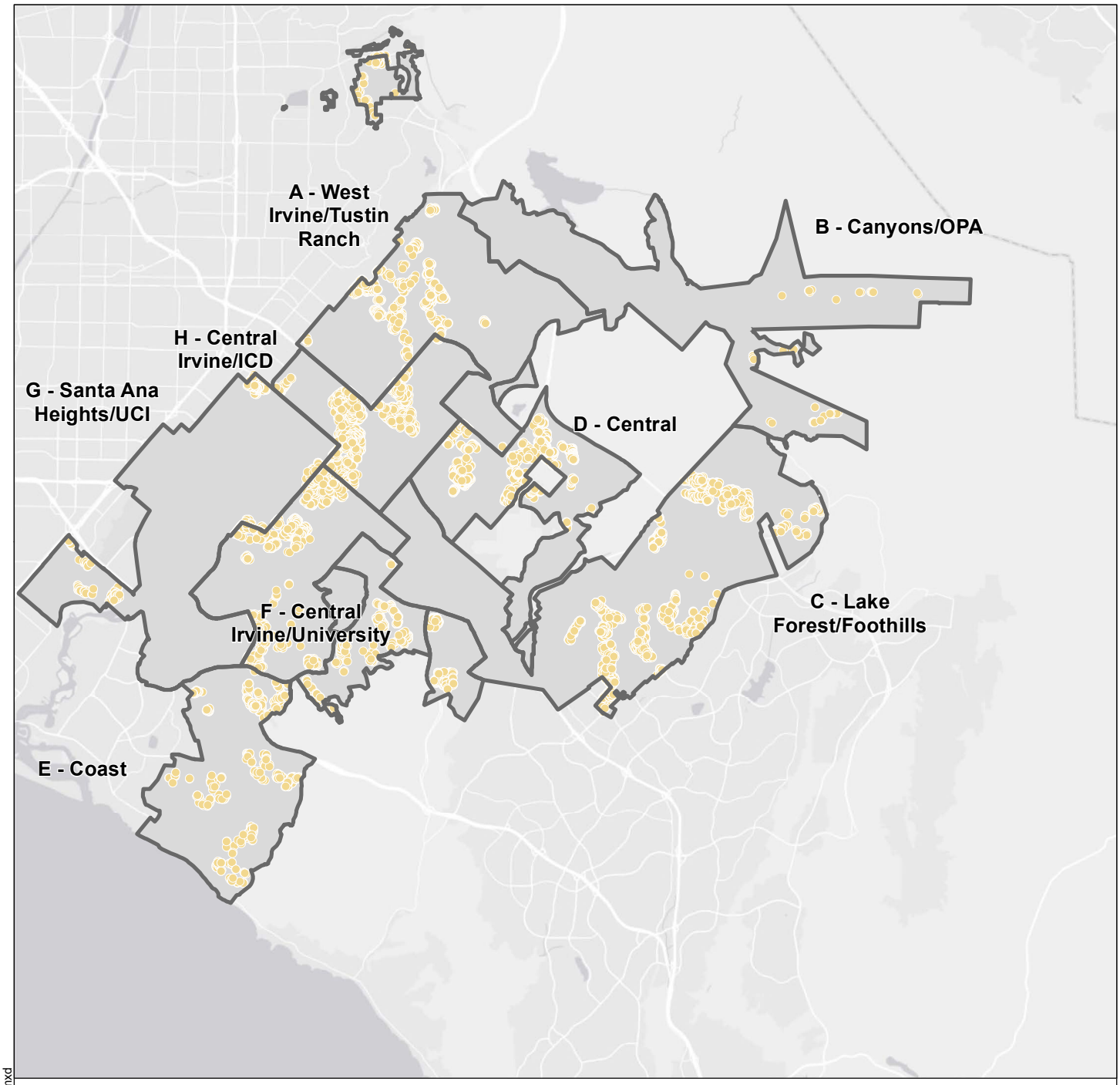
Service Points in High Pressure Zones

Irvine Ranch Water District
December 2019
B80129.00

Figure 6-11b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 6-11b-Pressure_SPs-high.mxd



Legend

Village Group Boundary

SFR SPs in Pressure Zone

- 80 - 90 psi

Sources

1. Basemap provided by ESRI.
2. Potable water system pressure contour provided by IRWD on August 2019.

N

0 3 6

(Scale in Miles)

Abbreviations

IRWD = Irvine Ranch Water District
psi = pounds per square inch
SFR = single-family residential
SP = service points

Notes

1. All locations are approximate.
2. Potable SFR SPs in areas with system pressure of 80 psi to 90 psi are shown.

SFR SPs in Areas with System Pressure of 80 psi to 90 psi

Irvine Ranch Water District
December 2019
B80129.00

Figure 6-11c

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig 6-11c-Pressure_SFR_SPs - 80-90 psi.mxd

Table 6-5
Summary of Potable Water SPs in Pressure Zones Exceeding 80 psi
Irvine Ranch Water District

Village Group	SPs with Pressure 80 - 90 psi				SPs with Pressure 90 - 100 psi				SPs with Pressure >100 psi			
	Number of SPs	Avg 2018 Water Use (CCF)	Average Water Pressure (psi)	Average Potential Pressure Reduction (psi)	Number of SPs	Avg 2018 Water Use (CCF)	Average Water Pressure (psi)	Average Potential Pressure Reduction (psi)	Number of SPs	Avg 2018 Water Use (CCF)	Average Water Pressure (psi)	Average Potential Pressure Reduction (psi)
Single-Family Residential												
A - West Irvine/Tustin Ranch	1,571	144	84	4	578	166	94	14	540	244	116	36
B - Canyons/OPA	149	268	85	5	213	370	95	15	447	287	115	35
C - Lake Forest/Foothills	2,958	145	85	5	1,959	130	95	15	3,218	122	111	31
D - Central	2,425	111	86	6	931	97	92	12	163	40	106	26
E - Coast	1,279	193	85	5	843	216	95	15	1,417	200	111	31
F - Central Irvine/University	2,478	128	85	5	402	160	93	13	332	173	109	29
G - Santa Ana Heights/UCI	703	133	86	6	3,386	121	95	15	339	211	113	33
H - Central Irvine/ICD	3,334	127	85	5	865	116	91	11	--	--	--	--
Total	**14,897**	**137**	**85**	**5**	**9,177**	**139**	**94**	**14**	**6,456**	**166**	**111**	**31**
Multi-Family Residential												
A - West Irvine/Tustin Ranch	1,465	130	83	3	167	116	92	12	12	10	101	21
B - Canyons/OPA	--	--	--	--	--	--	--	--	--	--	--	--
C - Lake Forest/Foothills	827	106	85	5	1,003	84	96	16	1,439	408	113	33
D - Central	2,452	102	84	4	449	104	93	13	93	28	112	32
E - Coast	775	106	84	4	159	112	94	14	269	217	106	26
F - Central Irvine/University	3,453	91	86	6	486	214	92	12	183	82	111	31
G - Santa Ana Heights/UCI	360	147	88	8	3,474	169	95	15	1,223	267	101	21
H - Central Irvine/ICD	306	120	84	4	6	208	92	12	--	--	--	--
Total	**9,638**	**105**	**85**	**5**	**5,744**	**149**	**95**	**15**	**3,219**	**307**	**107**	**27**
Landscape Irrigation, Potable												
A - West Irvine/Tustin Ranch	16	157	84	4	6	50	95	15	6	625	105	25
B - Canyons/OPA	2	723	87	7	--	--	--	--	1	200	107	27
C - Lake Forest/Foothills	193	1,177	85	5	137	1,441	95	15	286	1,248	113	33
D - Central	4	1,742	83	3	--	--	--	--	--	--	--	--
E - Coast	7	3,047	87	7	12	3,240	94	14	9	2,017	106	26
F - Central Irvine/University	73	717	85	5	24	943	94	14	24	536	112	32
G - Santa Ana Heights/UCI	28	1,499	84	4	127	1,367	96	16	74	1,098	103	23
H - Central Irvine/ICD	41	438	85	5	15	1,289	93	13	--	--	--	--
Total	**364**	**1,021**	**85**	**5**	**321**	**1,409**	**95**	**15**	**400**	**1,183**	**111**	**31**
Commercial												
A - West Irvine/Tustin Ranch	119	579	83	3	9	128	95	15	7	245	108	28
B - Canyons/OPA	5	2,050	86	6	1	2,718	97	17	4	515	120	40
C - Lake Forest/Foothills	539	429	86	6	409	423	94	14	545	719	112	32
D - Central	48	311	84	4	19	224	92	12	5	266	103	23
E - Coast	104	307	86	6	69	1,009	94	14	92	884	113	33
F - Central Irvine/University	118	1,710	84	4	15	422	92	12	24	1,203	113	33
G - Santa Ana Heights/UCI	83	977	86	6	601	1,111	95	15	488	1,189	102	22
H - Central Irvine/ICD	122	765	85	5	113	479	93	13	--	--	--	--
Total	**1,138**	**645**	**85**	**5**	**1,236**	**792**	**95**	**15**	**1,165**	**933**	**108**	**28**
Industrial												
A - West Irvine/Tustin Ranch	9	1,452	82	2	--	--	--	--	--	--	--	--
B - Canyons/OPA	--	--	--	--	--	--	--	--	--	--	--	--
C - Lake Forest/Foothills	95	525	86	6	37	1,708	93	13	31	984	106	26
D - Central	--	--	--	--	--	--	--	--	--	--	--	--
E - Coast	--	--	--	--	--	--	--	--	1	2	121	41
F - Central Irvine/University	14	1,246	87	7	--	--	--	--	--	--	--	--
G - Santa Ana Heights/UCI	1	2,668	81	1	150	7,140	98	18	242	4,604	100	20
H - Central Irvine/ICD	19	596	86	6	17	919	93	13	--	--	--	--
Total	**138**	**684**	**85**	**5**	**204**	**5,636**	**96**	**16**	**274**	**4,178**	**101**	**21**
Institutional												
A - West Irvine/Tustin Ranch	6	293	85	5	2	1,172	95	15	3	429	104	24
B - Canyons/OPA	--	--	--	--	4	668	97	17	6	208	120	40
C - Lake Forest/Foothills	5	436	84	4	11	284	95	15	8	147	119	39
D - Central	2	144	85	5	1	36	95	15	--	--	--	--
E - Coast	3	324	88	8	2	99	95	15	17	325	127	47
F - Central Irvine/University	14	1,480	85	5	2	297	90	10	--	--	--	--
G - Santa Ana Heights/UCI	10	69,468	87	7	24	30,596	95	15	15	46,340	105	25
H - Central Irvine/ICD	13	433	83	3	5	471	91	11	--	--	--	--
Total	**53**	**13,703**	**85**	**5**	**51**	**14,620**	**95**	**15**	**49**	**14,374**	**117**	**37**

7. ESTIMATED POTENTIAL SAVINGS BY WATER EFFICIENCY PROGRAMS

Based on the opportunities identified for each water efficiency (WE) program in Section 6.1.4, three potential implementation scenarios were selected and evaluated: a low, medium, and high scenario. The basis and assumptions for each WE program scenario are discussed in the following sections. Water and energy savings were calculated using the following resources:

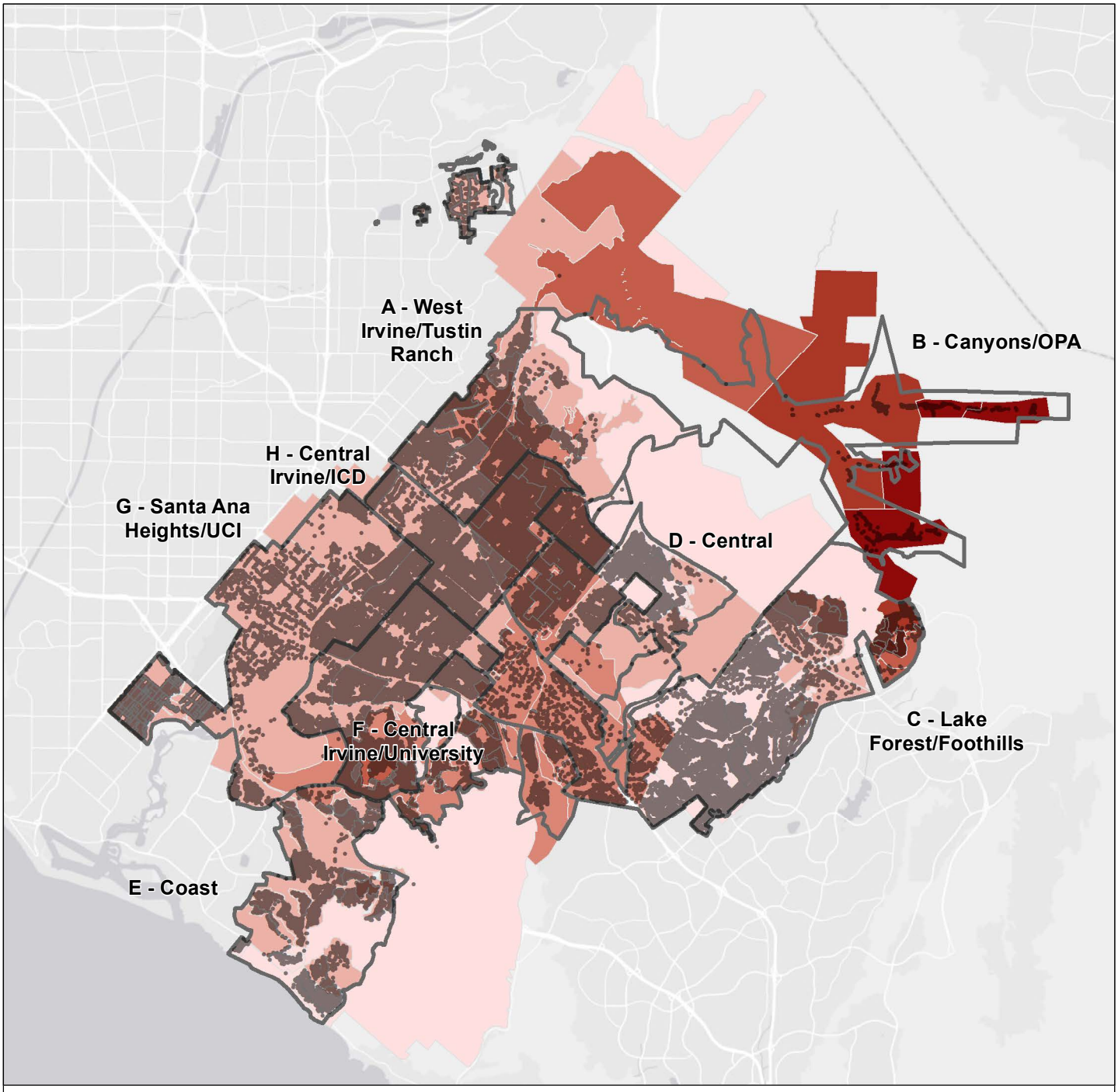
- Estimated water savings rates are based on the Irvine Ranch Water District- (IRWD) specific rates developed in Section 4.
- Water cost savings are calculated based on the avoided cost to purchase new water supply of $1,331 per acre foot (AF).[72]
- Embedded energy costs are based on the IRWD-only[73] embedded energy costs for potable water, inclusive of supply, treatment, and distribution per Navigant (2015). **Figure 7-1** shows the embedded energy zones for potable water (exclusive of the sewer service) used for this analysis. All the turf programs and the outdoor or irrigation water savings from the pressure regulating or pressure reducing valve (PRV) program use the energy cost of the potable water (exclusive of the sewer component), and the leakage water savings from the PRV program also use the energy cost of the potable water (exclusive of the sewer component) as a conservative estimate of the energy savings.

Estimated Potential Savings

The potential water and energy savings and the associated benefit-cost ratios for IRWD (i.e., expected savings in terms of reduced water and energy costs relative to the cost to implement the WE program) were calculated for four potential new or refined WE programs and associated implementation scenarios, as summarized below. Each WE program was evaluated at three implementation levels, generally consisting of (1) "business-as-usual", (2) "increased", and (3) "aggressive and targeted." These scenarios bracket a range of potential savings, which are dependent on how the programs are implemented. This analysis also shows that there are diminishing returns (i.e., a lower benefit/cost ratio) with increased intensity of implementation. Thus, the more aggressive scenarios are not recommended under normal conditions. However, the aggressive scenarios can be used to support planning for future extreme drought or other conditions.

Program Approach	Benefit/Cost Ratio for Implementation Scenario		
	Business-As-Usual	Increased	Aggressive
SFR Turf - Targeting Largest Landscape Areas	**2.3**	**2.3**	**1.7**
SFR Turf -Targeting Drought-Reducing Customers	**2.3**	**2.0**	**2.0**
Non-Residential Turf Removal Targeting	0.2	0.2	0.2
PRV Program Pilot Study for SFR SPs	0.6		
PRV Program Pilot Study for Potable Landscape Irrigation Accounts	**4.7**		

[72] Avoided cost of water provided by IRWD by email on 16 August 2019. Based on Navigant (2015), the average cost of electricity used is $0.12/kWh.
[73] Does not include embedded energy costs for non-IRWD owned facilities such as MWD, State Water Project, and Colorado River Aqueduct facilities.



Legend

IRWD Embedded Energy (kWh/AF)

- 0 - 500
- 501 - 1,000
- 1,001 - 1,500
- 1,501 - 2,000
- 2,001 - 2,500
- 2,501 - 4,451

Village Group Boundary

Service Meter Location

Sources

1. Basemap provided by ESRI.
2. Navigant, 2015. Embedded Energy Plan, Final Report, Navigant Consulting, Inc. and HDR Engineering, December 2015.

N

0 3 6

(Scale in Miles)

Abbreviations

IRWD = Irvine Ranch Water District
kWh/AF = kilowatt hour per acre foot

Notes

1. All locations are approximate.
2. Embedded energy values include only those associated with IRWD facilities, for energy related to the supply, treatment, and distribution of potable water.

Embedded Energy Zones (Potable Water, No Sewer)

Irvine Ranch Water District
December 2019
B80129.00

Figure 7-1

Path: X:\B80129\Maps\2019\12_Final\Fig 7-1-Energy.mxd

- Lifetime savings are based on an assumed lifetime of 10 years for turf removal projects, consistent with the assumed project lifetime used by Metropolitan Water District of Southern California (MWD). The lifetime savings for a PRV replacement is assumed to be 10 years.[74]
- Lifetime cost savings are adjusted to a net present value using a discount rate of 2.875%.

Program implementation costs can vary depending on the specific amount of rebate offered or cost of device, the incremental additional administrative costs to implement, the cost of marketing, and more. Program implementation costs for each scenario were estimated based on program administration and marketing costs typically incurred, based on information provided by IRWD.[75] These costs are scaled based on the assumed level of participation.

Water and cost savings (benefits) were estimated on an annual basis based on the identified implementation levels, to allow for greater flexibility in planning. As a program is implemented over time, program participation rates would be expected to attenuate, as more customers are reached and saturation increases. Therefore, the annual participation rates represent the upper end of the range of implementation rates and are suitable for planning purposes. The total lifetime costs are estimated based on one year of implementation at the specified levels.

A benefit-cost ratio is calculated for each scenario based on the calculated lifetime cost savings incurred by IRWD through avoided water, energy and sewer costs (the "benefit") as compared to the assumed IRWD implementation costs (the "cost").

7.1. SFR Turf Removal Rebate Program

Potential outdoor water use savings remain in the District. Based on the water savings analysis presented in Section 4.2, Turf Removal programs have proven to result in more savings than weather-based irrigation controller (WBIC) programs. The current Turf Removal program has been successful, but to date has only reached about 3% of single-family residential (SFR) customers in the District. Even taking into account the multiplier effect (IRWD, 2016), it is estimated that only about 8% of SFR customers have likely replaced their irrigated turf area with water-efficient landscaping. The remaining SFR service points (SPs) represent a potential for additional outdoor water savings. As shown in **Table 7-1** below, the annual rate of participation in this program during 2015 and 2016 (with increased marketing and outreach and statewide messaging due to the drought) was more than three times the annual participation rate in 2014, 2017, and 2018, across the District, and over four times the prior annual participation rate in the Canyons/OPA and Central Village Groups.

[74] Per the J.R. Pluming website (http://jrplumbinginc.com/prv.html), the average lifespan of household PRVs is 7 to 12 years, and per the conversation with a representative of a well-known valve manufacturer (Cla-Val), with good maintenance (service every 2 to 5 years), a PRV could last 20 years. Since the lifespan of PRVs depend on various factors, such as water pressure in the watermain, some areas in IRWD have high water pressure, and homeowners tend not to repair equipment until they fail, a lifetime of 10 years is used as a conservative estimate.
[75] Program costs provided by IRWD by email, 1 October 2019.

Table 7-1
Effect of Increased Marketing on SFR Turf Removal Rebate Participation

Village Group	Average Number of SPs Participating		Rate of Participation Increase with Increased Marketing
	Business-As-Usual - 2014, 2017, and 2018	Statewide Drought and Increased Outreach - 2015 and 2016	
A - West Irvine/Tustin Ranch	18	59	3.3
B - Canyons/OPA	3	14	4.1
C - Lake Forest/Foothills	58	222	3.8
D - Central	2	10	4.1
E - Coast	11	35	3.3
F - Central Irvine/University	20	65	3.3
G - Santa Ana Heights/UCI	18	42	2.4
H - Central Irvine/ICD	41	137	3.3
Total	**171**	**582**	**3.4**

In order to quantify the potential savings that could result from future Turf Removal program implementation, three different scenarios were evaluated:

- **Business-As-Usual Scenario:** assumes that program participation rates continue consistent with program participation observed in years when the program existed, but where the program was not specifically or heavily promoted through marketing (i.e., 2014, 2017, and 2018). It is assumed that program administration is provided by MWDOC and that IRWD performs all pre-and post-inspections.
- **Increased and Targeted Implementation Scenario:** assumes an aggressive marketing and outreach campaign is conducted to promote this program and that customers in the Village Groups with the largest lawn sizes are specifically targeted (i.e., Canyons/OPA, Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD). Participation rates in Village Groups Canyons/OPA, Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD are assumed to be equal to that of the rates observed in 2015 and 2016. Participation rates for all other areas of the District are assumed to be 50% of that observed during 2015 and 2016.[76] It is assumed that program administration is provided by MWDOC and that IRWD performs all pre- and post-inspections**.**
- **Aggressive Implementation Scenario:** assumes that marketing, outreach, and rebate amount are increased similar to that during the drought. Participation rates for this scenario are assumed to be the same as occurred in 2015 and 2016. It is assumed that program administration is provided by MWDOC and that IRWD performs all pre-and post-inspections**.**

[76] Per **Table 7-1**, participation rates for the turf removal program during 2014, 2017, and 2018 were approximately 29% of the participation rates during the height of the drought (2015 and 2016). Therefore, it is assumed that with increased outreach, participation rates can be increased to 50% of the 2015 and 2016 rates.

Such a program could include a continuation of the turf rebate program, an increase in rebate amount, or a less traditional Turf Removal program that includes provision of planning assistance, labor, plants, and/or other supplies. **Tables 7-2a** and **b** present the results of this analysis, including the modeled water, energy, and cost savings for each of these scenarios, and detailed assumptions for each metric. **Table 7-3** presents a summary of the annual estimated savings and the benefit-cost ratio for each scenario. All three implementation scenarios are estimated to be cost effective, with the business-as-usual and increased scenarios having approximately the same level of cost-effectiveness. The aggressive implementation scenario, which represents a more extreme water shortage condition, is estimated to be less cost-effective relative two the lower scenarios, but still cost-effective.

Table 7-3
Summary of Estimated Savings for SFR Turf Removal Rebate Program

Implementation Scenario	Estimated Annual Savings			Estimated Lifetime Cost Savings	Benefit/ Cost Ratio
	Potable Water (AFY)	Embedded Energy (kWh)	Cost Savings		
Business-As-Usual	23	18,924	$32,947	$291,000	2.3
Increased and Targeted Implementation	68	54,911	$97,557	$862,000	2.3
Aggressive Implementation	79	64,136	$112,544	$994,000	1.7

7.2. Targeting SFR Customers that Reduced their Water Use During the Drought and Have Since Rebounded

Many SFR customers (estimated 6.6%) let their lawns go brown during the drought, which was encouraged by IRWD's "Brown is the new green" campaign (IRWD, 2016). As described in Section 6.2.2, customers who likely let their lawn go brown but have since increased their water use to pre-drought levels were identified, and amounted to approximately 5% of all SFR SPs. Given that these customers likely let their lawns (or other landscaping) go brown during the short term, these customers are potentially more likely to live without a lawn for the long-term as well. Therefore, it is assumed that these customers will participate at higher rates than that observed within the SFR sector as a whole for the same level of outreach. The scenarios described below compare the costs and savings of targeting just these approximately 2,800 customers.

In order to quantify the potential savings that could result from continued program implementation, three different scenarios were evaluated:

- **Business-As-Usual Scenario:** assumes that program participation rates for the identified customers are twice the program participation rates observed in years when the program existed, but where the program was not specifically or heavily promoted through marketing (i.e., 2014, 2017, and 2018). It is assumed that program administration is provided by MWDOC and that IRWD performs all pre-and post-inspections**.**
- **Increased Targeted Implementation Scenario:** assumes that the identified customers are targeted with one mailing and, based on their experience of letting their landscape go brown, participate at the same rate as observed in 2015 and 2016. It is assumed that program administration is provided by MWDOC and that IRWD performs all pre-and post-inspections**.**

Table 7-2a
SFR Turf Removal Potential Program Implementation Scenarios - Savings Estimates
Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	18	469	469	8,440	0.0735	1,009	2.2	2,253	$2,971	$270	$3,241
B - Canyons/OPA	3	2,347	1,000	3,333	0.0620	2,285	0.7	1,700	$990	$204	$1,194
C - Lake Forest/Foothills	58	567	567	33,060	0.0735	526	8.7	4,595	$11,637	$551	$12,188
D - Central	2	364	364	848	0.0689	754	0.2	159	$280	$19	$299
E - Coast	11	565	565	6,025	0.0918	792	2.0	1,577	$2,651	$189	$2,840
F - Central Irvine/University	20	549	549	10,788	0.0620	977	2.4	2,351	$3,204	$282	$3,486
G - Santa Ana Heights/UCI	18	537	537	9,482	0.0758	853	2.6	2,206	$3,442	$265	$3,707
H - Central Irvine/ICD	41	488	488	20,006	0.0574	988	4	4,083	$5,502	$490	$5,992
Total	**171**	--	**4,537**	**91,982**	--	--	**23**	**18,924**	**$30,676**	**$2,271**	**$32,947**

Key Assumptions:

- Participation rates are based on average participation in 2014, 2017, and 2018 (i.e., years when the program was not as heavily promoted).
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR turf removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Increased and Targeted Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	30	469	469	13,832	0.0735	1,009	3.7	3,692	$4,869	$443	$5,312
B - Canyons/OPA	14	2,347	1,000	13,500	0.0620	2,285	3.0	6,883	$4,010	$826	$4,836
C - Lake Forest/Foothills	222	567	567	125,532	0.0735	526	33.2	17,447	$44,187	$2,094	$46,281
D - Central	5	364	364	1,727	0.0689	754	0.4	323	$570	$39	$609
E - Coast	18	565	565	9,884	0.0918	792	3.3	2,587	$4,349	$310	$4,660
F - Central Irvine/University	65	549	549	35,382	0.0620	977	7.9	7,711	$10,509	$925	$11,434
G - Santa Ana Heights/UCI	21	537	537	11,271	0.0758	853	3.1	2,623	$4,091	$315	$4,406
H - Central Irvine/ICD	137	488	488	66,848	0.0574	988	14	13,645	$18,383	$1,637	$20,021
Total	**509**	--	**4,537**	**277,977**	--	--	**68**	**54,911**	**$90,968**	**$6,589**	**$97,557**

Key Assumptions:

- Assumes that outreach efforts are increased and focused heavily on the four village groups with the largest turf area sizes (i.e., Canyons/OPA, Lake Forest/Foothills, Central Irvine/University, and Central Irvine/ICD). For these groups, it is assumed that participation is equal to that of 2015 and 2016. For the remaining village groups, it is assumed that participation is 50% that of 2015 and 2016.
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR turf removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Table 7-2a
SFR Turf Removal Potential Program Implementation Scenarios - Savings Estimates
Irvine Ranch Water District

Aggressive Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	59	469	469	27,664	0.0735	1,009	7.3	7,385	$9,738	$886	$10,624
B - Canyons/OPA	14	2,347	1,000	13,500	0.0620	2,285	3.0	6,883	$4,010	$826	$4,836
C - Lake Forest/Foothills	222	567	567	125,532	0.0735	526	33.2	17,447	$44,187	$2,094	$46,281
D - Central	10	364	364	3,455	0.0689	754	0.9	646	$1,140	$78	$1,218
E - Coast	35	565	565	19,769	0.0918	792	6.5	5,174	$8,698	$621	$9,319
F - Central Irvine/University	65	549	549	35,382	0.0620	977	7.9	7,711	$10,509	$925	$11,434
G - Santa Ana Heights/UCI	42	537	537	22,541	0.0758	853	6.1	5,245	$8,183	$629	$8,812
H - Central Irvine/ICD	137	488	488	66,848	0.0574	988	14	13,645	$18,383	$1,637	$20,021
Total	**582**	--	**4,537**	**314,691**	--	--	**79**	**64,136**	**$104,847**	**$7,696**	**$112,544**

Key Assumptions:

- Participation rates are based on average participation in 2015 and 2016 (i.e., years when the program was heavily promoted).
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR Turf Removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Abbreviations

AFY = acre feet per year
kWhr = kilowatt hour
SFR = single-family residential
SP = service point
sq ft = square feet

Table 7-2b

SFR Turf Removal Potential Program Implementation Scenario - Benefit/Cost Estimates

Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$92,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes no specific targeted marketing is implemented	$34,000
Total Implementation Cost	*$126,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$291,000
Benefit/Cost Ratio	**2.3**

Increased and Targeted Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$278,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes targeted marketing is implemented and SPs in the four selected village groups receive 2-direct mailings	$102,000
Total Implementation Cost	*$379,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$862,000
Benefit/Cost Ratio	**2.3**

Table 7-2b

SFR Turf Removal Potential Program Implementation Scenario - Benefit/Cost Estimates

Irvine Ranch Water District

Aggressive Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$315,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes increased marketing is implemented and all SFR SPs receive 2 direct-mailings	$269,000
Total Implementation Cost	*$584,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$994,000
Benefit/Cost Ratio	**1.7**

Abbreviations

IRWD = Irvine Ranch Water District
kWhr = kilowatt hour
MWDOC = Municipal Water District of Orange County
SFR = single-family residential
SP = service point
sq ft = square feet

Notes

a) Implementation rates are based on Table 7-2a.
b) Estimated costs and savings are rounded to the nearest $1,000.

- **Aggressive Targeted Implementation Scenario:** assumes that the identified customers are targeted with two mailings and, based on their demonstrated willingness to let their landscape go brown, will participate at very high levels (i.e., three times the rate observed in 2015 and 2016).[77] It is assumed that program administration is provided by MWDOC and that IRWD performs all pre-and post-inspections**.**

Tables 7-4a and **b** presents the results of this analysis, including the modeled water, energy, and cost savings for each of these scenarios, and detailed assumptions for each metric. **Table 7-5** presents a summary of the annual estimated savings and benefit-cost ratio for each scenario. All three implementation scenarios are estimated to be cost effective, with the business-as-usual scenario being the most cost-effectiveness. Even at the very high participation rates assumed in the aggressive implementation scenario, the cost-effectiveness of this program is still approximately the same as that of the increased targeted scenario.

Table 7-5
Summary of Estimated Annual Savings for SFR Turf Removal Rebate Program Targeting Customers That Reduced Water Use During Drought and Rebounded

Implementation Scenario	Estimated Annual Savings			Estimated Lifetime Cost Savings	Benefit/Cost Ratio
	Potable Water (AFY)	Embedded Energy (kWh)	Cost Savings		
Business-As-Usual	3.2	2,878	$4,663	$41,000	2.3
Increased Targeted Implementation	4.9	4,090	$6,999	$62,000	2.0
Aggressive Targeted Implementation	14	11,522	$19,708	$174,000	2.0

7.3. Non-Residential Turf Removal Rebate Program

Recycled water is available for landscaping use across the majority of the District, and much of the larger turf areas associated with non-residential customers are currently irrigated by recycled water. However, in the limited areas where recycled water is not available (see Section 6.2.3), turf associated with commercial, industrial, and potable irrigation accounts is irrigated with potable water and represents an opportunity for water savings[78]. As discussed in Section 4.6, only 30 mixed-use meter commercial, industrial, and institutional (CII) SPs have participated in a turf removal program.[79] In order to quantify the potential savings that could result from future non-residential Turf Removal program implementation, three different scenarios were evaluated:

[77] Per **Table 7-1**, participation rates for the turf removal program for SFR SPs during the 2015 and2016 (at the height of the drought), were three to four times the participation rates during 2014, 2017, and 2018. Therefore, it is assumed that with increased outreach, participation rates can be increased to similar levels.
[78] Institutional accounts are not targeted in this analysis because it is likely this is functional turf (e.g., sports fields).
[79] It should be taken into account that the landscape areas for the majority of CII customers have been converted to dedicated irrigation SPs (often served by recycled water) and thus turf removal rates associated with CII SPs would be expected to be low.

Table 7-4a
Turf Removal Program Targeting of Customers that Reduced Water Use During Drought and Rebounded Scenarios - Estimated Savings
Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Embedded Energy (kWhr)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	2	484	484	967	0.0735	1,009	72	0.3	258	$340	$31	$371
B - Canyons/OPA	1	2,255	1,000	1,000	0.0620	2,285	142	0.2	510	$297	$61	$358
C - Lake Forest/Foothills	8	517	517	4,136	0.0735	526	160	1.1	575	$1,456	$69	$1,525
D - Central	1	196	196	196	0.0689	754	10	0.0	37	$65	$4	$69
E - Coast	1	546	546	546	0.0918	792	40	0.2	143	$240	$17	$257
F - Central Irvine/University	3	549	549	1,646	0.0620	977	100	0.4	359	$489	$43	$532
G - Santa Ana Heights/UCI	3	591	591	1,772	0.0758	853	115	0.5	412	$643	$49	$693
H - Central Irvine/ICD	6	477	477	2,864	0.0574	988	162	1	585	$788	$70	$858
Total	**25**	--	**4,359**	**13,127**	--	--	**799**	**3.2**	**2,878**	**$4,318**	**$345**	**$4,663**

Key Assumptions:

- Participation rates are based on average participation in 2014, 2017, and 2018 (i.e., years when the program was not as heavily promoted).
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR turf removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Increased Targeted Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Embedded Energy (kWhr)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	3	484	484	1,451	0.0735	1,009	108	0.4	387	$511	$46	$557
B - Canyons/OPA	1	2,255	1,000	1,000	0.0620	2,285	142	0.2	510	$297	$61	$358
C - Lake Forest/Foothills	14	517	517	7,238	0.0735	526	279	1.9	1,006	$2,548	$121	$2,668
D - Central	1	196	196	196	0.0689	754	10	0.0	37	$65	$4	$69
E - Coast	2	546	546	1,092	0.0918	792	79	0.4	286	$480	$34	$515
F - Central Irvine/University	4	549	549	2,194	0.0620	977	133	0.5	478	$652	$57	$709
G - Santa Ana Heights/UCI	3	591	591	1,772	0.0758	853	115	0.5	412	$643	$49	$693
H - Central Irvine/ICD	10	477	477	4,773	0.0574	988	271	1	974	$1,313	$117	$1,430
Total	**38**	--	**4,359**	**19,716**	--	--	**1,136**	**4.9**	**4,090**	**$6,508**	**$491**	**$6,999**

Key Assumptions:

- Participation rates are based on average participation in in 2015 and 2016 (i.e., years when the program was heavily promoted).
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR turf removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Table 7-4a
Turf Removal Program Targeting of Customers that Reduced Water Use During Drought and Rebounded Scenarios - Estimated Savings
Irvine Ranch Water District

Aggressive Targeted Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Average Size of Turf Area per SP (sq ft)	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Embedded Energy (kWhr)	Water Savings w/ Multiplier Effect (AFY)	Embedded Energy Savings w/Multiplier Effect (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	8	484	484	3,869	0.0735	1,009	287	1.0	1,033	$1,362	$124	$1,486
B - Canyons/OPA	3	2,255	1,000	3,000	0.0620	2,285	425	0.7	1,530	$891	$184	$1,075
C - Lake Forest/Foothills	41	517	517	21,196	0.0735	526	818	5.6	2,946	$7,461	$353	$7,814
D - Central	1	196	196	196	0.0689	754	10	0.0	37	$65	$4	$69
E - Coast	5	546	546	2,729	0.0918	792	198	0.9	714	$1,201	$86	$1,286
F - Central Irvine/University	12	549	549	6,583	0.0620	977	399	1.5	1,435	$1,955	$172	$2,127
G - Santa Ana Heights/UCI	8	591	591	4,727	0.0758	853	306	1.3	1,100	$1,716	$132	$1,848
H - Central Irvine/ICD	28	477	477	13,366	0.0574	988	758	3	2,728	$3,676	$327	$4,003
Total	**106**	--	**4,359**	**55,665**	--	--	**3,201**	**13.8**	**11,522**	**$18,326**	**$1,383**	**$19,708**

Key Assumptions:

- Participation rates are based on three times the average participation in 2015 and 2016 (i.e., years when the program was heavily promoted).
- As discussed in Section 4.2, the SFR turf area identified by Quantum Spatial (2016) appears to be low based on the average turf size of SFR turf removal projects that have been implemented (800 sq ft). While customers are not likely to replace 100% of their turf, given this apparently discrepancy in the data, it is assumed that customers replace all of their turf except for those in the Canyons/OPA village group.
- The calculated water savings in Section 4 for the Central village group was anomalous due to small sample size. The average for the District is used instead.
- A weighted average embedded energy was calculated by village group based on the location of SFR accounts.
- Based on IRWD (2016) a multiplier effect of 2.6 has been observed for the SFR turf removal program. Therefore, the assumed savings are multiplied by 3.6 to capture the effective savings associated with this program.

Abbreviations

AFY = acre feet per year
kWhr = kilowatt hour
SFR = single-family residential
SP = service point
sq ft = square feet

Table 7-4b
Turf Removal Program Targeting of Customers that Reduced Water Use During Drought and Rebounded Scenarios - Benefit/Cost Estimates
Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$13,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes no specific targeted marketing is implemented	$5,000
Total Implementation Cost	*$18,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$41,000
Benefit/Cost Ratio	**2.3**

Increased and Targeted Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$20,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes targeted marketing is implemented and selected SPs receive 1-direct mailing	$12,000
Total Implementation Cost	*$31,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$62,000
Benefit/Cost Ratio	**2.0**

Table 7-4b
Turf Removal Program Targeting of Customers that Reduced Water Use During Drought and Rebounded Scenarios - Benefit/Cost Estimates
Irvine Ranch Water District

Aggressive Targeted Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$56,000
Administration Cost • Assumes program is administered by MWDOC with IRWD providing pre- and post-inspection services ($200/site) • Assumes increased marketing is implemented and all SFR SPs receive 2 direct-mailings	$29,000
Total Implementation Cost	*$85,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$174,000
Benefit/Cost Ratio	**2.0**

Abbreviations
IRWD = Irvine Ranch Water District
kWhr = kilowatt hour
MWDOC = Municipal Water District of Orange County
SFR = single-family residential
SP = service point
sq ft = square feet

Notes
a) Implementation rates are based on Table 7-4a.
b) Estimated costs and savings are rounded to the nearest $100 or $1,000.

- **Business-As-Usual Scenario:** assumes that program participation rates are generally consistent with program participation observed for commercial, industrial, and potable landscape irrigation SPs in years when the program existed, but was not specifically or heavily promoted through marketing (i.e., 2013, 2014, 2017, and 2018). It is assumed that program administration is provided by MWDOC and CII pre and post inspections will be performed by MWD contractor.

- **Increased Implementation Scenario:** assumes that marketing, outreach, and rebate amount is increased similar to that of during the drought (one mailing to the targeted commercial, industrial, and potable irrigation accounts, see **Figure 6-10**). Participation rates for this scenario are assumed to be the same as occurred in 2015. It is assumed that program administration is provided by MWDOC and that the MWD contractor performs all pre-and post-inspections**.**

- **Aggressive Implementation Scenario:** assumes an aggressive marketing and outreach campaign (two mailings to the targeted commercial, industrial, and potable irrigation accounts, see **Figure 6-10**) is conducted to promote this program and participation is three times that observed in 2015.[80] This very high participation level was selected as an upper bound to test the sensitivity of the cost-effectiveness of this program. It is assumed that program administration is provided by MWDOC and that the MWD contractor performs all pre-and post-inspections**.**

Such a program could include a continuation of the turf rebate program, an increase in rebate amount, or a less traditional Turf Removal program that includes provision of planning assistance, labor, plants, and/or other supplies. **Tables 7-6a** and **b** present the results of this analysis, including the modeled water, energy, and cost savings for each of these scenarios, and detailed assumptions for each metric. **Table 7-7** presents a summary of the annual estimated savings and benefit-cost ratio for each scenario. Based on this assessment, the Non-Residential Turf Removal Rebate program targeting areas of the District not served by recycled water was not found to be cost-effective, and the estimated cost-effectiveness ratio shows little sensitivity to the level of implementation and participation.

Table 7-7
Summary of Estimated Annual Savings for Non-Residential Turf Removal Rebate Program

Implementation Scenario	Estimated Annual Savings			Estimated Lifetime Cost Savings	Benefit/ Cost Ratio
	Potable Water (AFY)	Embedded Energy (kWhr)	Cost Savings		
Business-As-Usual	0.7	832	$1,029	$9,000	0.2
Increased Implementation	4.9	5,133	$7,186	$63,000	0.2
Aggressive Implementation	15	15,398	$21,557	$190,000	0.2

[80] Per **Table 7-1**, participation rates for the turf removal program for SFR SPs during 2015 and2016 (at the height of the drought) were three to four times the participation rates during 2014, 2017, and 2018. Therefore, it is assumed that with increased outreach, participation rates can be increased even further.

Table 7-6a

Commercial, Industrial, and Potable Landscape Irrigation Turf Removal Potential Program Implementation Scenarios - Estimated Savings

Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings (AFY)	Embedded Energy (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
B - Canyons/OPA	0.5	21,780	10,890	0.0178	2,114	0.19	409	$257	$49	$307
C - Lake Forest/Foothills	1	6,970	6,970	0.0178	750	0.12	93	$165	$11	$176
G - Santa Ana Heights/UCI	2	8,930	21,432	0.0178	868	0.38	331	$507	$40	$546
Total	**4**	--	**39,292**	--	--	**0.7**	**832**	**$929**	**$100**	**$1,029**

Key Assumptions:

- Participation rates are based on participation in 2013, 2014, 2016, 2017, and 2018 (i.e., years when the program was not as heavily promoted) for CII and potable landscape irrigation SPs. No CII or potable landscape irrigation accounts in the Canyons/OPA area have previously participated; participation is assumed to be 0.5 SP per year.
- The median landscape size of each village group is used based on the available billing data since average is sensitive to large values.
- The calculated water savings in Section 4 for potable landscape irrigation accounts is used for the basis for the water savings factor.
- A weighted average embedded energy was calculated by village group based on the location of commercial, industrial, and potable landscape irrigation accounts.
- No multiplier effect is assumed for commercial, industrial, or landscape irrigation accounts.

Increased Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings (AFY)	Embedded Energy (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
B - Canyons/OPA	2	21,780	43,560	0.0178	2,114	0.77	1,636	$1,030	$196	$1,226
C - Lake Forest/Foothills	8	6,970	55,760	0.0178	750	1.0	743	$1,318	$89	$1,407
G - Santa Ana Heights/UCI	20	8,930	178,600	0.0178	868	3.2	2,754	$4,222	$331	$4,552
Total	**30**	--	**277,920**	--	--	**4.9**	**5,133**	**$6,570**	**$616**	**$7,186**

Key Assumptions:

- Participation rates are based on average participation in in 2015 (i.e., when the program was heavily promoted) for CII and potable landscape irrigation SPs. No CII or potable landscape irrigation accounts in the Canyons/OPA area have previously participated; participation is assumed to be 4 SPs.
- The median landscape size of each village group is used based on the available billing data since average is sensitive to large values.
- The calculated water savings in Section 4 for potable landscape irrigation accounts is used for the basis for the water savings factor.
- A weighted average embedded energy was calculated by village group based on the location of commercial, industrial, and potable landscape irrigation accounts.
- No multiplier effect is assumed for commercial, industrial, or landscape irrigation accounts.

Table 7-6a

Commercial, Industrial, and Potable Landscape Irrigation Turf Removal Potential Program Implementation Scenarios - Estimated Savings

Irvine Ranch Water District

Aggressive Implementation Scenario

Village Group	Assumed No. Participating SPs per Year	Assumed Turf Removal Area per SP (sq ft)	Total Assumed Turf Replaced (sq ft)	Water Savings (AFY/1,000 sq ft)	Embedded Energy (kWhr/AF)	Water Savings (AFY)	Embedded Energy (kWhr)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
B - Canyons/OPA	6	21,780	130,680	0.0178	2,114	2.3	4,907	$3,089	$589	$3,678
C - Lake Forest/Foothills	24	6,970	167,280	0.0178	750	3.0	2,229	$3,954	$267	$4,222
G - Santa Ana Heights/UCI	60	8,930	535,800	0.0178	868	10	8,263	$12,666	$992	$13,657
Total	**90**	--	**833,760**	--	--	**15**	**15,398**	**$19,709**	**$1,848**	**$21,557**

Key Assumptions:

- Participation is assumed to be three times that of participation in the medium implementation scenario.
- The median landscape size of each village group is used based on the available billing data since average is sensitive to large values.
- The calculated water savings in Section 4 for potable landscape irrigation accounts is used for the basis for the water savings factor.
- A weighted average embedded energy was calculated by village group based on the location of commercial, industrial, and potable landscape irrigation accounts.
- No multiplier effect is assumed for commercial, industrial, or landscape irrigation accounts.

Abbreviations

AFY = acre feet per year
CII = commercial, industrial, and institutional
kWhr = kilowatt hour
SP = service point
sq ft = square feet

Table 7-6b
Commercial, Industrial, and Potable Landscape Irrigation Turf Removal
Potential Program Implementation Scenarios - Benefit/Cost Estimates
Irvine Ranch Water District

Business-as-Usual Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$39,000
Administration Cost • Assumes program is administered by MWDOC with MWD contractor providing pre- and post-inspection services ($200/site) • Assumes no specific targeted marketing is implemented	$780
Total Implementation Cost	*$40,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$9,000
Benefit/Cost Ratio	**0.2**

Increased Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$278,000
Administration Cost • Assumes program is administered by MWDOC with MWD contractor providing pre- and post-inspection services ($200/site) • Assumes increased marketing is implemented and commerical, industrial, and potable landscape irrigation accounts in Figure 6-10 receive 1 direct-mailings	$9,000
Total Implementation Cost	*$287,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$63,000
Benefit/Cost Ratio	**0.2**

Table 7-6b
Commercial, Industrial, and Potable Landscape Irrigation Turf Removal
Potential Program Implementation Scenarios - Benefit/Cost Estimates
Irvine Ranch Water District

Aggressive Implementation Scenario

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $1/sq ft provided by IRWD, based on current funding levels	$834,000
Administration Cost • Assumes program is administered by MWDOC with MWD contractor providing pre- and post-inspection services ($200/site) • Assumes increased marketing is implemented and commerical, industrial, and potable landscape irrigation accounts in Figure 6-10 receive 2 direct-mailings	$23,000
Total Implementation Cost	*$857,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$190,000
Benefit/Cost Ratio	**0.2**

Abbreviations
IRWD = Irvine Ranch Water District
kWhr = kilowatt hour
MWD = Metropolitan Water District of Southern California
MWDOC = Municipal Water District of Orange County
sq ft = square feet

Notes
a) Implementation rates are based on Table 7-6a.
b) Estimated costs and savings are rounded to the nearest $100 or $1,000.
c) Institutional and landscape irrigation potable water accounts are not included in the analysis.

7.4. Pressure Regulating Valve (Pressure Reducing Valve) Program

The potable water system within the District has a wide range of pressures, from approximately 30 to 180 pounds per square inch (psi), depending on where a customer is located within the system. As identified in Section 6.2.4 and **Appendix F**, increased pressure is associated with increased leakage and irrigation water use. The analysis that evaluated outdoor water use relative to pressure zone suggests that an increase in water pressure of 10 psi is correlated with approximately 0.8 to 1.9 gallons of additional water use per square foot of landscape during summer months at potable landscape irrigation SPs. Given that approximately one-half of SFR and multi-family residential (MFR) SPs, 60% of potable landscape irrigation SPs, and 70% of CII SPs are located in areas where distribution system pressure exceeds 80 psi, there is a potential benefit to implementing a PRV installation and/or replacement program in the District.

Considerations that should be taken into account for the design of such a program include:

- While an 80 psi PRV is required under the plumbing code, a WE program could incentivize the installation of a more restrictive PRV, such as 60 psi, for additional water savings.
- The actual operating pressure at an SP can be tested as a criterion for program eligibility, and would help IRWD identify SPs with existing, but poor performing PRVs.
- SPs in zones with pressure greatly exceeding 80 psi would likely be experiencing substantial negative impacts indoors without a PRV in place; thus, SPs in the highest pressure zones are likely to already have a PRV installed. However, these may be good candidates for the replacement of an existing PRV with a PRV that reduces pressure below 80 psi, but within an acceptable range (e.g., 60 to 70 psi).
- Most indoor water use devices, such as clothes washers, dishwashers, toilets, and showerheads typically have an internal mechanism that limit the amount of water used regardless of available water pressure. Increased water pressure would be expected to result in a higher degree of inefficiency among outdoor water using devices such as sprinklers, garden hoses, and drip irrigation, than among indoor devices.
- SPs in areas with high pressure and inadequate pressure regulation are likely to experience more leaks and breakages due to the increased pressure than SPs in lower pressure areas (Lambert, 2001).
- Changing water pressure for industrial accounts may have a potential impact on manufacturing operations, and thus should be approached with caution.
- The cost-effectiveness of the program.

Given these considerations, it is recommended that a pilot PRV program be evaluated and implemented, and that the program be designed to target selected SFR and potable landscape irrigation customers in pressure zones ranging from 80 to 90 psi and include the installation of a 60 psi PRV. This subset of SPs is recommended for targeting because, given that system pressures are close to the 80 psi threshold that requires the installation of a PRV, customers in these areas may be less likely to have a PRV installed. As part of the pilot, the actual operating pressure at SPs with PRVs installed should be measured and the data reviewed to evaluate whether PRVs are functioning as intended, particularly in older areas of the District. If it is found that PRVs are not regulating pressures to the intended range, it is recommended that the pilot be expanded to the areas of the District with the highest system pressures (i.e., customers in areas with pressure exceeding 100 psi). It is also recommended that the District follow up with customers

to see if they have experienced any issues as a result of the lower pressure. Based on the results of this pilot, the water savings achieved can be evaluated and based on the results, could inform the design of broader scale program.

Nearly 15,000 SFR customers and 356 potable landscape irrigation customers are located in areas with water pressure ranging from 80 to 90 psi. These customers are shown on **Figure 6-11c**. Of these customers, those in the Coast, Canyons/OPA, West Irvine/Tustin Ranch, and Lake/Forest Foothills Village Groups have higher than average water use (**Table 6-5**). Therefore, it is recommended that the pilot program target customers within one or more of these Village Groups.

A preliminary estimate of the benefit-cost of a targeted PRV installation program is presented below, based on the methodologies described in **Appendix F**. Due to the high cost of the program, and the potential uncertainty associated with the associated water savings potential, it is recommended that IRWD conduct one or more pilot studies to confirm the preliminary findings presented herein prior to larger-scale implementation.

7.4.1. PRV Pilot Program Targeting SFR Customers

A pilot program targeting up to 200 SFR customers from the West Irvine/Tustin Ranch Village Group is proposed. The West Irvine/Tustin Ranch Village Group was chosen because of the high embedded energy costs associated with serving that area (1,009 kWhr/AF; see **Appendix F**). It also contains a reasonable number of customers (1,571) within the 80 to 90 psi pressure zone so that the marketing costs can be minimized, and the number of participants is still achievable. The benefit-cost analysis is shown in **Table 7-8**.

7.4.2. PRV Pilot Program for Potable Landscape Irrigation Accounts

A pilot program targeting up to 50 potable landscape irrigation customers from the Central Irvine/University Village Group is proposed. The Central Irvine/University Village Group is chosen because of its high embedded energy cost (1,113 kWhr/AF; see **Appendix F**) associated with serving that area and because it contains the second largest number of potable landscape irrigation customers (i.e., 72 customers) within the 80 to 90 psi pressure zone. The benefit-cost analysis is shown in **Table 7-9**.

7.4.3. Summary of the Two PRV Pilot Programs

Table 7-10 presents a summary of the annual estimated savings and benefit-cost ratio for the two pilot programs. The PRV pilot program that targets selected potable landscape irrigation accounts is estimated to have benefit-cost ratio greater than 1.0. This is due to the larger water savings associated with reducing irrigation inefficiency at potable landscape irrigation accounts with larger irrigated areas. Therefore, the District could consider a PRV program targeted at potable irrigation accounts. It does not appear that a program targeted at SFR SPs would be cost-effective for the District. However, it should be noted that the available water savings data on this program are more limited than the others evaluated, and thus further evaluation or a smaller scale SFR pilot study could be appropriate.

Table 7-8
PRV Program Pilot Study for SFR SPs in the West Irvine/Tustin Ranch Village Group
Irvine Ranch Water District

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $550 per PRV Installation provided by IRWD, and 200 participations	$110,000
Administration Cost • Assumes program is administered by IRWD • Assumes targeted marketing is implemented and all SFR SPs in that village group receive 1 direct mailing • Assumes $95/account administration cost	$21,000
Pre-inspection • Assumed $100 per account and all accounts are inspected	$20,000
Post -inspection • Assumed 10% accounts are inspected post-installation	$2,000
Total Implementation Cost	*$153,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$89,000
Benefit/Cost Ratio	**0.6**

Abbreviations

IRWD = Irvine Ranch Water District
PRV = pressure regulating or reducing valve
SFR = single-family residential
SP = service point

Notes

a) The size of the pilot study is assumed to be 200 participants.
b) Estimated costs and savings are rounded to the nearest $100 or $1,000.
c) SFR SPs in the West Irvine/Tustin Ranch Village Group are targeted in the pilot study.
d) Details on savings are documented in Appendix D.

Table 7-9
PRV Program Pilot Study for Potable Landscape Irrigation Accounts
in the Central Irvine/University Village Group
Irvine Ranch Water District

Costs, Benefits, and Assumptions	Estimated Cost/Savings
Program Implementation Costs	
Direct Costs (Device/Rebates) • Assumed $550 per PRV Installation provided by IRWD, and 50 participations	$28,000
Administration Cost • Assumes program is administered by IRWD • Assumes targeted marketing is implemented and all potable landscape irrigation SPs in that village group receive 1 direct mailing • Assumes $95/account administration cost	$5,000
Pre-inspection • Assumed $100 per account and all accounts are inspected	$5,000
Post -inspection • Assumed 10% accounts are inspected post-installation	$1,000
Total Implementation Cost	*$38,000*
Program Lifetime Savings (Net Present Value)	
• Assumes 10-year lifetime • Assumes 2.875% discount rate	$168,000
Benefit/Cost Ratio	**4.4**

Abbreviations
IRWD = Irvine Ranch Water District
PRV = pressure regulating or reducing valve

Notes
a) The size of the pilot study is assumed to be 200 participants.
b) Estimated costs and savings are rounded to the nearest $100 or $1,000.
c) SFR SPs in the West Irvine/Tustin Ranch Village Group are targeted in the pilot study.
d) Details on savings are documented in Appendix D.

Table 7-10
Summary of Estimated Annual Savings for the PRV Pilot Studies

Implementation Scenario	Estimated Annual Savings			Estimated Lifetime Cost Savings	Benefit/Cost Ratio
	Potable Water (AFY)	Embedded Energy (kWhr)	Cost Savings		
PRV Program Pilot Study for SFR SPs in the West Irvine/Tustin Ranch Village Group	7	7,011	$10,087	$89,000	0.6
PRV Program Pilot Study for Potable Landscape Irrigation Accounts in the Central Irvine/University Village Group	13	14,624	$19,249	$170,000	4.5

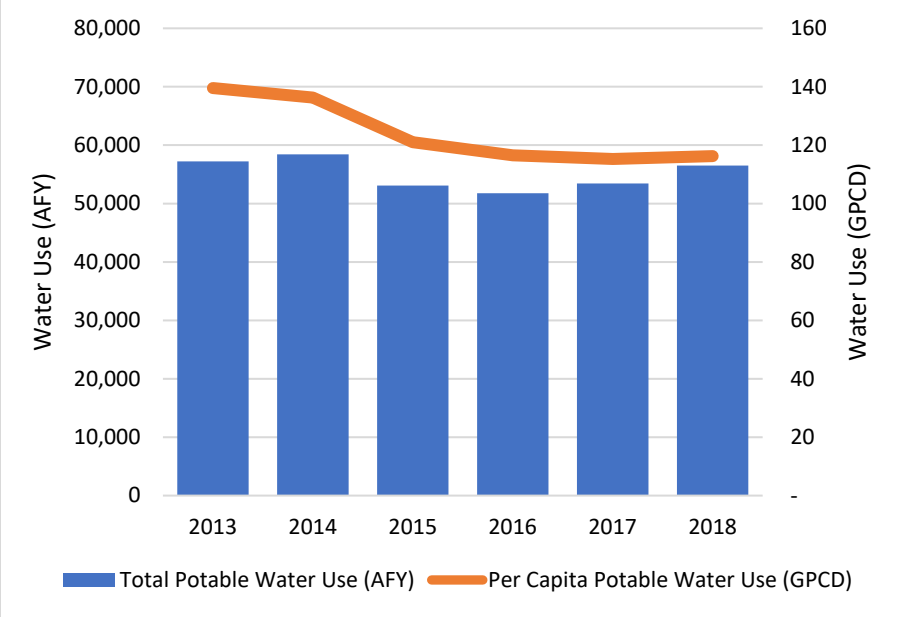
8. WATER SHORTAGE SAVINGS OPPORTUNITIES

The water efficiency (WE) program scenarios evaluated in Section 7 include both typical "business-as-usual" scenarios, and increased urgency scenarios similar to the experiences during the 2013-2017 drought. Irvine Ranch Water District (IRWD) customers reduced their water use during the 2013-2017 drought, and while water use has increased somewhat since the drought, water use has not fully rebounded to pre-drought conditions, particularly on a per capita basis (**Figure 8-1**). Water savings during the drought would have resulted from a combination of behavioral changes (such as irrigating less) and permanent fixture/device changes (such as replacing old devices and removing turf).[81] In order to plan for future droughts, this analysis was conducted to understand which customers reduced their water use during the drought and by how much, and which customers have maintained their water usage at a reduced level. For example, customers whose water use has not rebounded are assumed to be "demand-hardened". In contrast, the water use rebound by customers is identified and quantified as those savings that were likely the result of behavioral changes and represent the remaining potential for short-term savings opportunities in a future drought or water shortage.

Future Potential Drought Savings

IRWD customers reduced their water use during the historic statewide 2013-2017 drought, and through 2018 water use has not fully rebounded to pre-drought conditions. Accounting for the demand hardening based on the limited rebound to date, if drought outreach and messaging were conducted at levels similar to that done in the 2013-2017 drought timeframe, it is estimated that approximately 15% water savings could be achieved in the SFR sector, 11% in the MFR sector, and 19% in the landscape irrigation sector. This represents approximately 5,000 AFY of potential potable water drought conservation savings.

Figure 8-1
Total and Per Capita Potable Water Use



The results of this analysis will help IRWD better plan for future droughts or water shortages, and understand what opportunities for short term drought-conservation are available, which customers are demand-hardened from the previous drought, and which customer sectors

[81] An Assessment of Increasing Water-Use Efficiency on Demand Hardening, Alliance for Water Efficiency, July 2015. https://www.allianceforwaterefficiency.org/sites/www.allianceforwaterefficiency.org/files/highlight_documents/An-Assessment-of-Increasing-Water-Use-Efficiency-on-Demand-Hardening_%28AWE_7-2015%29.pdf

may need specific outreach and programs, depending on the severity of the drought or shortage. Depending on the water savings needed in future droughts or water shortages, IRWD would likely need to increase outreach and other efforts to achieve the same results as during the 2013-2017 drought period, and even then, due to demand hardening, the same level of savings may not be feasible.

8.1. Savings Opportunities by Sector

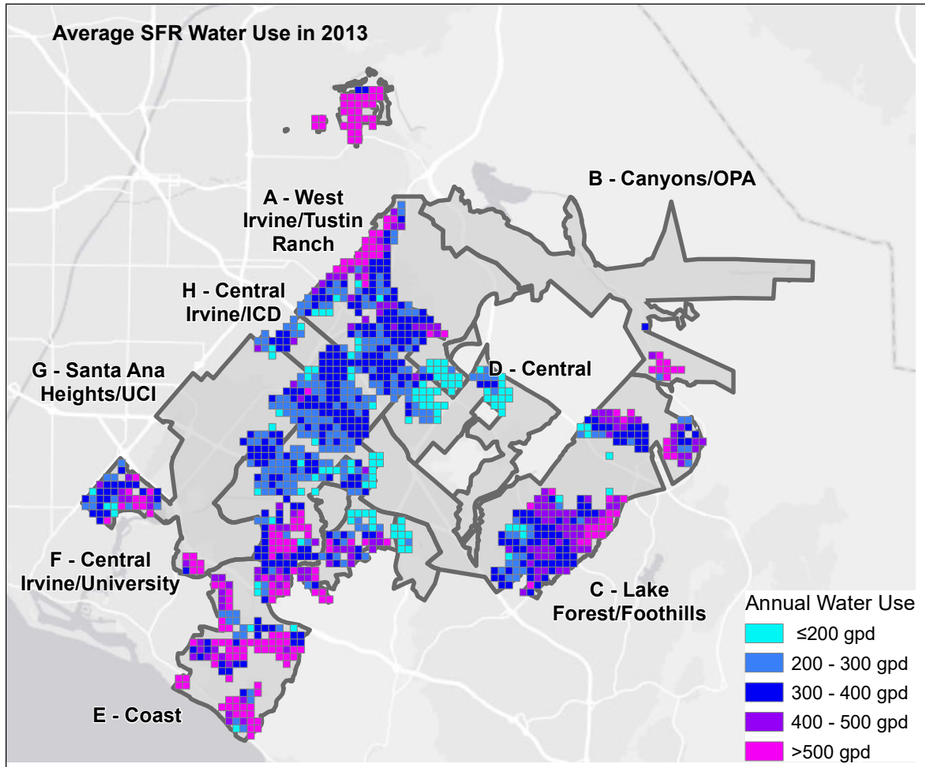
Water use data from each of the potable water sectors were analyzed: single-family residential (SFR), multi-family residential (MFR), potable water landscape irrigation, and commercial, industrial, and institutional (CII). For purposes of this analysis, water use in 2013 was considered the pre-drought condition; water use in 2016 was considered the drought condition, and 2018 was used as the post-drought, most recent condition. Only service points (SPs) with monthly water use greater than zero each month for the respective analysis years were included. The relative percent difference between 2013 and 2016 was calculated for each SP to determine the SP's magnitude of response to the drought. The relative percent difference between 2016 and 2018 was calculated to determine the magnitude of the SP's drought rebound to date.[82] A negative change in water use indicates a reduction in water use and a positive change indicates an increase in water use at a given account. For purposes of visualizing and presenting the data in **Figures 8-1a** through **8-6b**, the annual water use and the change in water use is presented as the average water use of all SPs located within a 1,000 ft X 1,000 ft grid cell.

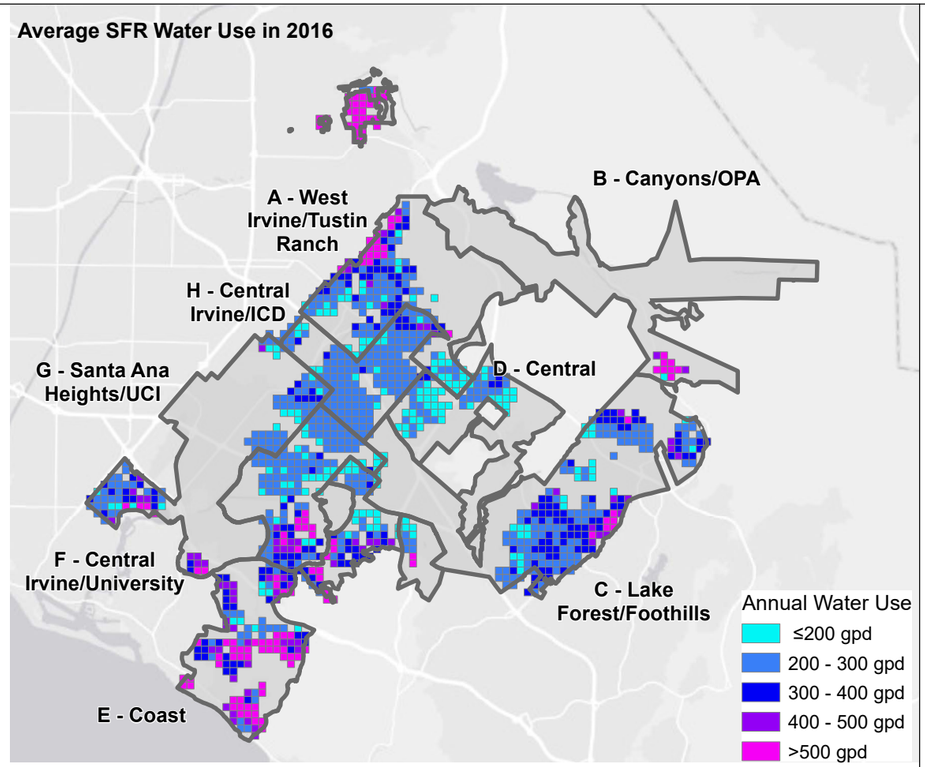
8.1.1. Single-Family Residential

Drought response and drought rebound by SFR SPs are shown in **Figures 8-2a** and **8-2b**, respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-2c** below. The vast majority (76%) of SFR customers decreased their water use during the drought. Over half decreased by at least 10%, and about 12% of the SPs decreased their water use by more than 30% between 2013 and 2016. In general, the proportion of SFR SPs that reduced their water use was the same across all Village Groups, with a slightly larger proportion of customers in the Lake Forest/Foothills and Central Irvine/ICD more aggressively reducing their usage. In the Central Village Group, however, over half of SFR SPs increased their water use,[83] and approximately one-third increased their water use by more than 10%, and nearly 20% increased their water use by more than 30%.

Following the drought, about 58% of SFR customers have increased their water use, and the response has been fairly uniform across all Village Groups. This is true even for customers in the Central Village Group, who did not reduce use during the drought.

[82] Since the comparisons were between the same SPs and the ET does not vary appreciably by year (**Table 6-1**), normalization for weather is not required.
[83] Additional analysis beyond the scope of this effort will be required to assess the reasons for the observed increase in water use.





Legend

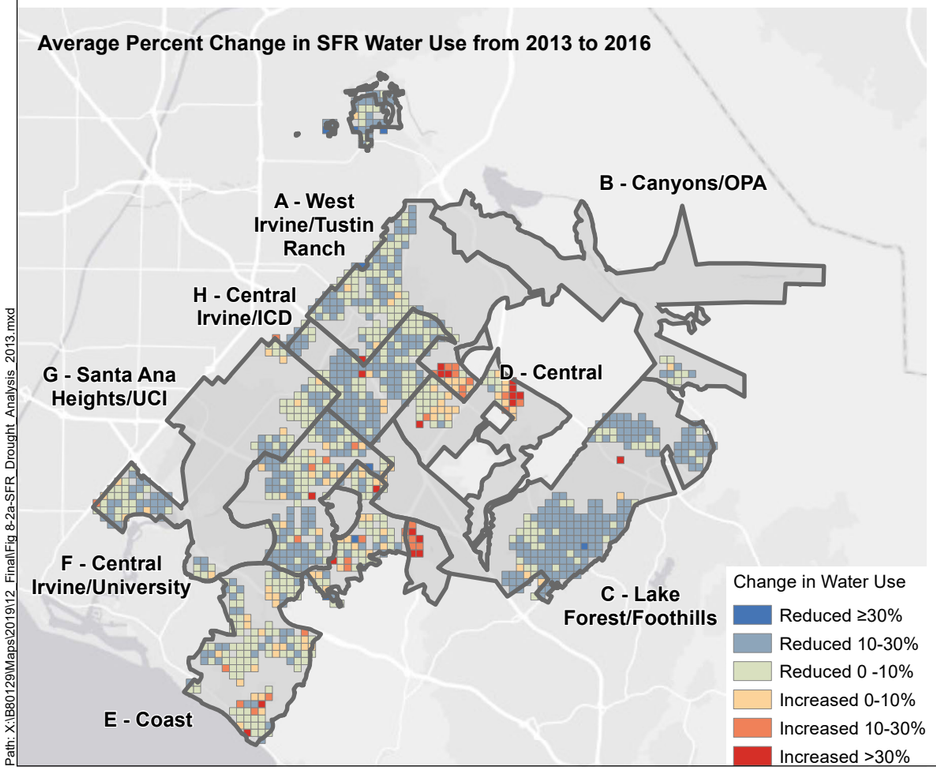
Village Group Boundaries

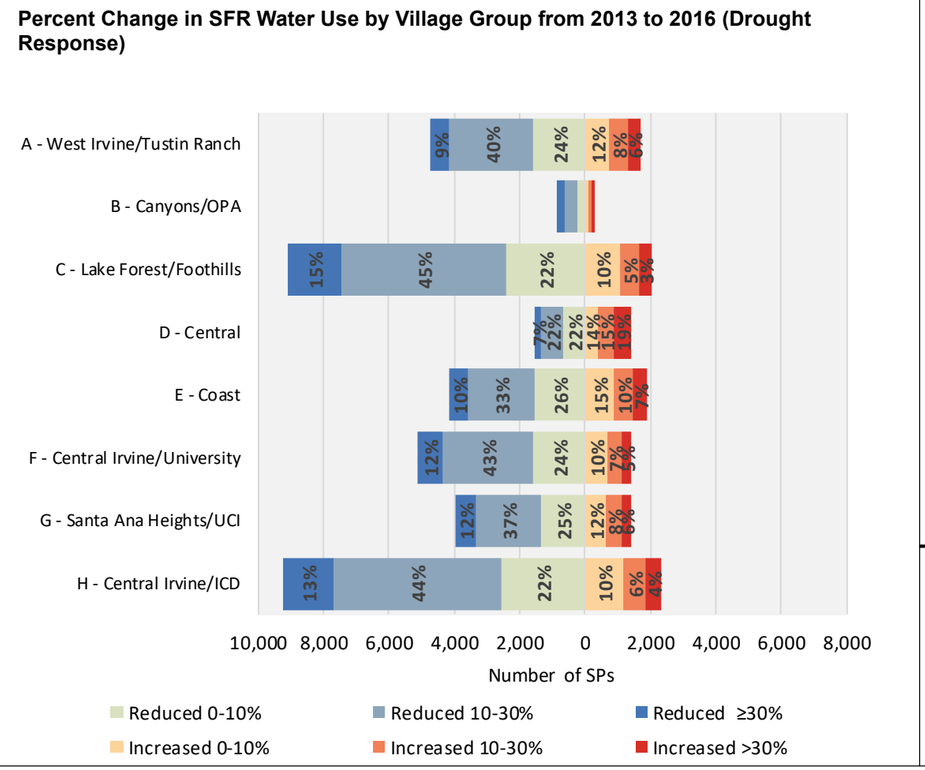
Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SFR = single-family residential
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.





Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

N

0 4 8
(Scale in Miles)

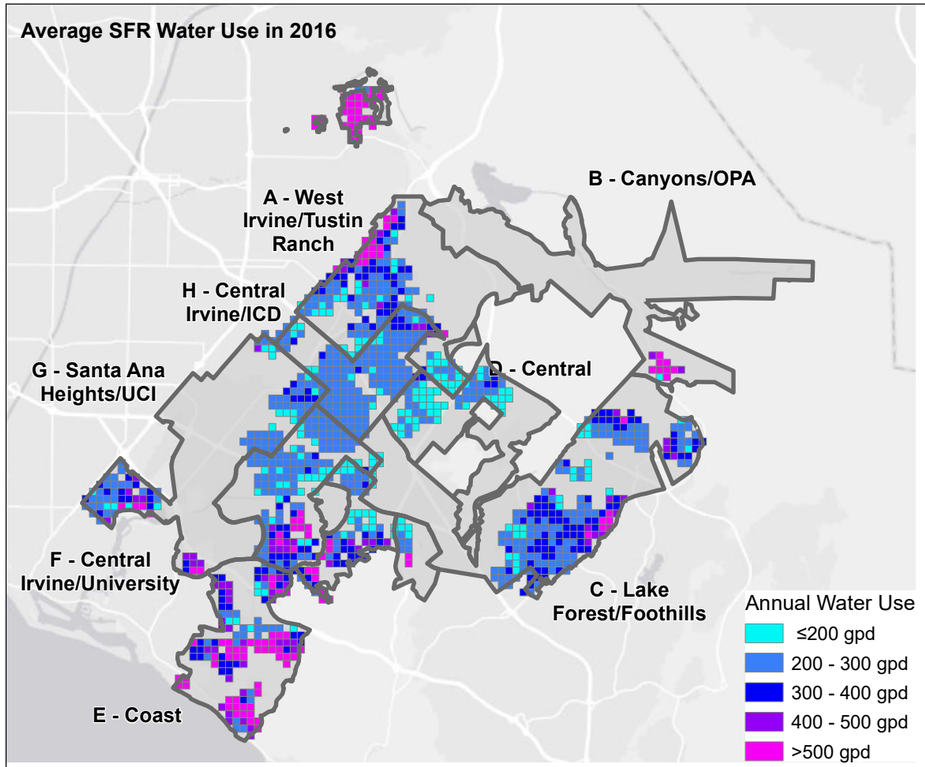
Drought Response by SFR SPs (2013-2016)

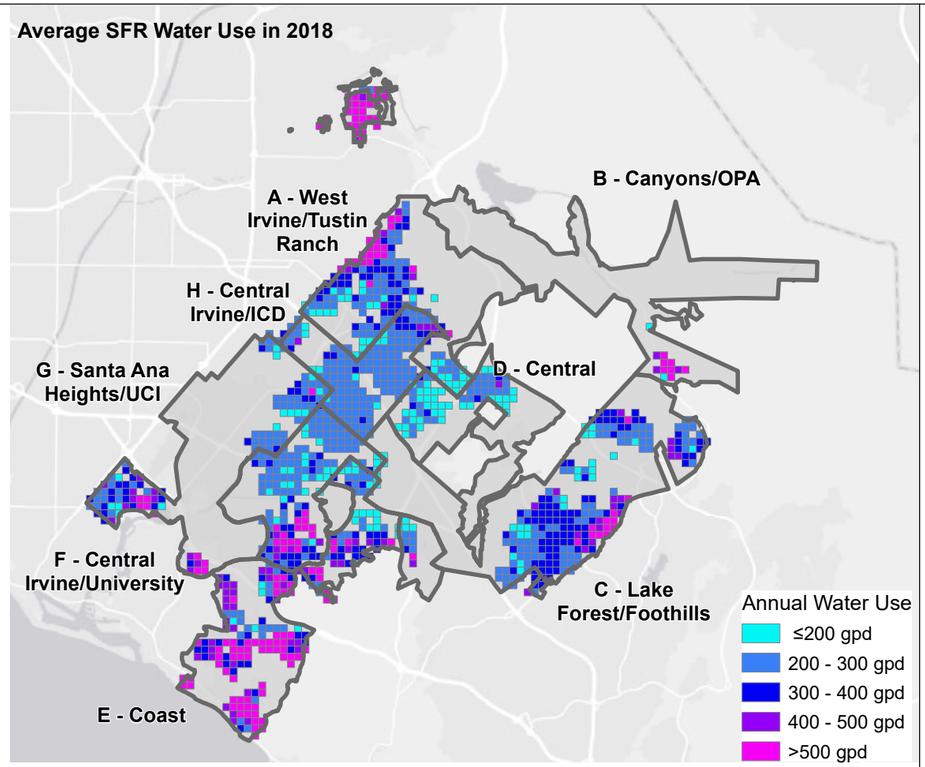
Irvine Ranch Water District

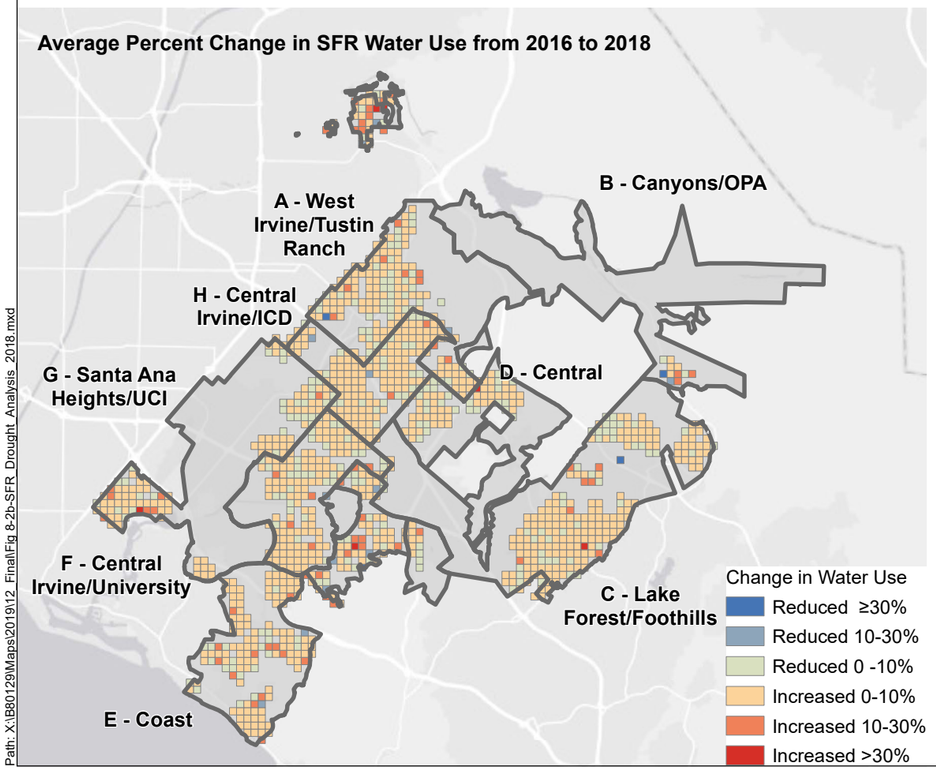
eki environment & water

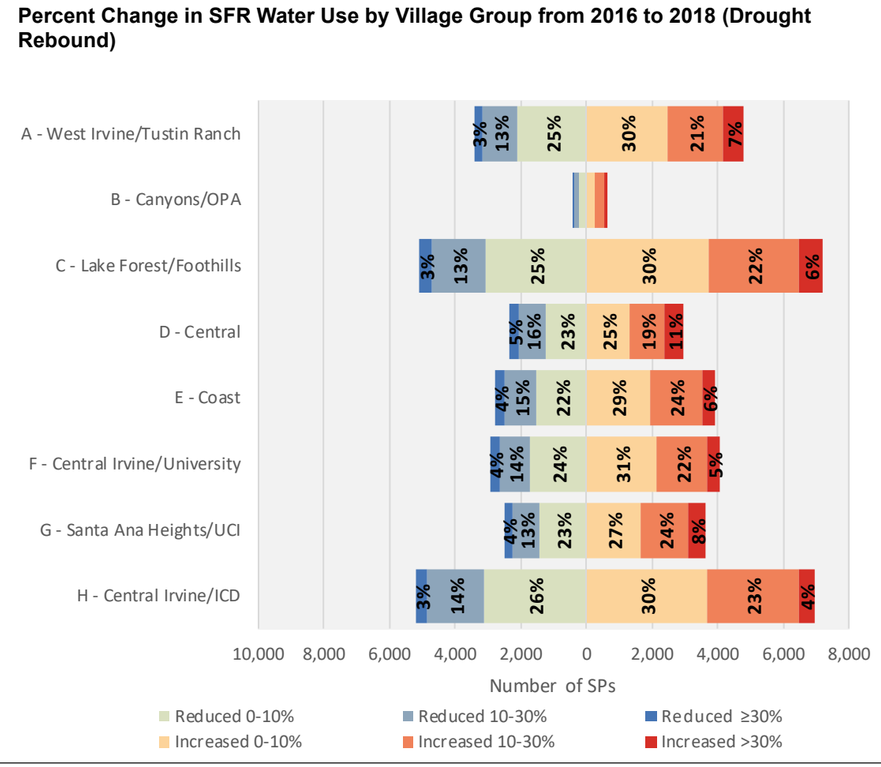
December 2019
B80129.00
Figure 8-2a

Path: X:\B80129\Maps\2019\12_FinalFig 8-2a-SFR_Drought_Analysis_2013.mxd









Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SFR = single-family residential
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

N

0 4 8
(Scale in Miles)

Drought Rebound by SFR SPs (2016-2018)

Irvine Ranch Water District

eki environment & water

December 2019
B80129.00
Figure 8-2b

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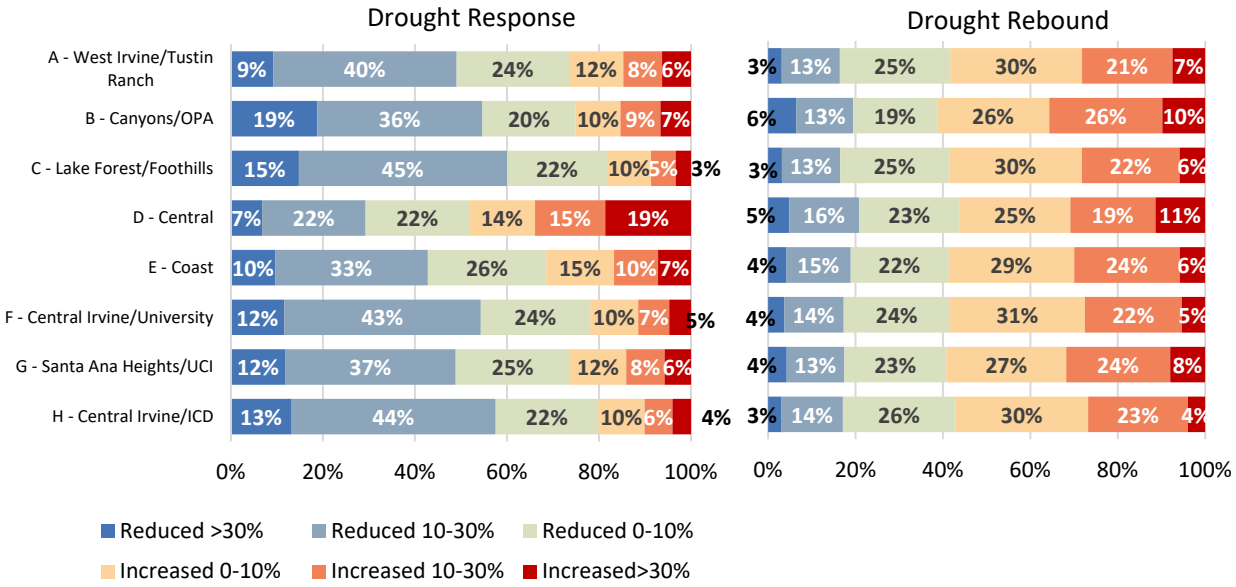
Figure 8-2c
Summary of Drought Response and Rebound by SFR SPs

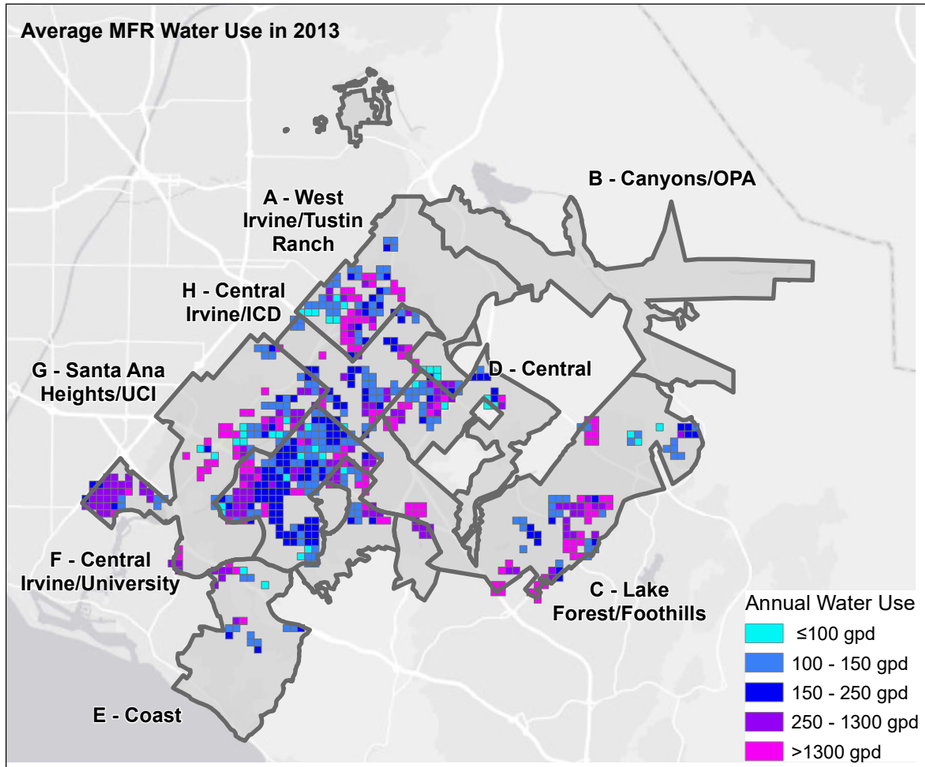


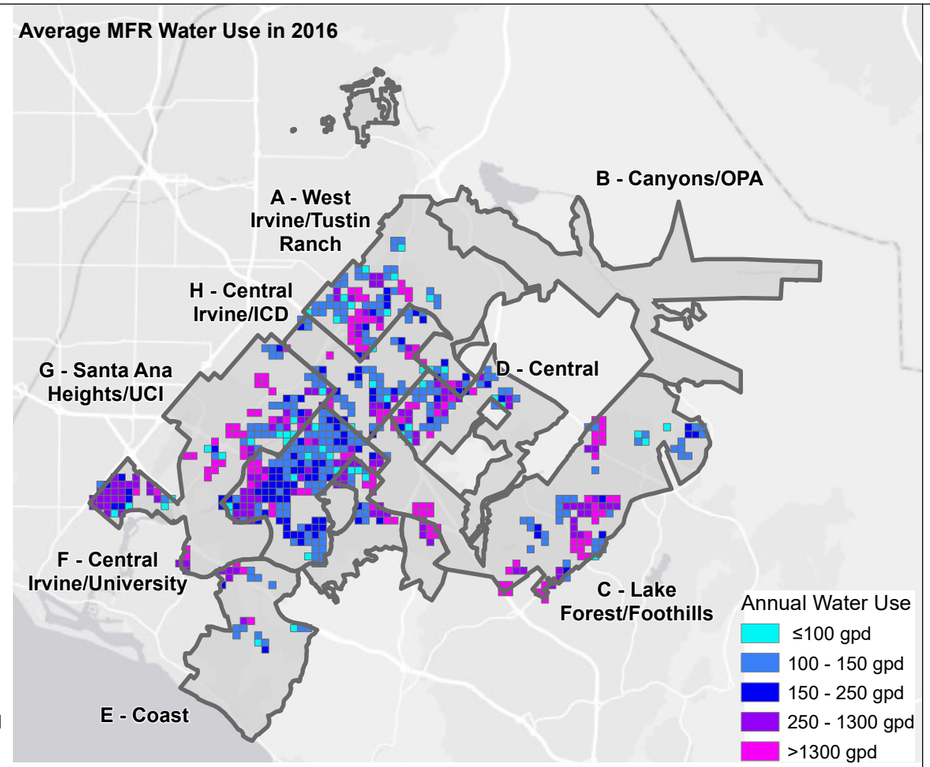
8.1.2. Multi-Family Residential

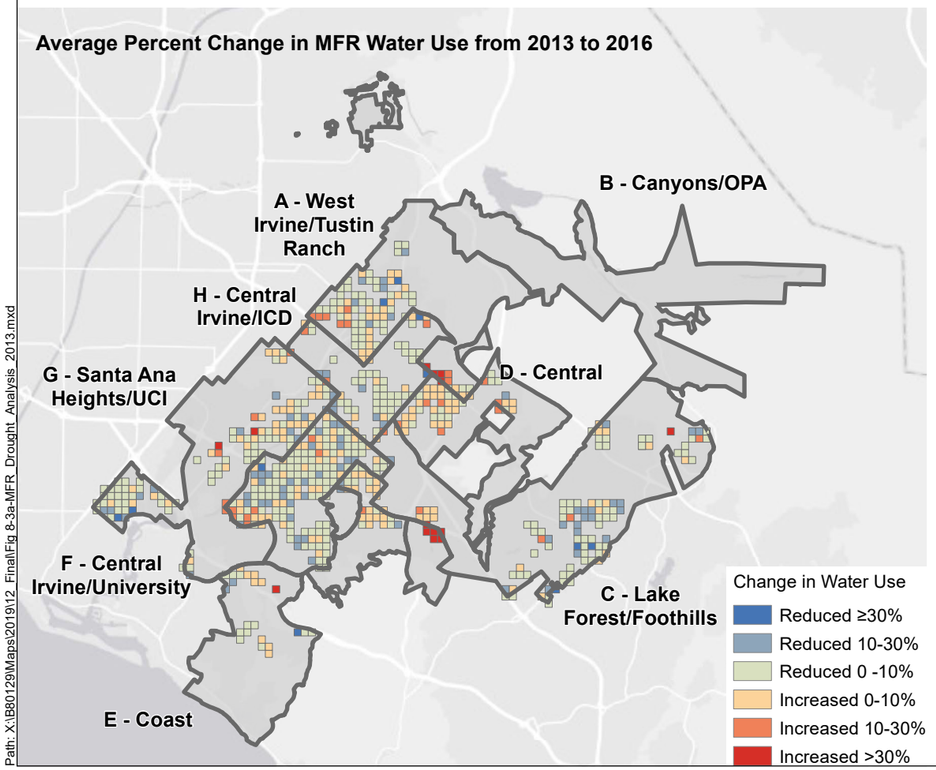
Drought response and drought rebound by MFR SPs are shown in **Figures 8-3a** and **8-3b**, respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-3c** below.

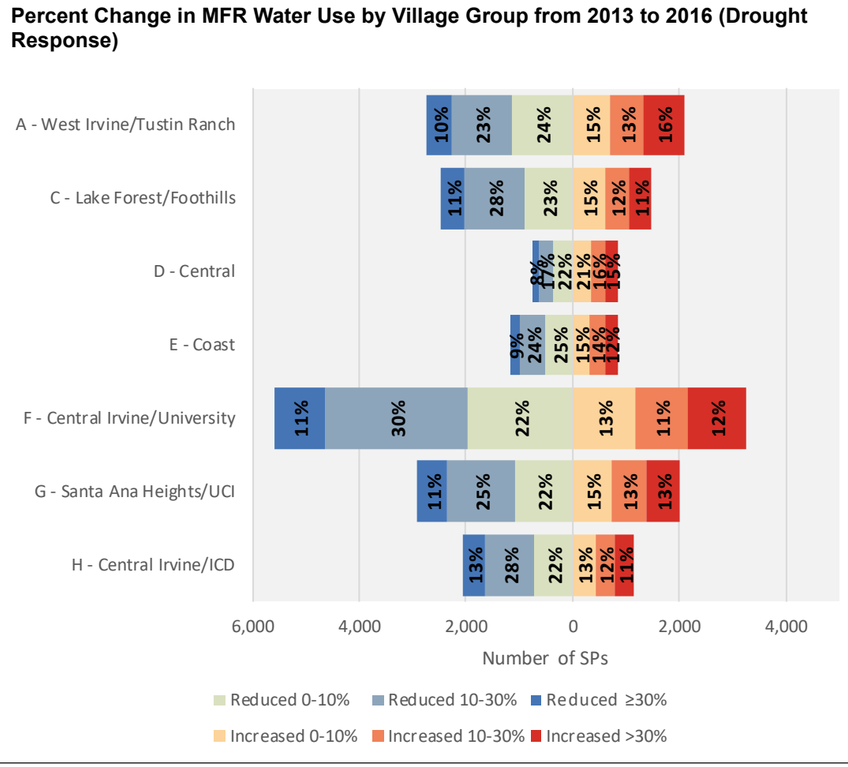
Sixty percent of MFR SPs decreased their water use during the drought. Nearly 40% of SPs decreased their water use by at least 10%, and about 11% of the SPs decreased their water use by more than 30% between 2013 and 2016. Compared to SFR customers, MFR customers demonstrated less water conservation in response to the drought, which is consistent with the idea that a lot of drought savings occurs from a reduction in outdoor irrigation water use. However, despite having limited outdoor space and irrigation needs, the majority of MFR customers demonstrated the ability to reduce their water use during the drought most likely due to behavioral changes. On the other hand, 40% of MFR customers increased their water use, including 13% that substantially increased usage, by over 30%.

Following the drought, approximately half of MFR SPs increased their water usage, and half decreased their water usage, showing overall less rebound than SFR SPs. As with SFR customers, MFR customers in the Central Village Group demonstrated less water savings than those in other Village Groups. Since many MFR customers have a separate meter for landscape irrigation, the water savings calculated here does not reflect the total outdoor water savings. Following the drought, a higher proportion of MFR customers in the Central Village Group have increased their water use than in other Village Groups.









Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
MFR = multi-family residential
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Response by MFR SPs (2013-2016)

Irvine Ranch Water District

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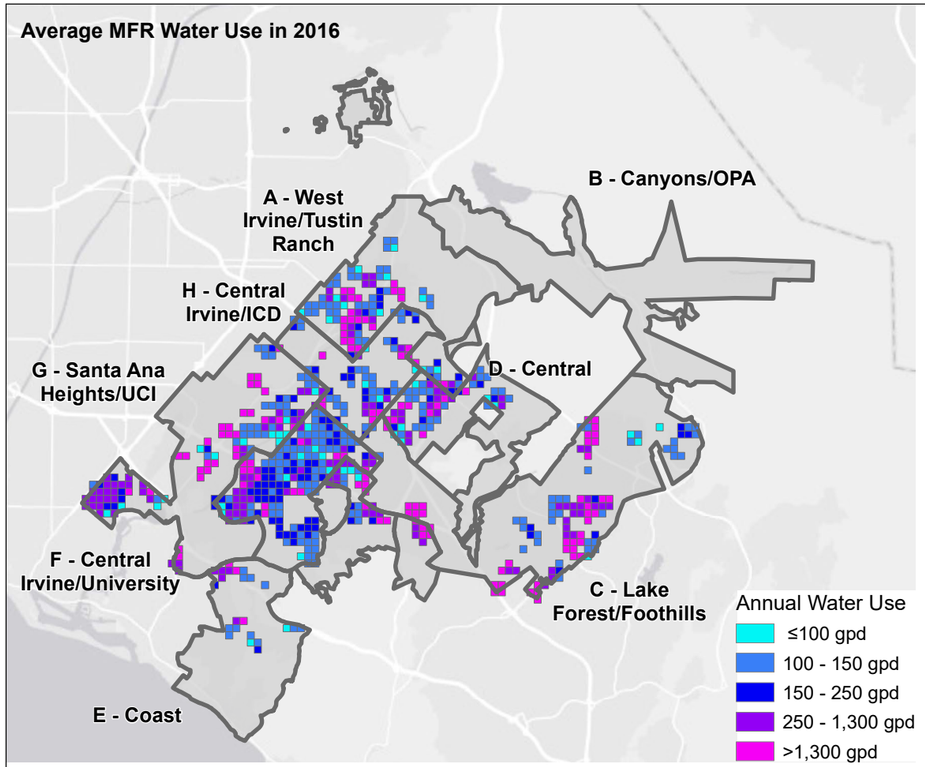
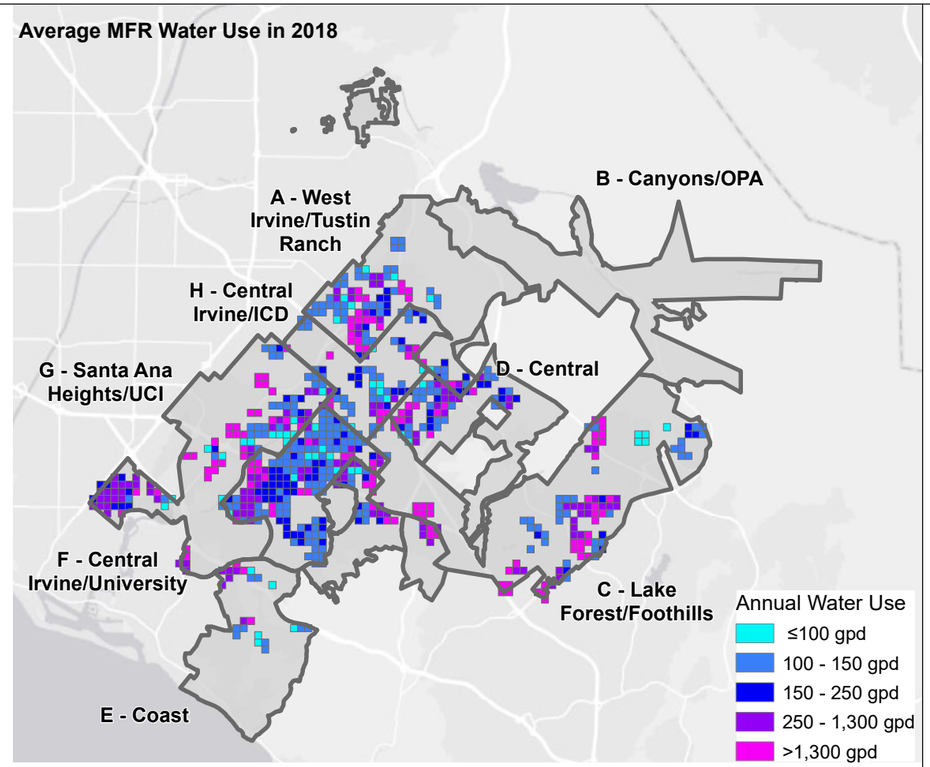
Figure 8-3a

Path: X:\B80129\Maps\2019\12_FinalFig 8-3a-MFR_Drought_Analysis_2013.mxd





Legend

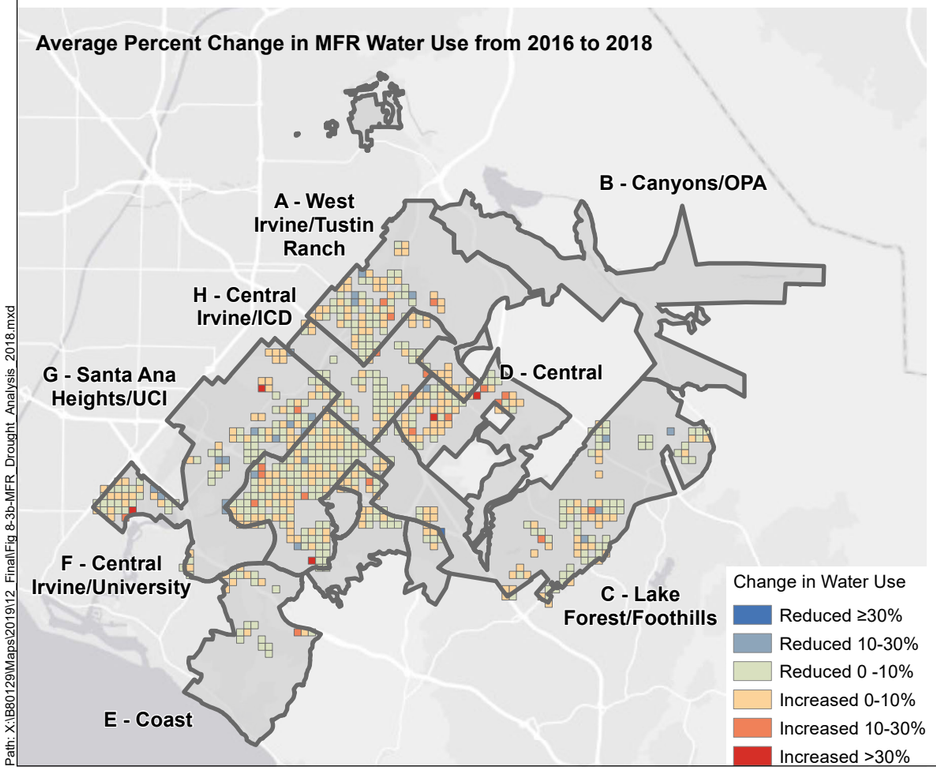
Village Group Boundaries

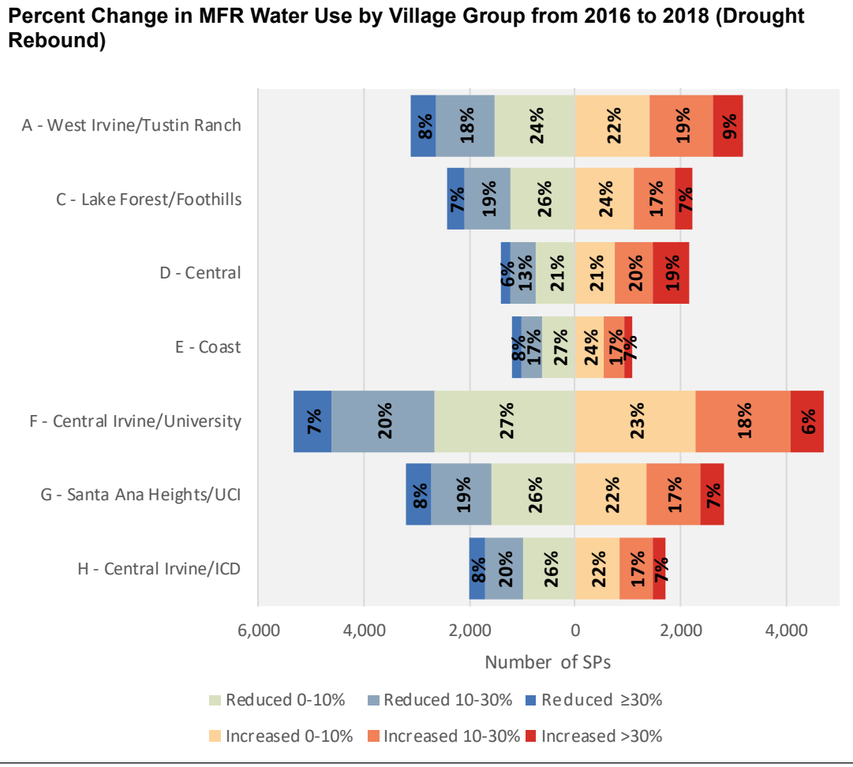
Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
MFR = multi-family residential
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.





Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Rebound by MFR SPs (2016-2018)

Irvine Ranch Water District

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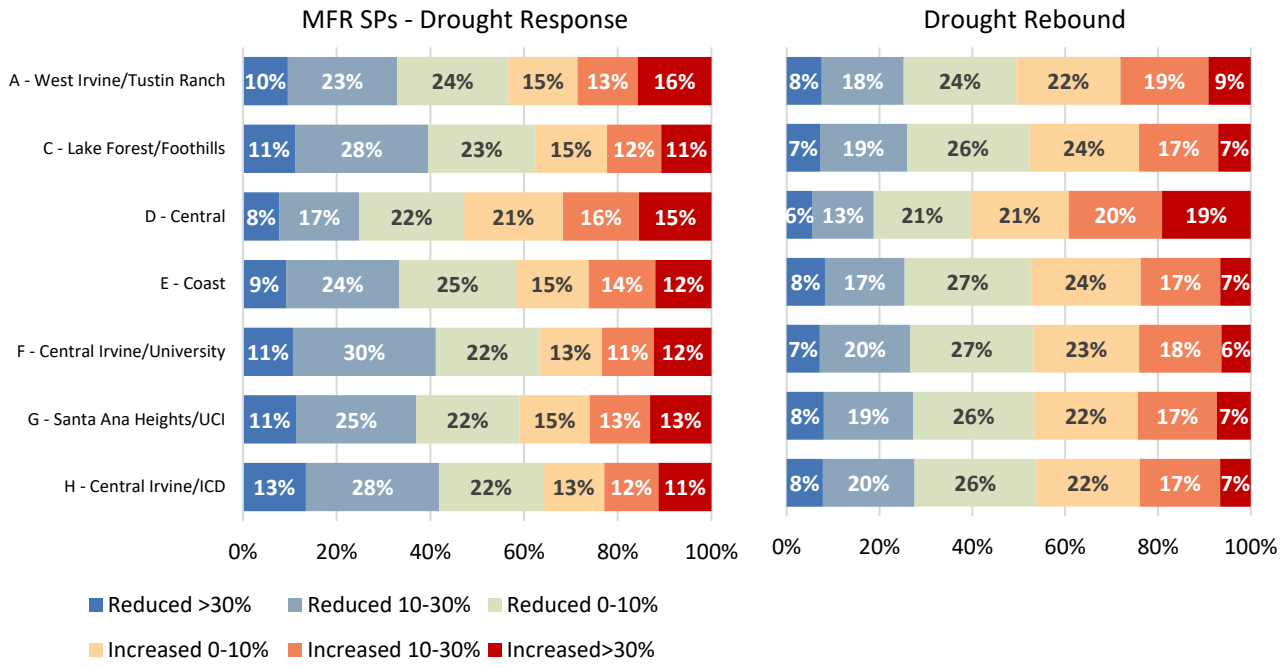
B80129.00
Figure 8-3b

Path: X:\B80129\Maps\2019\12_FinalFig 8-3b-MFR_Drought_Analysis_2018.mxd

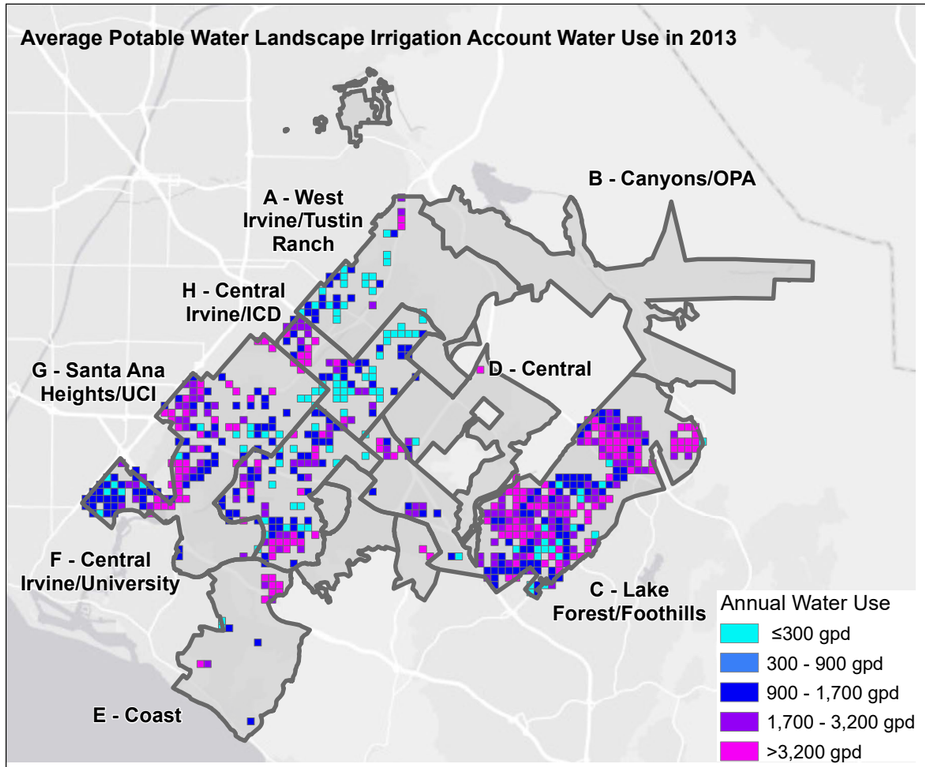
Figure 8-3c
Summary of Drought Response and Rebound by MFR SPs

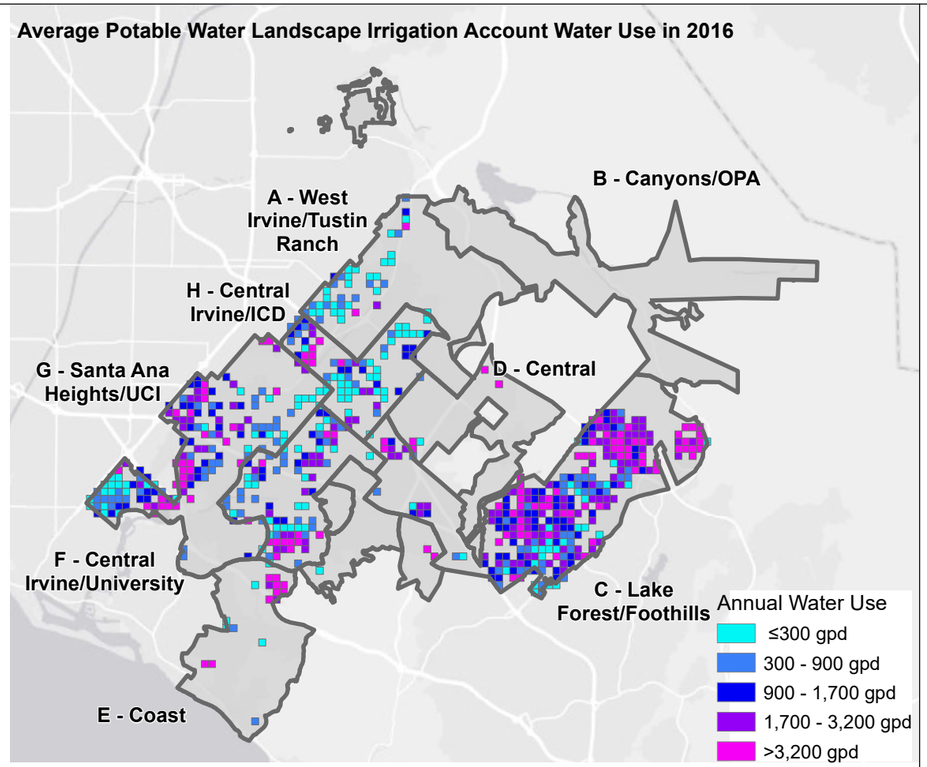


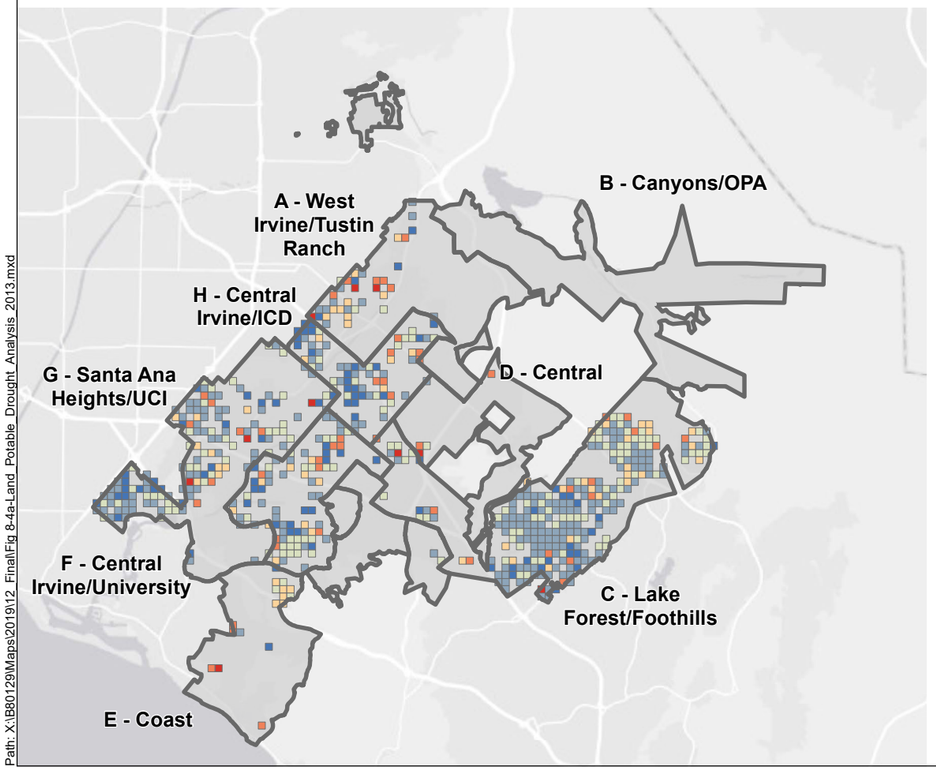
8.1.3. Landscape Irrigation, Potable Water

Drought response and drought rebound by potable landscape irrigation SPs are shown in **Figures 8-4a** and **8-4b** respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-4c** below.

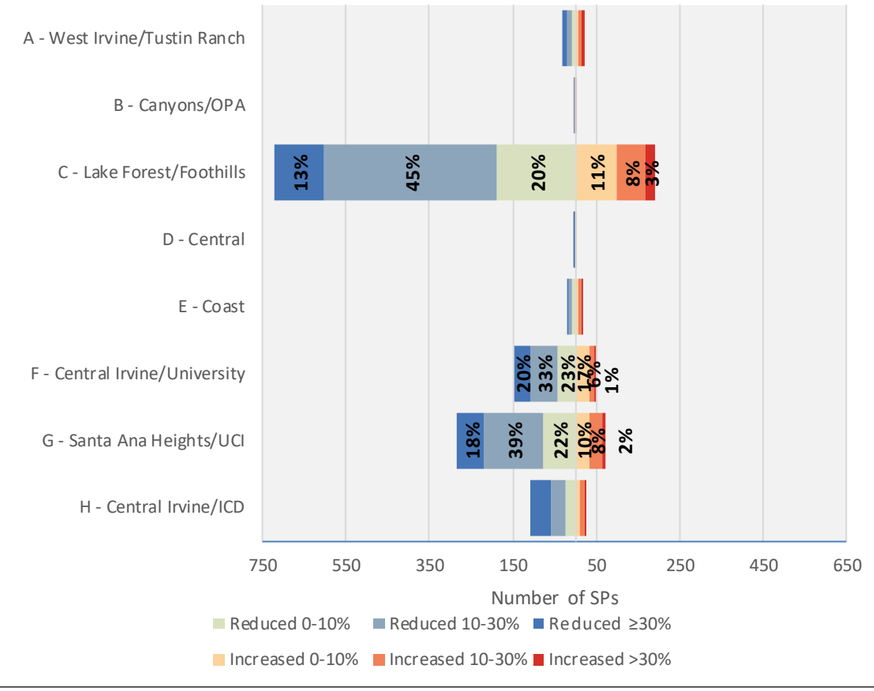
Overall, 78% of potable landscape irrigation customers decreased their water use during the drought, and 17% decreased use by more than 30%. Approximately 80% of potable landscape irrigation customers decreased their water use between 2013 and 2016 in the Lake Forest/Foothills, Central Irvine/University, Santa Ana Heights/UCI, and Central Irvine/ICD Village Groups, and these areas contained many customers. In contrast, less than 60% of the customers decreased their water use in the West Irvine/Tustin Ranch and Coast Village Groups, although it should be noted that these two Village Groups include few potable landscape irrigation SPs compared to the other areas.







Percent Change in Landscape Irrigation Potable Water Use by Village Group from 2013 to 2016 (Drought Response)



Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Response by Potable Water Landscape Irrigation Accounts (2013-2016)

Irvine Ranch Water District
December 2019
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Figure 8-4a

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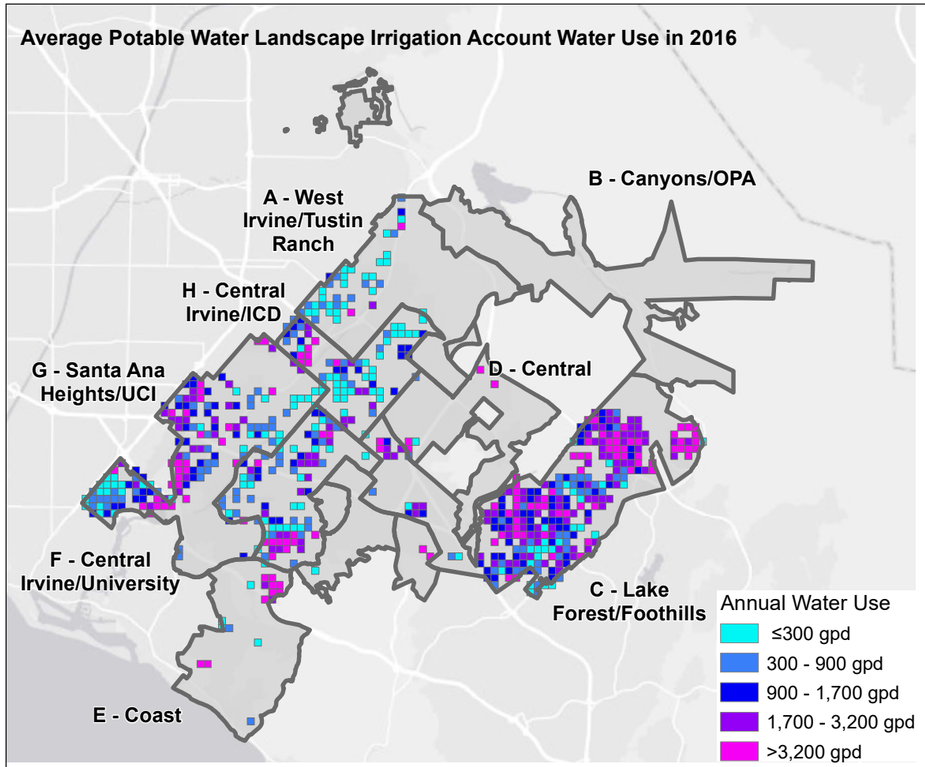
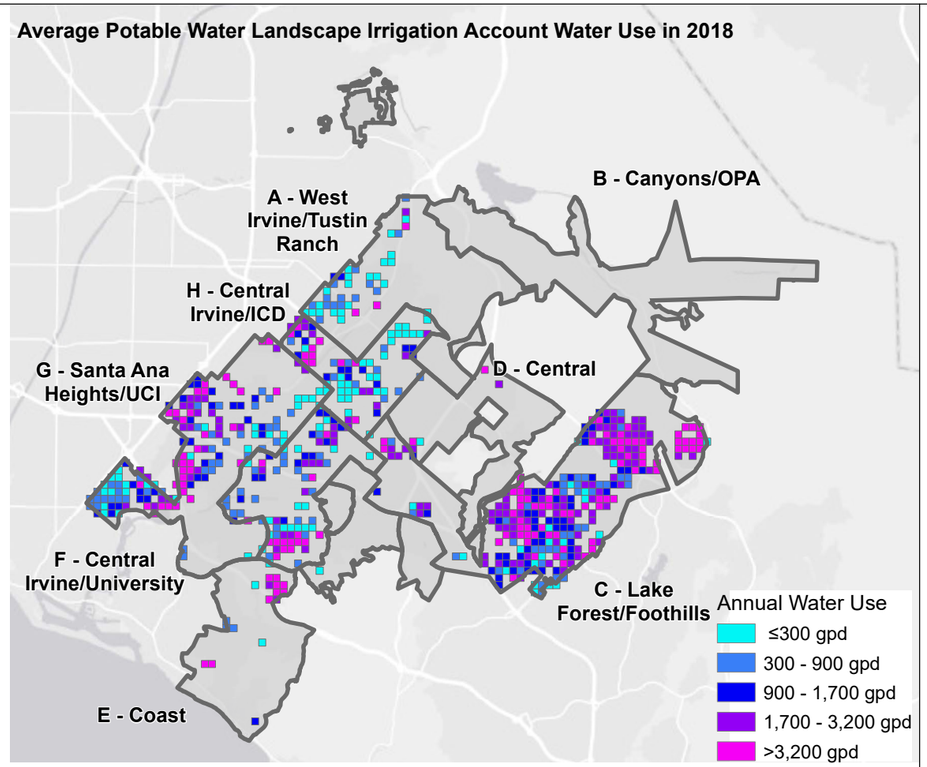
Path: X:\B80129\Maps\2019\12_Final\Fig 8-4a-Land_Potable_Drought_Analysis_2013.mxd





Legend

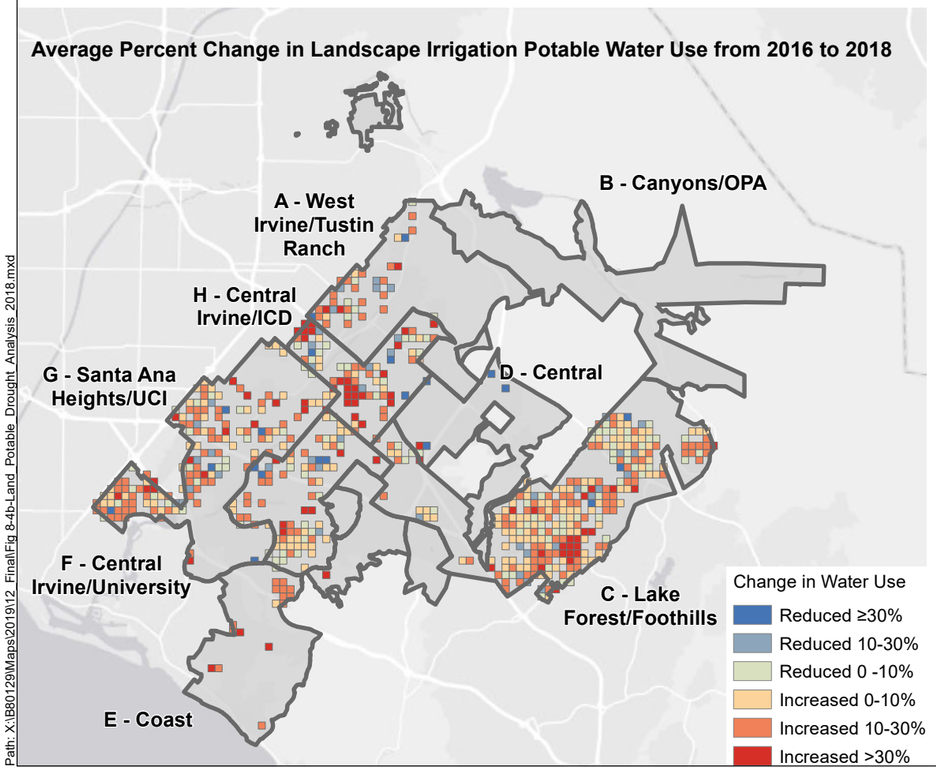
Village Group Boundaries

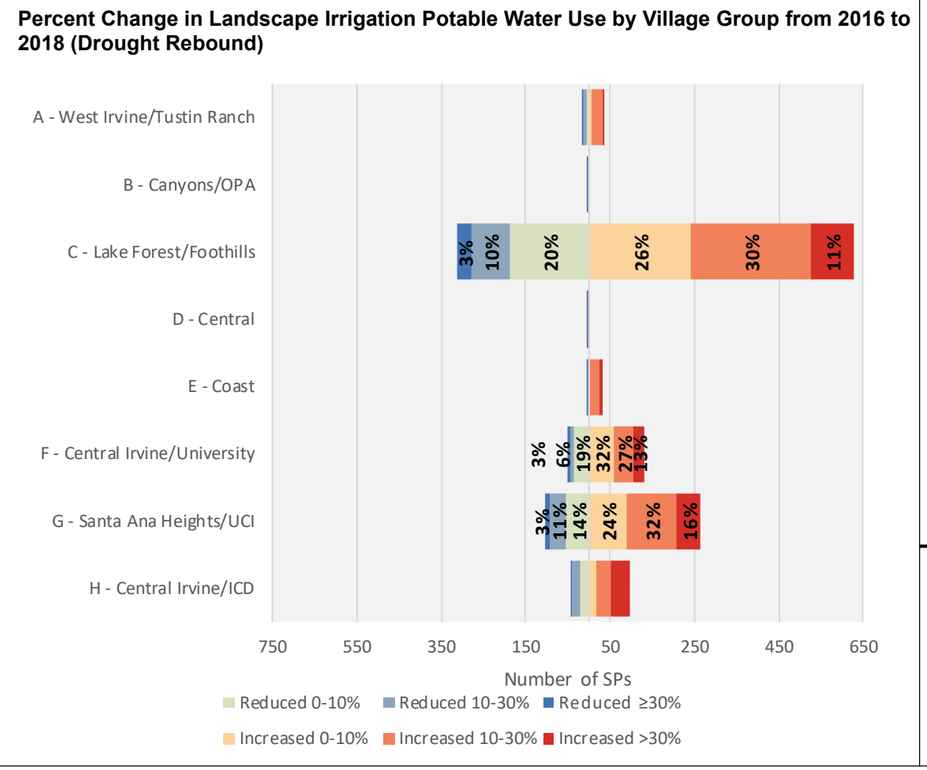
Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.





Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Rebound by Potable Water Landscape Irrigation Accounts (2016-2018)

Irvine Ranch Water District
December 2019
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Figure 8-4b

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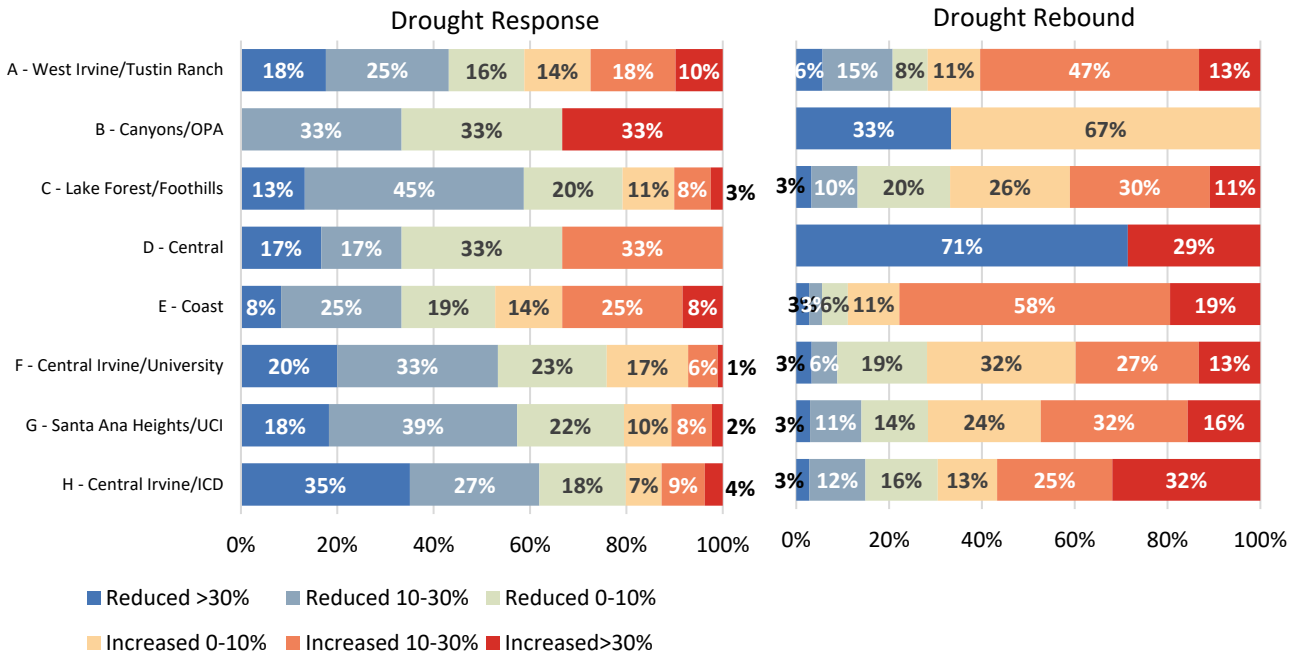
Path: X:\B80129\Maps\2019\12_Final\Fig 8-4b-Land_Potable_Drought_Analysis_2018.mxd

Figure 8-4c
Summary of Drought Response and Rebound by Potable Landscape Irrigation SPs



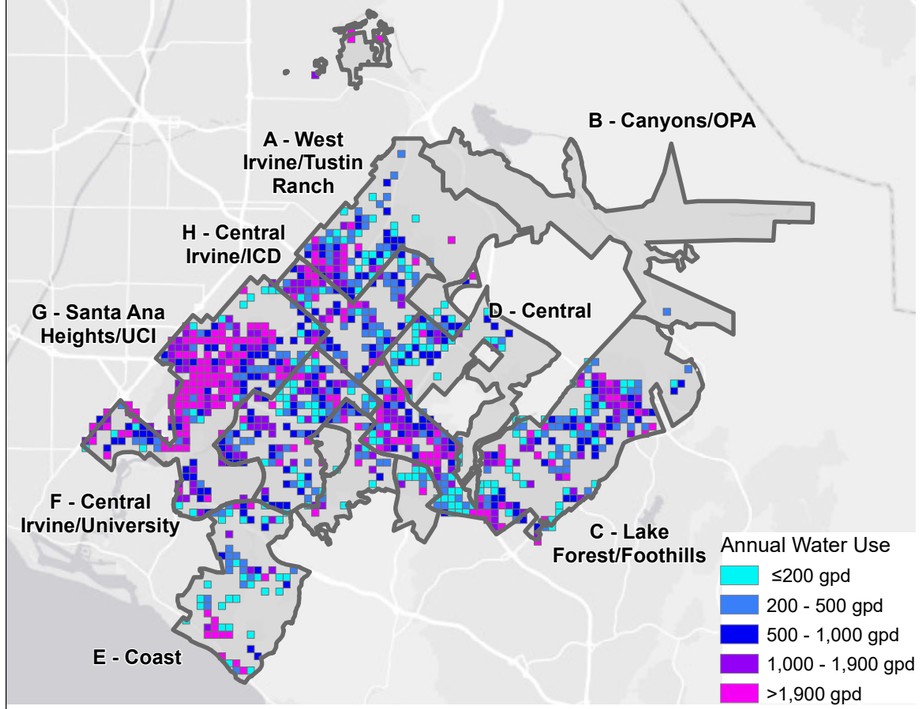
Following the drought, about 70% of potable landscape irrigation customers have increased their water use, and 14% have increased it by more than 30%. The vast majority (75%) of potable landscape irrigation SPs are located in the Lake Forest/Foothills and Santa Ana Heights/UCI Village Groups which demonstrated very similar rates of drought reductions as rebound. As shown in the 2013 water use panel in **Figure 8-4a** and the 2018 water use panel in **Figure 8-4b**, drought use by the potable landscape irrigation customers is generally consistent pre- and post-drought. Therefore, drought rebound by potable landscape irrigation customers appears to be more complete than that of SFR and MFR customers, which may have been driven by the fact that water budgets for irrigation accounts were reduced during the drought, and then adjusted post-drought.

8.1.4. Commercial

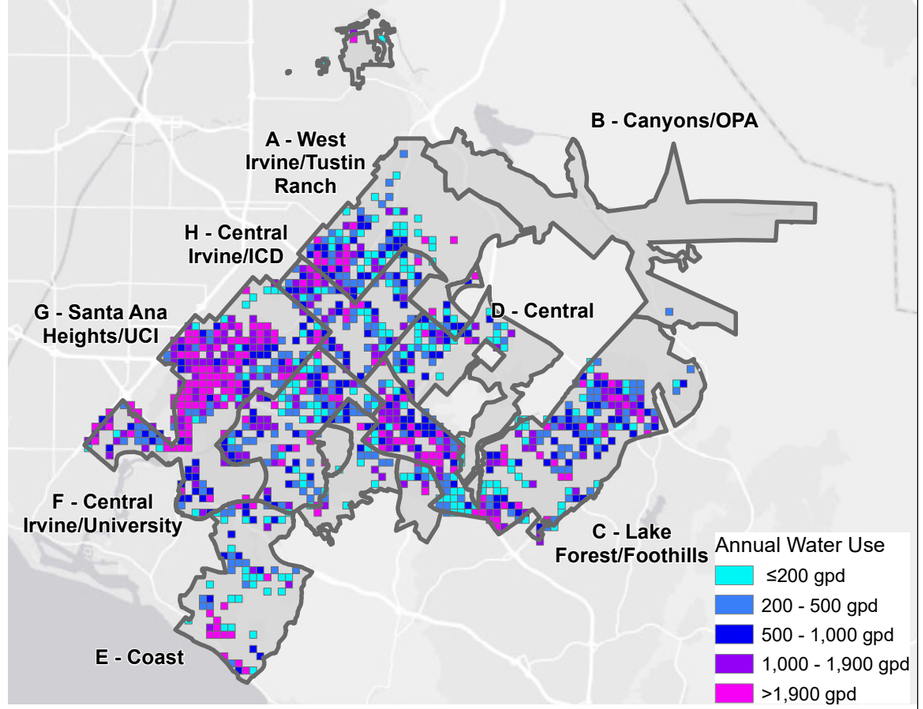
Drought response and drought rebound by commercial SPs are shown in **Figures 8-5a** and **8-5b**, respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-5c** below.

About half of the commercial customers increased their water use during the drought and half decreased their water use. This rather symmetrical distribution of responses suggests that water use within the commercial sector was generally not affected by the drought. It should be noted that IRWD drought messaging and outreach focused on the residential sector and outdoor irrigation, and did not include specific efforts focused on the commercial sector. While widespread media attention related to the drought likely meant that the employees within the commercial sector were exposed to at least some drought messaging, the fact that there was not a reduction in water use by most commercial customers

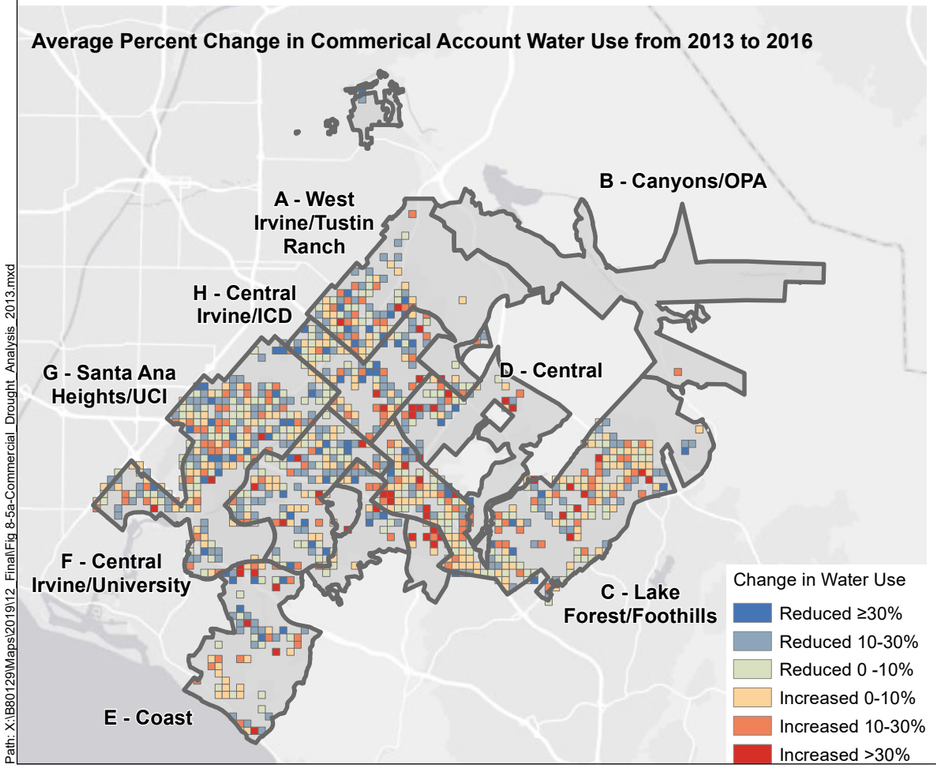
Average Commerical Account Water Use in 2013



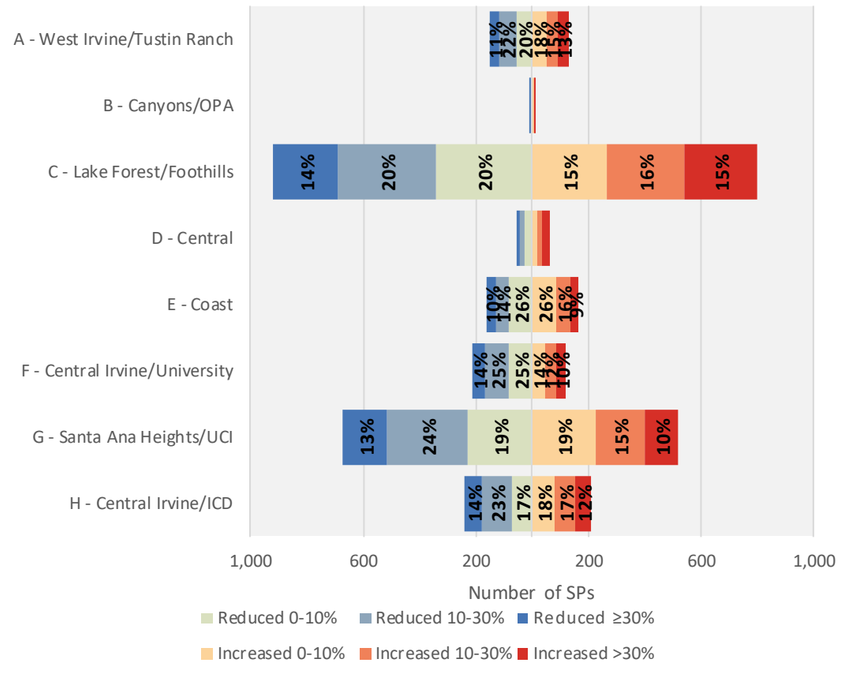
Average Commercial Account Water Use in 2016



Average Percent Change in Commerical Account Water Use from 2013 to 2016



Percent Change in Commerical Account Water Use by Village Group from 2013 to 2016 (Drought Response)



Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Response by Commerical Accounts (2013-2016)

Irvine Ranch Water District

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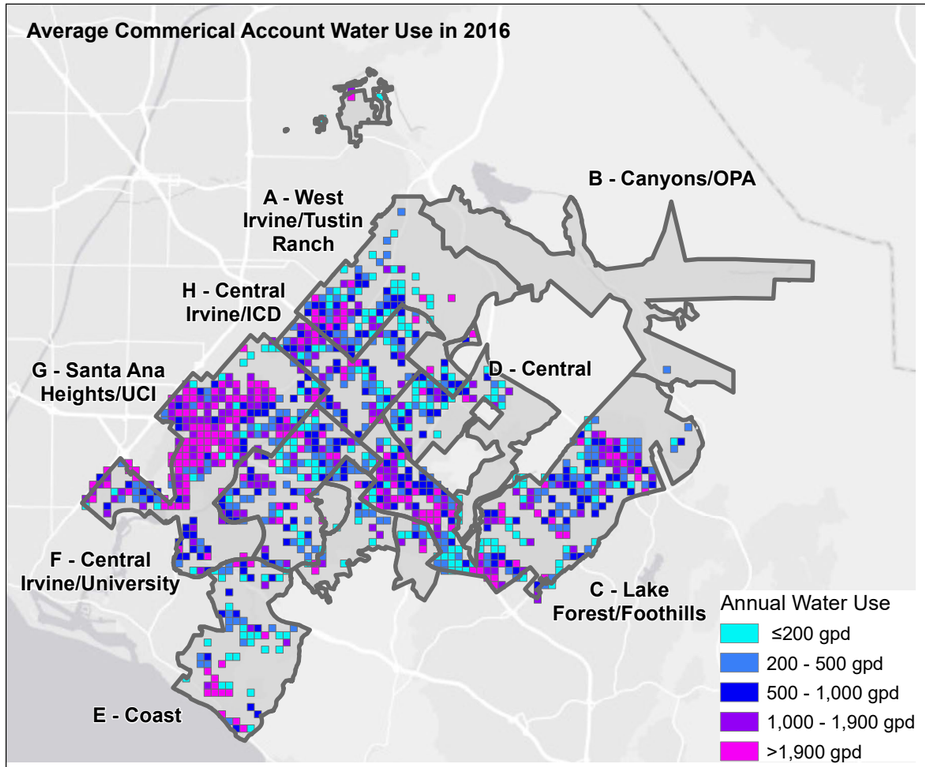
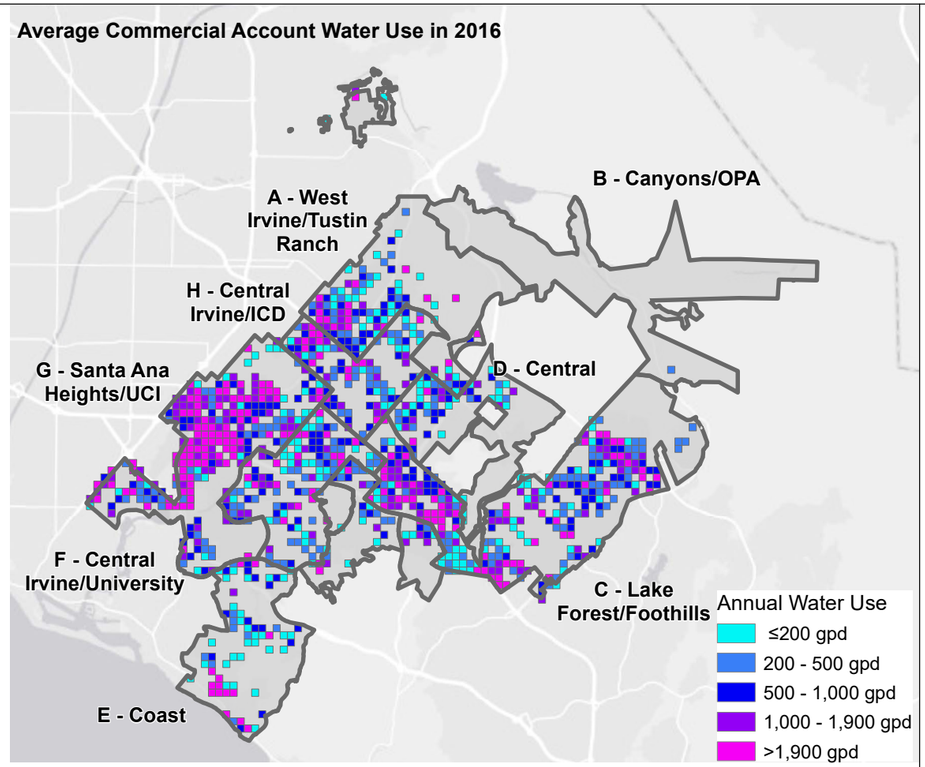
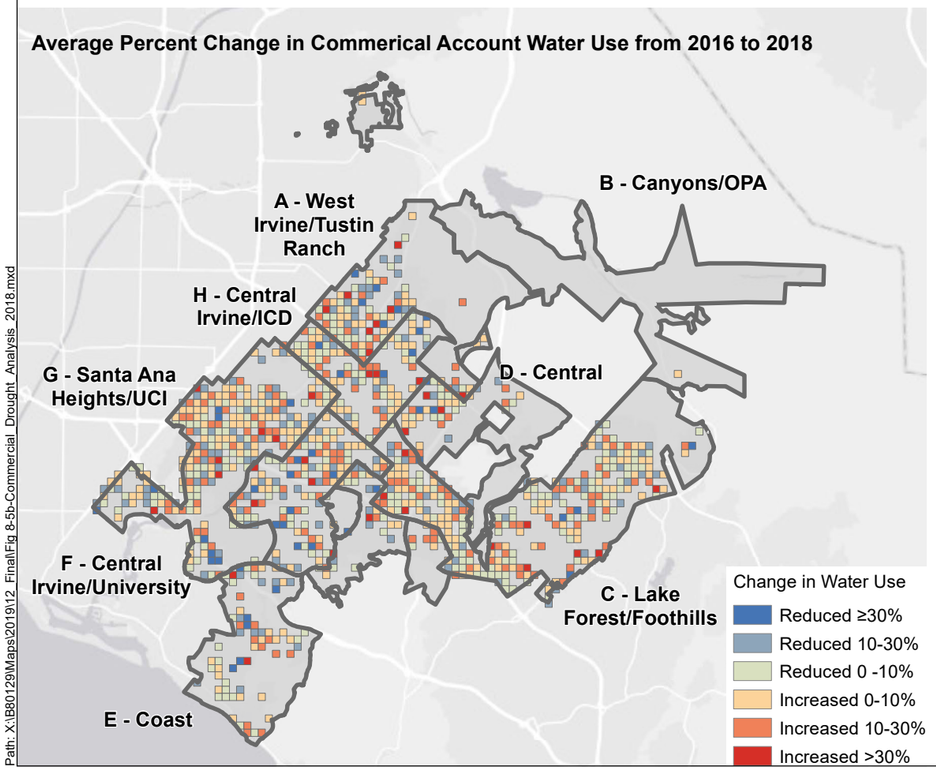
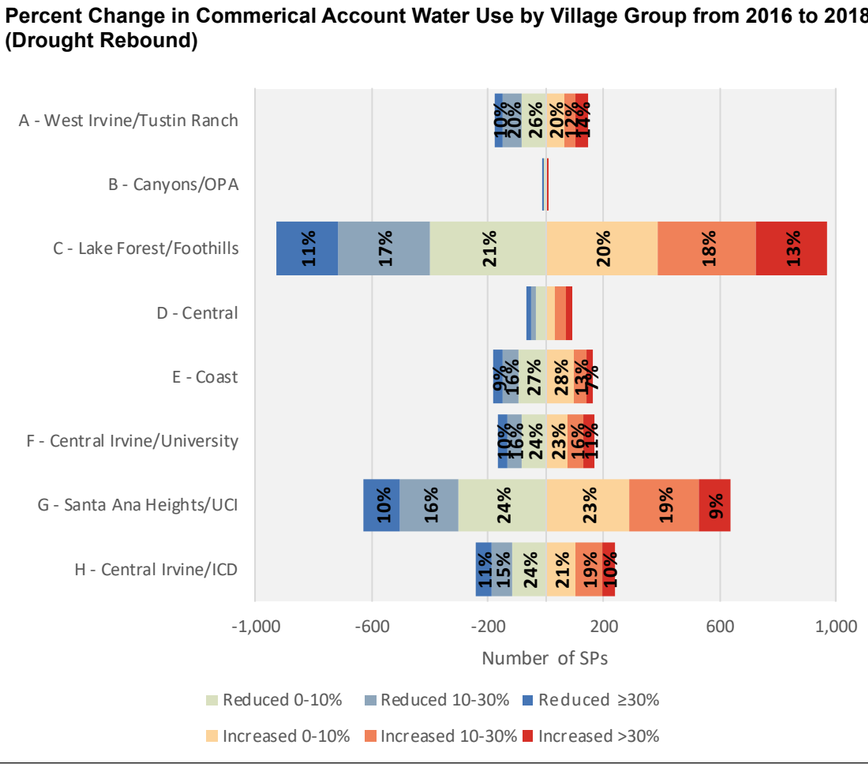
Figure 8-5a

Path: X:\B80129\Maps\2019\12_FinalFig 8-5a-Commercial_Drought_Analysis_2013.mxd









Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Rebound by Commerical Accounts (2016-2018)

Irvine Ranch Water District

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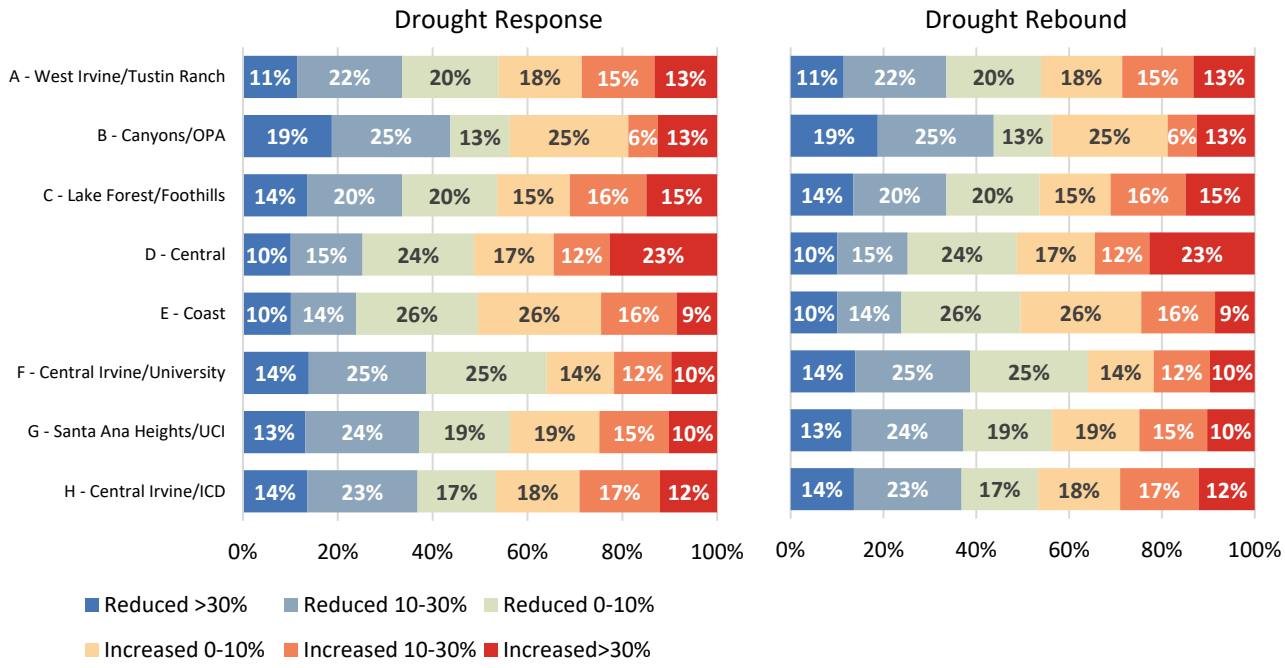
Figure 8-5b

Path: X:\B80129\Maps\2019\12_FinalFig 8-5b-Commercial_Drought_Analysis_2018.mxd

as a "natural" result of the general drought awareness suggests that commercial water use is fairly inelastic and primarily indoor only since the majority of outdoor water use is separately metered.

The results for the rebound period are very similar for the commercial sector, with about half of the commercial customers showing a decrease and half showing an increase in water use.

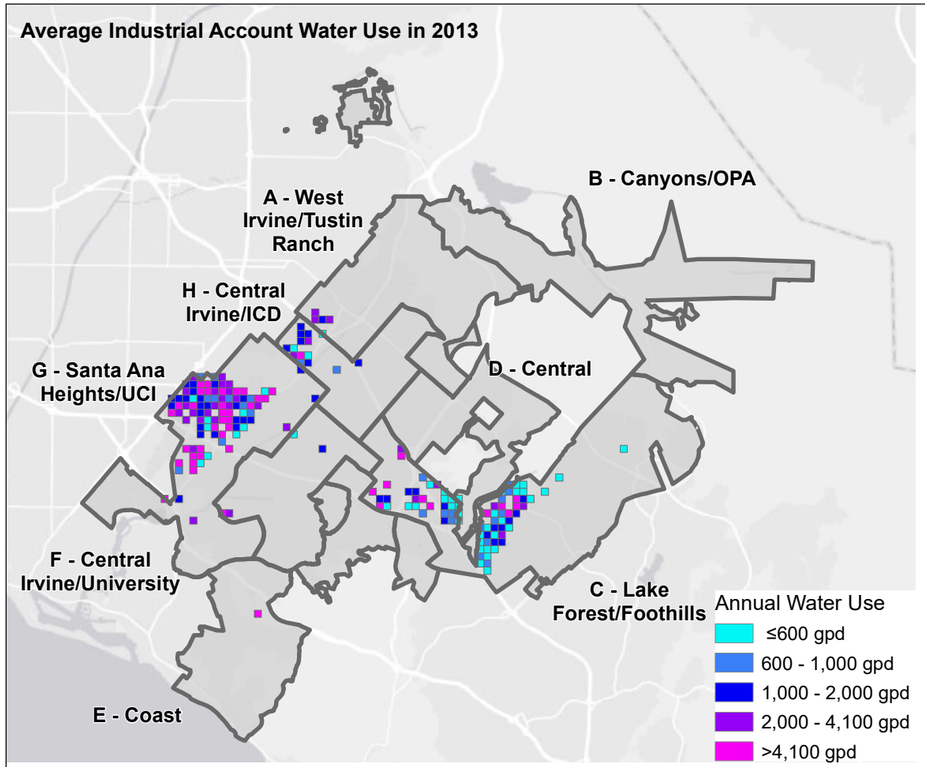
Figure 8-5c
Summary of Drought Response and Rebound by Commercial SPs

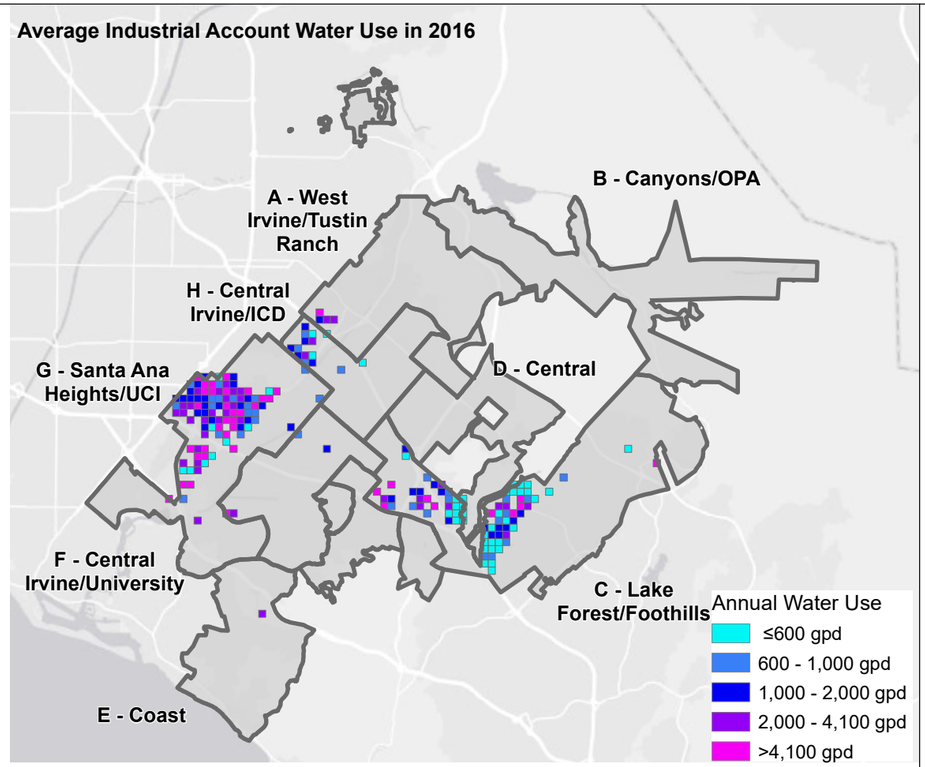


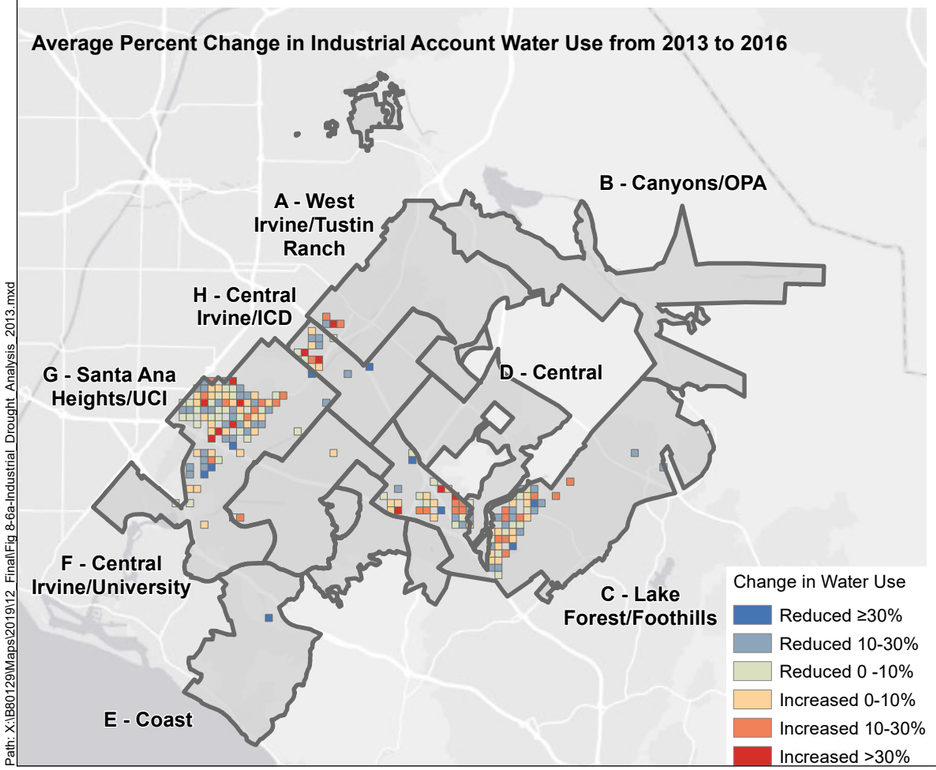
8.1.5. Industrial

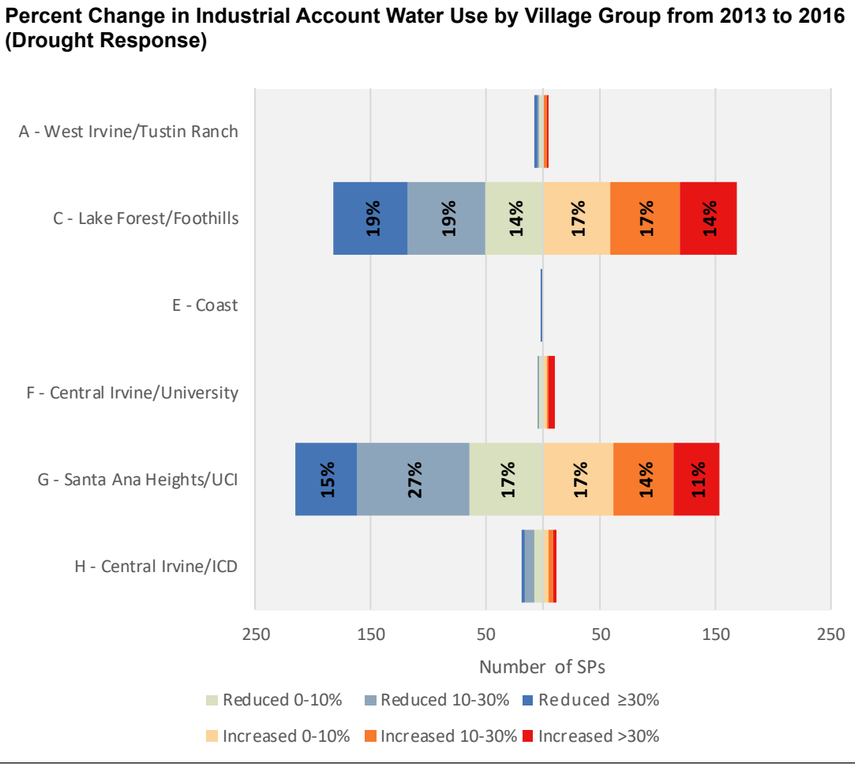
Drought response and drought rebound by industrial SPs are shown in **Figures 8-6a** and **8-6b**, respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-6c** below.

The majority (92%) of industrial SPs are located in the Lake Forest/Foothills and Santa Ana Heights/UCI Village Groups. As with the commercial sector, drought response and rebound by industrial SPs was very symmetrical, suggesting that there was little to no response to the drought among industrial customers. Also, like the commercial sector, water use by the industrial sector appears to be fairly inelastic during drought conditions and primarily indoor only since the majority of outdoor water use is separately metered.









Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

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(Scale in Miles)

Drought Response by Industrial Accounts (2013-2016)

Irvine Ranch Water District

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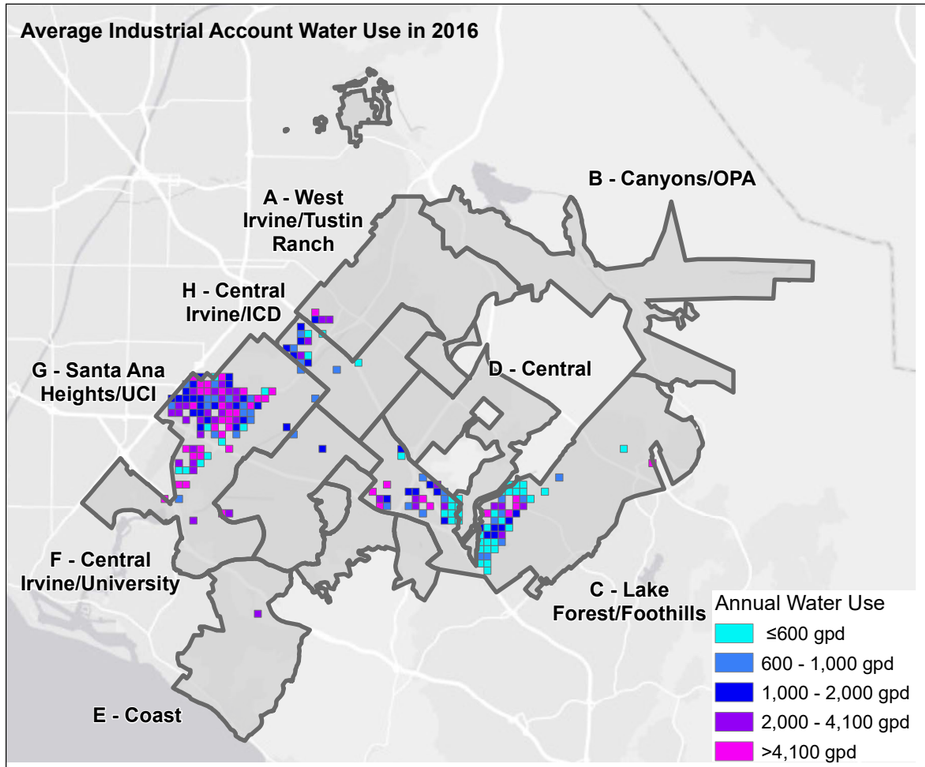
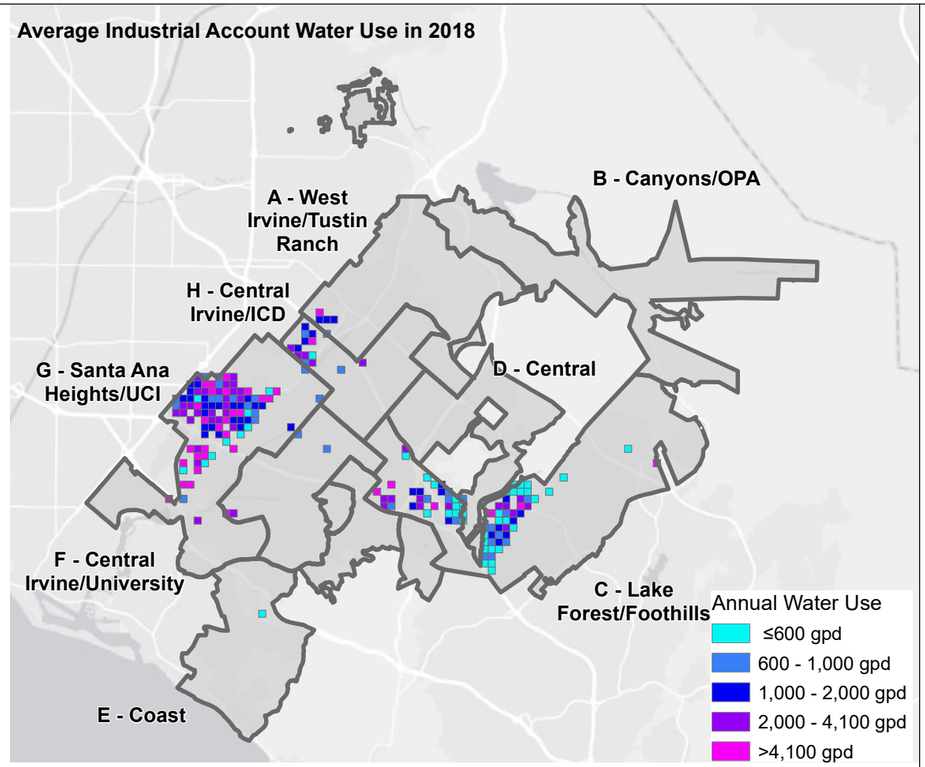
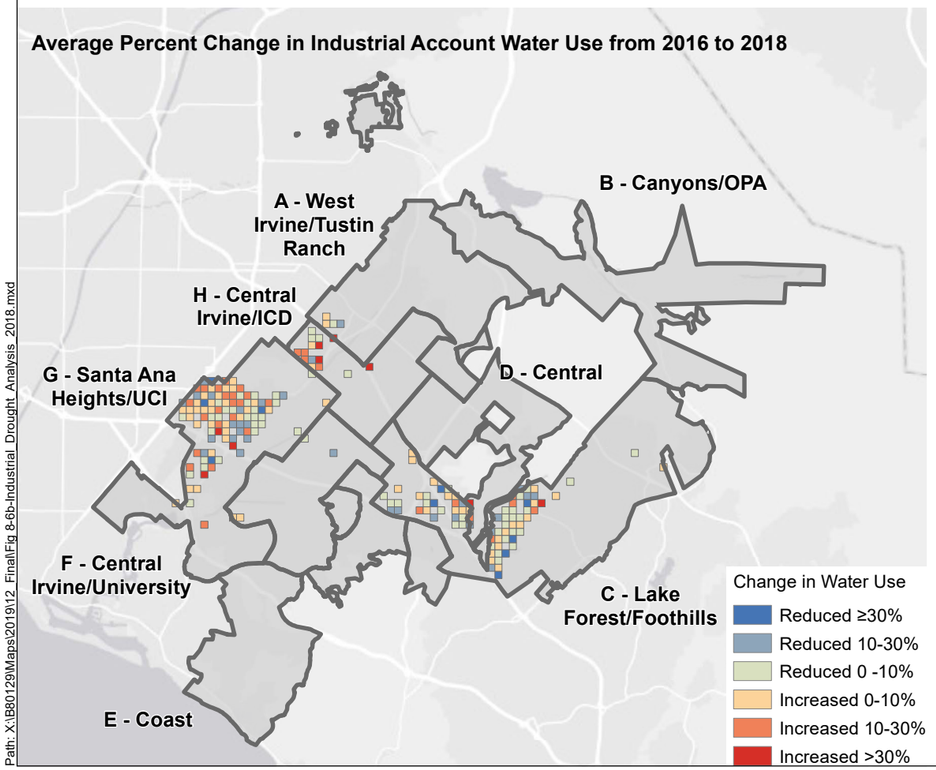
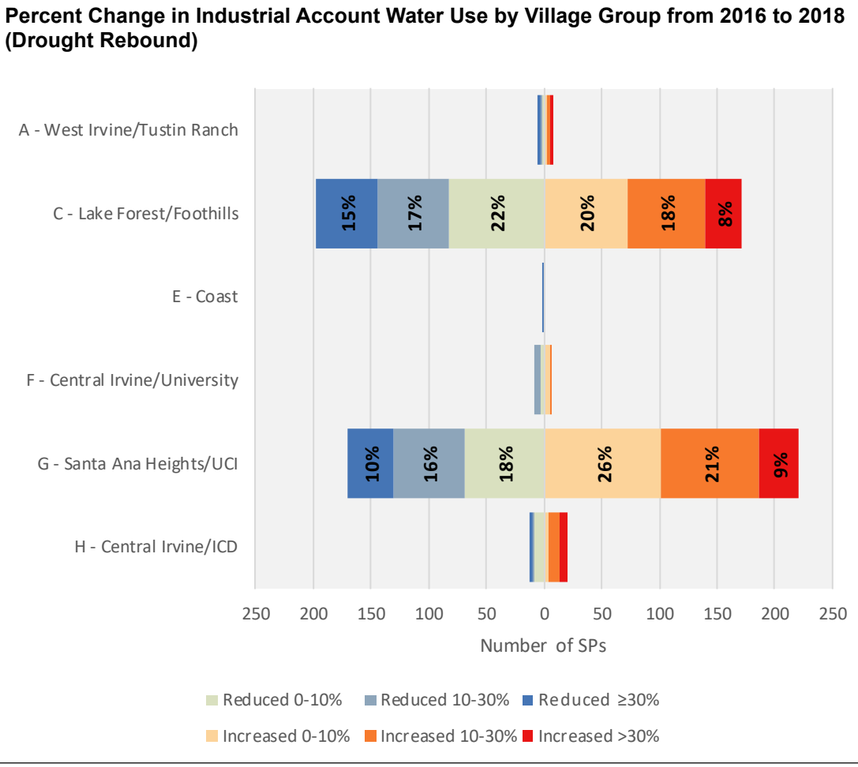
Figure 8-6a

Path: X:\B80129\Maps\2019\12_Final\Fig 8-6a-Industrial_Drought_Analysis_2013.mxd









Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

N

0 4 8

(Scale in Miles)

Drought Rebound by Industrial Accounts (2016-2018)

Irvine Ranch Water District

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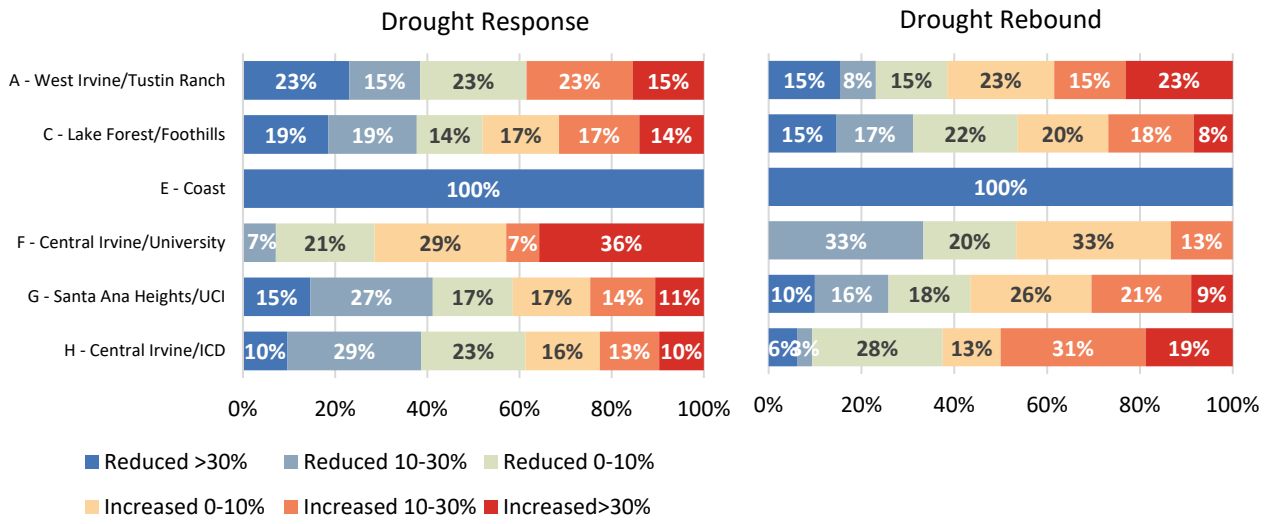
December 2019
B80129.00

Figure 8-6b

Path: X:\B80129\Maps\2019\12_Final\Fig 8-6b-Industrial_Drought_Analysis_2018.mxd

Figure 8-6c
Summary of Drought Response and Rebound by Industrial SPs

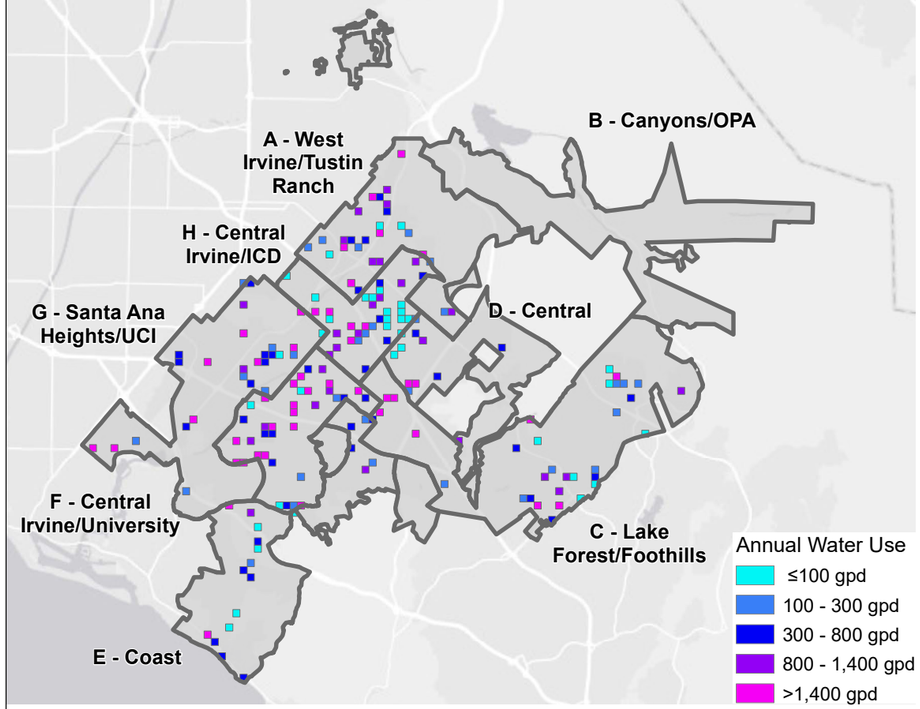


8.1.6. Institutional

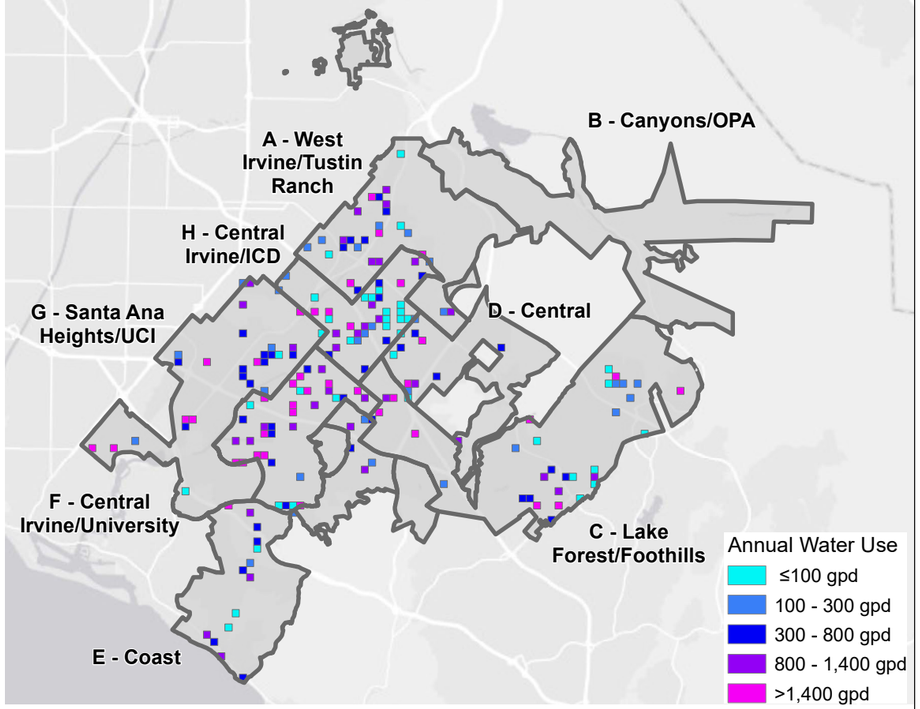
Drought response and drought rebound by institutional SPs are shown in **Figures 8-7a** and **8-7b**, respectively. A side by side comparison of these results by Village Group is presented in **Figure 8-7c** below.

The institutional sector is the smallest sector, with less than 300 SPs within the District, fairly evenly distributed between Village Groups. As with the commercial and industrial sectors, about half of SPs reduced their water use and half increased their water use during the drought. Following the drought, slightly more than half (55%) increased their water use. Water use by the institutional sector appears similarly inelastic during drought conditions.

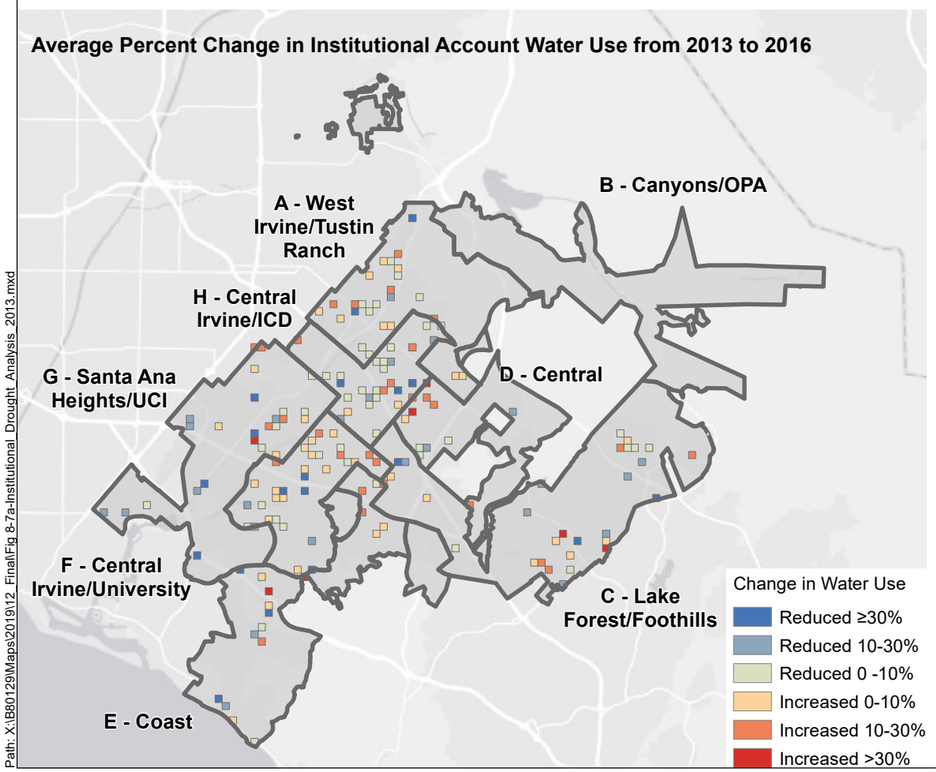
Average Institutional Account Water Use in 2013



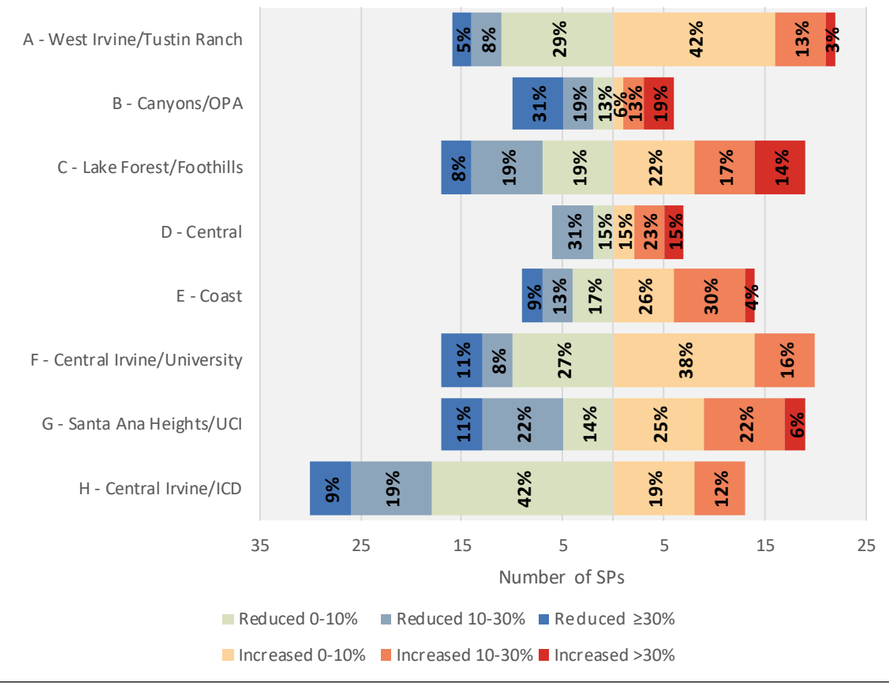
Average Institutional Account Water Use in 2016



Average Percent Change in Institutional Account Water Use from 2013 to 2016



Percent Change in Institutional Account Water Use by Village Group from 2013 to 2016 (Drought Response)



Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

N

0 4 8

(Scale in Miles)

Drought Response by Institutional Accounts (2013-2016)

Irvine Ranch Water District

eki environment & water

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Figure 8-7a

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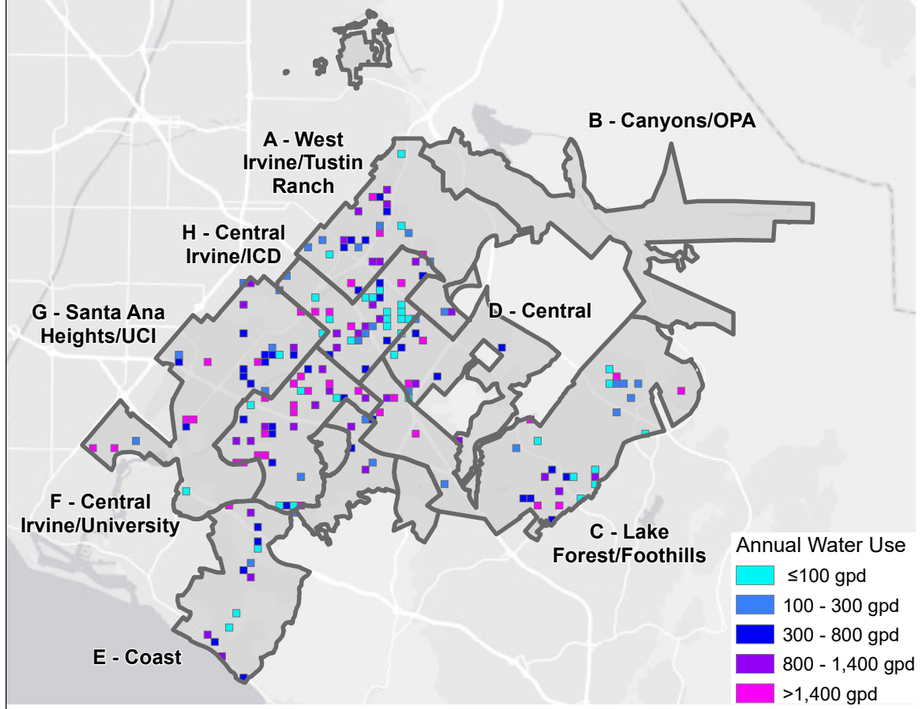
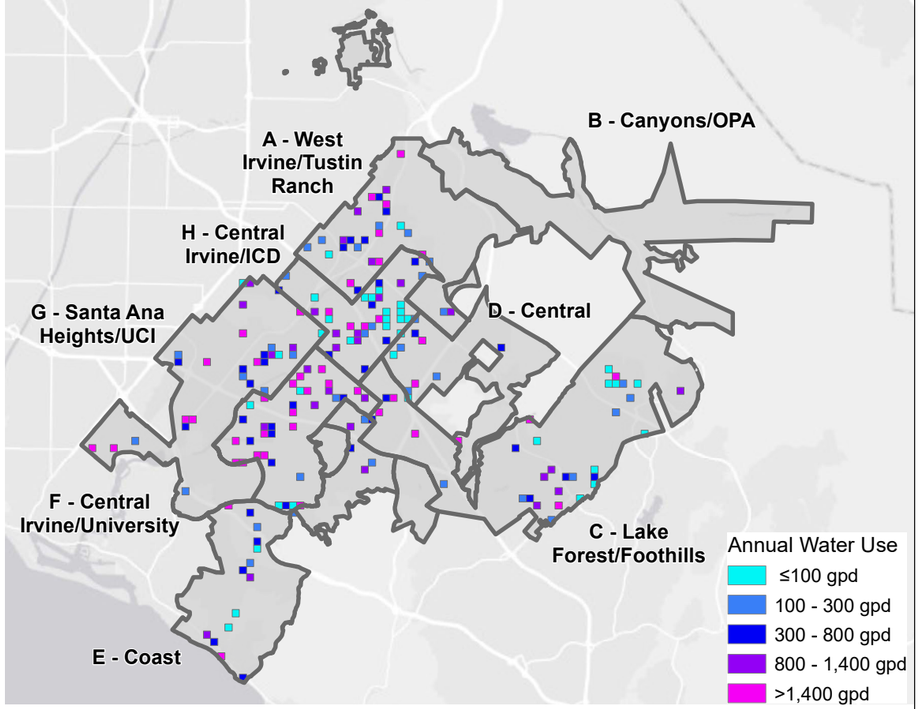
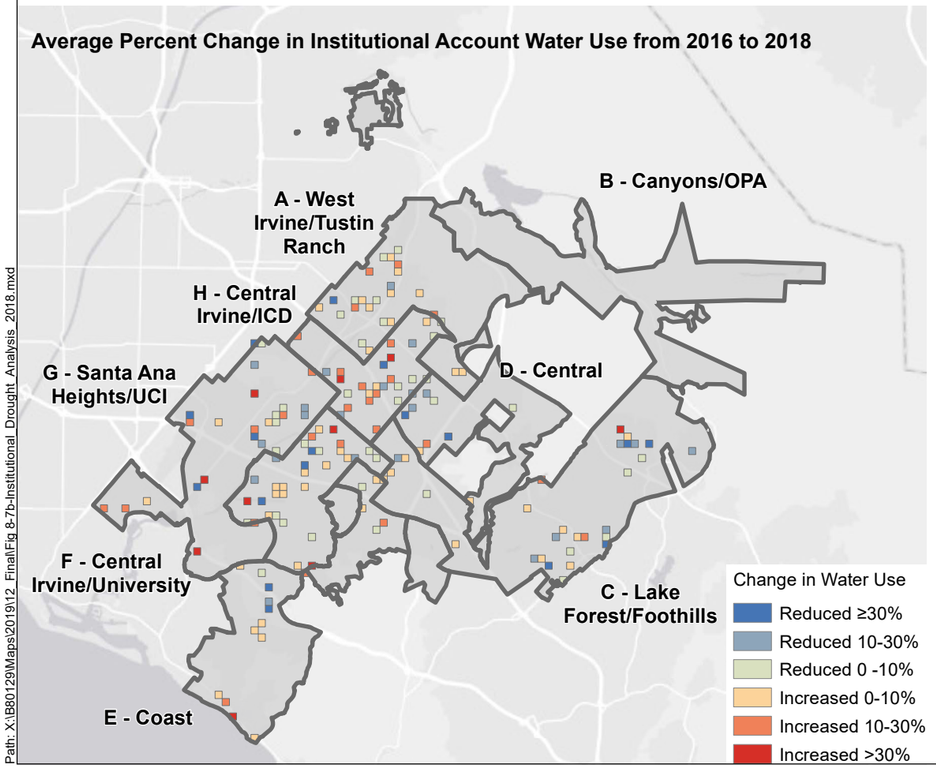
Average Institutional Account Water Use in 2016



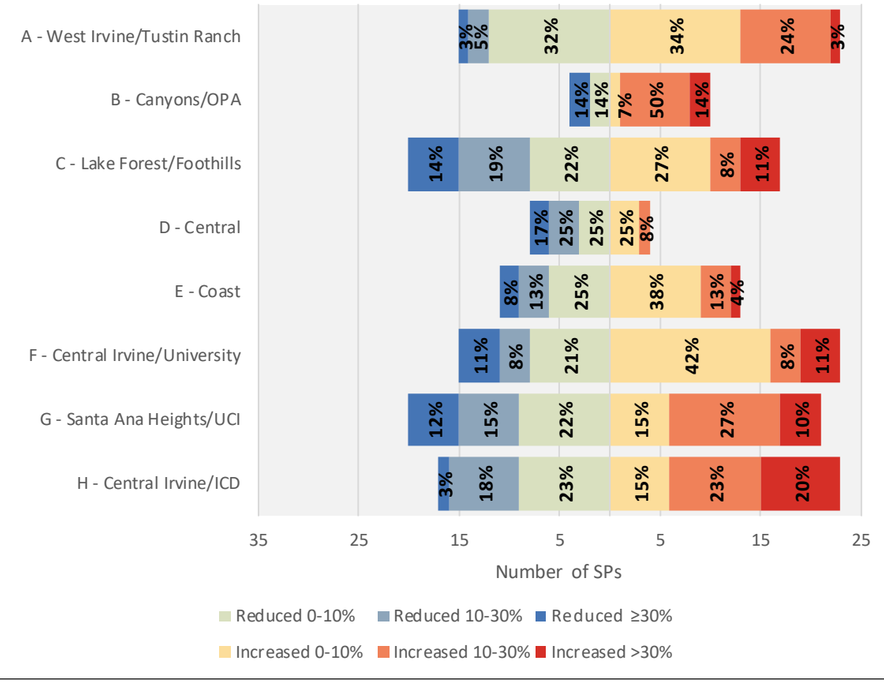
Average Institutionall Account Water Use in 2018



Average Percent Change in Institutional Account Water Use from 2016 to 2018



Percent Change in Institutional Account Water Use by Village Group from 2016 to 2018 (Drought Rebound)



Legend

Village Group Boundaries

Abbreviations

gpd = gallons per day
IRWD = Irvine Ranch Water District
SP = service point

Notes

1. All locations are approximate.
2. For purposes of visualizing and presenting these data, average annual water use is presented as the average water use of all SPs located within a grid cell and reported in gpd per SP. Grid size is 1,000 ft X 1,000 ft.

Sources

1. Water use data provided by IRWD.
2. Basemap provided by ESRI.

N

0 4 8
(Scale in Miles)

Drought Rebound by Institutional Accounts (2016-2018)

Irvine Ranch Water District

eki environment & water

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Figure 8-7b

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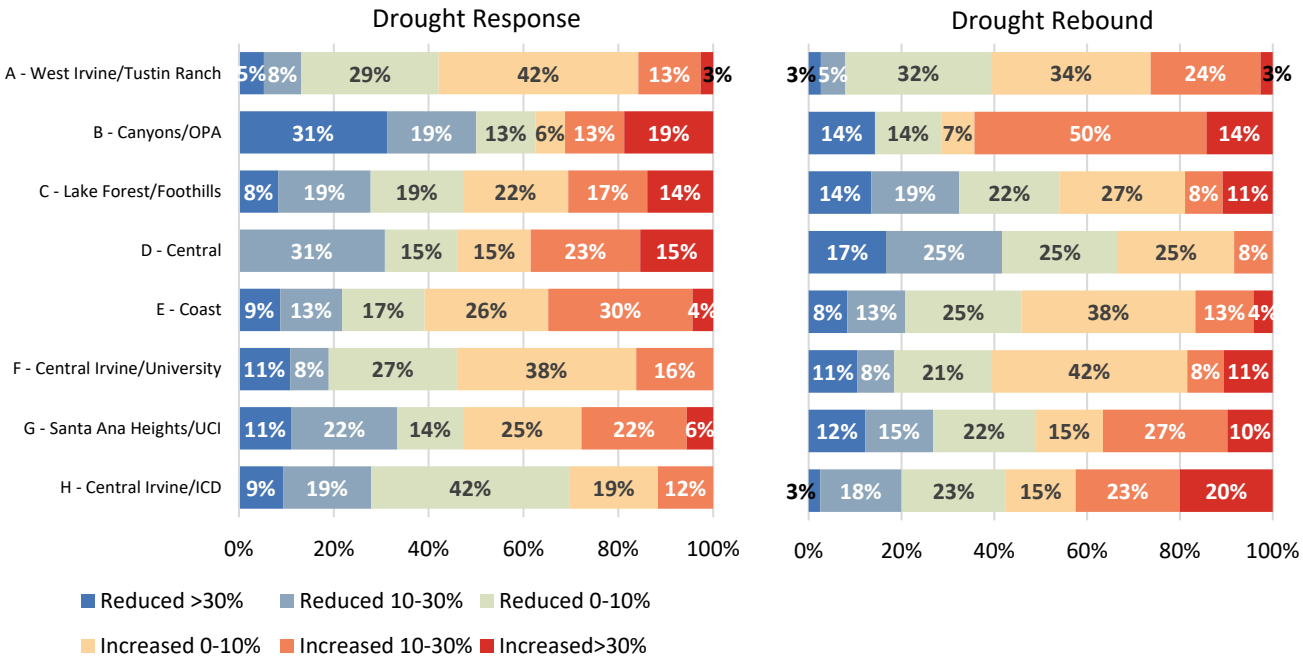
Figure 8-7c
Summary of Drought Response and Rebound by Institutional SPs



8.2. Drought Savings Scenario

As discussed above, most residential customers reduced their water use during the drought, but many have not fully rebounded to post drought conditions. This likely represents "demand hardening," and suggests that customers will not be able to conserve as much water in a future drought as they did in the 2013-2017 drought.

Potable landscape irrigation customers reduced their water use during the drought, but have rebounded more than residential customers. The CII sector, however, does not appear to have been substantially affected by the drought, despite the widespread awareness of drought conditions. In order to estimate the amount of potential savings achievable in a future drought, the change in water use from 2016 to 2018 for SFR, MFR, and potable landscape irrigation customer water use was analyzed. The amount of water use increase between 2016 and 2018 is identified as the estimated future drought savings potential.[84]

The results of this analysis are shown in **Table 8-1** below by Village Group. Based on this analysis, if drought outreach and messaging were conducted similar to that done in the 2013-2017 drought timeframe, it is estimated that approximately 15% water savings could be achieved in the SFR sector, 11% in the MFR

[84] The change in water use is calculated on a customer-by-customer basis. The change in water use for SPs that reduced their water use during this time period is excluded from this estimate. SPs that did not have any water use in 2016 and/or 2018 were excluded.

sector, and 19% in the landscape irrigation sector. This represents approximately 5,000 acre-feet of potential potable water drought conservation savings.

Table 8-1
Potential Future Drought Savings

Village Group	Increased Water Use Since 2016 (AFY)	Potential Future Drought Savings Relative to 2018 Water Use
Single-Family Residential		
A - West Irvine/Tustin Ranch	407	14%
B - Canyons/OPA	167	21%
C - Lake Forest/Foothills	596	14%
D - Central	271	19%
E - Coast	467	16%
F - Central Irvine/University	326	15%
G - Santa Ana Heights/UCI	331	17%
H - Central Irvine/ICD	495	14%
Total	**3,060**	**15%**
Multi-Family Residential		
A - West Irvine/Tustin Ranch	190	11%
C - Lake Forest/Foothills	221	10%
D - Central	207	13%
E - Coast	61	8.4%
F - Central Irvine/University	279	13%
G - Santa Ana Heights/UCI	210	8%
H - Central Irvine/ICD	91	10%
Total	**1,259**	**11%**
Potable Landscape Irrigation		
A - West Irvine/Tustin Ranch	11	27%
B - Canyons/OPA	0.08	2.1%
C - Lake Forest/Foothills	478	17%
D - Central	10	28%
E - Coast	70	33%
F - Central Irvine/University	48	13%
G - Santa Ana Heights/UCI	174	22%
H - Central Irvine/ICD	61	28%
Total	**851**	**19%**

8.3. Summary of Future Potential Drought Savings

IRWD customers reduced their water use during the historic statewide 2013-2017 drought, and through 2018 water use has not fully rebounded to pre-drought conditions. Water savings during the drought would have resulted from a combination of behavioral changes (such as irrigating less) and more

permanent fixture/device changes (such as replacing old fixtures and removing turf). Customers whose water use has not rebounded are assumed to be "demand-hardened." The water use rebound by customers is identified and quantified as those savings that were likely the result of behavioral changes and represent the remaining potential for short-term savings opportunities in a future shortage. Depending on the water savings needed in future droughts or water shortages, IRWD will likely need to increase outreach and other efforts to achieve the same results as during the 2013-2017 drought period and even then, due to demand hardening, the same level of savings may not be feasible. Accounting for the demand hardening based on the limited rebound to date, if drought outreach and messaging were conducted at levels similar to that done in the 2013-2017 drought timeframe, it is estimated that approximately 15% water savings could be achieved in the SFR sector, 11% in the MFR sector, and 19% in the landscape irrigation sector. This represents approximately 5,000 AFY of potable water potential drought conservation savings.

9. CONCLUSIONS AND SUPPORT FOR FUTURE EFFORTS

The water efficiency (WE) programs implemented to date by Irvine Ranch Water District (IRWD or District) have been very successful, with over 150,000 devices and over 100 acres of turf replaced by District customers through participation in the wide variety of WE programs offered over the last ten years. Participation in these WE programs coupled with natural replacement with newer more efficient devices has resulted in measurable water savings and a substantial reduction in water use per account.

Based on the analyses performed for this Study, the largest remaining opportunities for water savings are in outdoor water use across all customer sectors, particularly through continued turf removal, and potentially through the implementation of a Pressure Reducing Valve (PRV) program. Marketing and outreach has proven to drive customer participation in WE programs to date, as particularly evidenced by the increased participation rates observed in response to marketing efforts during the 2013-2017 drought. In fact, these outreach and marketing efforts appear to have a much more significant effect on program participation than the dollar amounts of rebates (Section 3.7). Therefore, the WE program opportunities and scenarios evaluated in this Study focused on the outdoor water savings potential and strategic ways to target the marketing and cross promotion of these programs. As new technologies and devices are developed and available on the market, more water savings opportunities may arise.

In addition to the specific conclusions and recommendations detailed herein, the analyses and associated raw files developed as part of this Study provide an extensive set of data and analytical tools that will serve as a foundation to strategically inform and guide the District's WE program planning efforts as the new State WE requirements and other WE drivers evolve.

In support of IRWD's future WE planning efforts, this detailed and comprehensive Study:

- Documents the estimated water savings achieved through IRWD's implementation of WE programs over the last 10 years;
- Provides a detailed evaluation of WE program participation drivers and trends based on past participation, and in terms of intra-District geography and key demographic and property characteristics;
- Provides IRWD-specific water savings factors for WE key programs that reflect participation trends and intra-District customer variability and can be used to improve local planning estimates and inform WE program prioritization, funding, targeting and marketing;
- Provides a framework for periodic future analyses to monitor changes in WE program performance (e.g., by evaluating participation density/hot spot analyses change over time);
- Documents analyses that will serve to support future targeted marketing outreach efforts, grant applications, and documentation of WE program implementation to the State;
- Provides an assessment of device saturation based on historical WE program implementation, natural replacement rates, and the observed changes in customer water use;
- Concludes that residential indoor WE devices are highly saturated and little opportunity for increased water savings remains, based on both a device saturation assessment and an analysis of change in estimated indoor water use;

- Concludes that the greatest potential WE remains in outdoor water use and identifies four new and refined WE programs and a cost-benefit analysis of the associated implementation scenarios targeting these opportunities: (1) Single family Residential (SFR) Turf Removal Rebate Program Prioritized by Size, (2) SFR Turf Removal Rebate Targeted at Customers that Reduced Water Use During Drought, (3) Non-Residential Turf Removal Rebate Program,[85] and (4) PRV Pilot Programs; and
- Evaluates the demand hardening that has occurred since the statewide 2013-2017 drought and estimates that the maximum conservation savings that could be achieved in a future similar drought or water shortage scenario is approximately 5,000 acre-feet of potable water per year.

[85] Based on this assessment, the Non-Residential Turf Removal Rebate program targeting areas of the District not served by recycled water was not found to be cost-effective.

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Appendix A

Key Data sources and Preliminary Analyses

Appendix A
Data Exploration and Key Preliminary Findings

This Appendix presents the results of preliminary review and analyses of the available data. These analyses were performed to evaluate the sufficiency of available data to support the anticipated analyses in this Study (i.e., identify data gaps), identify parameters with which to frame the analyses, and identify key water use and customer characteristics within the service area.

1. Customer Sector

Over half of all service points (SPs) in the service area are in the single-family residential (SFR) sector. Together with multi-family residential (MFR), the residential sector comprises nearly 90% of SPs within the Irvine Ranch Water District (IRWD) service area. As shown in the charts below (**Figure A-1a**), the number of SPs in total and each customer sector has increased over the past 10 years. The total number of SPs has increased by 80% over the last 10 years (i.e., from 64,755 to 116,586). The greatest increase was observed in the MFR sector, with a 136% increase in SPs (i.e., from 16,992 to 40,089), and the smallest rate of growth was observed in the Institutional/Public Authority sector, with only a 17% increase in SPs (i.e., from 268 to 313. In general, there was a greater rate of increase in SPs through 2014, with a slower rate of increase from 2014 through 2018. It should be noted that the number of dwelling units per MFR SP ranges from 1 to over 500, and that these SPs include a mix of indoor only meters and mixed-use indoor/outdoor meters. The increase in MFR dwelling units over the last 10 years is shown in **Figure A-1b** to the right. Although the number of MFR SPs has increased by 136%, the number of individual dwelling units has increased by approximately 70%. This is because each dwelling unit in new MFR tends to be individually metered.

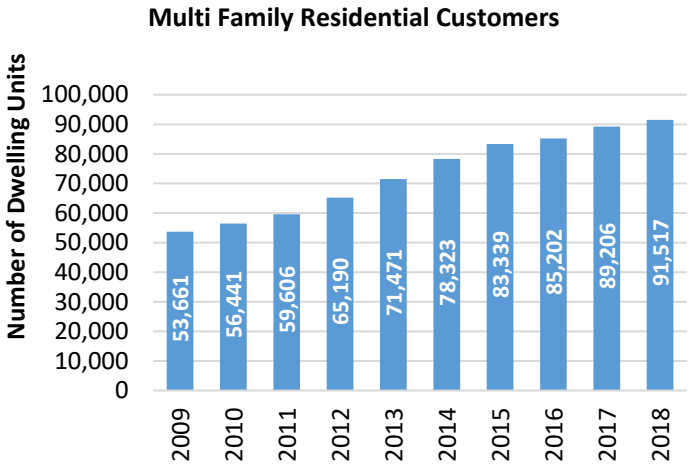

Figure A-1b MFR Dwelling Unit Growth Between 2009 and 2018

2. Change in Annual Water Use

As a high level, preliminary analysis, **Figure A-2** presents the annual water use on a total, by source, per capita, and per account[1] basis over the last 10 years. Despite the significant increase (80%) in number of SPs over the last 10 years, total water use has only increased by approximately 4% (1,160 million gallons

[1] For purposes of this discussion and figures, SPs are referred to as accounts. It should be noted that a customer account may have multiple SPs associated with it. The analysis presented in this appendix were preliminary analyses intended to guide the analyses used in subsequent portions of the Study and thus are less refined than those presented elsewhere.

[MG]). Total annual water use decreased sharply between 2009 and 2010, increased between 2010 and 2014, decreased between 2014 and 2015 (concurrent with local and state-wide drought conservation messaging and water use restrictions), followed by an increase through 2018.

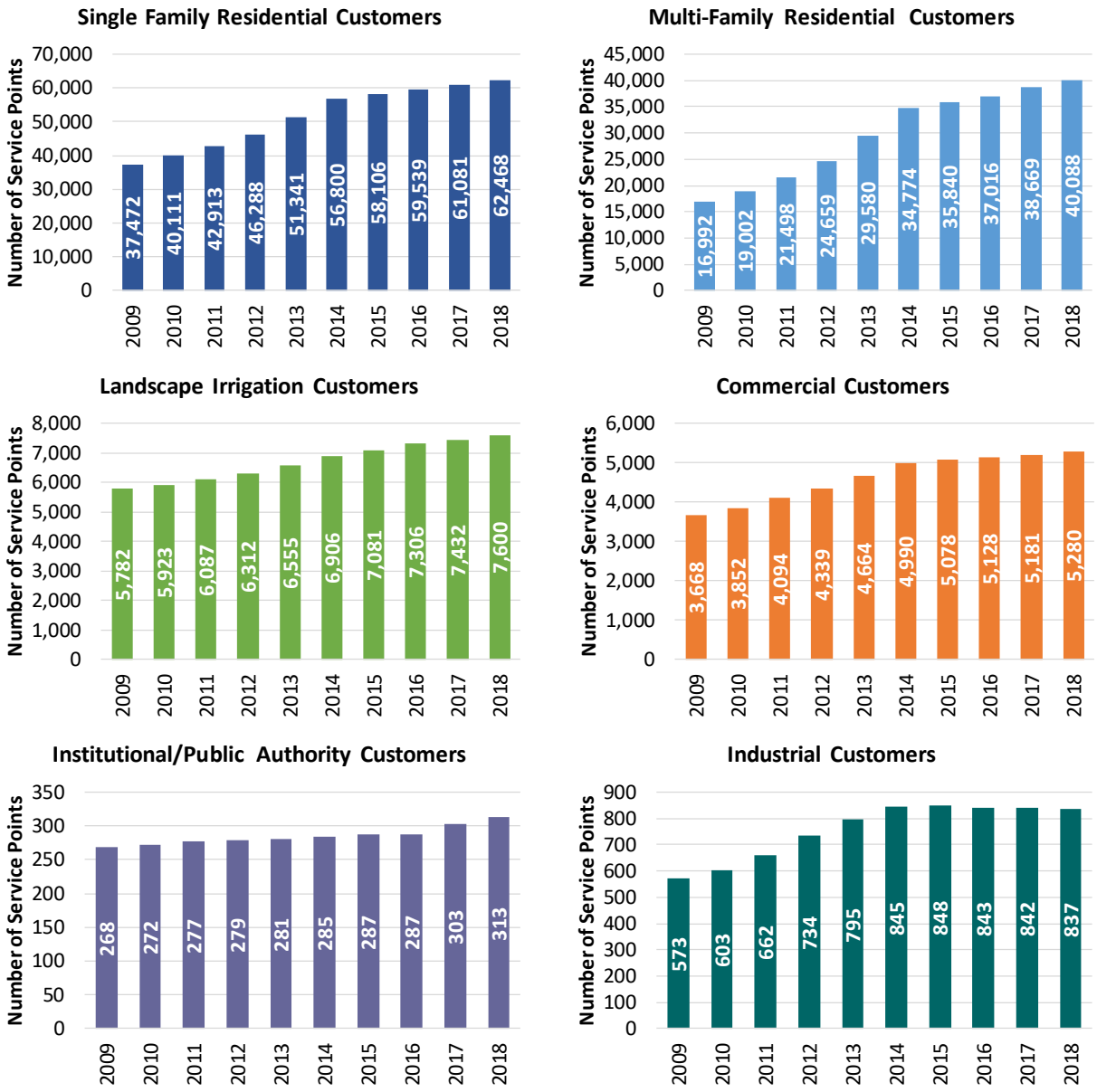

Figure A-1a SP Growth by Sector between 2009 and 2018. For purposes of the preliminary analyses, potable and non-potable landscape irrigation SPs are grouped together. The number of SPs shown are based on SPs included in billing data. As new buildings are constructed and SPs established, there is a time delay before the newly constructed SPs are reflected in the billing system.

Fluctuations in water use on a per capita basis[2] are generally similar to those observed in total water use; however, on a per capita basis, water use has decreased by 20% over this ten-year period (i.e., from 220 to 175 gallons per capita per day [GPCD]). Water use on a per account basis is decreasing even more substantially, with a 42% decrease over the same period (i.e., from 1,121 to 650 gallons per day [GPD]). This decrease in per account water use appears to be driven by the large increase in number of MFR SPs relative to SFR and Commercial, Industrial, and Institutional/Public Authority (CII) sector SPs. In 2009, MFR accounts represented 26% of overall SPs, while in 2018 MFR represented 34%.

Based on the changes and total per capita water use observed, it appears that reduction in water use due to the historic drought occurred between 2014 and 2015, corresponding to increased local and statewide drought conservation messaging. Given this, for the purposes of this Study, 2013 water use will be considered for pre-drought effects and 2016 as drought water use.

Figure A-3 below, shows the breakdown of annual water use by customer sector. The SFR sector has the highest total water use of each sector and the fluctuations in water use over the last 10 years generally track with total water use. Water use by the commercial, industrial, and institutional sectors exhibit less year-to-year variability than the SFR and landscape irrigation sectors.

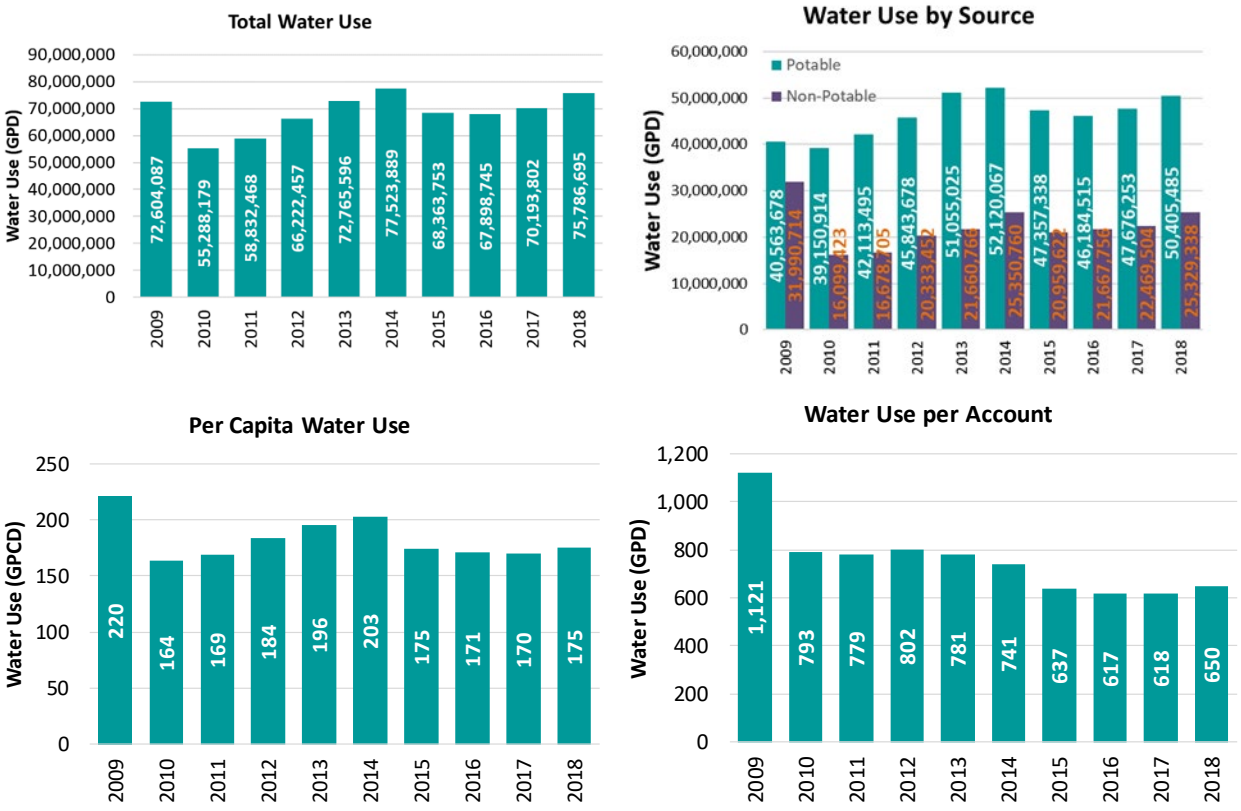

Figure A-2 Total, Source-Specific, Per Capita, and Per Account Water Use for 2009 through 2018

[2] Annual population values were obtained from IRWD's 2015 Urban Water Management Plan and the State Water Resources Control Board (SWRCB) Urban Water Supplier Report Dataset, and was linearly interpolated for years where a value was not available. From 2009 to 2018, the service area population increased by approximately 35%.

Figure A-4 through **Figure A-9** show the changes in water use per account in 2009, 2014, 2015, and 2018, by sector, presented as histograms (i.e., charts illustrating frequency distribution). As shown on the charts, average and median water use has decreased over the past 10 years for all sectors, except for potable and non-potable landscape irrigation, where the medians have increased. This trend becomes more evident if we look at the change in skewness of the histograms, particularly for the SFR and MFR SPs, which illustrate that most customers are using less water and becoming increasingly efficient over time.[3] For the CII sectors, this shift towards efficiency is less significant. These analyses help to identify sectors that are experiencing demand hardening and were used to guide the analyses presented in Sections 6 through 8 of the Study.

[3] This analysis shows MFR water use by SP, rather than dwelling unit. A similar analysis in Section 6 of the Study was conducted, in which MFR water use is normalized by dwelling unit.

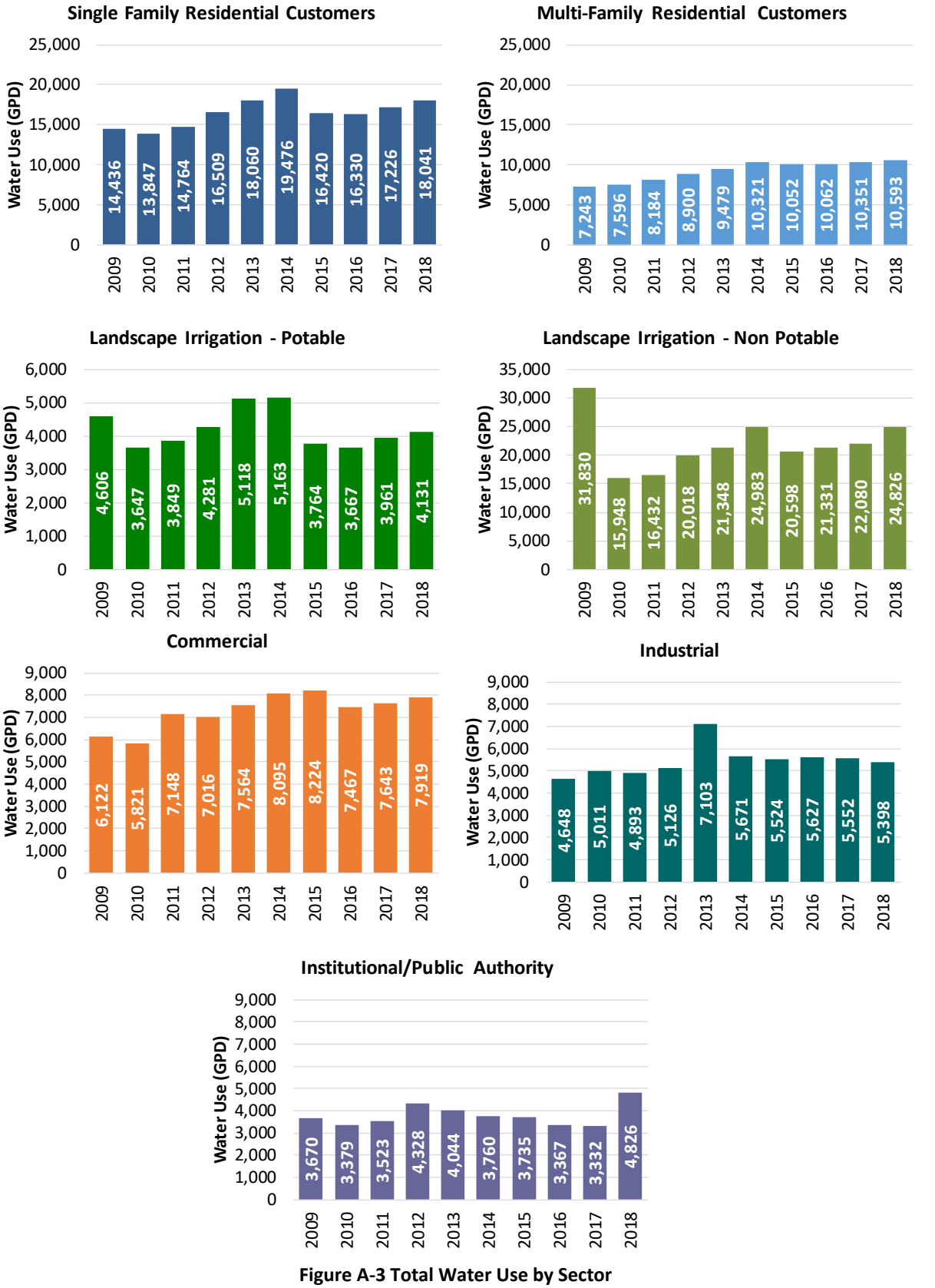

Figure A-3 Total Water Use by Sector

3. Indoor vs Outdoor Water Use

The following charts (**Figure A-10**) show monthly water use by dedicated landscape irrigation SPs (including both potable and non-potable) and all other sectors for the past five years. Water use by the majority of SFR, MFR, and CII SPs shown here represents a combination of indoor and outdoor water use (i.e., they are single meter accounts). As shown in **Figure A-10,** for all SPs, monthly water use is highest during summer, driven largely by increased water use for outdoor irrigation.

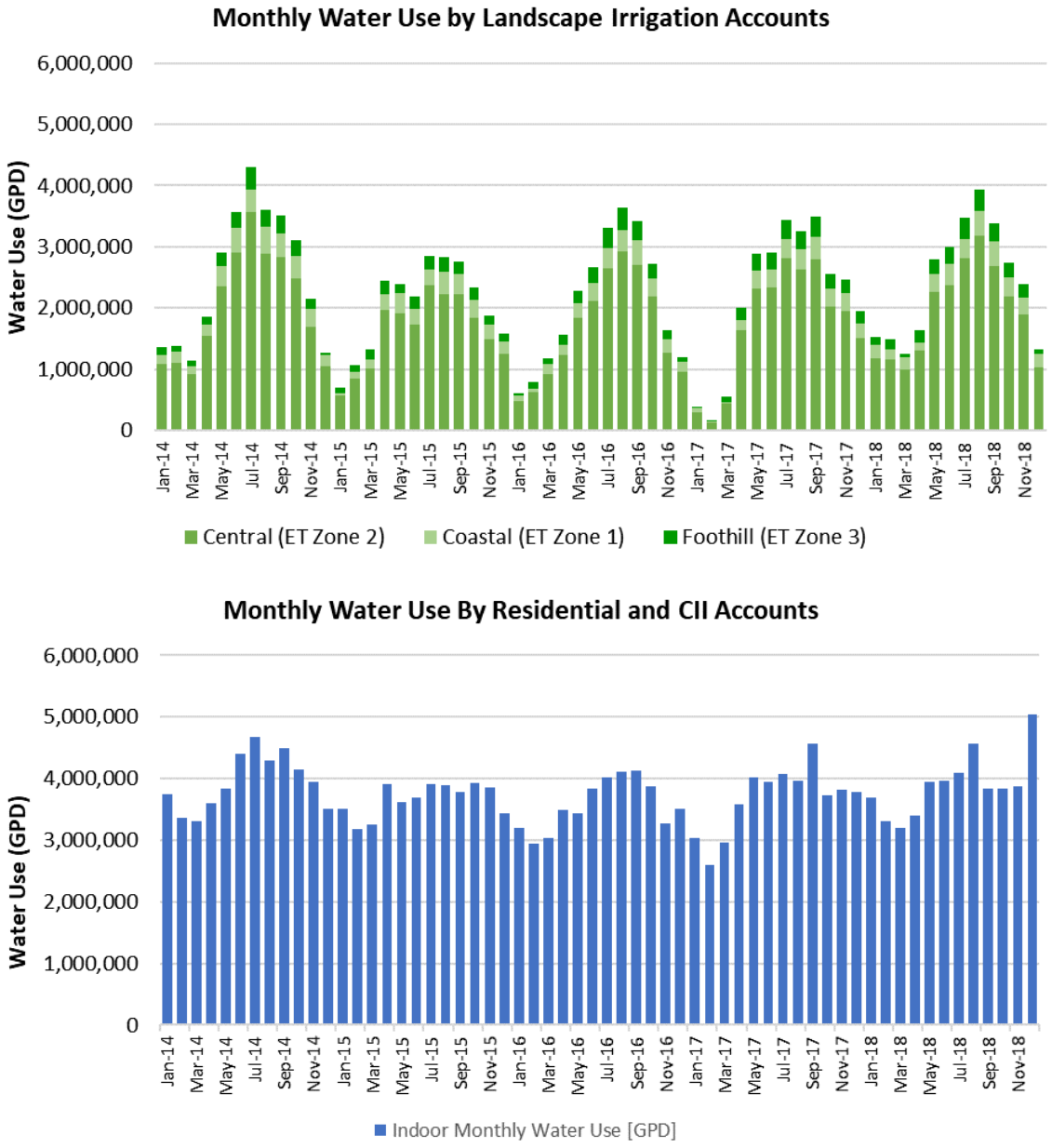

Figure A-10: Monthly Water Use by Landscape Irrigation and All Other Sectors

In some areas of California, indoor water use can be generally assumed to be equivalent to the lowest water use month, usually between December and February, with the difference attributable to outdoor

use. However, in the IRWD service area, irrigation takes place year-round, although the magnitude of water use in the summer versus winter may vary significantly year to year due to precipitation volumes and patterns. In order to estimate indoor versus outdoor water use at SPs with a single water meter, an annual scaling factor will be calculated based on observed water use at dedicated irrigation accounts for each of the three evapotranspiration (ET) zones. This "scaling factor" will then applied to the total water use measured by meters that are reflective of both indoor and outdoor water use. That is, instead of assuming that the entirety of the water use in the lowest water use month represents indoor water use, this method estimates the amount of outdoor water use in the low water use month relative to the amount of water use observed in irrigation only accounts. This outdoor water use analysis is presented in Section 6 of the Study.

4. CII Customer Classification

Understanding water use and identifying potential opportunities for efficiency in the CII sector is challenging due to the broad range of end uses and the range in scales, even for businesses with similar operations. Currently, there is no clear guidance for classifying business types in terms of water use, although it is anticipated that a process or standard may be developed as part of the "Making Water Conservation a California Way of Life" legislation (AB-1668/SB-606). The North American Industry Classification System (NAICS) is a standard used by U.S. federal statistical agencies for classifying business establishments for the collection, tabulation, presentation, and analysis of statistical data describing the U.S. economy.[4] The NAICS codes are set up as a hierarchical system, where the first two digits represent a broad economic sector classification that is broken down into further levels of classification, down to the most specific 6-digit classification. This system is designed and used to classify businesses based on economic sector, and not water use, but may potentially be a useful tool for evaluating CII water use. Therefore, EKI has reviewed the available NAICS data for its potential use as part of this Study.

Based on the data provided (6,311 records), 6-digit NAICS codes have been associated with 5,420 out of 8,689 CII SPs (62%). In some cases, where a SP is associated with more than one business activity, multiple NAICS codes have been attributed. For purposes of this preliminary analysis, EKI summarized the data based on a the primary NAICS code assigned (i.e., field NAICS_1_Code). **Table A-1** shows the number of SPs by the two highest level NAICS groupings (i.e., 2-digit economic sector and 3-digit economic subsector) and the number of SPs associated with each customer sector based on the billing structure.

When looking at the NAICS classification, the breakdown by customer sector is not as one would expect based on the NAICS business classification alone. For example, 14% of the SPs classified as the retail trade industry (NAICS 44 or 45) are associated with industrial sector SPs, rather than commercial as expected. Conversely, only 41% of the SPs classified as the manufacturing industry (NAICS 31 - 33) are associated with industrial sector SPs. While not presented in a table herein, the same issue is encountered when the classifications are broken down to the finest detail 6-digit level. Based on closer review of a subset of SPs, it appears that often the NAICS code attributed to an account is based on the overall operations of a company, and not the specific operations at the physical location within the IRWD service area. For example, the office-based marketing, sales, and distribution operations for a pharmaceutical

[4] The District provided EKI with 6,311 records of NAICS codes (6-digit) associated with 5,420 CII SPs within the service area (received 8 January 2019). In some cases, where an SP ID is associated with more than one business activity, multiple NAICS codes are attributed.

manufacturing company may be located in the IRWD service area, while the actual water-intensive pharmaceutical manufacturing operations occur in another area. In this case, the NAICS code may identify the business as manufacturing, but the customer account type within the IRWD service area would be better identified as commercial or office space. Therefore, the customer sector appears to be a more reliable indicator of business operations than the NAICS code alone.

In addition, CII water use is expected to vary greatly relative to the scale of operations and number of employees within a given building and/or industry. Often when water use associated with CII SPs is estimated or benchmarked, it is calculated on a per employee or a per square footage basis. The number of employees associated with IRWD businesses is not known and the building square footage is only known for a subset of CII customers (i.e., the Assessor parcel data set provided to EKI includes building size data for 1,503 out of 6,451 CII SPs, 764 of which have NAICS codes assigned). Further, a given building may have multiple SPs (meters) associated with it, and it is not readily known from available data how much of the building square footage is associated with each account. Therefore, very little data are actually available with which to normalize CII water use for comparisons within or across business sectors. Given these data limitations, it is anticipated that as part of this Study, water use will be primarily evaluated on the broader customer sector basis, and that the high level NAICS groupings (primarily 2- and 3-digit levels) will be used to identify specific CII customer types that may present significant opportunities for increased water efficiency.

5. References

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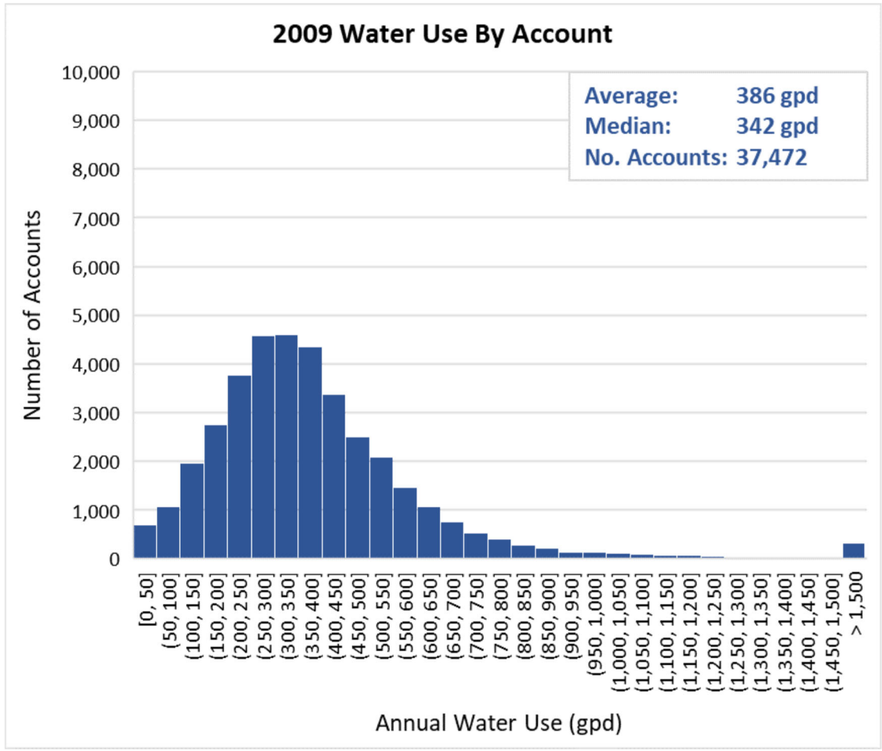
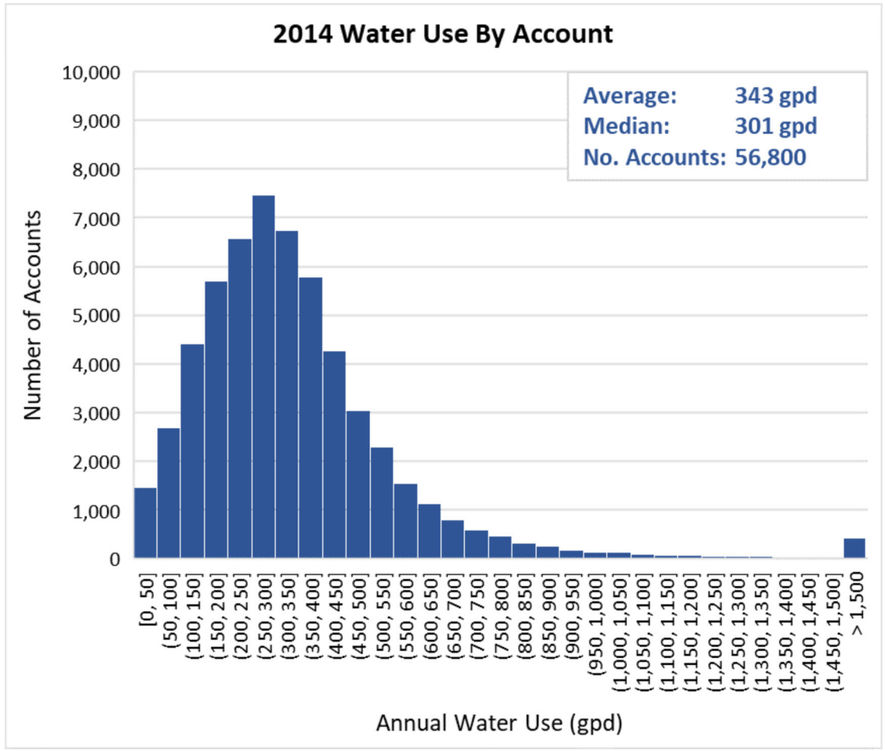
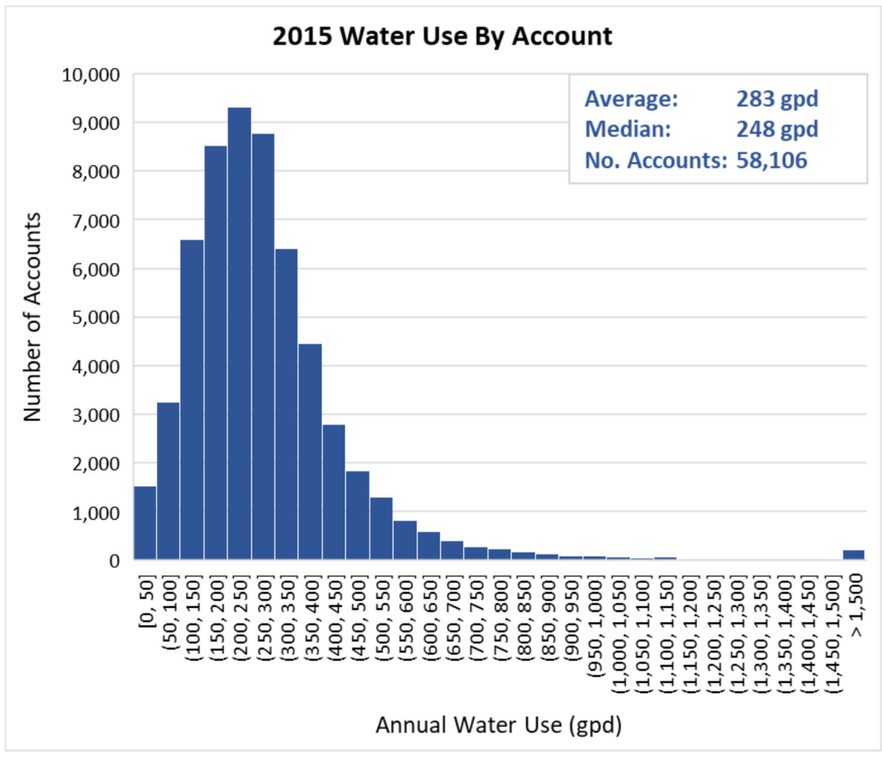
SWRCB, 2019. June 2014 – November 2018 Urban Water Supplier Report Dataset, https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html, California State Water Resources Control Board, downloaded 28 January 2019.

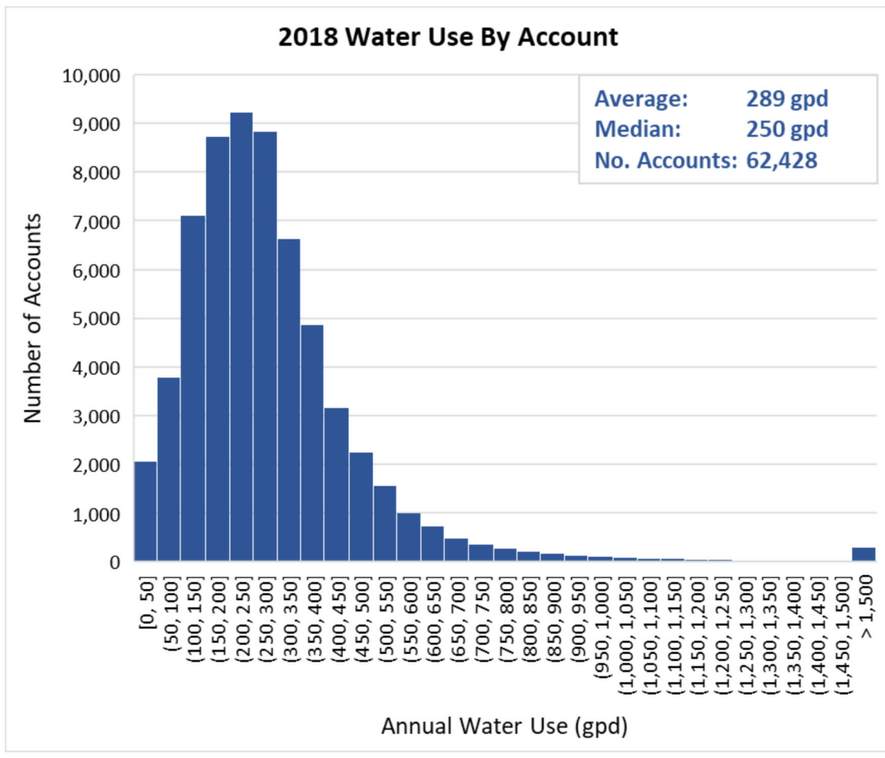
Figures

Tables









Notes

1. Charts show the frequency of total use per account (histograms) for residential single family accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

SFR = Single Family Residence

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

SFR Water Use per Account in 2009, 2014, 2015 and 2018

Irvine Ranch Water District
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Figure A-4

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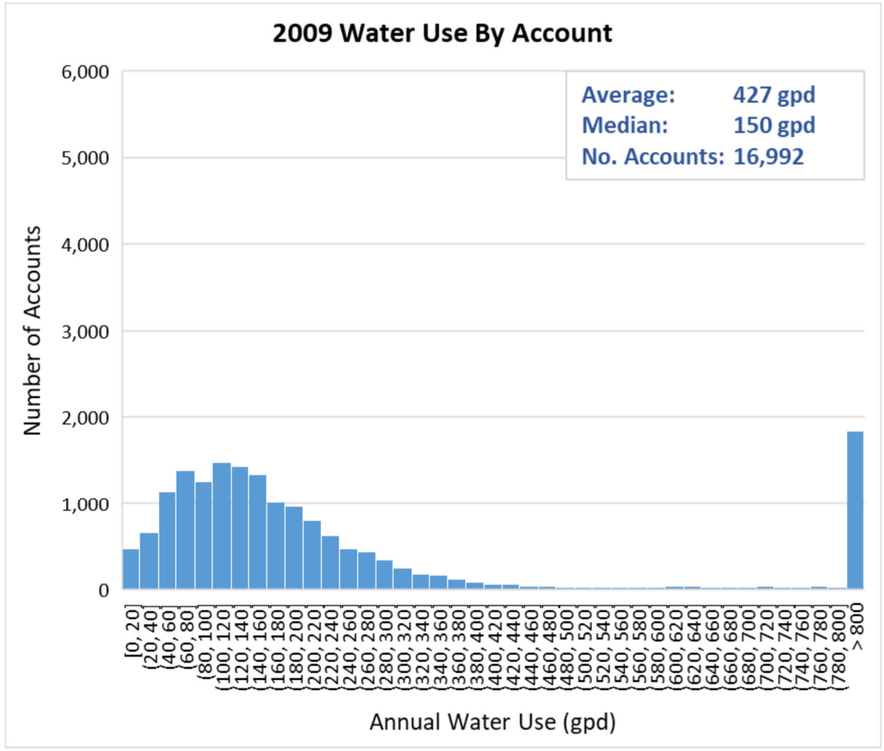

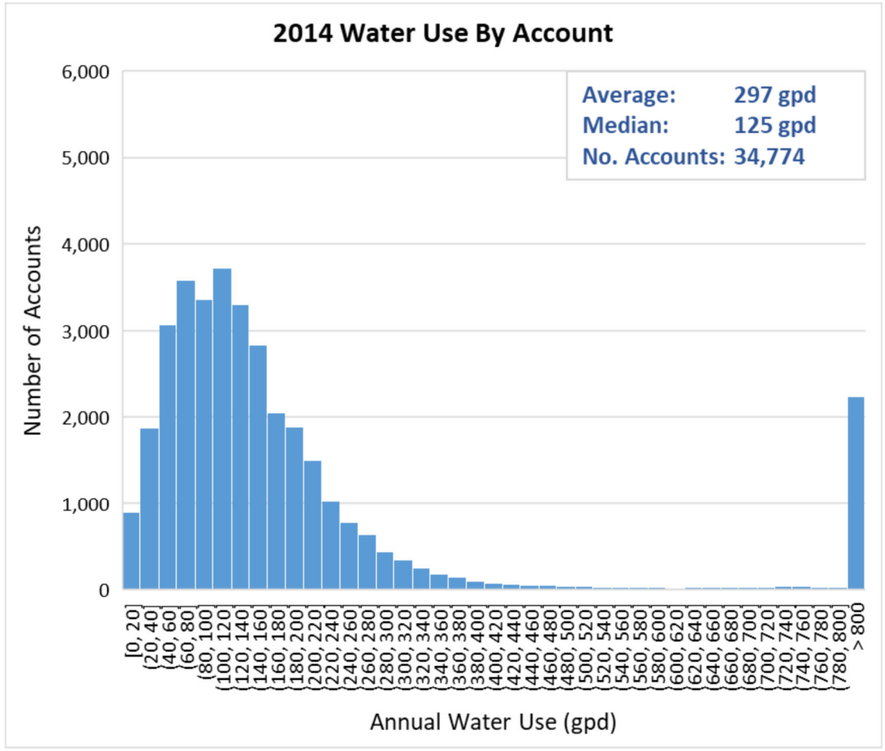

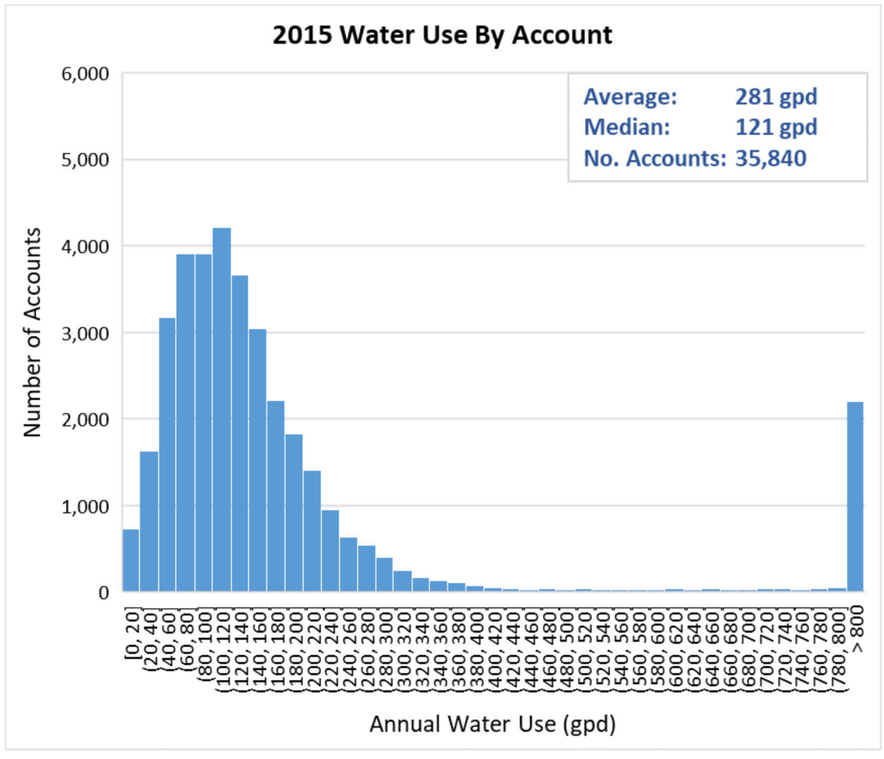

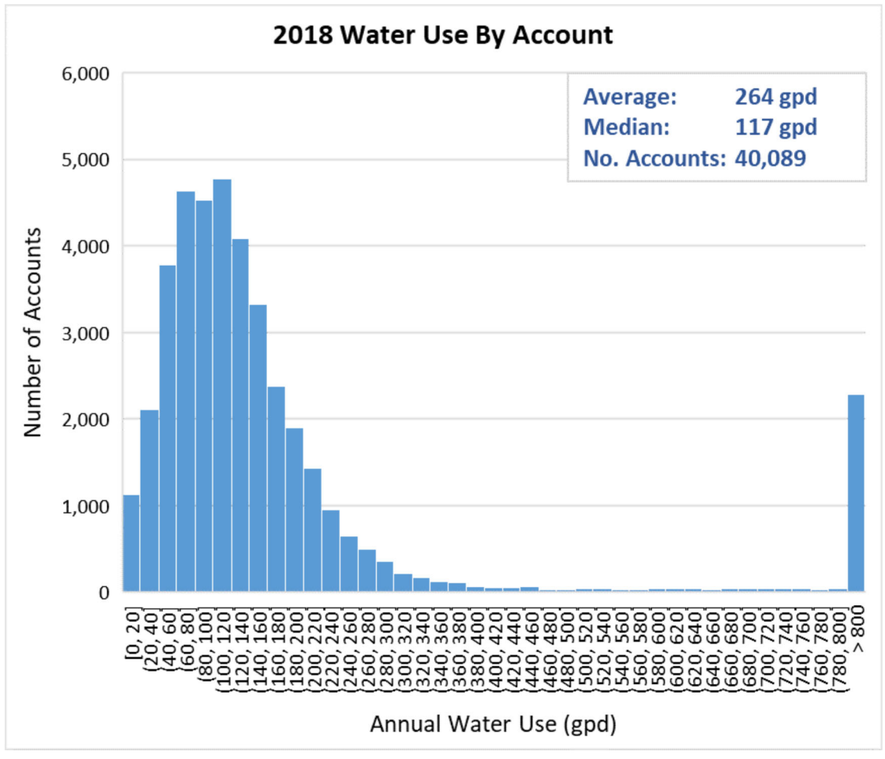

Notes

1. Charts show the frequency of total use per account (histograms) for residential multi-family accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

MFR = Multi-Family Residence

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

MFR Water Use per Account in 2009, 2014, 2015 and 2018

Irvine Ranch Water District
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Figure A-5

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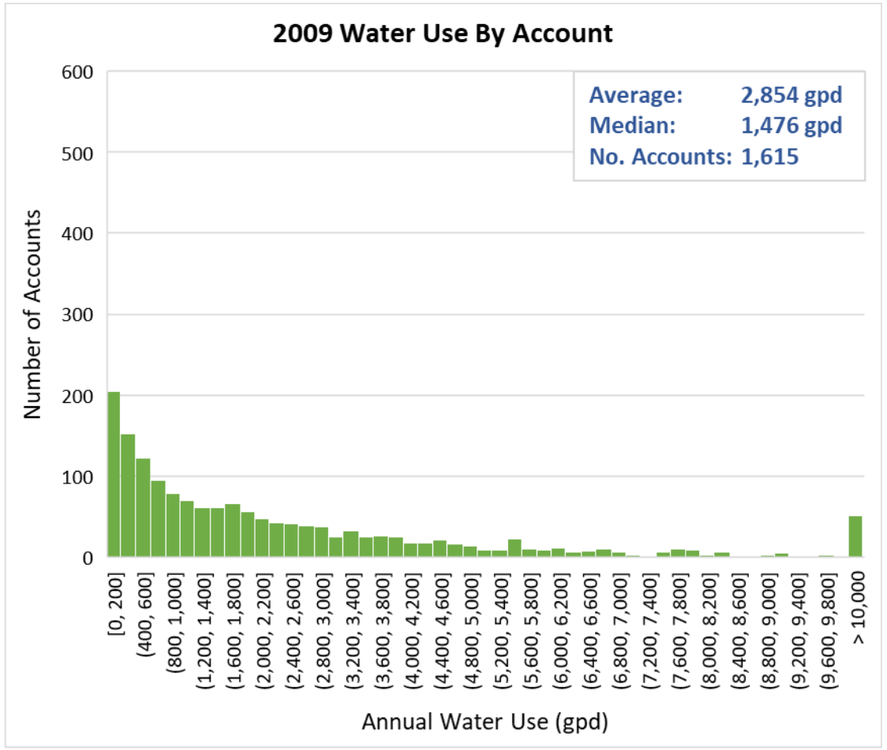

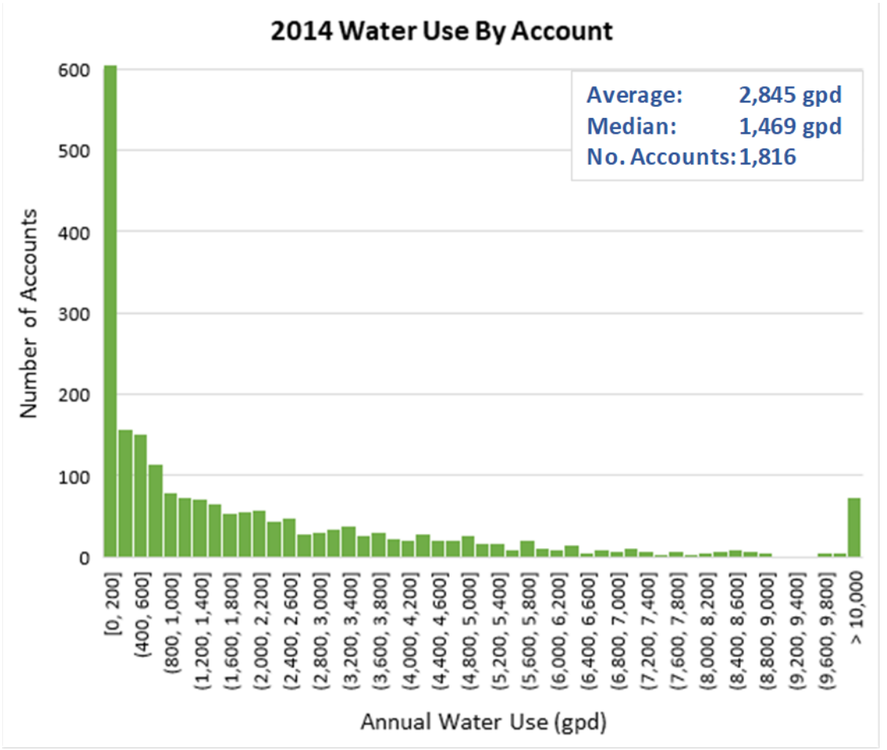

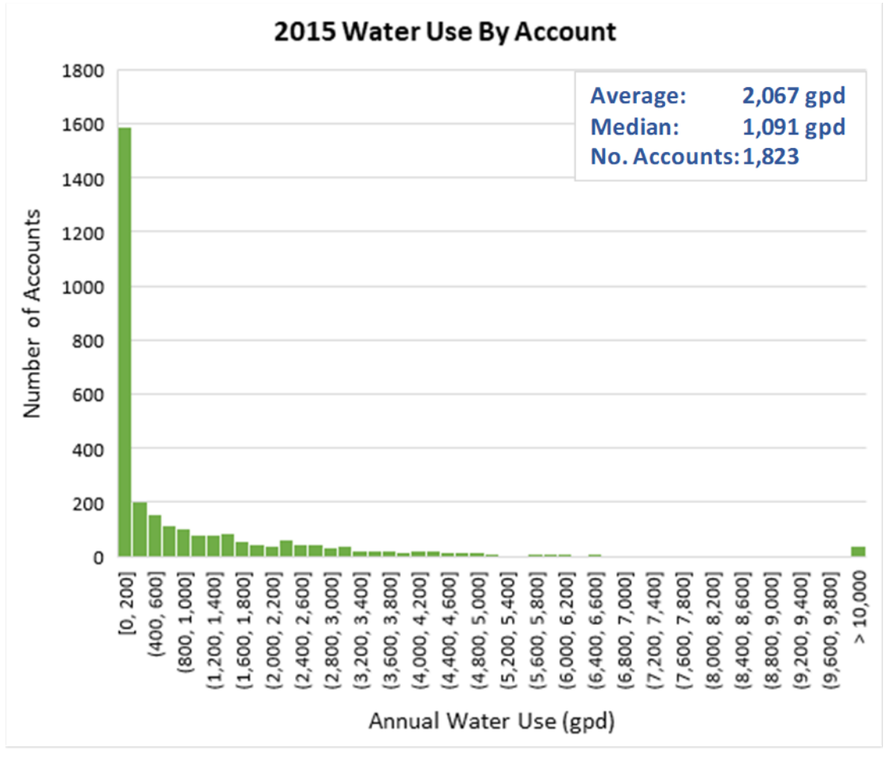

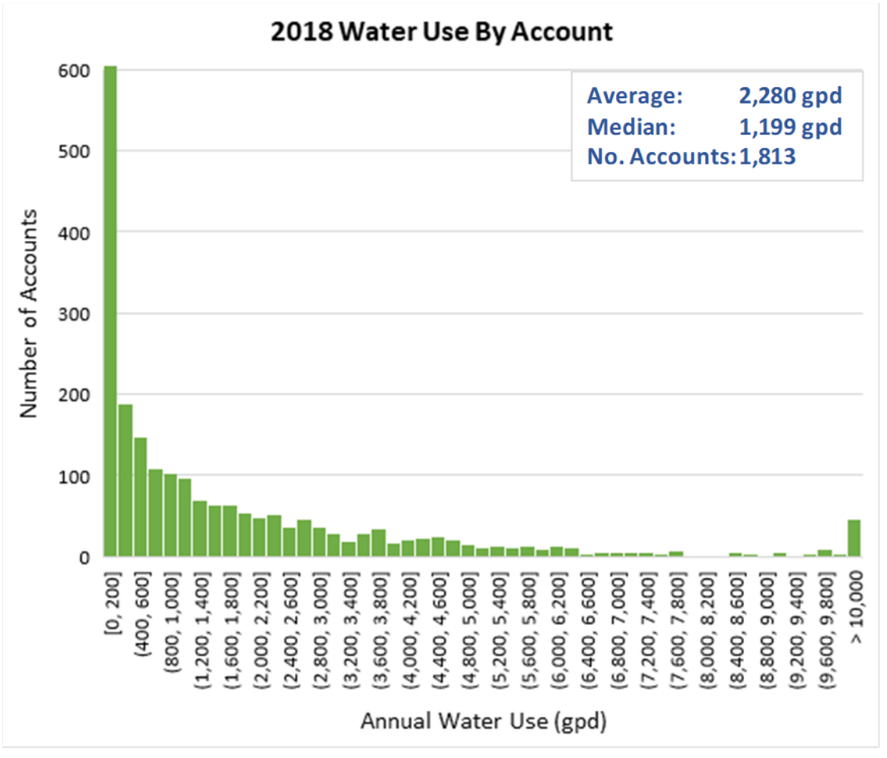

Notes

1. Charts show the frequency of total use per account (histograms) for dedicated landscape potable water irrigation accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

Landscape Irrigation Potable Water Use Per Account in 2009, 2014, 2015, and 2018

Irvine Ranch Water District
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B80129.00
Figure A-6a

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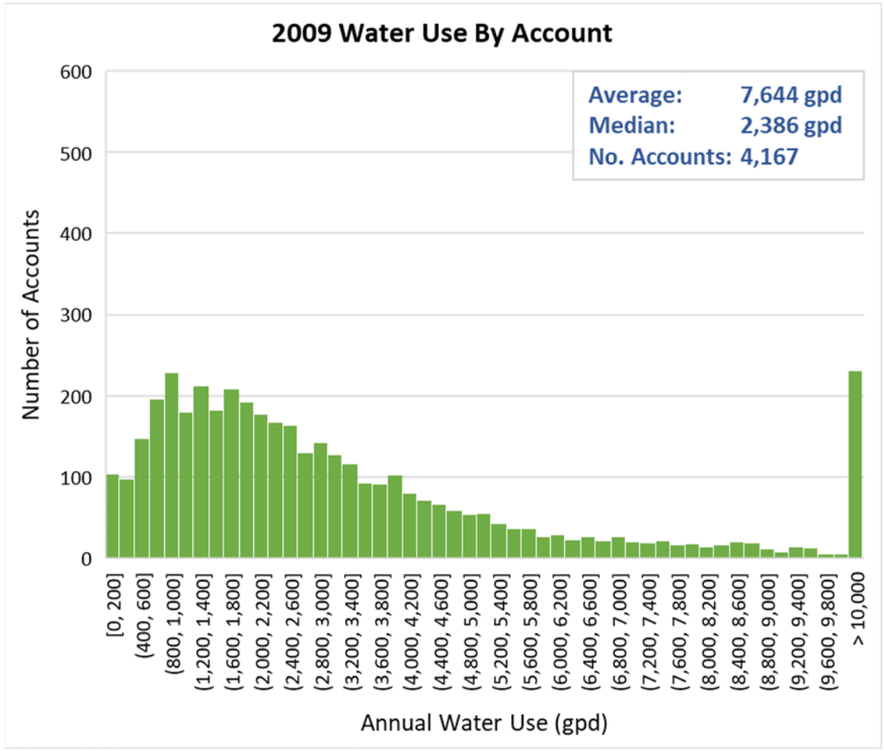

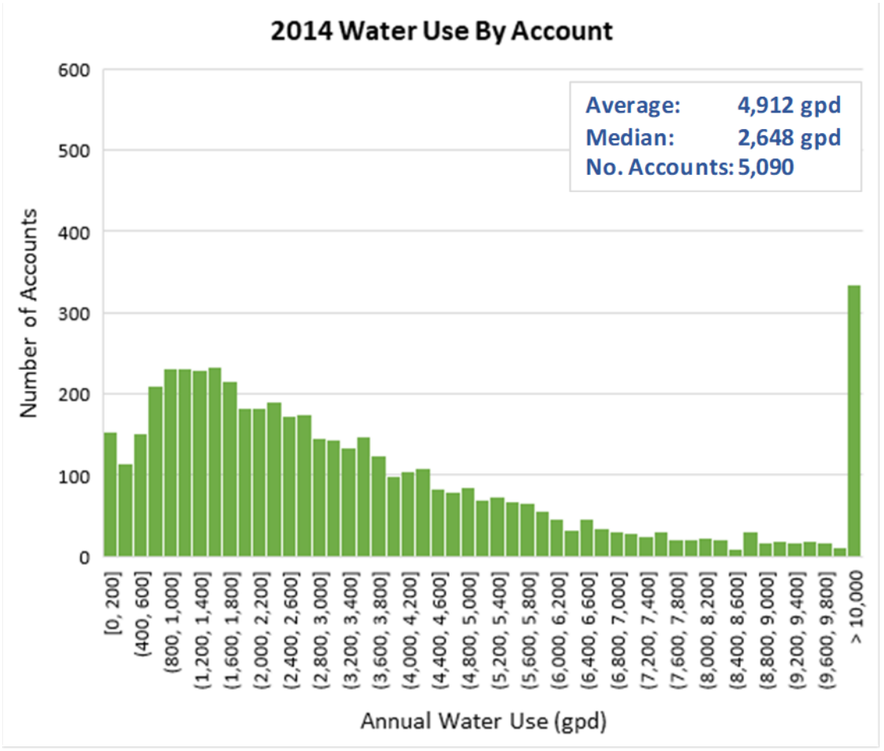

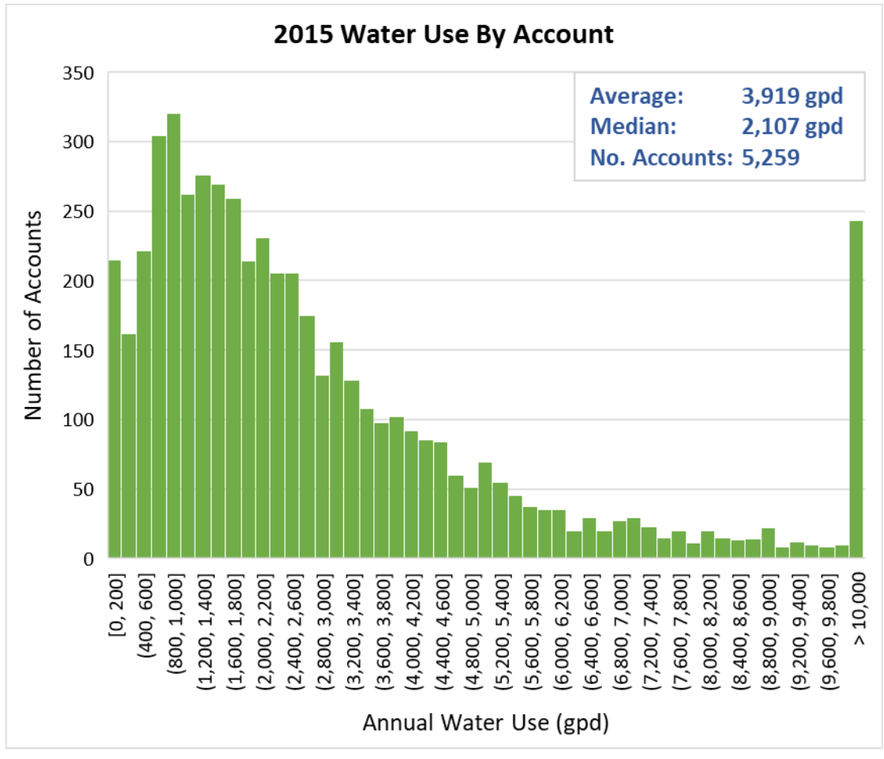

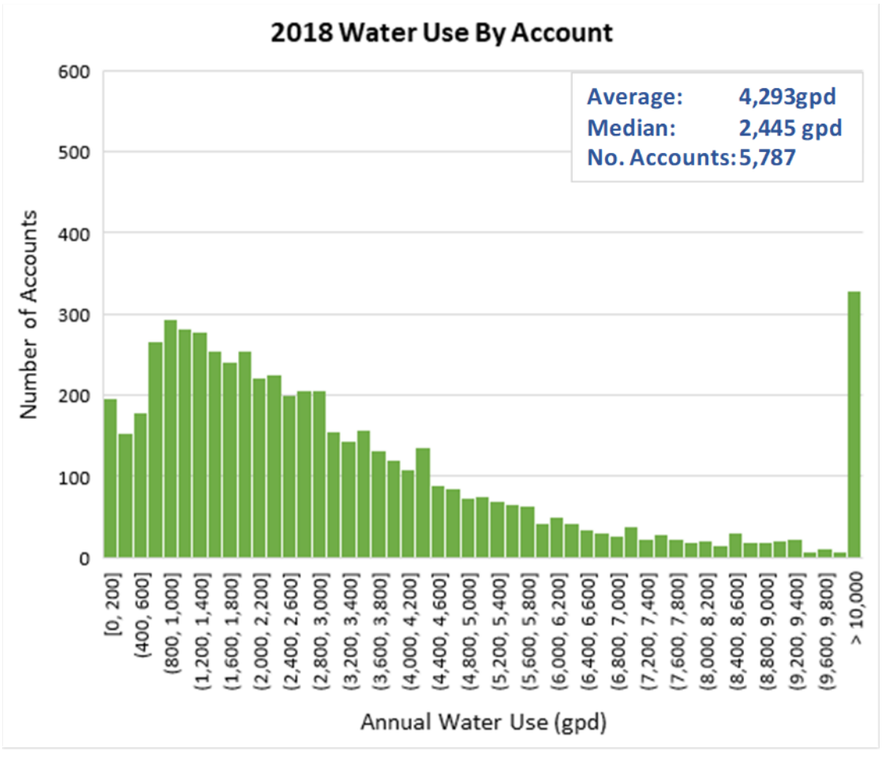

Notes

1. Charts show the frequency of total use per account (histograms) for dedicated landscape non-potable water irrigation accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

Landscape Irrigation Non-Potable Water Use Per Account in 2009, 2014, 2015, and 2018

Irvine Ranch Water District
December 2019
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Figure A-6b

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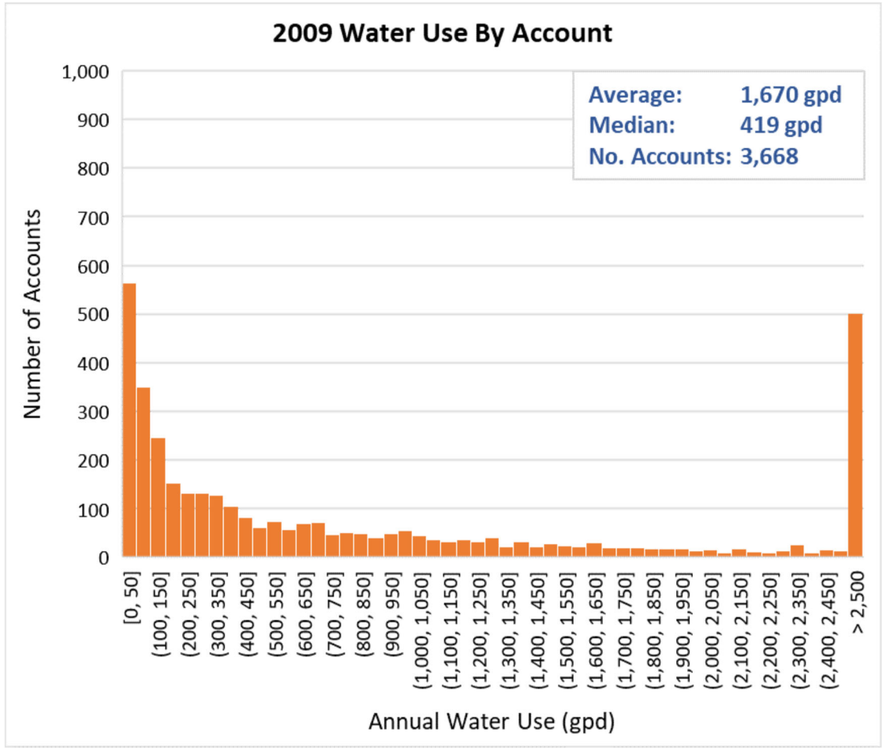

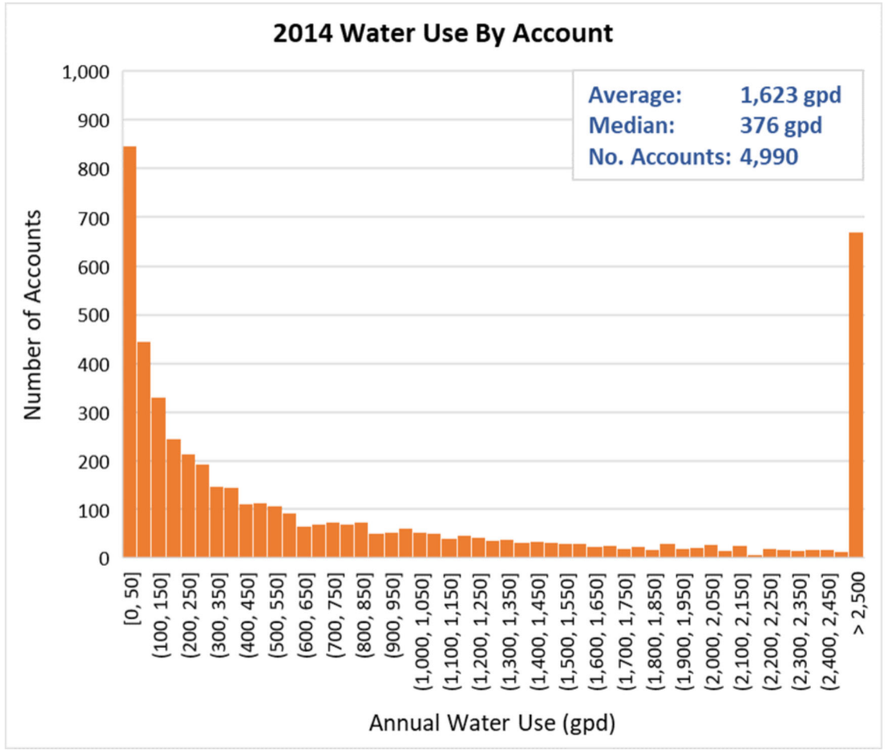

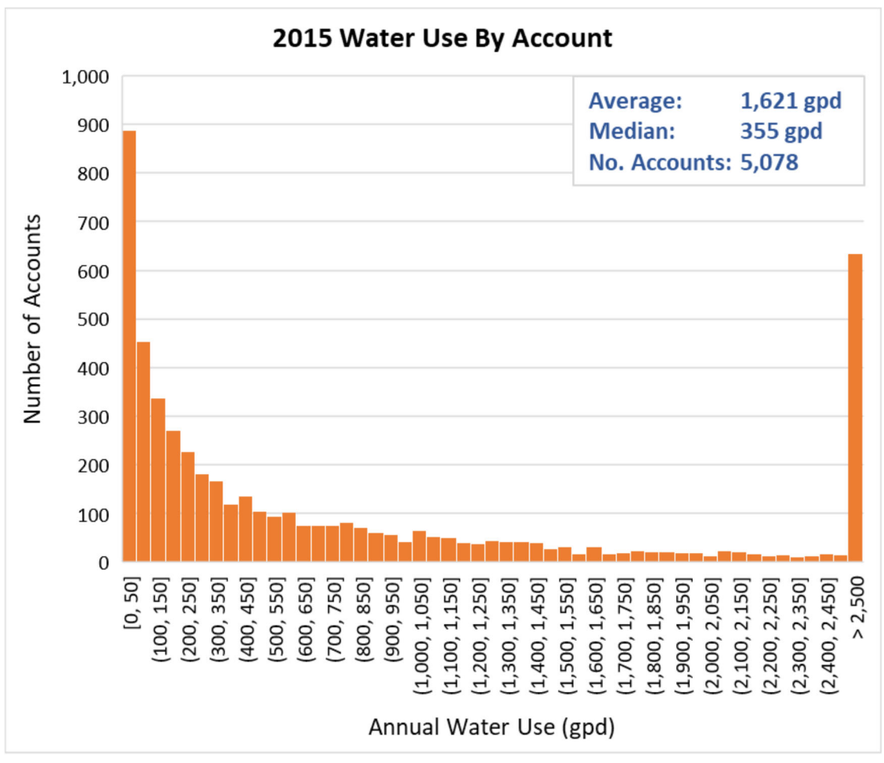

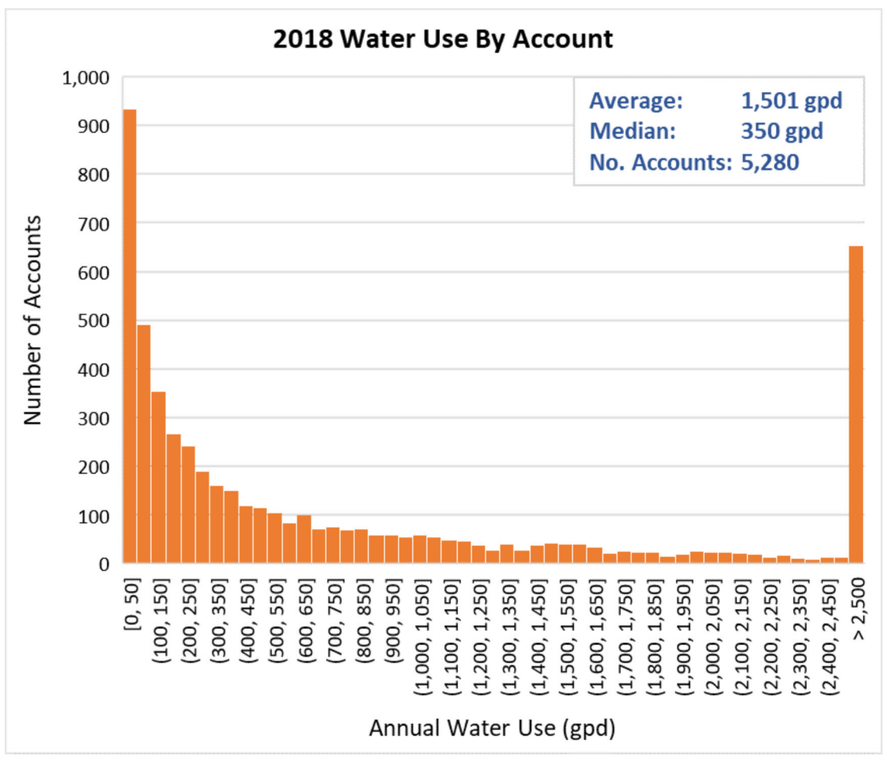

Notes

1. Charts show the frequency of total use per account (histograms) for commercial accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

Commercial Water Use per Account in 2009, 2014, 2015, and 2018

Irvine Ranch Water District
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Figure A-7

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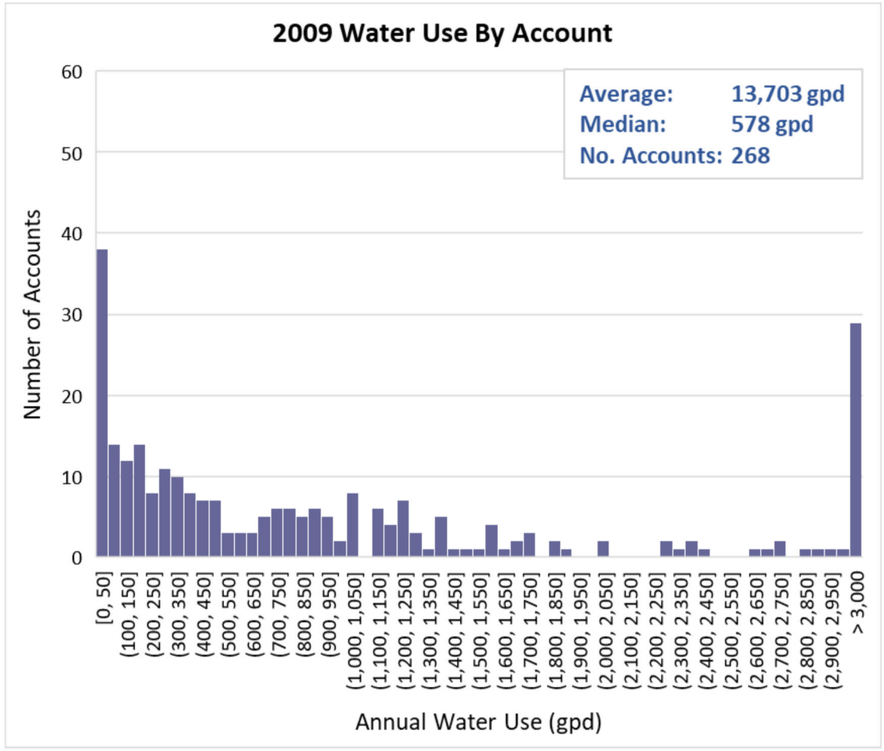

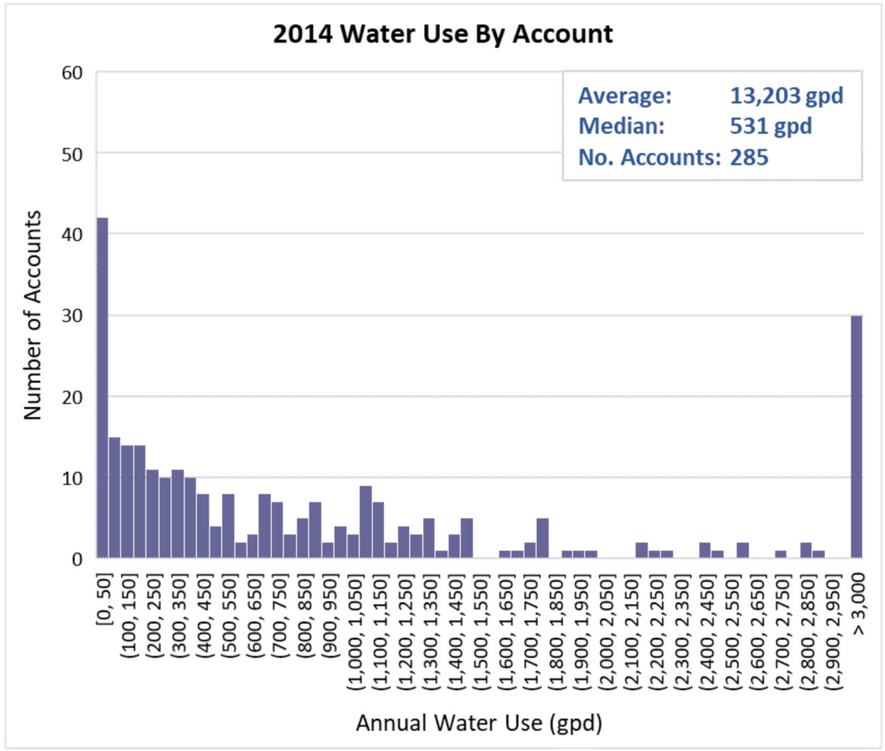

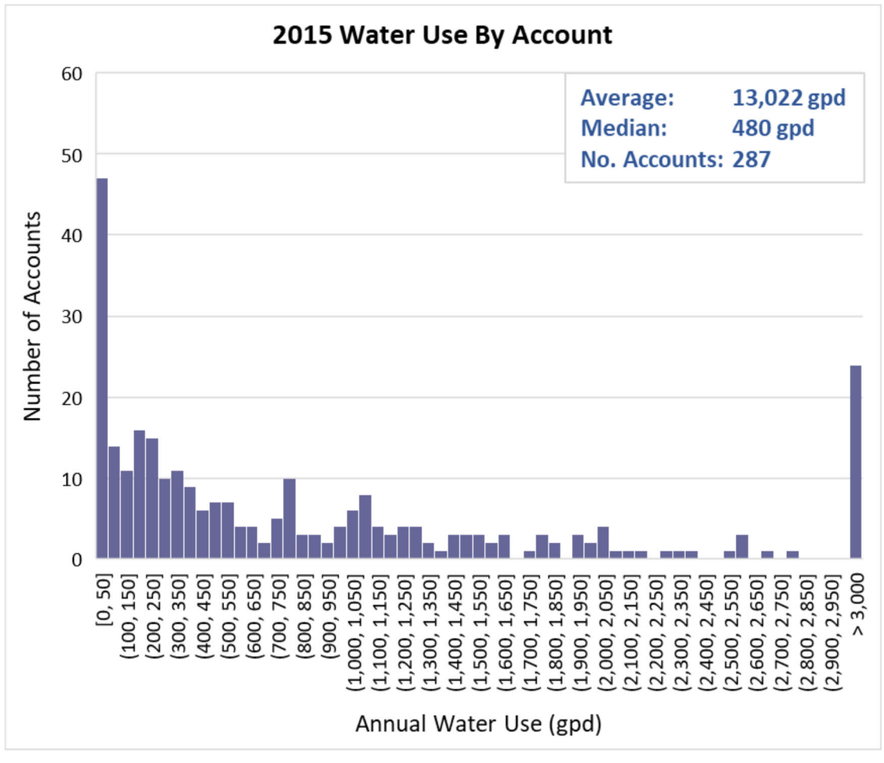

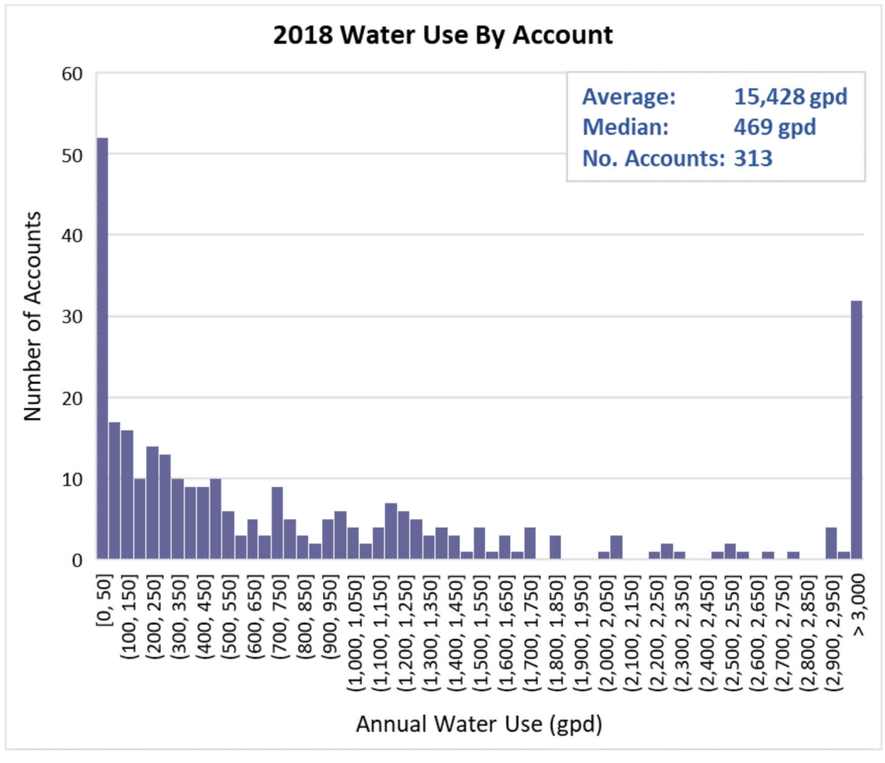

Notes

1. Charts show the frequency of total use per account (histograms) for institutional/public authority accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

Institutional/Public Authority Water Use per Account in 2009, 2014, 2015, and 2018

Irvine Ranch Water District
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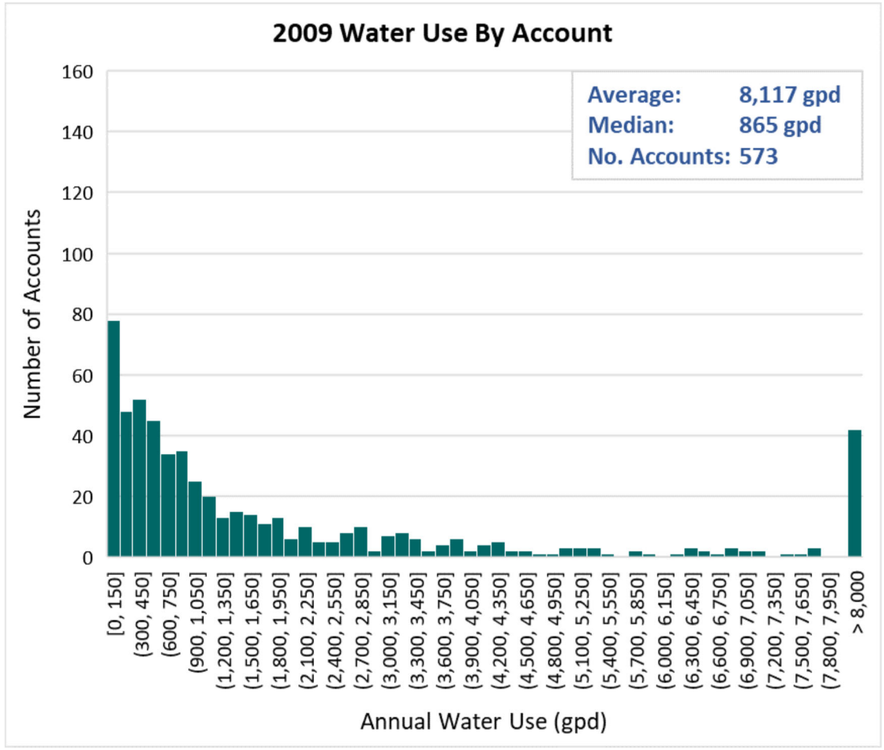

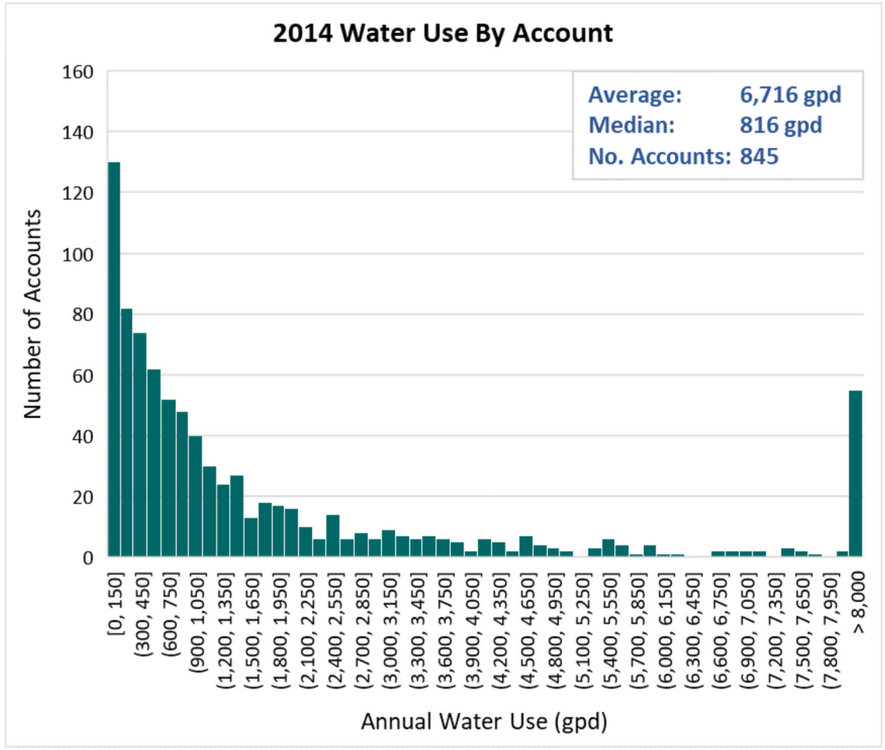

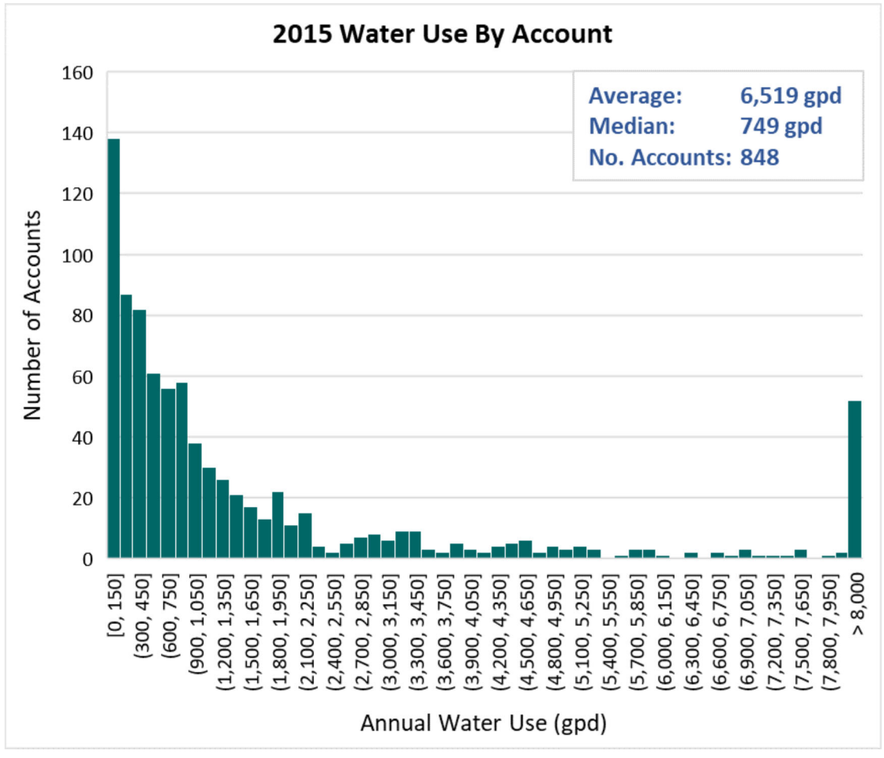

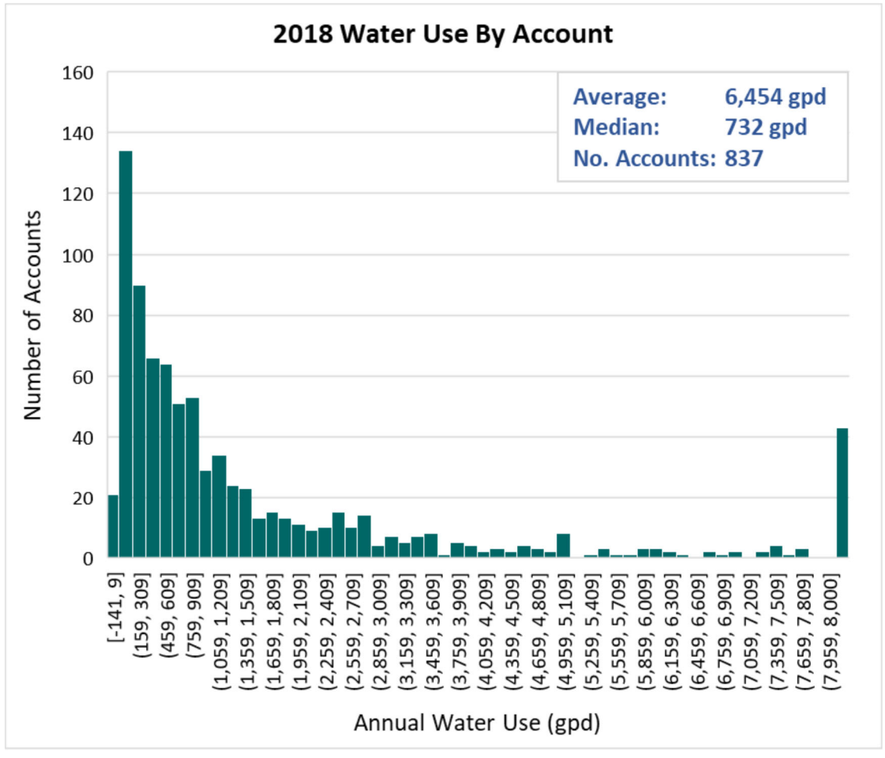

Notes

1. Charts show the frequency of total use per account (histograms) for industrial accounts.
2. Annual water use by account is shown for selected years. Total and per account water use in the IRWD service area generally increased through 2014, with a significant decrease observed in 2015 coinciding with drought conditions.

Abbreviations

gpd = gallons per day

IRWD = Irvine Ranch Water District

Source

1. IRWD, 2019. Customer Water Use Data, downloaded on 13 January 2019.

Industrial Water Use per Account in 2009, 2014, 2015, and 2018

Irvine Ranch Water District
December 2019
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Figure A-9

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Table A-1
Summary of Service Points by NAICS Code and Customer Sector
Irvine Ranch Water District

NAICS Code	2012 NAICS US Title	Number of Service Points by Sector			
		Commercial	Industrial	Institutional	Total
11	**Agriculture, Forestry, Fishing and Hunting**	**4**	**1**	**--**	**5**
11	Crop Production	4	--	--	4
5	Support Activities for Agriculture and Forestry	--	1	--	1
21	**Mining, Quarrying, and Oil and Gas Extraction**	**4**	**4**	**--**	**8**
3	Support Activities for Mining	4	4	--	8
22	**Utilities**	**30**	**7**	**1**	**38**
1	Utilities	30	7	1	38
23	**Construction**	**296**	**38**	**3**	**337**
23	Construction of Buildings	85	9	--	94
23	Heavy and Civil Engineering Construction	173	10	3	186
8	Specialty Trade Contractors	38	19	--	57
31	**Manufacturing [31 - 33]**	**42**	**28**	**--**	**70**
31	Food Manufacturing	22	9	--	31
31	Beverage and Tobacco Product Manufacturing	3	1	--	4
31	Textile Mills	3	--	--	3
31	Textile Product Mills	3	9	--	12
31	Apparel Manufacturing	9	9	--	18
6	Leather and Allied Product Manufacturing	2	--	--	2
32	**Manufacturing [31 - 33]**	**62**	**48**	**--**	**110**
32	Wood Product Manufacturing	1	1	--	2
32	Paper Manufacturing	1	3	--	4
32	Printing and Related Support Activities	16	10	--	26
32	Petroleum and Coal Products Manufacturing	1	--	--	1
32	Chemical Manufacturing	26	23	--	49
32	Plastics and Rubber Products Manufacturing	5	5	--	10
7	Nonmetallic Mineral Product Manufacturing	12	6	--	18
33	**Manufacturing [31 - 33]**	**234**	**160**	**--**	**394**
33	Primary Metal Manufacturing	3	1	--	4
33	Fabricated Metal Product Manufacturing	25	18	--	43
33	Machinery Manufacturing	18	17	--	35
33	Computer and Electronic Product Manufacturing	91	50	--	141
335	Electrical Equipment, Appliance, and Component Manufacturing	18	12	--	30
33	Transportation Equipment Manufacturing	24	14	--	38
33	Furniture and Related Product Manufacturing	6	3	--	9
9	Miscellaneous Manufacturing	49	45	--	94
42	**Wholesale Trade**	**234**	**99**	**1**	**334**
42	Merchant Wholesalers, Durable Goods	162	68	--	230
4	Merchant Wholesalers, Nondurable Goods	72	31	1	104

Table A-1
Summary of Service Points by NAICS Code and Customer Sector
Irvine Ranch Water District

NAICS Code	2012 NAICS US Title	Number of Service Points by Sector			
		Commercial	Industrial	Institutional	Total
44	**Retail Trade [44 - 45]**	**237**	**41**	**2**	**280**
44	Motor Vehicle and Parts Dealers	38	21	--	59
44	Furniture and Home Furnishings Stores	22	3	--	25
44	Electronics and Appliance Stores	16	--	--	16
444	Building Material and Garden Equipment and Supplies Dealers	16	3	--	19
44	Food and Beverage Stores	66	4	--	70
44	Health and Personal Care Stores	32	4	--	36
44	Gasoline Stations	27	--	--	27
8	Clothing and Clothing Accessories Stores	20	6	2	28
45	**Retail Trade [44 - 45]**	**98**	**12**	**--**	**110**
451	Sporting Goods, Hobby, Musical Instrument, and Book Stores	21	3	--	24
45	General Merchandise Stores	20	2	--	22
45	Miscellaneous Store Retailers	39	7	--	46
4	Nonstore Retailers	18	--	--	18
48	**Transportation and Warehousing [48 - 49]**	**22**	**5**	**5**	**32**
48	Air Transportation	1	1	--	2
48	Truck Transportation	4	1	--	5
48	Transit and Ground Passenger Transportation	7	--	3	10
8	Support Activities for Transportation	10	3	2	15
49	**Transportation and Warehousing [48 - 49]**	**19**	**6**	**4**	**29**
49	Postal Service	1	--	4	5
49	Couriers and Messengers	--	2	--	2
3	Warehousing and Storage	18	4	--	22
51	**Information**	**65**	**11**	**1**	**77**
51	Publishing Industries (except Internet)	20	6	--	26
51	Motion Picture and Sound Recording Industries	9	--	--	9
51	Broadcasting (except Internet)	12	3	--	15
51	Telecommunications	17	2	--	19
8	Data Processing, Hosting, and Related Services	3	--	--	3
9	Other Information Services	4	--	1	5
52	**Finance and Insurance**	**180**	**13**	**1**	**194**
52	Credit Intermediation and Related Activities	73	2	1	76
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	76	6	--	82
52	Insurance Carriers and Related Activities	30	5	--	35
5	Funds, Trusts, and Other Financial Vehicles	1	--	--	1
53	**Real Estate and Rental and Leasing**	**904**	**130**	**--**	**1034**
53	Real Estate	885	129	--	1014
53	Rental and Leasing Services	18	1	--	19
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	1	--	--	1
54	**Professional, Scientific, and Technical Services**	**289**	**46**	**43**	**378**
1	Professional, Scientific, and Technical Services	289	46	43	378
55	**Management of Companies and Enterprises**	**21**	**3**	**--**	**24**

Table A-1
Summary of Service Points by NAICS Code and Customer Sector
Irvine Ranch Water District

NAICS Code	2012 NAICS US Title	Number of Service Points by Sector			
		Commercial	Industrial	Institutional	Total
1	Management of Companies and Enterprises	21	3	--	24
56	**Administrative and Support and Waste Management and Remediation Services**	**245**	**23**	**2**	**270**
56	Administrative and Support Services	236	23	1	260
2	Waste Management and Remediation Services	9	--	1	10
61	**Educational Services**	**103**	**6**	**130**	**239**
1	Educational Services	103	6	130	239
62	**Health Care and Social Assistance**	**170**	**25**	**20**	**215**
62	Ambulatory Health Care Services	117	22	1	140
62	Hospitals	6	--	--	6
62	Nursing and Residential Care Facilities	9	--	--	9
4	Social Assistance	38	3	19	60
71	**Arts, Entertainment, and Recreation**	**74**	**4**	**7**	**85**
71 1	Performing Arts, Spectator Sports, and Related Industries	13	1	--	14
71 2	Museums, Historical Sites, and Similar Institutions	1	--	--	1
71 3	Amusement, Gambling, and Recreation Industries	60	3	7	70
72	**Accommodation and Food Services**	**518**	**16**	**2**	**536**
72	Accommodation	191	2	--	193
2	Food Services and Drinking Places	327	14	2	343
81	**Other Services (except Public Administration)**	**583**	**27**	**2**	**612**
81	Repair and Maintenance	68	7	--	75
81	Personal and Laundry Services	73	4	1	78
81 3	Religious, Grantmaking, Civic, Professional, and Similar Organizations	442	16	1	459
92	**Public Administration**	**19**	**--**	**84**	**103**
92 1	Executive, Legislative, and Other General Government Support	13	--	30	43
92	Justice, Public Order, and Safety Activities	4	--	46	50
92	Administration of Human Resource Programs	--	--	3	3
92	Administration of Economic Programs	1	--	5	6
7	Space Research and Technology	1	--	--	1

Source
NAICS codes for commercial, industrial and institutional (CII) accounts provided by IRWD on 8 January 2019.

Appendix B

Alternative Participation Density Hot Spot Analyses

Participation Density
Turf Removal for SFR Accounts
2011 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for Turf Removal for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-1a

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Path: X:\B80129\Maps\2019\12_Final\Fig B-1a_HotSpot_TurfRemoval_SFR alt 1.mxd

Participation Density
Turf Removal for SFR Accounts
2011 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for Turf Removal for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-1b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-1B_HotSpot_TurfRemoval_SFR alt 2.mxd

Participation Density
WBIC Rebates for SFR Accounts
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for WBIC Rebates for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-2a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-2a_HotSpot_WBIC_Rebates_SFR alt 1.mxd

Participation Density
WBIC Rebates for SFR Accounts
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for SFR Accounts

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for WBIC Rebates for SFR Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure B-2b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-2b_HotSpot_WBIC_Rebates_SFR alt 2.mxd

Participation Density
SFR One-Stop-Shop WBICs
2017 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC SFR No-Cost Program

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for SFR One-Stop-Shop WBICs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-3a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-3a_HotSpot_WBIC_NoCost_SFR alt 1.mxd

Participation Density
SFR One-Stop-Shop WBICs
2017 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC SFR No-Cost Program

Abbreviations

IRWD = Irvine Ranch Water District
SFR = single family residential
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for SFR One-Stop-Shop WBICs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-3b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-3b_HotSpot_WBIC_NoCost_SFR alt 2.mxd

Participation Density
SFR HET Rebate Program
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HET Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for SFR HET Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-4a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-4a_HotSpot_HET_Rebates_SFR alt 1 .mxd

Participation Density
SFR HET Rebate Program
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HET Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for SFR HET Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-4b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-4b_HotSpot_HET_Rebates_SFR alt 2.mxd

Participation Density
SFR One-Stop-Shop HETs
2017-2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR No-Cost HET Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for SFR One-Stop-Shop HETs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-5a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-5a_HotSpot_HET_NoCost_SFR alt 1.mxd

Participation Density
SFR One-Stop-Shop HETs
2017-2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR No-Cost HET Program

Abbreviations

IRWD = Irvine Ranch Water District
HET = high efficiency toilet
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for SFR One-Stop-Shop HETs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

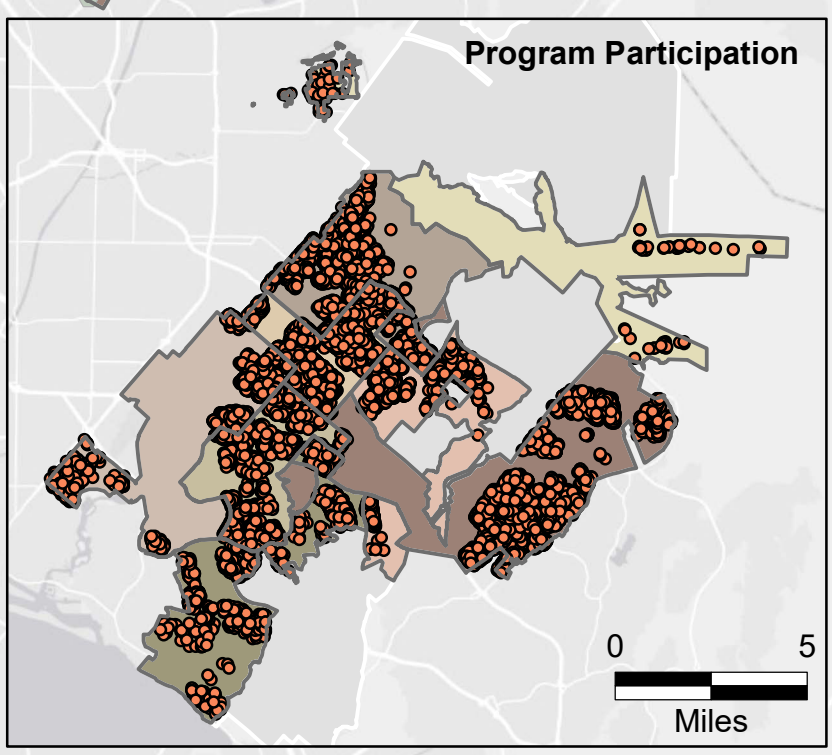
Figure B-5b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-5b_HotSpot_HET_NoCost_SFR alt 2.mxd

Participation Density
SFR HECW Rebate Program
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E



Legend

- Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HECW Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HECW = high efficiency clothes washer
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for SFR HECW Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-6a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-6a_HotSpot_HECW_Rebates_SFR alt 1.mxd

Participation Density
SFR HECW Rebate Program
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- SFR HECW Rebate Program

Abbreviations

IRWD = Irvine Ranch Water District
HECW = high efficiency clothes washer
SFR = single family residential

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for SFR HECW Rebate Program

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-6b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-6b_HotSpot_HECW_Rebates_SFR alt 2.mxd

Participation Density
WBIC Rebates for Large Landscape Accounts
2008 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for Large Landsacpe Accounts

Abbreviations

IRWD = Irvine Ranch Water District
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for WBIC Rebates for Large Landscape Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-7a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-7a_HotSpot_WBIC_LargeLandscape alt 1.mxd

Participation Density
WBIC Rebates for Large Landscape Accounts
2008 - 2018

Group A
Group B
Group H
Group G
Group D
Group F
Group C
Group E

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- WBIC Rebates for Large Landsacpe Accounts

Abbreviations

IRWD = Irvine Ranch Water District
WBIC = weather-based irrigation controller

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

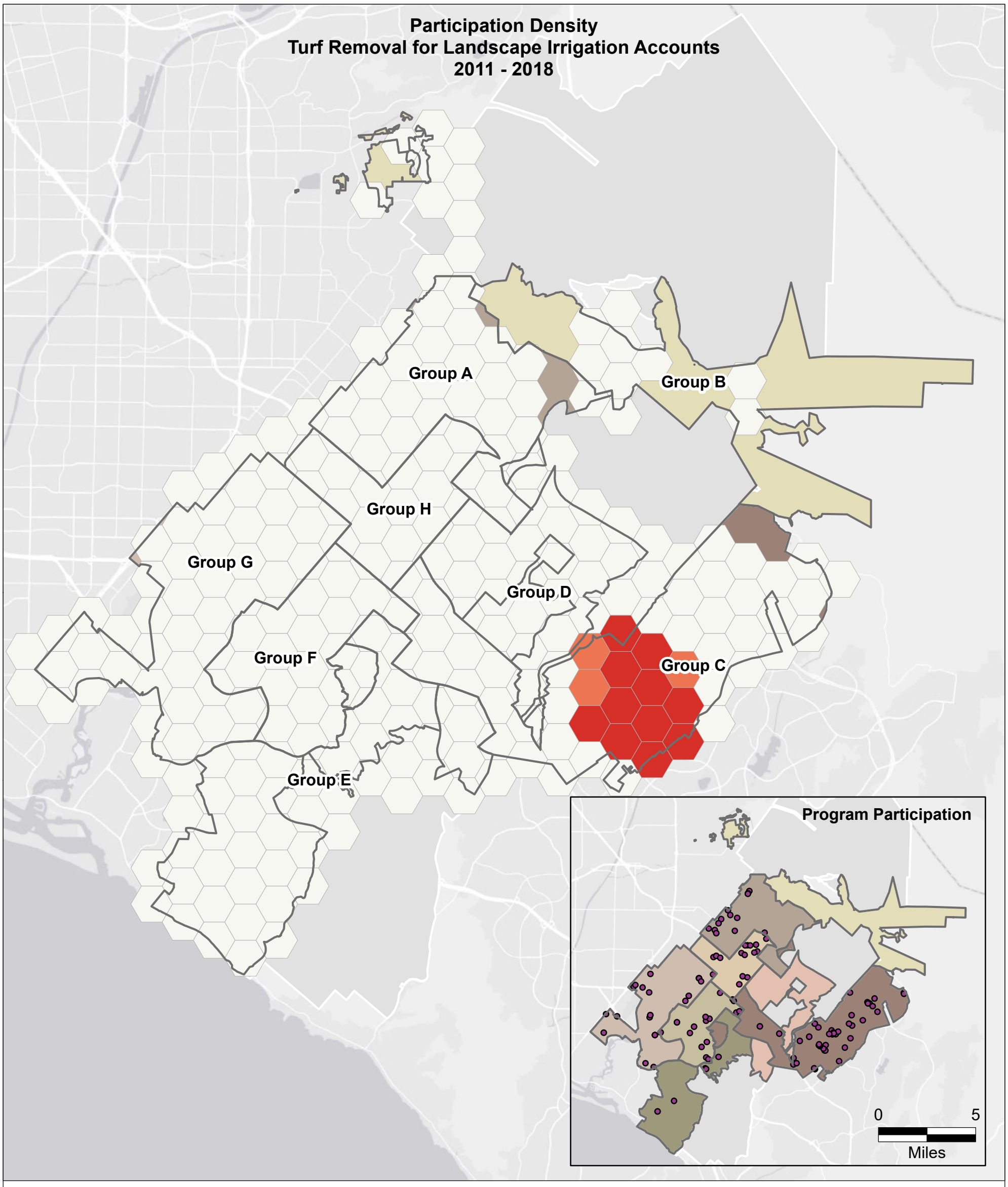
Alternative 2: Participation Density for WBIC Rebates for Large Landscape Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure B-7b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-7b_HotSpot_WBIC_LargeLandscape alt 2.mxd

Participation Density
Turf Removal for Landscape Irrigation Accounts
2011 - 2018



Legend

- Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for Landscape Irrigation Accounts

Abbreviations

IRWD = Irvine Ranch Water District

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N

0 2 4

(Scale in Miles)

Alternative 1: Participation Density for Turf Removal for Landscape Irrigation Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-8a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-8a_HotSpot_TurfRemoval_IRR alt 1.mxd

Participation Density
Turf Removal for Landscape Irrigation Accounts
2011 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal for Landscape Irrigation Accounts

Abbreviations

IRWD = Irvine Ranch Water District

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for Turf Removal for Landscape Irrigation Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-8b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-8b_HotSpot_TurfRemoval_IRR alt 2.mxd

Participation Density
Turf Removal Rebates for CII Accounts
2013 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- Turf Removal Rebates for CII Accounts

Abbreviations

IRWD = Irvine Ranch Water District
CII = commercial, industrial, and institutional

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.
3. The sample size of the CII turf removal program participants is not sufficient to run the Alternative 1 Analysis, and therefore could not be included.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for Turf Removal Rebates for CII Accounts

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00
Figure B-9

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-9 HotSpot_TurfRemoval_CII alt 2.mxd

Participation Density
All CII Indoor Rebate Programs
2011 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- All CII Indoor Rebate Programs

Abbreviations

IRWD = Irvine Ranch Water District
CII = commercial, industrial, and institutional

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 1: Participation Density for All CII Indoor Rebate Programs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-10a

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-10a_HotSpot_CII_Indoor_Rebates alt 1.mxd

Participation Density
All CII Indoor Rebate Programs
2011 - 2018

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Group H

Program Participation

0 5
Miles

Legend

Village Group Boundary

Participation Hot and Cold Spots

- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Program Participation

- All CII Indoor Rebate Programs

Abbreviations

IRWD = Irvine Ranch Water District
CII = commercial, industrial, and institutional

Notes

1. All locations are approximate.
2. Program participation hot and cold spots were evaluated using the Esri ArcGIS 10.6.0 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord GI* statistic. This statistic is a measure of the spatial distribution of incidents (participation) relative to a random, equally-spaced distribution.

Sources

1. Water use efficiency program data received from IRWD in February 2019.
2. Village boundaries received from IRWD on 9 January 2019.
3. Basemap provided by ESRI.

N
0 2 4
(Scale in Miles)

Alternative 2: Participation Density for All CII Indoor Rebate Programs

Irvine Ranch Water District
Orange County, California
December 2019
B80129.00

Figure B-10b

eki environment & water

Path: X:\B80129\Maps\2019\12_Final\Fig B-10b_HotSpot_CII_Indoor_Rebates_alt 2.mxd

Appendix C

Box-Plots of Water Savings Analysis Group Populations

Appendix C
Box-Plots of Water Savings Analysis Group Populations

The following box-plots illustrate the population variation for both participant (red boxes) and program sample groups (green boxes) used in the water savings analysis presented in Section 4 of the Future Potential Water Efficiency Study (Study). The box-plots also illustrate the population variation of the resultant water savings estimates (blue boxes). An explanation of the elements of a box-plot is provided further below.

For each of the ten programs analyzed, two box-plots are shown. The first box-plot presents the entirety of the dataset used, and the scale of the second box-plot is zoomed-in to allow for easier comparison of the inter-quartile ranges (IQRs).

These box-plots illustrate that the significant variability in the water savings amounts for the cohort sample groups and the significantly lower variability in the water savings for the participant sample groups. They also show that there is generally an increased water savings by the participant sample groups relative to the cohort sample groups for the SFR Turf Removal, HET/PHET Rebate, HECW Rebate, and One-Stop programs. The water savings data for the non-SFR programs are much more variable, likely due to the relatively limited number of service points (SPs) available for the analysis.

Based on this analysis, the sample and cohort populations appear to reflect a similar level of variability, and do not appear to be skewed by outliers. By using the largest participant and cohort group population sizes available, this analysis minimizes the effects of individual outlier results and instead reflects the inherent variability associated with people's behaviors, habits, and needs.

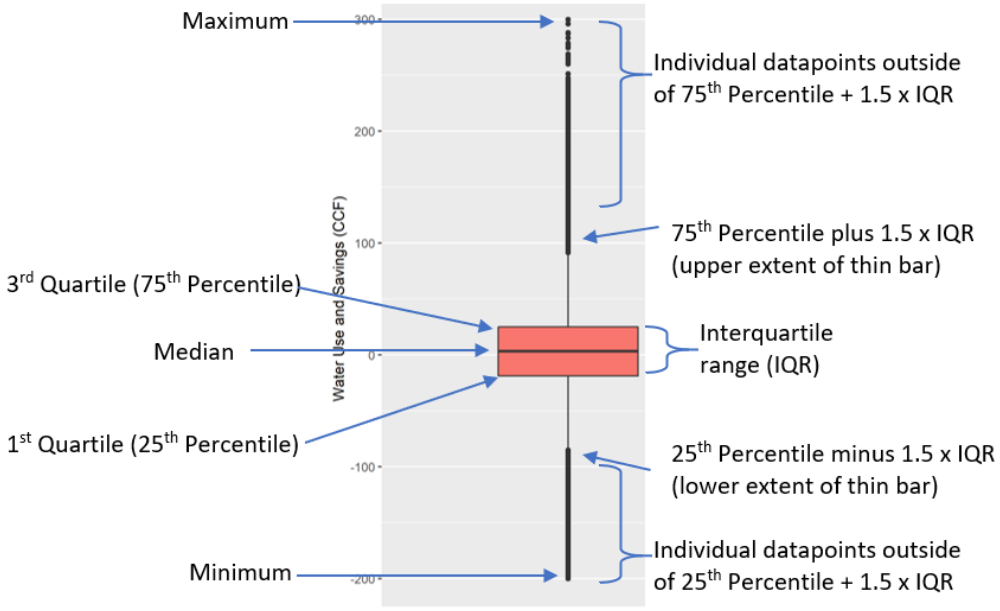
Explanation of Box-Plot Elements:

A box-plot (also referred to as a box and whisker plot) displays the five-number summary of a set of data. The five-number summary is the minimum, first quartile (Q2), median, third quartile(Q3), and maximum. These points are identified on the key diagram on the following page.

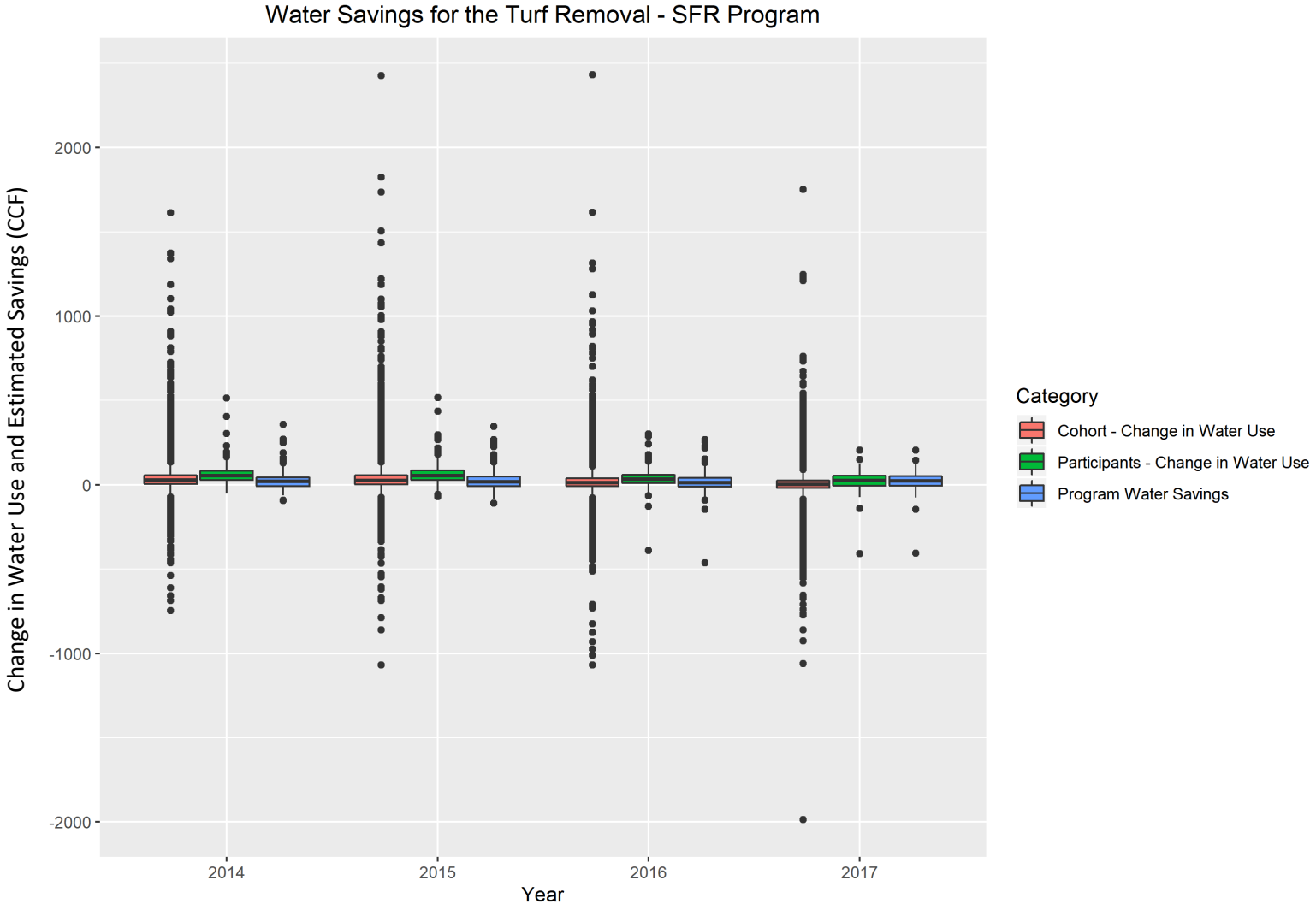
The median is represented by a horizontal bar within the box. The IQR is the width of the box in the box-plot, and represents the data falling between the first and third quartile (the middle 50% of the population). The IQR can be used as a measure of how spread-out the values are. If the data is skewed, the median will not be exactly in the middle of the IQR. The medians can be found throughout the boxes because of how each set of data is distributed.

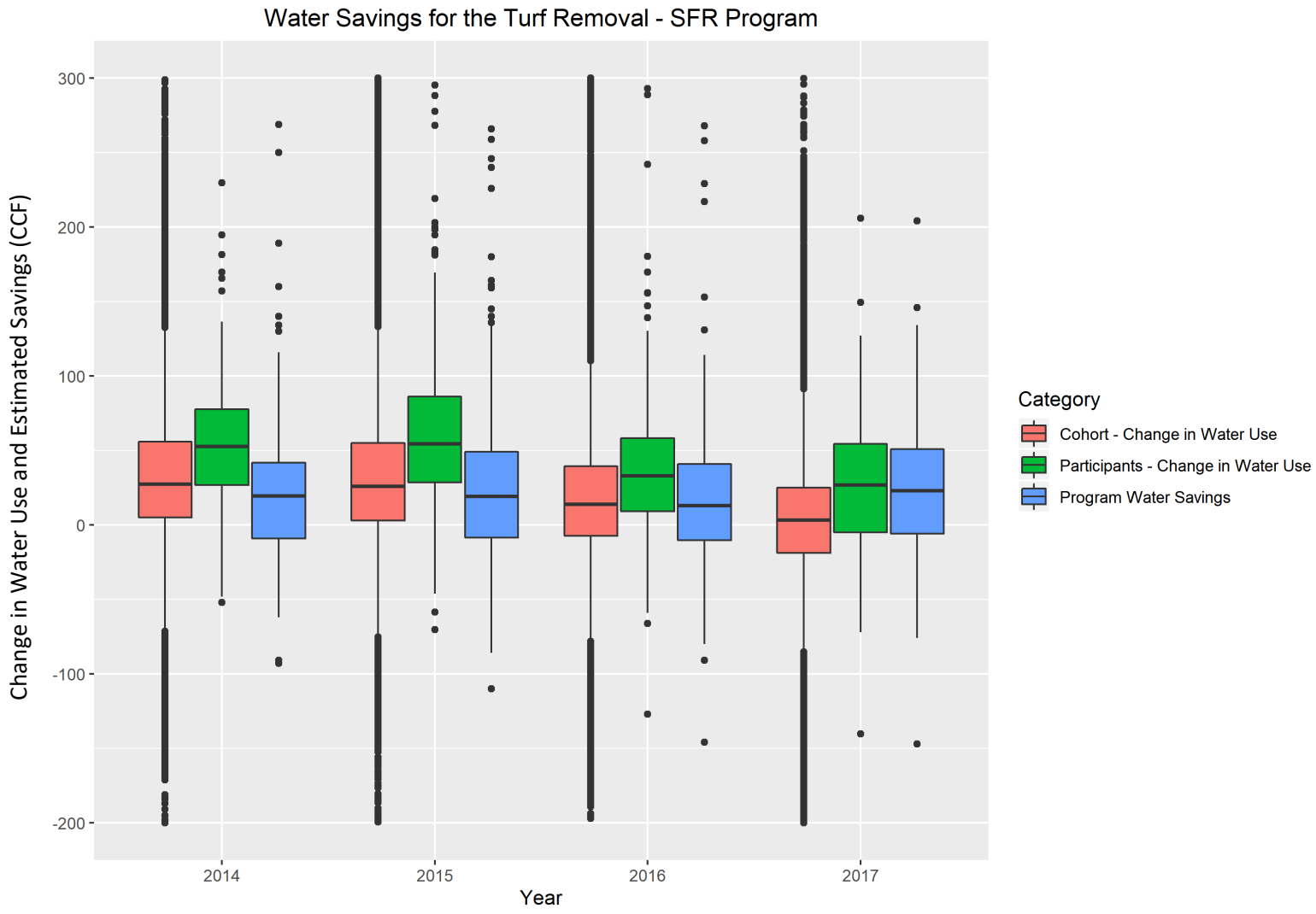
The points located on the on the extreme vertical ends of the plots represent the minimum and maximum values of the population. When reviewing a box-plot, an outlier is defined as a data point that is located outside the fences (or whiskers) of the boxplot. The fences represent 1.5 times the interquartile range above the upper quartile and below the lower quartile.

Box-Plot Key

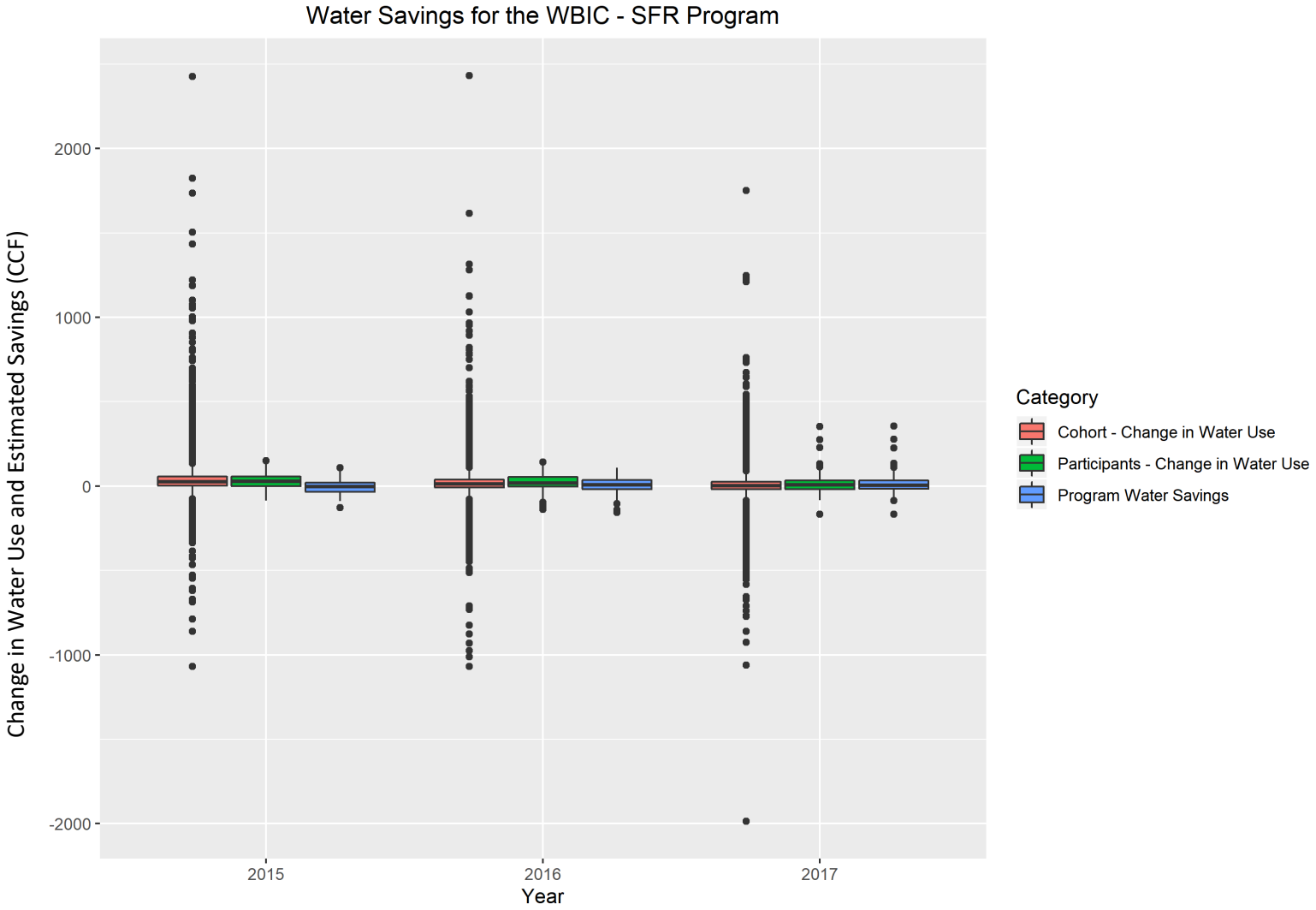

Maximum
Individual datapoints outside of 75th Percentile + 1.5 x IQR
75th Percentile plus 1.5 x IQR (upper extent of thin bar)
3rd Quartile (75th Percentile)
Median
Interquartile range (IQR)
1st Quartile (25th Percentile)
25th Percentile minus 1.5 x IQR (lower extent of thin bar)
Minimum
Individual datapoints outside of 25th Percentile + 1.5 x IQR
Water Use and Savings (CCF)
300
200
100
0
-100
-200

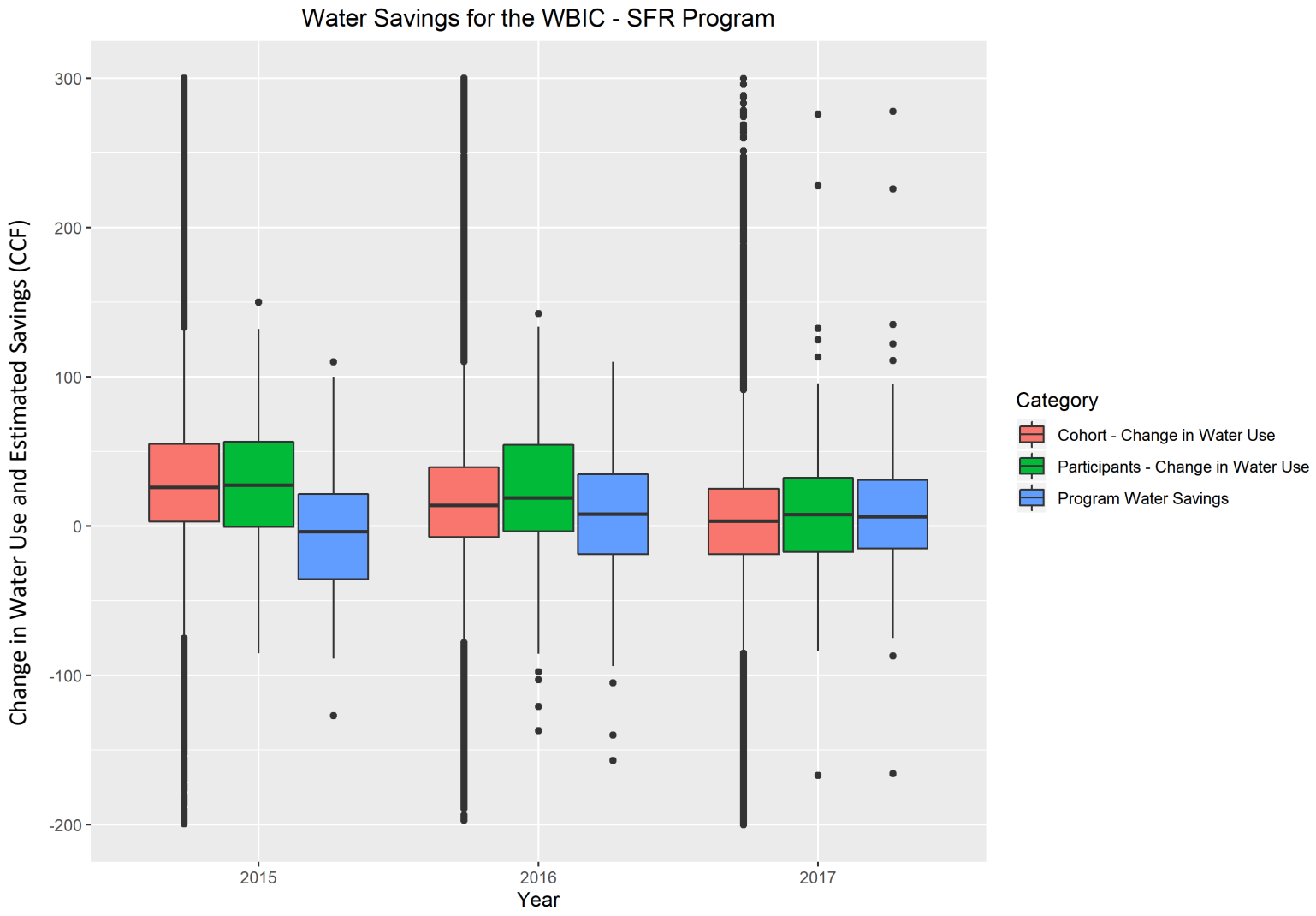
Sample Population Variation for SFR Turf Removal Program Water Savings Analysis



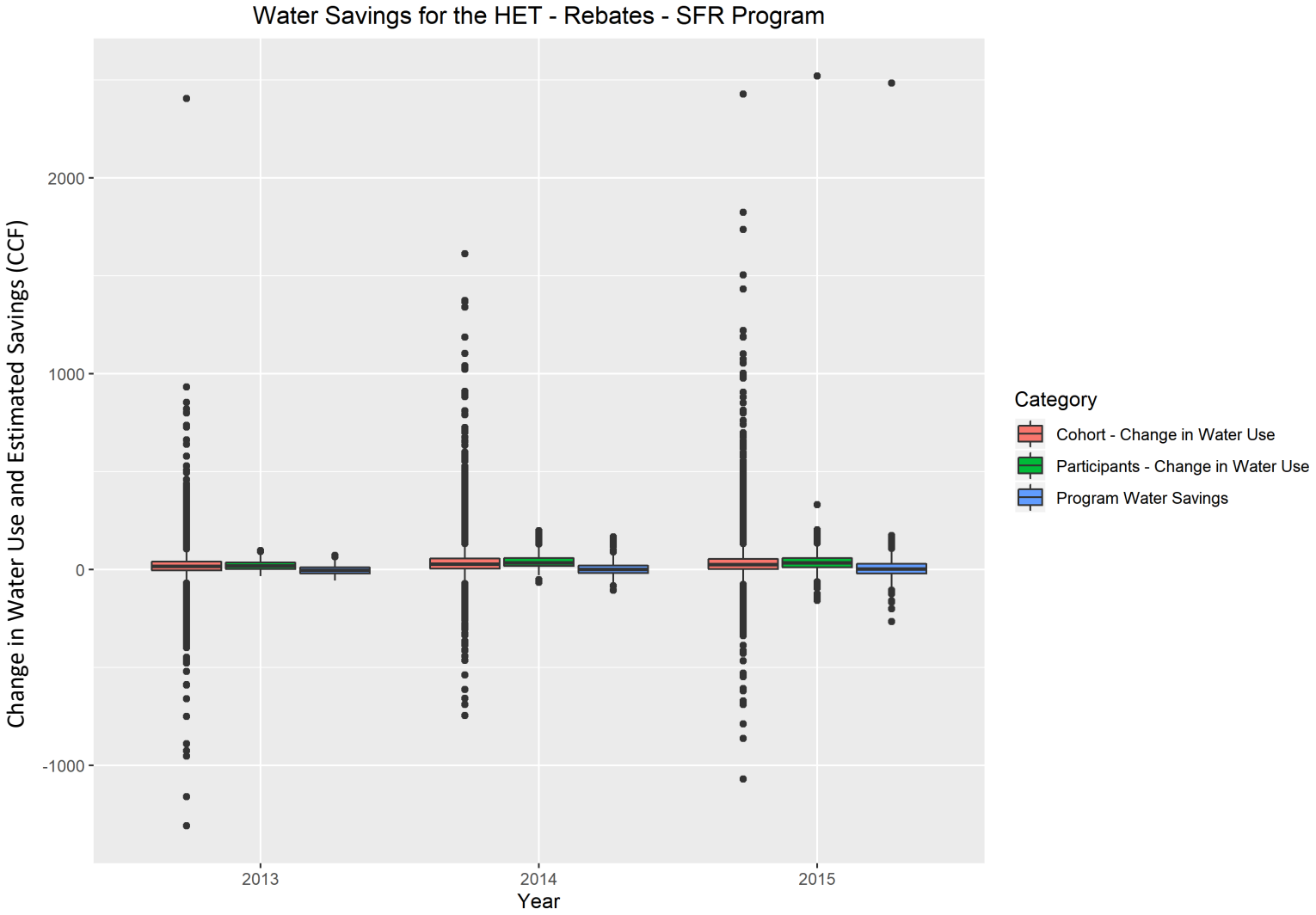

Water Savings for the Turf Removal - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2014
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

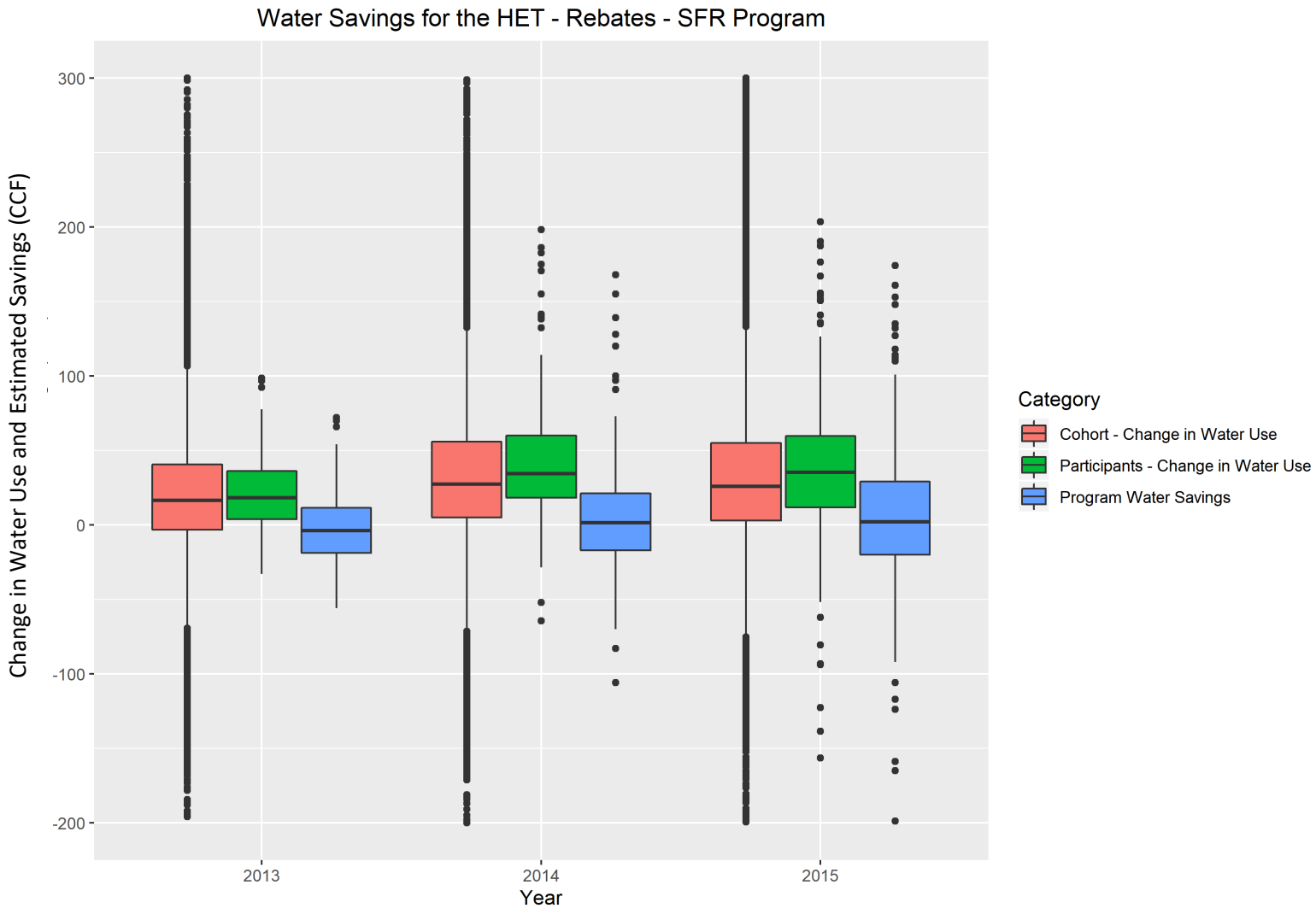
Sample Population Variation for SFR WBIC Rebate Program Water Savings Analysis



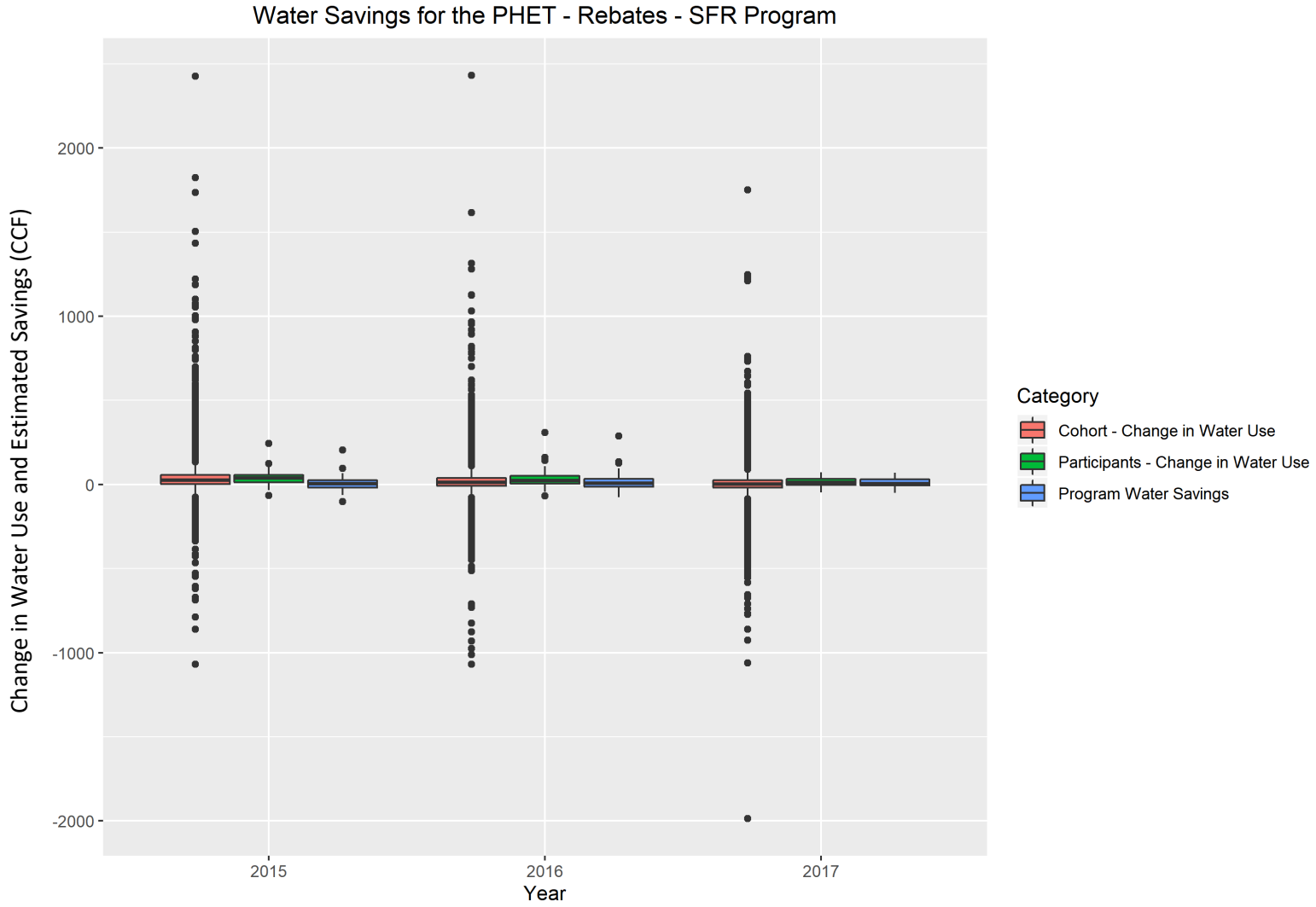

Water Savings for the WBIC - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

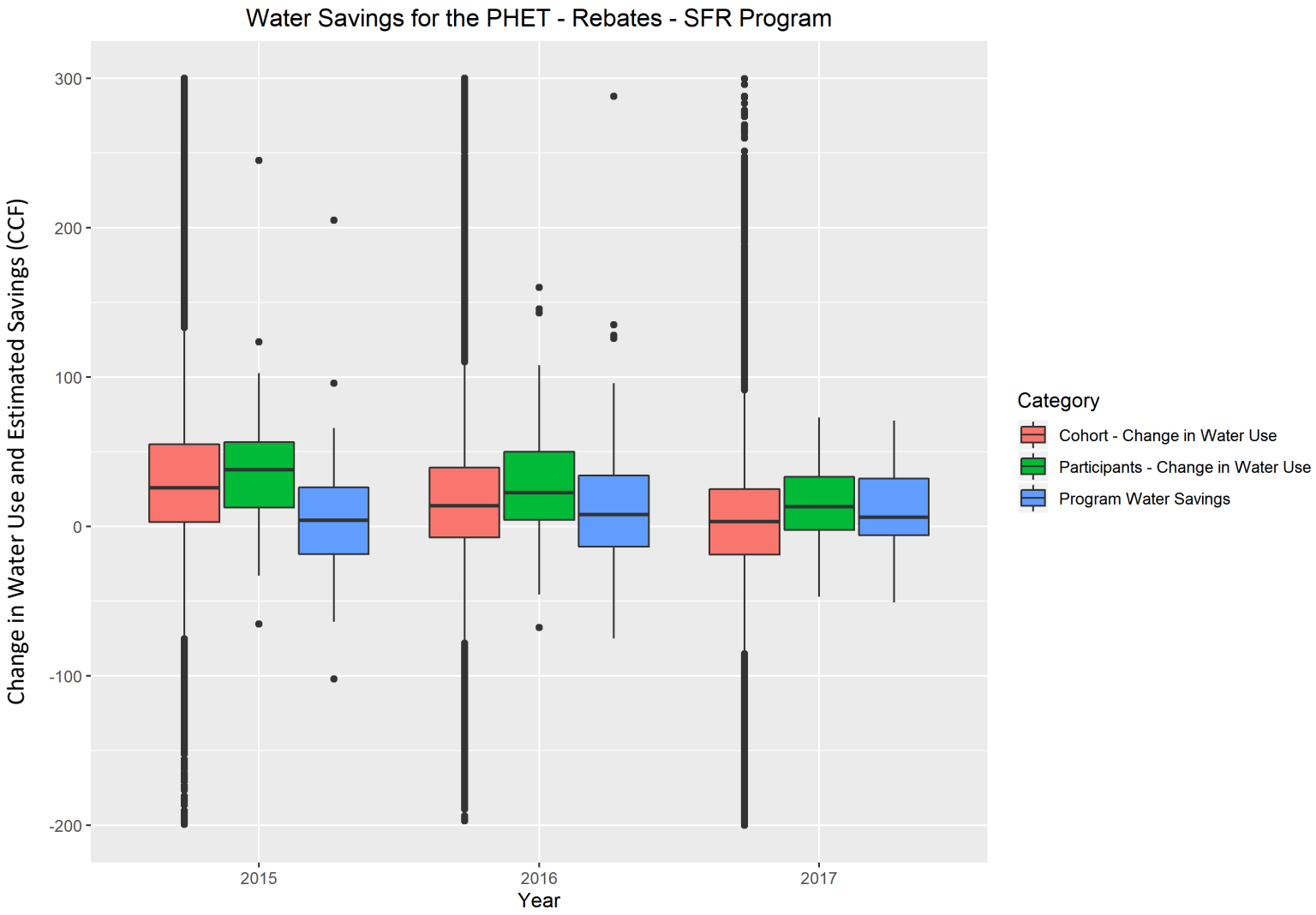
Sample Population Variation for SFR HET Rebate Program Water Savings Analysis



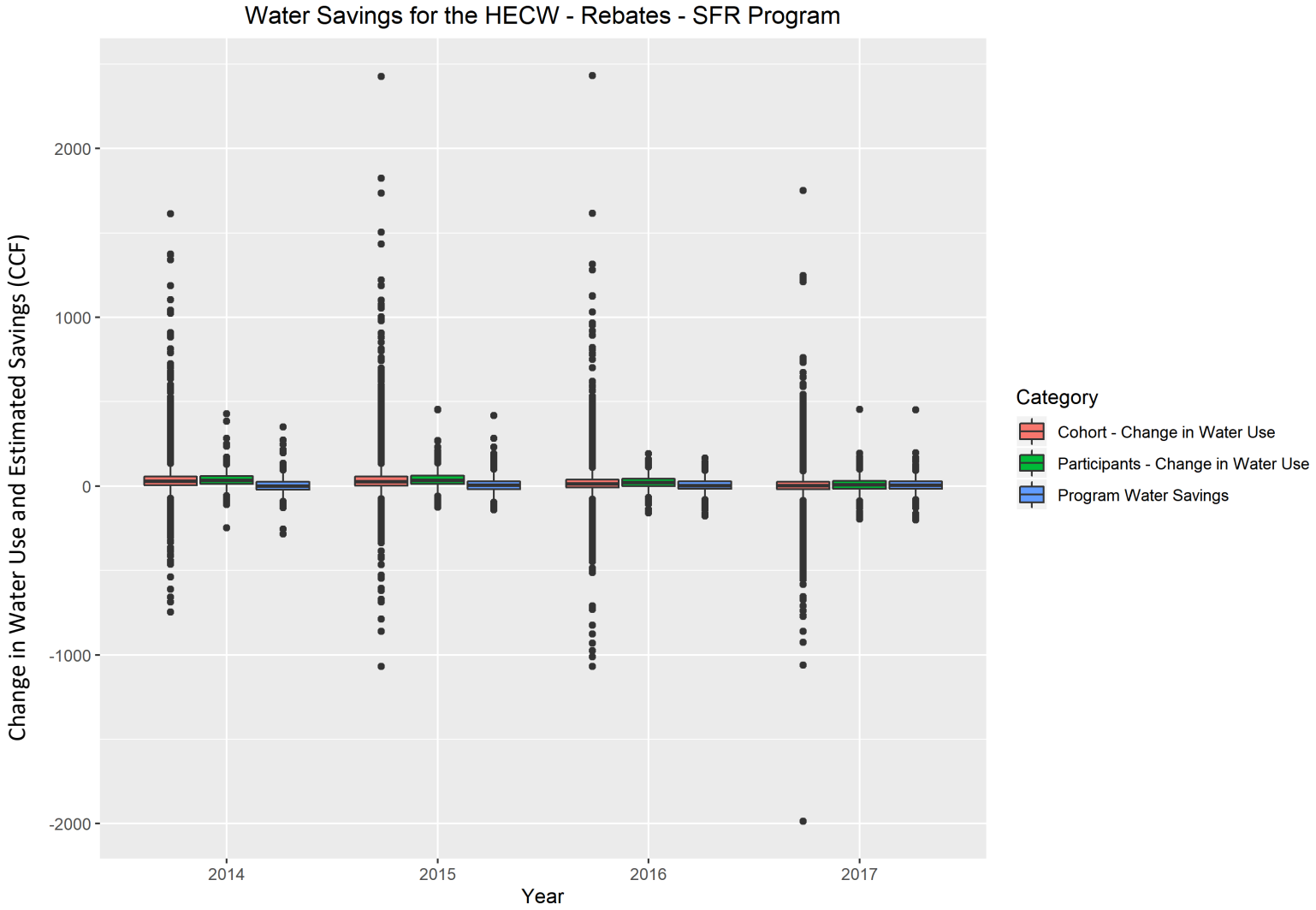

Water Savings for the HET - Rebates - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2013
2014
2015
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

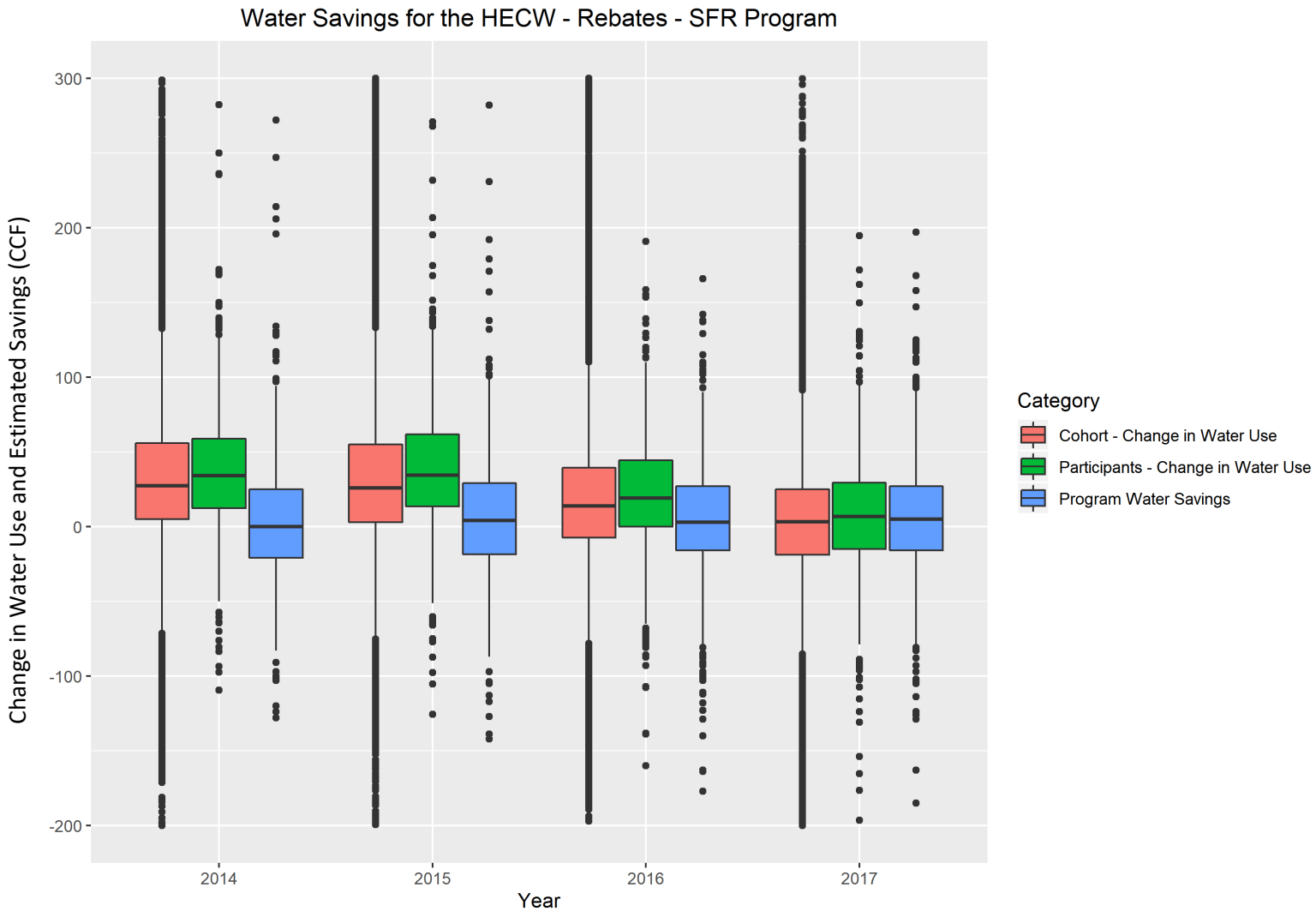
Sample Population Variation for SFR PHET Rebate Program Water Savings Analysis



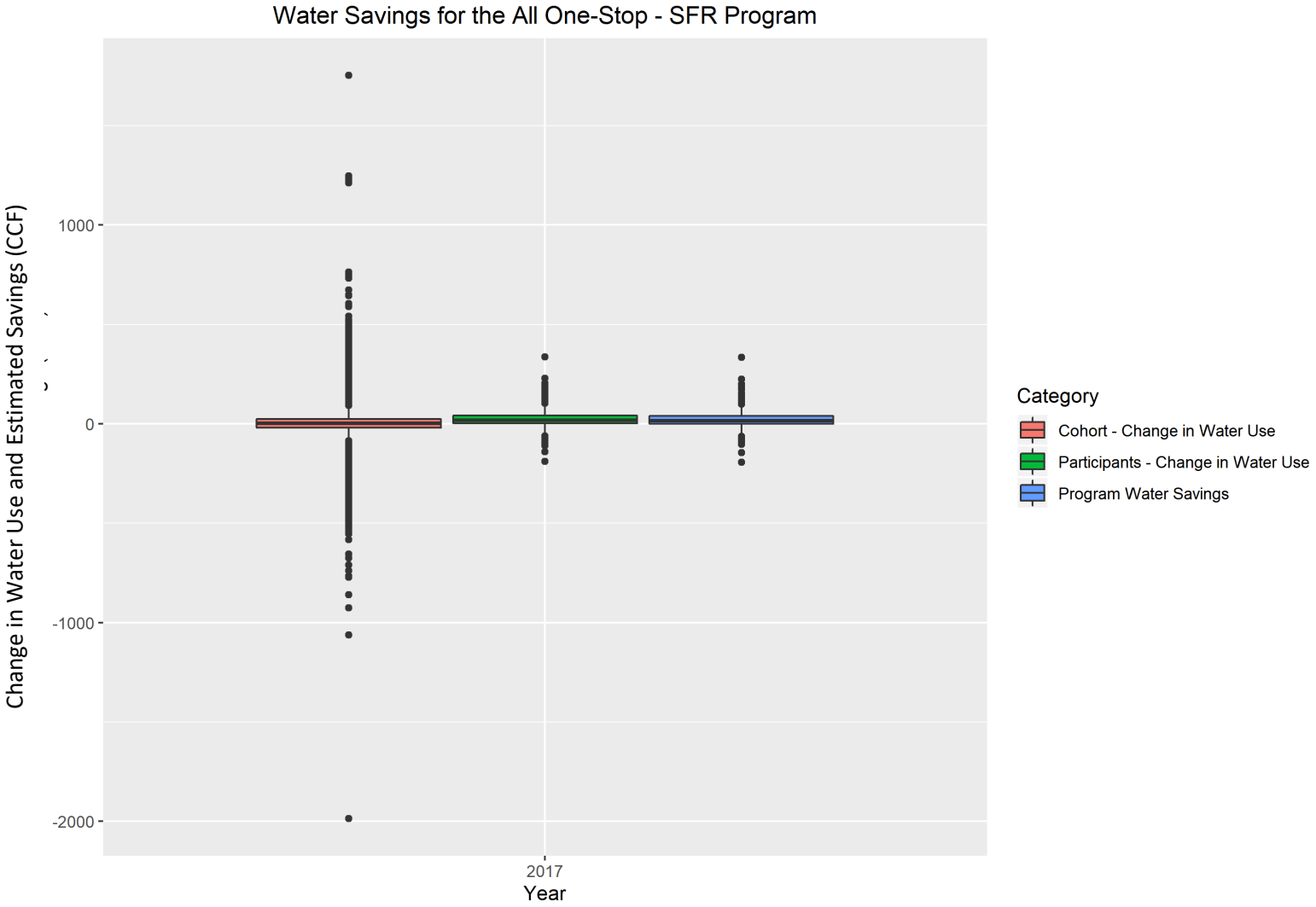

Water Savings for the PHET - Rebates - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

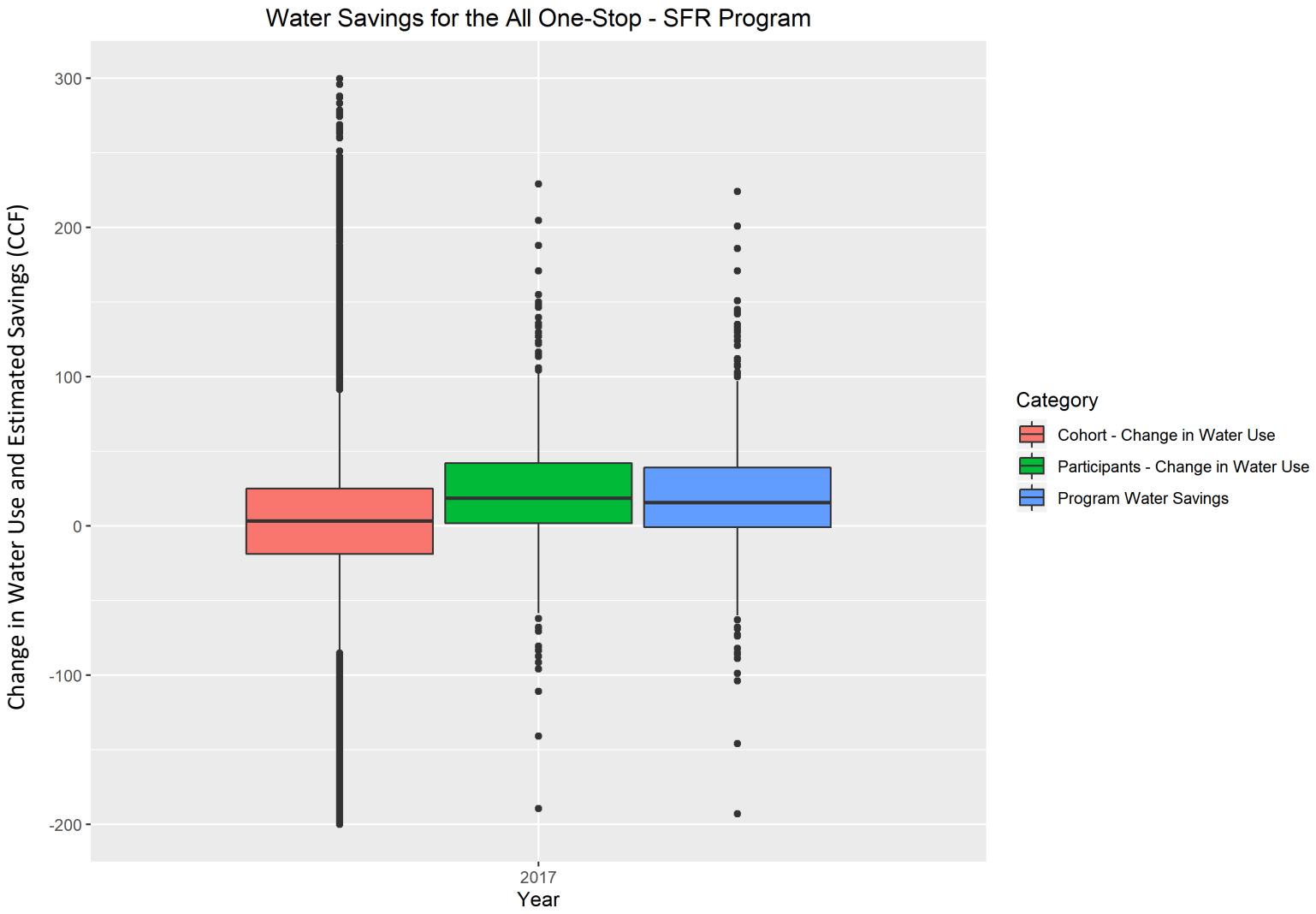
Sample Population Variation for SFR HECW Rebates Program Water Savings Analysis



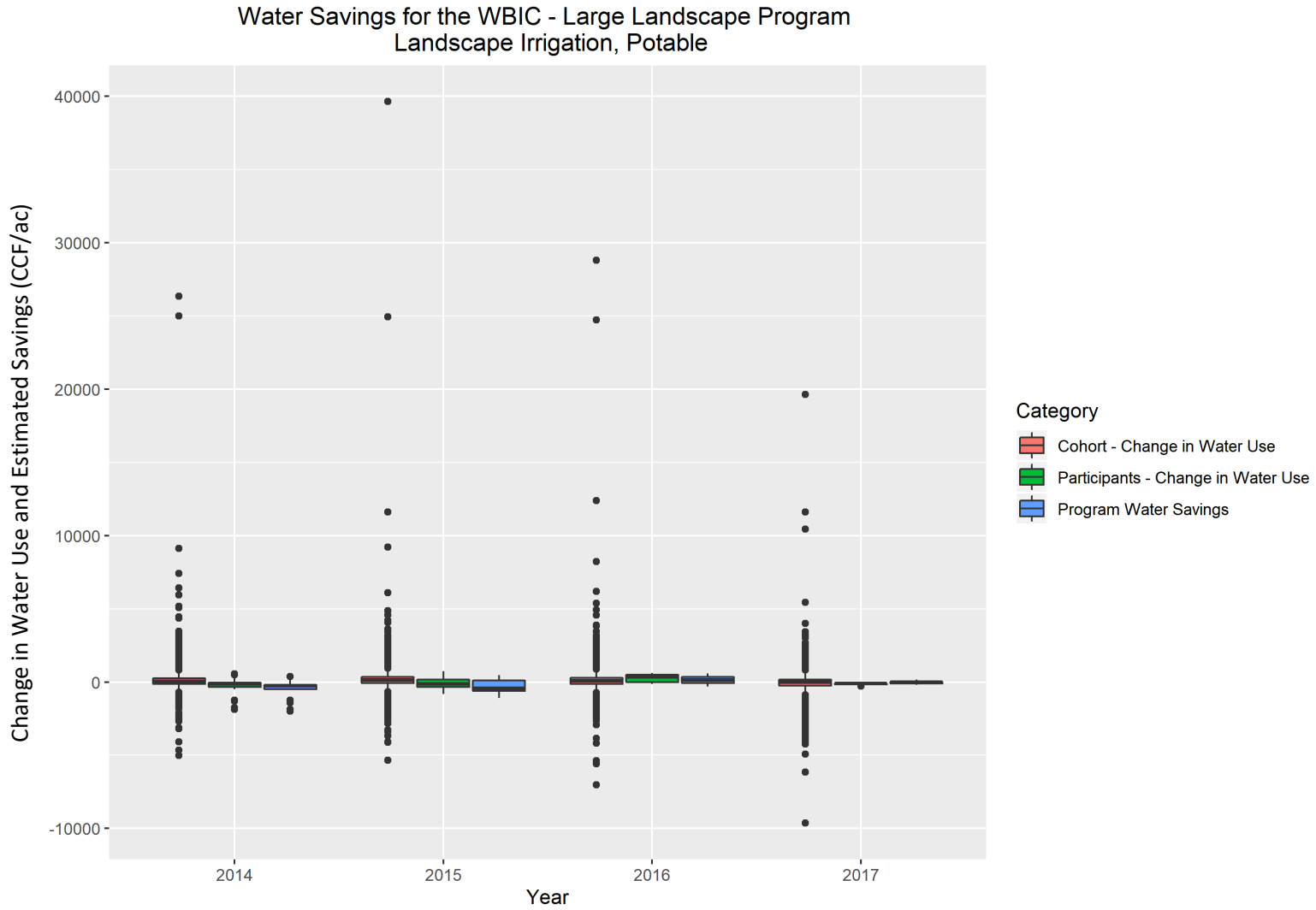

Water Savings for the HECW - Rebates - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2014
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

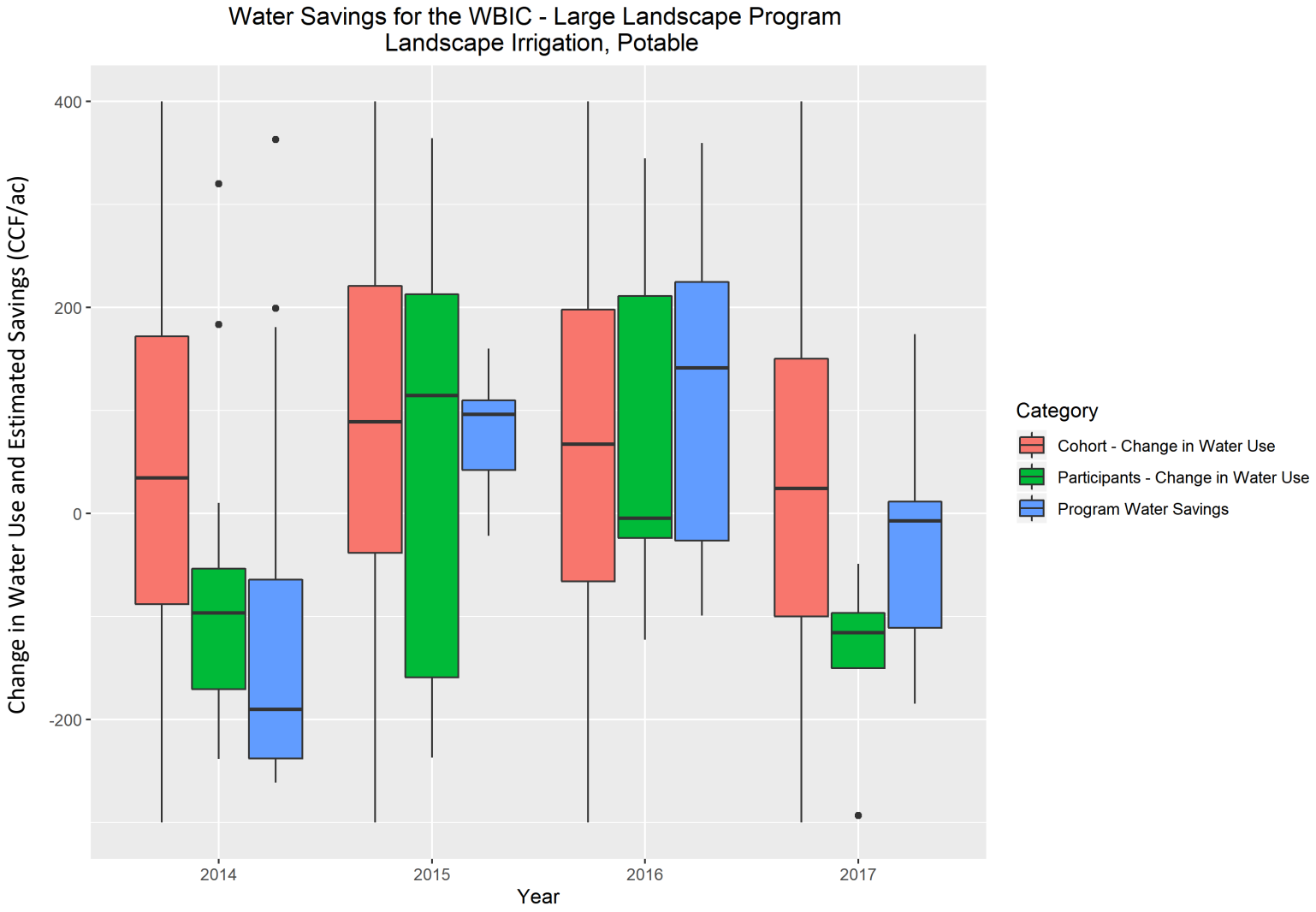
Sample Population Variation for One-Stop-Shop Program Water Savings Analysis



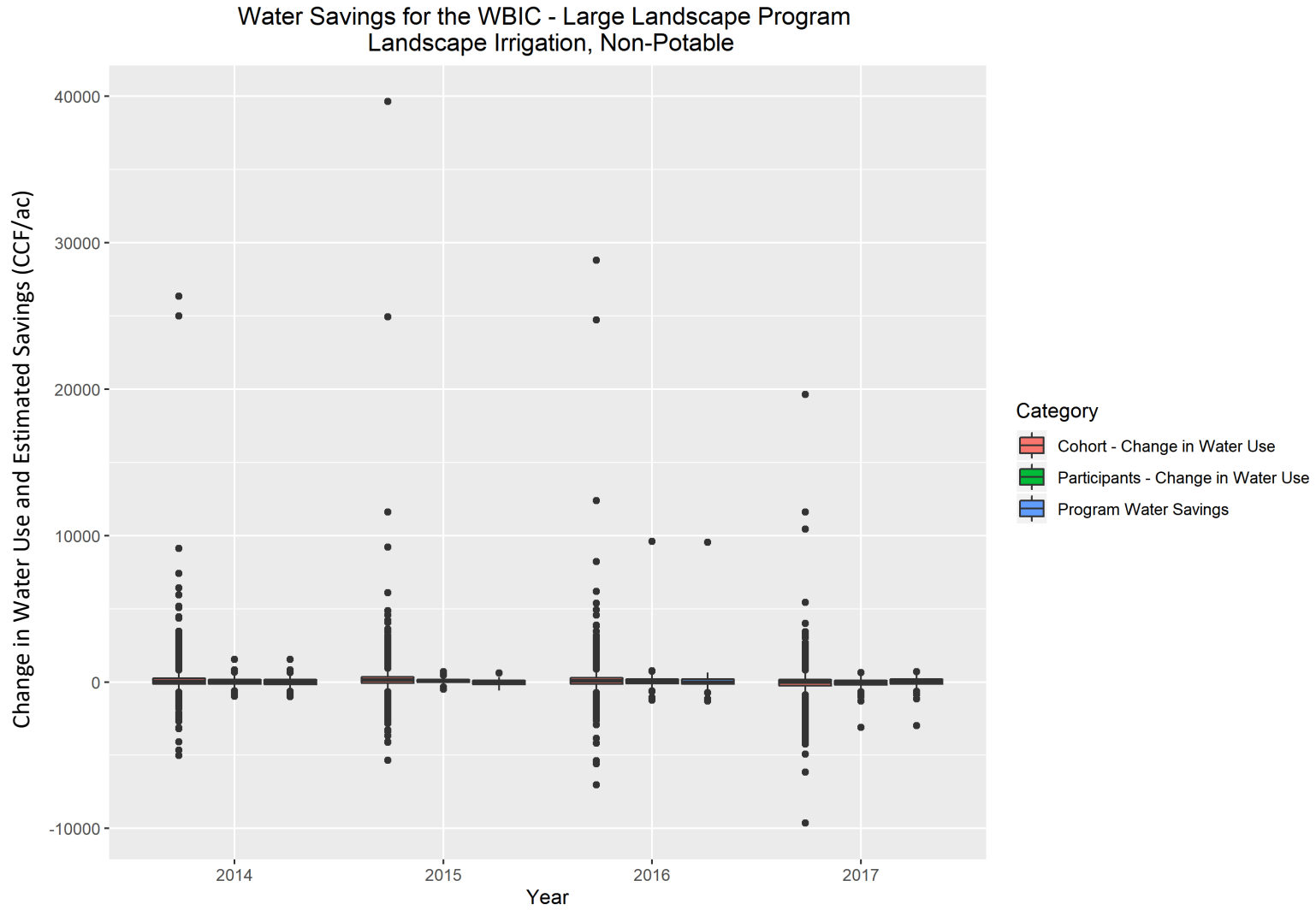

Water Savings for the All One-Stop - SFR Program
Change in Water Use and Estimated Savings (CCF)
300
200
100
0
-100
-200
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

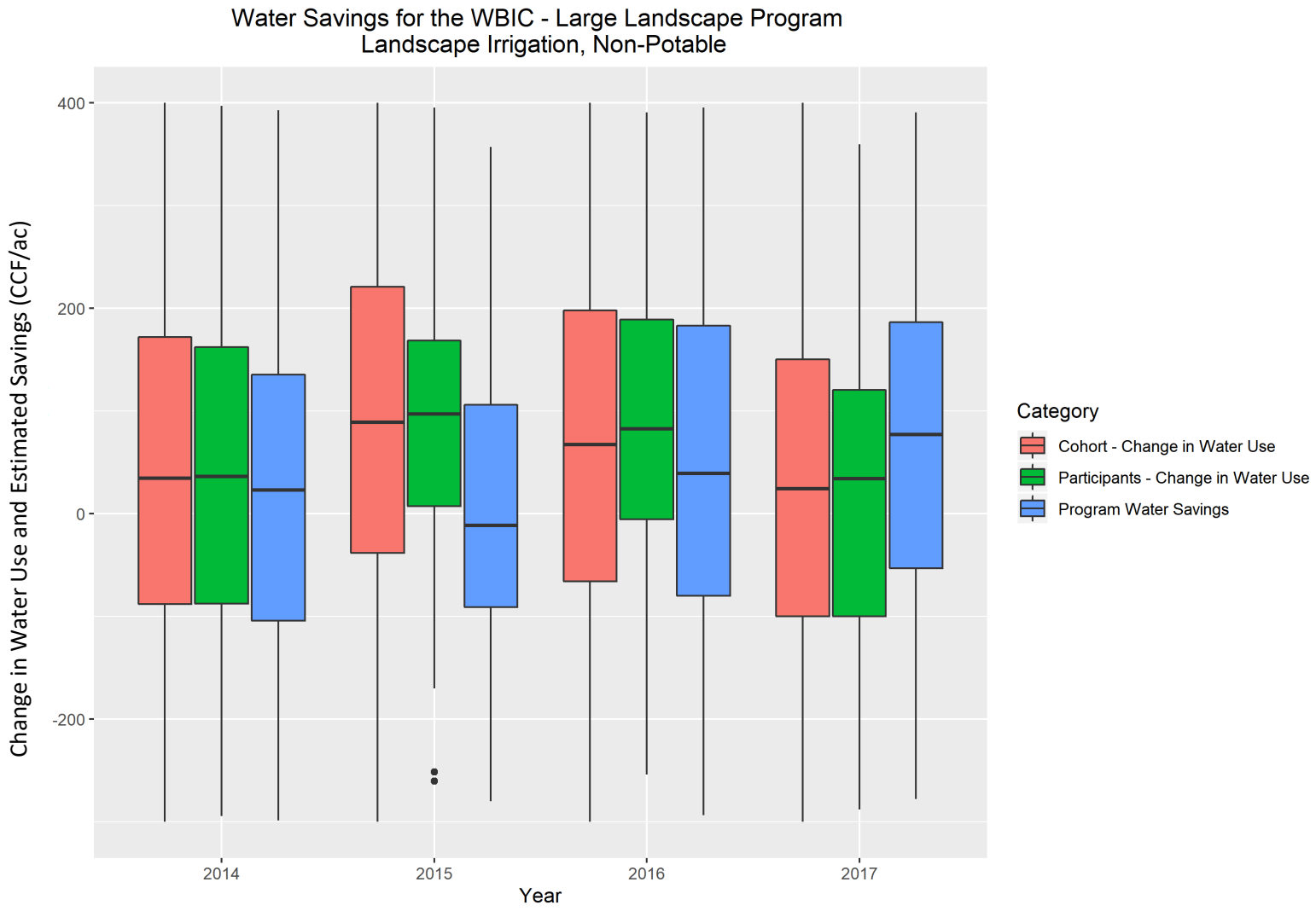
Sample Population Variation for WBIC Rebates for Potable Landscape Irrigation Accounts Program Water Savings Analysis



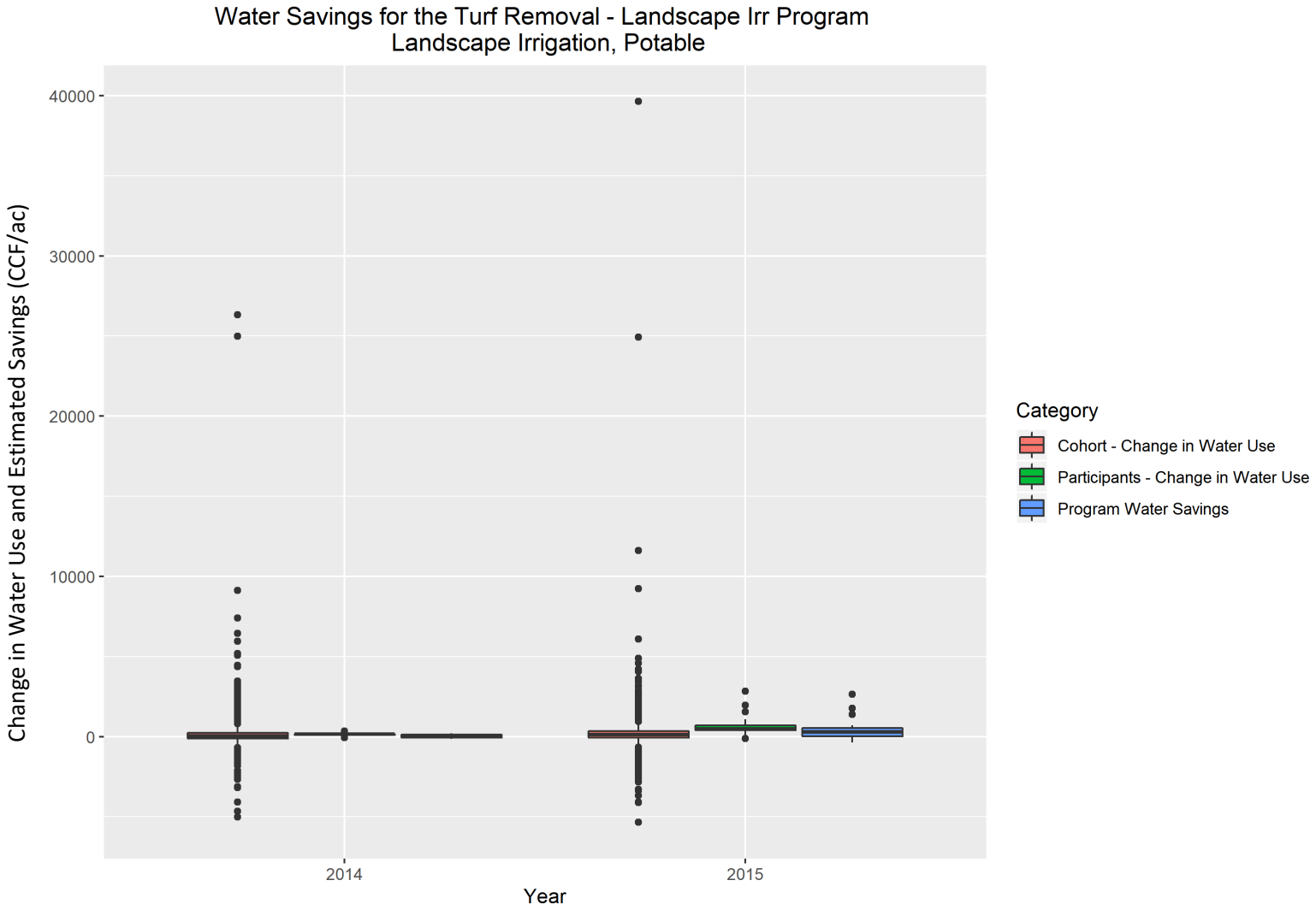

Water Savings for the WBIC - Large Landscape Program
Landscape Irrigation, Potable
Change in Water Use and Estimated Savings (CCF/ac)
400
200
0
-200
2014
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

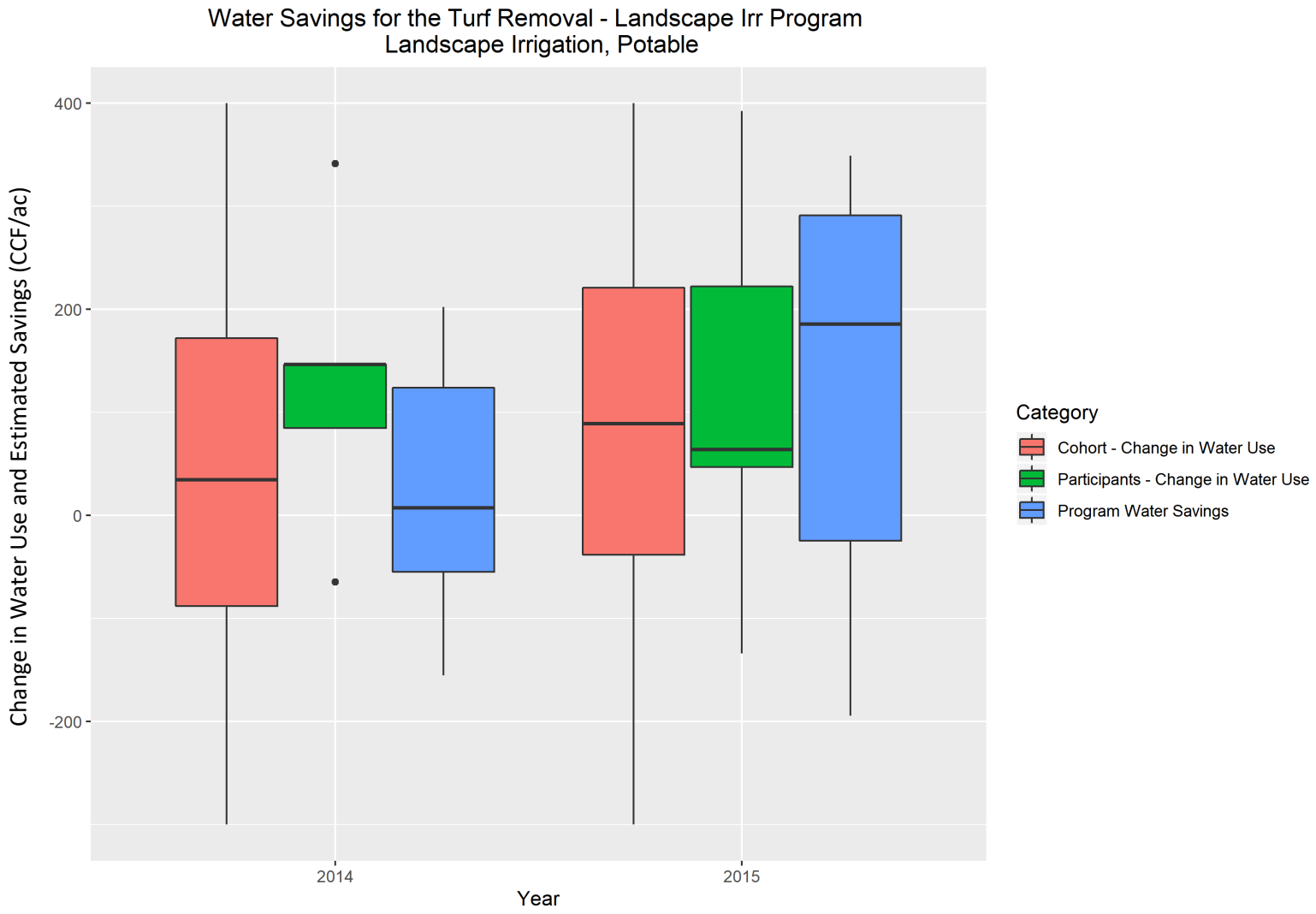
Sample Population Variation for WBIC Rebates for Non-Potable Landscape Irrigation Accounts Program Water Savings Analysis



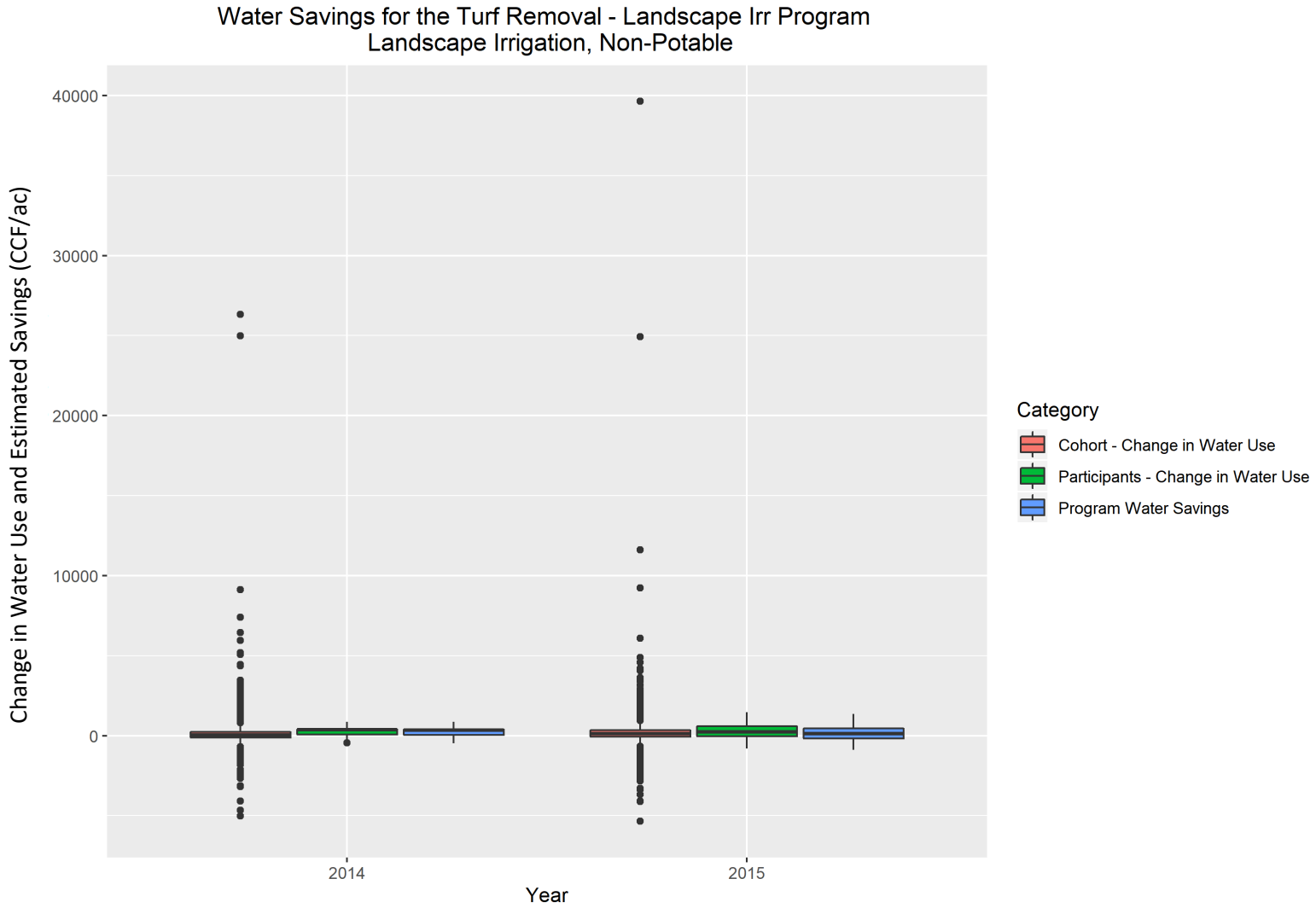

Water Savings for the WBIC - Large Landscape Program
Landscape Irrigation, Non-Potable
Change in Water Use and Estimated Savings (CCF/ac)
400
200
0
-200
2014
2015
2016
2017
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

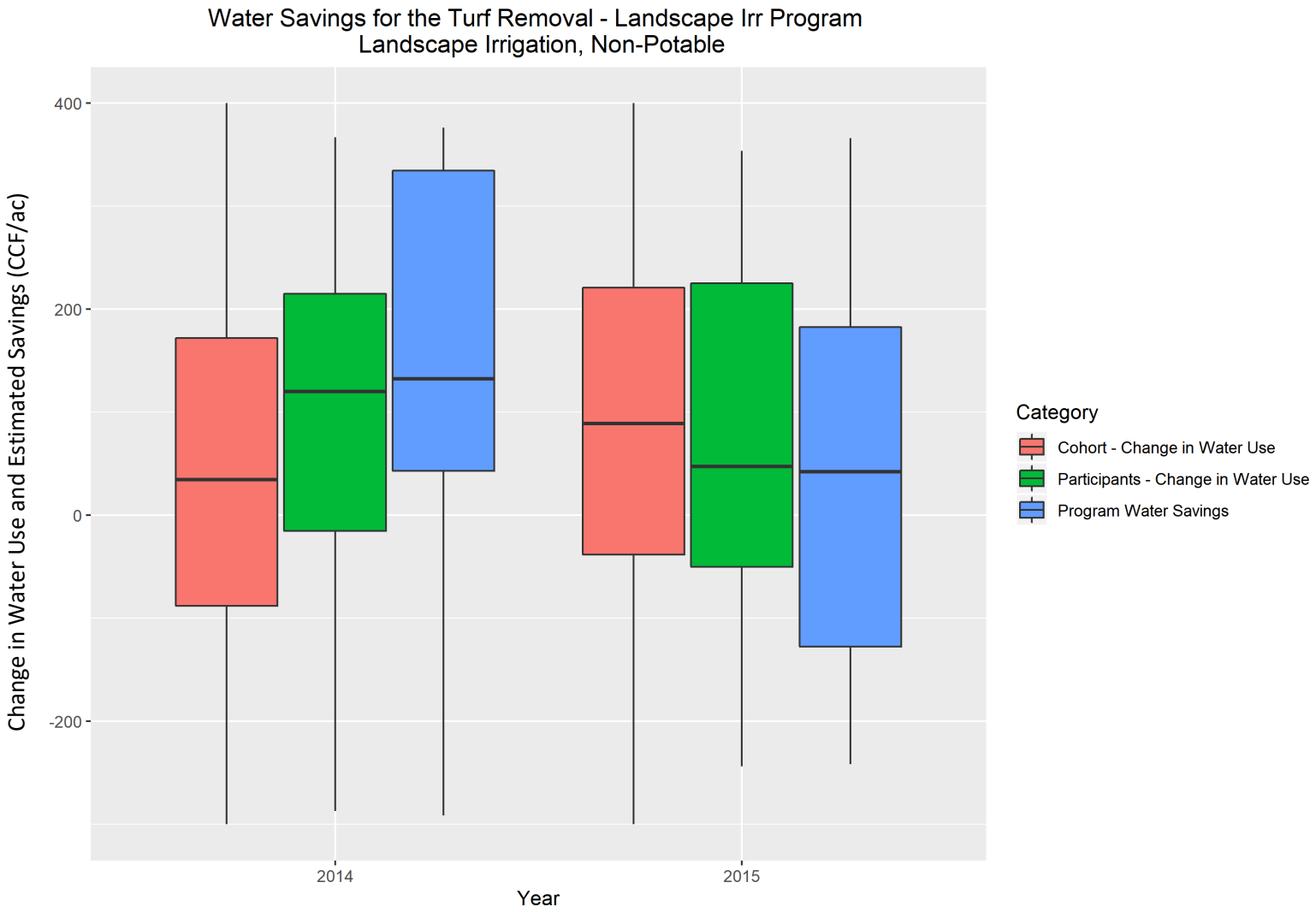
Sample Population Variation for Turf Removal Rebates for Potable Landscape Irrigation Accounts Program Water Savings Analysis




Water Savings for the Turf Removal - Landscape Irr Program
Landscape Irrigation, Potable
Change in Water Use and Estimated Savings (CCF/ac)
400
200
0
-200
2014
2015
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

Sample Population Variation for Turf Removal Rebates for Non-Potable Landscape Irrigation Accounts Program Water Savings Analysis




Water Savings for the Turf Removal - Landscape Irr Program
Landscape Irrigation, Non-Potable
Change in Water Use and Estimated Savings (CCF/ac)
400
200
0
-200
2014
2015
Year
Category
Cohort - Change in Water Use
Participants - Change in Water Use
Program Water Savings

Appendix D

Additional Analyses to Support Saturation Estimates

Appendix D
Additional Analyses to Support Saturation Estimates

1. Property Turnover Rates

A substantial amount of passive water savings results from water fixture changeout driven by the sale of property due to a number of factors including: (1) remodeling that is often done in anticipation of or following the sale of a property (typically all water using fixtures and frequently landscaped areas), (2) the need to purchase new appliances (especially clothes washers, and (3) regulatory requirements to replace toilets (SB 407). As these fixtures are changed out and landscapes reconfigured, due to market and regulatory drivers identified in Section 5.1 of the Study, water efficiency increases.

Property transfer rates for residential units constructed before 2010 were calculated based on Orange County Assessor data and are presented in **Table D-1**. On average, 3.4% of single-family residential properties were bought and sold per year over the last 10 years, with a peak transfer rate in 2010 (at 4.2%).[1] Multi-family residential properties, which include condominium properties, were bought and sold at an average rate of 1.8%.

Even though these fixture changeouts would occur independent of water efficiency incentive programs, customers often apply for and receive rebates for these changeouts, which is termed "free ridership." Therefore, a portion of the water savings identified as a result of the water efficiency programs is likely to be passive savings and free ridership.

Table D-1
Rate of Residential Property Transfers for Homes Built before 2010

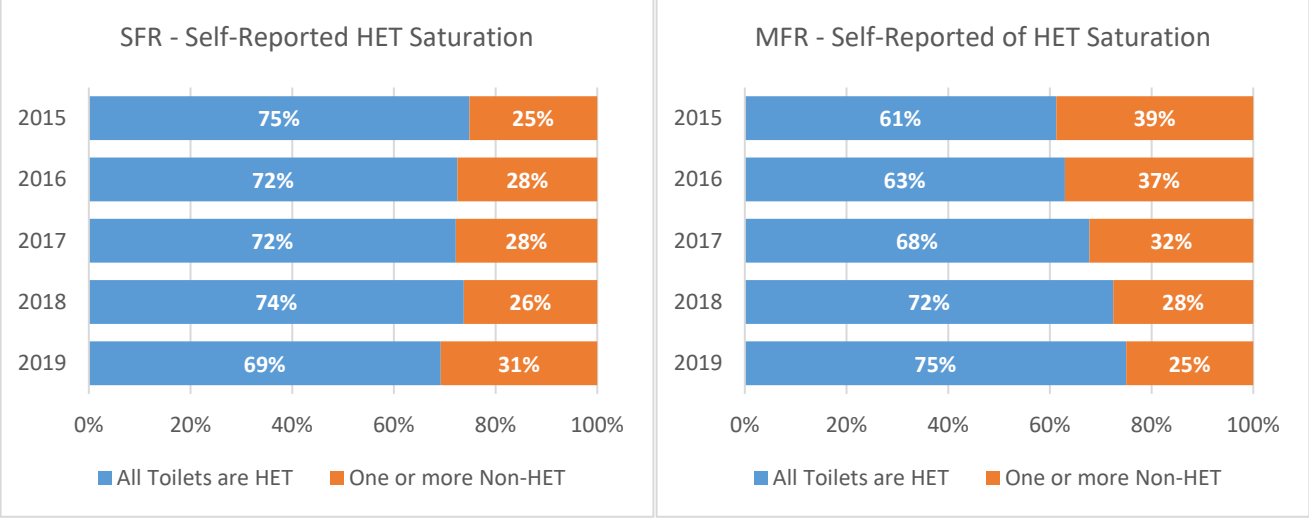
Village Group	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Avg.
Single Family Residential											
A - West Irvine/Tustin Ranch	3.5%	3.5%	3.1%	3.3%	3.3%	3.0%	2.7%	2.6%	2.5%	1.7%	**2.9%**
B - Canyons/OPA	4.3%	4.1%	4.5%	2.8%	3.3%	3.4%	3.3%	4.6%	4.4%	3.0%	**3.8%**
C - Lake Forest/Foothills	3.7%	3.9%	3.9%	2.9%	3.0%	3.0%	3.4%	3.6%	3.3%	2.2%	**3.3%**
D - Central	7.1%	11%	5.1%	2.8%	2.3%	1.6%	1.6%	1.5%	1.5%	1.2%	**3.6%**
E - Coast	3.5%	4.2%	4.2%	4.9%	5.2%	4.4%	4.0%	5.1%	5.2%	3.4%	**4.4%**
F - Central Irvine/University	3.8%	3.8%	4.4%	2.6%	3.1%	2.4%	3.0%	2.8%	3.1%	2.4%	**3.1%**
G - Santa Ana Heights/UCI	5.2%	3.9%	4.1%	3.1%	3.1%	2.9%	3.6%	3.0%	3.8%	2.8%	**3.6%**
H - Central Irvine/ICD	3.7%	4.3%	4.6%	2.4%	3.0%	2.7%	3.0%	3.4%	3.4%	2.4%	**3.3%**
Total	**3.9%**	**4.2%**	**4.1%**	**3.1%**	**3.3%**	**2.9%**	**3.1%**	**3.2%**	**3.3%**	**2.3%**	**3.4%**
Multi-Family Residential											
A - West Irvine/Tustin Ranch	1.4%	1.6%	1.6%	1.9%	1.7%	1.5%	2.2%	3.0%	1.8%	1.3%	**1.8%**
C - Lake Forest/Foothills	1.6%	1.9%	1.8%	1.7%	1.6%	1.6%	1.8%	2.0%	1.9%	1.5%	**1.8%**
D - Central	2.5%	3.7%	1.3%	1.0%	0.9%	0.5%	0.5%	0.5%	0.8%	0.4%	**1.2%**
E - Coast	2.4%	1.4%	1.6%	1.6%	2.1%	1.5%	1.8%	4.0%	2.4%	1.7%	**2.1%**
F - Central Irvine/University	2.4%	2.4%	2.7%	2.4%	2.4%	2.1%	2.6%	5.0%	2.4%	4.3%	**2.9%**
G - Santa Ana Heights/UCI	1.2%	1.3%	1.2%	1.3%	1.5%	1.1%	1.2%	2.2%	1.1%	0.9%	**1.3%**
H - Central Irvine/ICD	1.8%	2.1%	2.3%	2.3%	2.1%	2.0%	2.3%	2.2%	2.3%	1.8%	**2.1%**
Total	**1.8%**	**1.9%**	**1.8%**	**1.8%**	**1.8%**	**1.5%**	**1.7%**	**2.6%**	**1.7%**	**1.7%**	**1.8%**

[1] The property transfers identified in this analysis reflect the most recent transfer per property in the available dataset. If a property was transferred two or more times during this period, only the date of the most recent transfer would be reflected.

2. Self-Reported Device Rates (WaterSmart Software)

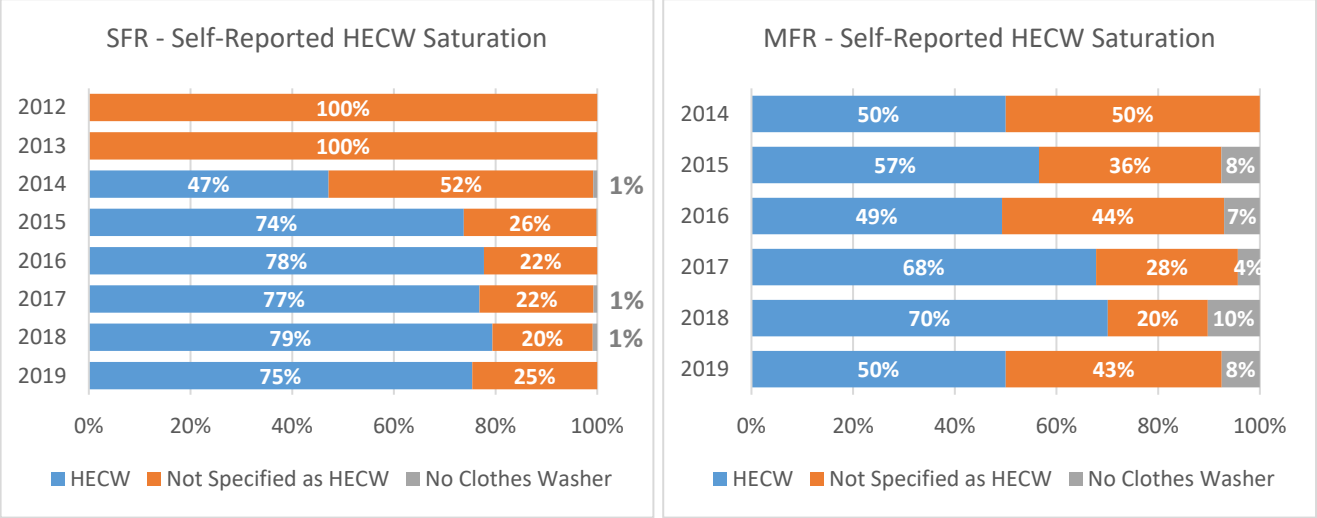
Irvine Ranch Water District (IRWD) utilizes WaterSmart Software, an opt-in service offered to customers to access their own water use data through a web-based customer portal. When customers sign up for this service, they are asked to complete an optional survey on their water use habits and devices. Given that the service is opt-in, and that completion of the survey is optional even for those customers, the survey respondents would tend to be those that are generally more interested/aware/focused on water use and efficiency than the general population. Further, the responses to the survey are provided by customers based on their own level of knowledge and would not be expected to be as accurate as the same assessment performed by a professional trained to perform water audits. Given these limitations to the dataset, survey responses are evaluated below with respect to changes in the self-reported proportion of water efficient devices over time for single-family and multi-family residential users. Individual counts of number of respondents in this analysis are detailed in **Table D-2**.

Figure D-1
Self-Reported Saturation of HETs



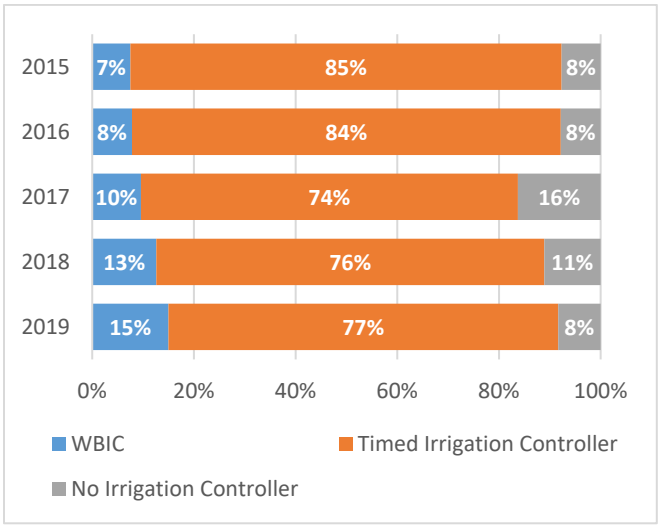
Based on the self-reported assessment, between 69% and 75% of single-family respondents have only High Efficiency Toilets (HETs) in their homes and this rate has stayed relatively constant since 2015. However, the rate of fully-HET multi-family households appears to have increase by about 3% per year over this time period.

Figure D-2
Self-Reported Saturation of HECWs



Up to 79% of single-family residential customers report having a high efficiency clothes washer (HECW) in their home and this proportion appears to be relatively consistent. The proportion of HECW reported by multi-family residential customers is somewhat lower and much more variable, ranging from 49% to 70% over the same period. These data do not suggest a steadily increasing trend in either customer type.

Figure D-3
Self-Reported Saturation of WBICs



Based on the self-reported data, single-family customers appear to be increasing their adoption of weather-based irrigation controllers (WBICs) by approximately 3% per year, although this still represents a small portion of the total population of irrigation controllers.

TABLES

FIGURES

Table D-2
Self-Reported Saturation Data through WaterSmart Software
Irvine Ranch Water District

Self-Reported Saturation of HETs

	SFR				MFR		
Year	Total Responses	All Toilets are HET	≥1 Toilets are HET		Total Responses	All Toilets are HET	≥1 Toilets are HET
2019	39	27	12		28	21	7
2018	362	267	95		196	142	54
2017	1,158	836	322		881	597	284
2016	349	253	96		54	34	20
2015	469	351	118		160	98	62
Total	**2,377**	**1,734**	**643**		**1,319**	**892**	**427**

Self-Reported Saturation of HECWs

	SFR				MFR			
Year	Total Responses	HECW	Not Specified as HECW	No Washer	Total Responses	HECW	Not Specified as HECW	No Washer
2019	61	46	15	0	40	20	17	3
2018	442	354	88	4	234	164	46	24
2017	1,394	1,079	315	10	1,087	737	303	47
2016	431	335	96	0	71	35	31	5
2015	700	517	183	1	198	112	71	15
2014	385	183	202	3	2	1	1	0
2013	336	0	336	0	--	--	--	--
2012	1	0	1	0	--	--	--	--
Total	**3,750**	**2,514**	**1,236**	**18**	**1,632**	**1,069**	**469**	**94**

Self-Reported Saturation of WBICs

	SFR				MFR			
Year	Total Responses	WBIC	Timed Irrigation Controller	No Irrigation Controller	Total Responses	WBIC	Timed Irrigation Controller	No Irrigation Controller
2019	55	9	46	5	12	2	6	4
2018	409	58	351	51	132	4	80	48
2017	1,153	132	1,021	224	426	19	204	203
2016	377	32	345	32	38	3	19	16
2015	542	44	498	45	103	5	48	50
Total	**2,536**	**275**	**2,261**	**357**	**711**	**33**	**357**	**321**

Abbreviations
HECW = high efficiency clothes washer
HET = high efficiency toilet
MFR = multi-family residential
SFR = single-family residential
WBIC = weather-based irrigation controller

Appendix E

Estimation of Indoor and Outdoor Water Use

Appendix E
Estimation of Indoor and Outdoor Water Use

For customer accounts without dedicated irrigation meters, the amount of water used indoors versus outdoors must be estimated. In warm arid climates such as Irvine Ranch Water District's (IRWD) service area, landscaping is typically irrigated year-round, which makes the common method of basing indoor water use on winter month demand less accurate than in cooler, wetter climates.

Section 1 below describes the methodology used to calculate the estimated water use in Section 6 of the Future Potential Water Efficiency Study (Study). Section 2 below describes an alternative methodology identified by IRWD and presents the results of this analysis using this alternative method. The difference in the results presented here and in Section 6 of the Study highlights the uncertainty inherent in such estimation methods. While these indoor water usage estimation methods are helpful for relative comparisons and for use as a planning metric, these values should not be taken as absolute.

1. Methodology Used for Section 6 of Study

EKI has developed a modified version of this method, using an annual irrigation scaling factor to better estimate winter water use. This irrigation scaling factor is calculated on an annual basis based on potable and/or recycled water deliveries to landscape customers in each of the three evapotranspiration (ET) Zones, and therefore reflects both local conditions and climatic variability between years.

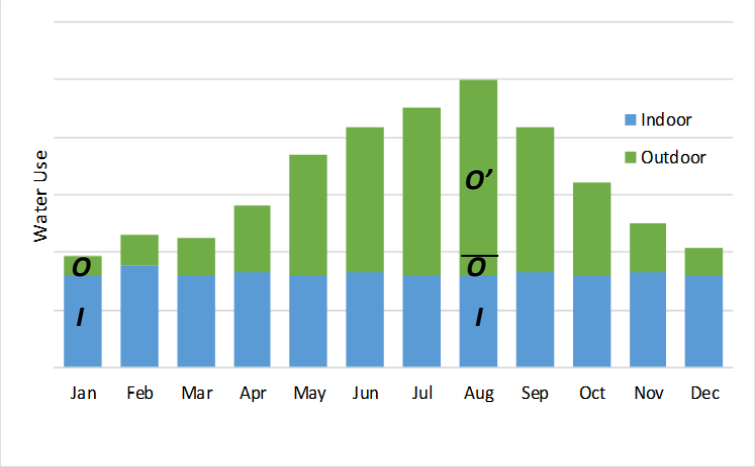
Based on the available data for dedicated irrigation SPs, the variations in monthly water use generally follow a consistent pattern: highest water use in the summer months and early fall (generally September), lowest water use in the winter month and early spring (generally March). A scaling factor is calculated for each dedicated irrigation SP by dividing the maximum monthly water use by the minimum monthly water use. Then, the scaling factors are grouped by ET zones (i.e., Coastal, Central, and Foothill) and water source (potable and non-potable) on an annual basis. The scaling factor for each category was calculated as the median scaling factor within each group, thus representing annual and spatial variability. These values were calculated separately for potable and non-potable SPs in order to evaluate for differences in water habits between the two types of accounts. **Table E-1** below presents the scaling factors calculated for each group and year.

Table E-1
Scaling Factors Calculated based on Dedicated Irrigation SPs

Year	Potable Dedicated Irrigation SPs			Non-Potable Dedicated Irrigation SPs		
	Coastal Zone	Central Zone	Foothill Zone	Coastal Zone	Central Zone	Foothill Zone
2009	8.0	10.9	19.1	8.9	13.4	14.8
2010	12.9	25.5	50.3	17.5	45.2	20.7
2011	9.4	14.9	13.9	11.9	23.3	23.3
2012	5.0	7.2	10.9	4.9	7.0	7.4
2013	6.9	9.7	10.2	19.8	14.8	10.7
2014	5.0	5.5	6.0	4.8	6.2	8.2
2015	5.8	6.6	5.0	8.5	6.8	5.5
2016	5.7	10.9	17.6	7.4	15.0	18.0
2017	7.0	25.4	47.8	20.8	48.3	116.5
2018	4.6	6.5	14.4	4.1	6.2	7.8
Average	**7.0**	**12.3**	**19.5**	**10.9**	**18.6**	**23.3**

These scaling factors are then used to estimate the proportion of water used for irrigation purposes for SPs without dedicated irrigation meters. This method assumes that indoor water use is generally consistent over the course of the year and that SPs within the same ET zone exhibit similar irrigation patterns. **Figure E-1** illustrates annual water use pattern and the components of the equations below used to derive estimated indoor and outdoor water use from the calculated scaling factors.

Figure E-1
Illustration of Estimation Methodology



The variables illustrated in this figure are:

I = indoor water use during the lowest water use month

O = outdoor water use during the lowest water use month

O' = the difference between *I* + *O* and the total water use during the high water use month

SF = max. monthly outdoor water use/ min. monthly outdoor water use

The mathematical relationship between these factors can be expressed as the equation below:

$$SF = \frac{O + O'}{O} = 1 + \frac{O'}{O}$$

This equation can be simplified. Thus, estimated winter outdoor water use can be estimated from the calculated scaling factor using the following equation:

$$O = \frac{O'}{SF - 1}$$

Once *O* is derived, indoor water use (*I*) can be estimated based on total water use during the lowest water using month and applied (adjusting for the number of days per month) to estimate indoor and outdoor water use for each month.

The method above was used to estimate water use for SPs with mixed indoor and outdoor water use meters.

2. Alternative Analysis by IRWD

2.1 Methodology

A landscape scaling factor was derived using potable dedicated irrigation meters. This scaling factor, developed with the same equation above, was then applied to single-family homes to estimate the amount of indoor and outdoor usage of a typical residence. Bills with an end date in the months of January, February, and March represented winter usage and bills with end dates in the months of July, August, and September were used to represent summer usage. IRWD reads meters throughout the month so usage is typically for a portion of the prior month and would therefore represent usage for a portion of December (for winter) and June (for summer).

The following selection criteria were applied to potable dedicated irrigation accounts, and then these accounts were used for purposes of calculating the scaling factor:

1. One full year of prior usage. This eliminates the presence of new landscapes that may use more water for plant establishment.
2. Same customer on the account as the prior year. This eliminates the possibility of a change in landscape maintenance practices or plant material.
3. Account billed for the six months used in the calculation to exclude any billing issues.
4. Total billing days between 170 to 190 days to exclude accounts with abnormally long or short billing periods that would not represent a normal month of usage.
5. Outliers were excluded if the summer month's usage was less than 50% of the water budget or greater than 150% of the water budget. This eliminated accounts with unreasonably low or high usage which may indicate malfunctioning meters, sites not fully irrigated, or had leaks.
6. Accounts with zero usage during summer months were excluded since it is unlikely to have zero usage on an established landscape during summer. Zero usage likely indicates a stopped meter or dead landscape.
7. Accounts with zero usage during the winter months, which is likely during a heavy rain season, were assigned a small fraction (0.075) of the account's water budget for that bill period. This avoided the calculation resulting in an infinite number due to the presence of zeros.

To ensure homes were occupied and had functioning meters, the landscape scaling factor was applied to single-family accounts that met the following criteria:

1. Same customer living in the home as the year prior to the year of the analysis. This eliminates the possibility of changes in usage patterns due to different occupants, different water using equipment and different irrigation habits.
2. Dwelling types classified as residential single-family in billing system and county parcel data. This added a degree of confidence in the dwelling type identification since condominiums may be coded as single-family in the billing data.

3. Accounts with zero usage were excluded since this type of usage may be attributed to a malfunctioning meter and not representative of normal water usage.
4. Outliers were excluded if any of the six month's usage was less than 40% or greater than 150% of the water budget. This eliminated accounts with unreasonably low or high usage which may indicate homes that were not fully occupied, had malfunctioning meters, or had leaks.

2.2 Results

As shown in **Table E-2** below, this method results in higher scaling factors.

Table E-2
Scaling Factors Calculated based on Dedicated Irrigation SPs Using Alternative Method

Year	Potable Dedicated Irrigation SPs			Non-Potable Dedicated Irrigation SPs		
	Coastal Zone	Central Zone	Foothill Zone	Coastal Zone	Central Zone	Foothill Zone
2009	16	21	33	23	33	22
2010	30	377	56	41	83	50
2011	23	373	26	32	55	43
2012	10	7.9	6.9	6.4	7.9	7.6
2013	22	41	13	93	53	21
2014	5.5	6.5	6.8	6.1	8.8	7.2
2015	12	17	11	16	26	9
2016	11	22	55	22	40	43
2017	31	50	108	123	101	133
2018	5.2	6.9	40	7.2	8.3	20
Average	**17**	**92**	**36**	**37**	**42**	**35**

Figures E-2 and **E-3** below present the estimated average monthly indoor and outdoor water use for SFR SPs based on these alternative scaling factors and SP data screening. In addition, the results are presented for SFR homes that were constructed: (1) in 1993 and earlier, (2) from 1994 to 2009, and (3) in 2010 or later. For both indoor and outdoor water use, homes constructed in 2010 or later are substantially more water efficient than older homes. In 2009, indoor water use by homes constructed from 1994 to 2009 appears to have been more efficient than homes constructed prior to 1993. However, in recent years, homes constructed before 1993 appear to have generally become more efficient. For outdoor water use, homes constructed before 1993 appear to have consistently used less water than those constructed from 1994 to 2009.

Figure E-2
Estimated SFR Average Monthly Indoor Water Use By Year of Construction

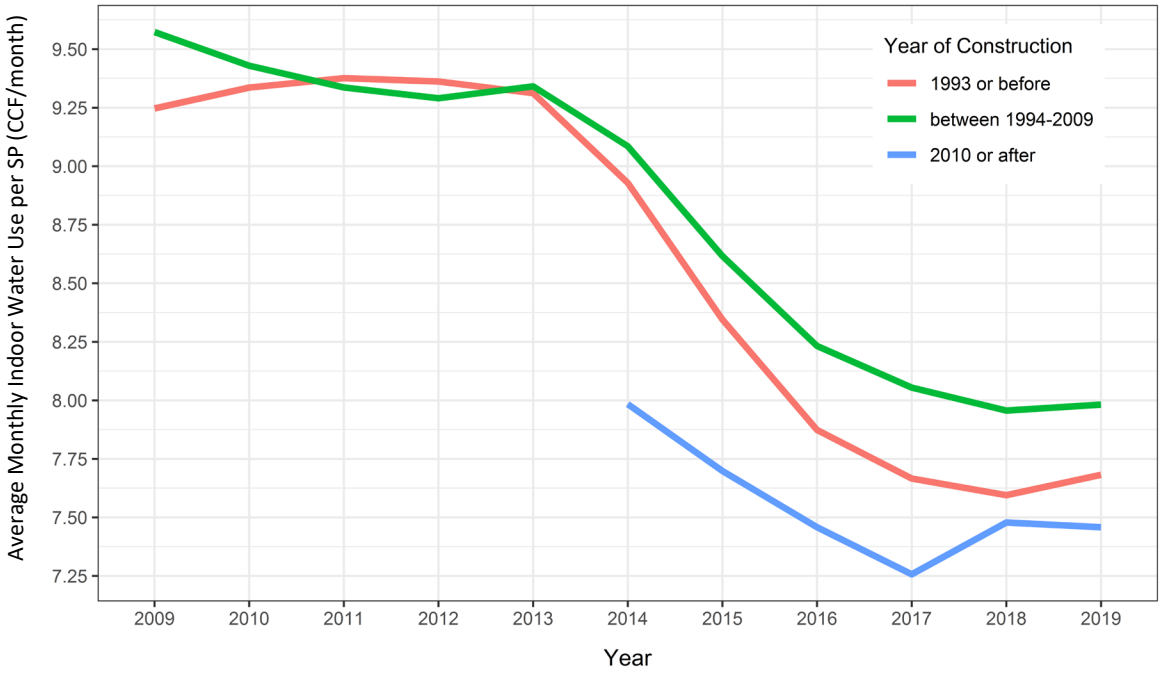
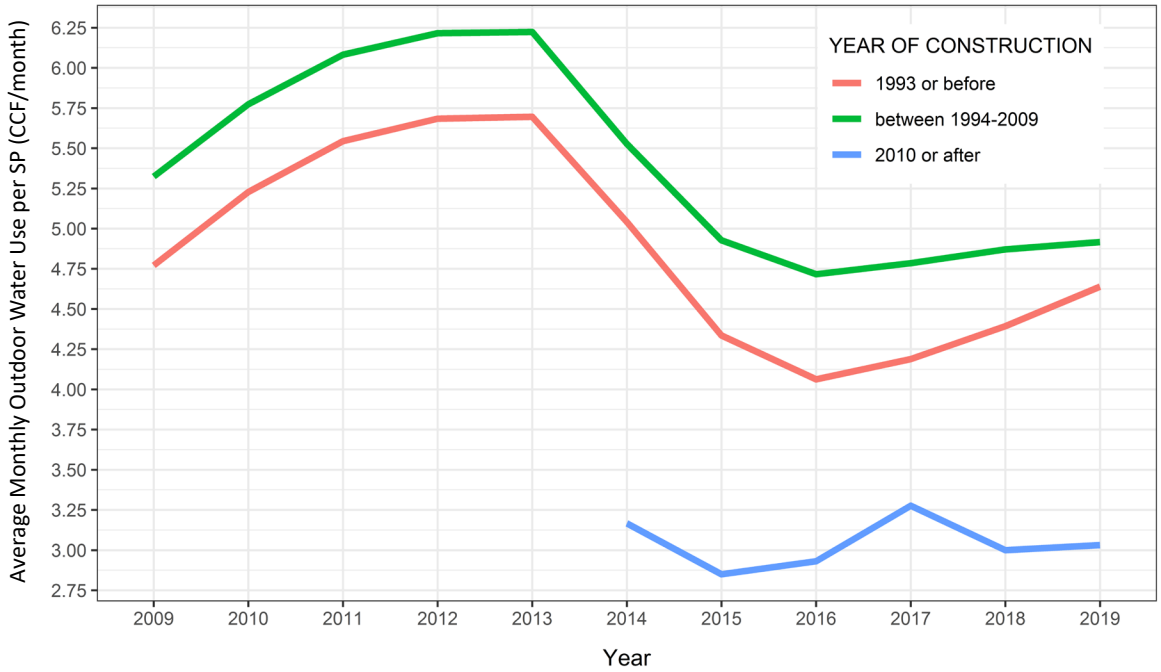


Figure E-3
Estimated SFR Average Monthly Outdoor Water Use By Year of Construction



TABLES

FIGURES

Appendix F

Support for Potential Pressure Reducing Valve (PRV) Program Water Savings Estimates

Appendix F
Support for Pressure Reducing Valve Program Water Savings Estimates

The water savings achieved by installing pressure regulating (or reducing) valves (PRVs) at customer accounts are attributed to: (1) leakage reduction and (2) increased irrigation efficiency.

Per a 2016 residential end use study (DeOreo, 2016) , the primary driver for water use associated with residential indoor fixtures, such as faucets, showerheads, dishwashers, toilets, and clothes washers, is user behaviors (i.e., frequency and duration of use) and the fixture design/specifications. System pressure is not shown to be a strong driver of water use by indoor fixtures, and, as such, PRVs would not be expected to have a significant impact on indoor water use savings. In contrast, elevated system water pressures have been shown to induce more leakages within in-home distribution (i.e., plumbing) systems and can cause pipe damage. Elevated pressures can also result in sprinkler overspray and increased inefficiency in outdoor irrigation.

Thus, when considering the impact of installing PRVs, only the potential water savings associated with leakage reduction and irrigation efficiency are analyzed herein.

1. Leakage Reduction Water Savings Estimates

The DeOreo (2016) study estimates that a typical single family residential (SFR) household with 2.6 persons has a leakage rate of 17 gallons per day (gpd). As in-home leakage rates have not been quantified in the Irvine Ranch Water District (IRWD) service area, the 17 gpd/household leakage rate is assumed herein for SFR Service points (SPs).

Per the discussion in Section 7.4, this analysis only considers the potential savings at those SFR SPs that are located in portions of the IRWD service area where the system pressures are between 80 to 90 pounds per square inch (psi; see **Table 6-5**), as it is assumed that SPs in higher pressure zones likely already have PRVs installed.[1] It is also assumed that the PRVs will decrease the water pressure to 60 psi, where most fixtures can operate efficiently.

Lambert (2001)[2], studied leakage in system-wide distribution systems[3] across the world and developed a relationship between leakage and pressure as follows:

$$Lnew = Lold * \left(\frac{Pnew}{Pold}\right)^{N1}$$

where L is the amount of leakage, P is the water pressure in the plumbing systems, and N1 is the coefficient of the exponent, which is experimentally-derived.

[1] As discussed in Section **6** in the main report**Error! Reference source not found.**, the California Plumbing Code §608.2 requires that a pressure regulating valve or pressure reducing valve (PRV) be installed at service connections where the system water pressure exceeds 80 psi.

[2]Lambert, Allan. "What do we know about pressure-leakage relationships in distribution systems." *IWA Conf. n* Systems approach to leakage control and water distribution system management. 2001.

[3] This equation was developed for system-wide distribution systems; however, due to the lack of information, it is assumed that a similar relationship exists in in-home distribution systems.

Per Lambert's (2001) conclusion, "Undetectable small 'background' leaks from joints and fittings in distribution systems are quite sensitive to pressure, with N1 values typically close to 1.5." Since most leaks in SFR homes will be "undetectable small leaks", an N1 value of 1.5 is used in this analysis.

Thus, the water saving in leakage reduction by installing PRVs can be calculated as follows:

$$water\ savings\ per\ SP = leakage\ per\ household * (1 - \left(\frac{Pnew}{Pold}\right)^{N1})$$

where L_{old} = 17 gpd/SP, P_{new} = 60 psi, and P_{old} is the average water pressure of SFR SPs in each Village Group with system pressures between 80 and 90 psi.

As shown in **Table F-1** in the attached tables, the total leakage reduction potential associated with the installation of PRVs at SFR SPs is estimated to be 115 acre-feet per year (AFY), with most of the reduction occurring in the Lake Forest/Foothills and Central Irvine/ICD village groups. For the purposes of conservatively computing the energy savings, only the embedded energy associated with delivering the water is considered (i.e., impacts on sewer flow savings were not included). Based on the above assumptions, the total potential annual cost savings (inclusive of the embedded energy costs discussed further below) if all SFR SPs in the pressure zone 80 and 90 psi participate is estimated to be $165,000.

2. Increased Irrigation Efficiency Water Savings Estimates

The water savings associated with increased irrigation efficiency as a result of PRV installation was estimated for those SFR SPs and landscape irrigation (potable water) accounts with more than zero outdoor water use in 2018 (considered to be a representative post-drought year) that are located in portions of the IRWD service area where the system pressures are between 80 and 90 psi (see **Table 6-5**). It is assumed that SPs in higher pressure zones likely have PRVs installed already.[4] It is also assumed that the main irrigation method is via sprinkler systems and that the PRVs will decrease the water pressure to 60 psi, where most irrigation systems can operate efficiently.

Based on the Russel (2016) study[5] of sprinkler system performance, the relationship between water pressure and sprinkler system flow rate is as follow:

$$P = \frac{Q^2}{K}$$

where P is pressure, Q is flow rate, and K is a coefficient that captures frictional loss and other head loss in the sprinkler system.

[4] As discussed in Section **6** in the main report**Error! Reference source not found.**, the California Plumbing Code §608.2 requires that a pressure regulating valve or pressure reducing valve (PRV) be installed at service connections where the system water pressure exceeds 80 psi.

[5] Fleming, Russell P. "Automatic sprinkler system calculations." SFPE Handbook of Fire Protection Engineering. Springer, New York, NY, 2016. 1423-1449.

Thus, if the water pressure is reduced, the square of the flow rate of the sprinkler will also be reduced proportionally and the new flow rate can be calculated as follows:

$$Qnew = Qold * \sqrt{\left(\frac{\text{Pnew}}{\text{Pold}}\right)}$$

Water savings in outdoor water use can be assumed to be reduced proportionally and calculated as follows:

$$water\ savings = Water\ use\ in\ 2018 * \left(1 - \frac{Qnew}{Qold}\right) = Water\ use\ in\ 2018 * (1 - \sqrt{\left(\frac{\text{Pnew}}{\text{Pold}}\right)})$$

Based on the equations derived above, the total potential water savings in the SFR sector and landscape irrigation sector (potable water) are estimated to be 381 AFY and 132 AFY, respectively, as shown in **Tables F-2** and **F-3**. The greatest potential water savings in the SFR sector are estimated to occur within the Lake Forest/Foothill and Central Irvine/ICD village groups, while majority of the potential water savings in the landscape irrigation sector (potable water) are within the Lake Forest/Foothills village group. Based on the above assumptions, the total potential annual cost savings if all SPs in the pressure zone 80 and 90 psi participate is estimated to be $550,000 for the SFR sector and $193,000 for the landscape irrigation section, as shown in **Tables F-2** and **F-3** attached.

3. Embedded Energy Assumptions

The embedded energy cost associated with delivering water varies throughout the IRWD service area. For example, as shown in **Tables F-4** and **F-5**, the weighted embedded energy cost to deliver water is different for the various village groups. As such, increased cost-benefit is realized when water savings are generated in areas where there are a lot of customers and the embedded energy costs are high.

Table F-4
Weighted Embedded Energy Cost for SFR SPs

Village Group	Weighted Embedded Energy Cost to Deliver Water (kWhr/AF)
A - West Irvine/Tustin Ranch	1,009
B - Canyons/OPA	2,285
C - Lake Forest/Foothills	526
D - Central	754
E - Coast	792
F - Central Irvine/University	977
G - Santa Ana Heights/UCI	853
H - Central Irvine/ICD	988

Table F-5
Weighted Embedded Energy Cost to Deliver Water for Potable Landscape Irrigation Accounts

Village Group	Weighted Embedded Energy Cost to Deliver Water (kWhr/AF)
A - West Irvine/Tustin Ranch	958
B - Canyons/OPA	1,922
C - Lake Forest/Foothills	646
D - Central	694
E - Coast	632
F - Central Irvine/University	1,113
G - Santa Ana Heights/UCI	864
H - Central Irvine/ICD	936

Tables

Table F-1
Water Savings from Leakage Reduction for SFR SPs
Irvine Ranch Water District

Village Group	Leakage Water Savings of SFR SPs					Cost Savings			
	Number of SPs	Leakage per household (gpd)	Average Water Pressure (psi)	Average Leakage Reduction per SP (gpd)	Total Leakage Reduction (AFY)	Embedded Energy (kWhr/AF)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
Single-Family Residential									
A - West Irvine/Tustin Ranch	1,571	17	84	7	12	1,009	$ 15,994	$ 1,456	$ 17,450
B - Canyons/OPA	149	17	85	7	1	2,285	$ 1,523	$ 314	$ 1,837
C - Lake Forest/Foothills	2,958	17	85	7	23	526	$ 30,410	$ 1,441	$ 31,851
D - Central	2,425	17	86	7	19	754	$ 25,400	$ 1,728	$ 27,127
E - Coast	1,279	17	85	7	10	792	$ 13,087	$ 934	$ 14,021
F - Central Irvine/University	2,478	17	85	7	19	977	$ 25,291	$ 2,227	$ 27,518
G - Santa Ana Heights/UCI	703	17	86	7	6	853	$ 7,467	$ 574	$ 8,041
H - Central Irvine/ICD	3,334	17	85	7	26	988	$ 33,975	$ 3,026	$ 37,001
Total	**14,897**		**85**		**115**		**$ 153,147**	**$ 11,699**	**$ 164,846**

Abbreviations

AFY = acre feet per year
gpd = gallons per day
psi = pounds per square inch
kWhr = kilowatt hour
kWhr/AF = kilowatt hour per acre-foot
SFR = single-family residential
SP = service point

Note

a) A weighted average embedded energy (without sewer service) was calculated by village group based on the location of SFR accounts.

Table F-2
Outdoor Irrigation Water Savings for SFR SPs
Irvine Ranch Water District

Village Group	Outdoor Water Saving for SFR SPs						Cost Savings			
	Count	Avg Pressure, psi	Avg Outdoor Water Use per SP in 2018, CCF	Total Outdoor Water Use in 2018, AFY	Percent Saving due to PRV	Water Saving through Intallation of PRV, AFY	Embedded Energy (kWhr/AF)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	1,556	84	75	268	16%	42	1,009	$ 56,087	$ 5,104	$ 61,191
B - Canyons/OPA	142	85	185	60	16%	10	2,285	$ 12,823	$ 2,642	$ 15,464
C - Lake Forest/Foothills	2,945	85	84	568	16%	90	526	$ 120,184	$ 5,694	$ 125,879
D - Central	2,402	86	53	295	16%	48	754	$ 63,797	$ 4,339	$ 68,137
E - Coast	1,278	85	100	294	16%	46	792	$ 61,826	$ 4,413	$ 66,239
F - Central Irvine/University	2,464	85	60	339	16%	54	977	$ 71,244	$ 6,273	$ 77,517
G - Santa Ana Heights/UCI	694	86	66	106	17%	17	853	$ 23,243	$ 1,788	$ 25,031
H - Central Irvine/ICD	3,309	85	63	482	16%	76	988	$ 101,012	$ 8,997	$ 110,009
Total	**14,790**	**85**	**71**	**2,411**	**16%**	**384**		**$ 510,216**	**$ 39,250**	**$ 549,466**

Abbreviations

AFY = acre feet per year
gpd = gallons per day
psi = pounds per square inch
kWhr = kilowatt hour
kWhr/AF = kilowatt hour per acre-foot
SFR = single-family residential
SP = service point

Note

a) A weighted average embedded energy (without sewer service) was calculated by village group based on the location of SFR accounts.
b) The total number of SFR SPs here is less than the number presented in Tables D-1 because some of the SFR SPs did not have water use in 2018, and therefore were not included in the study.

Table F-3
Outdoor Irrigation Water Savings for Potable Landscape Irrigation Accounts
Irvine Ranch Water District

Village Group	Potable Water Savings for Landscape Irrigation Accounts						Cost Savings			
	Count	Avg Pressure, psi	Avg Outdoor Water Use per SP in 2018, CCF	Total Outdoor Water Use in 2018, AFY	Percent Saving due to PRV	Water Saving through Installation of PRV, AFY	Embedded Energy (kWhr/AF)	Avoided Water Cost Savings	Embedded Energy Cost Savings	Total Estimated Annual Cost Savings
A - West Irvine/Tustin Ranch	16	84	157	6	16%	1	958	$ 1,196	$ 103	$ 1,299
B - Canyons/OPA	2	87	723	3	17%	1	1,922	$ 749	$ 130	$ 879
C - Lake Forest/Foothills	187	85	1,215	521	16%	83	646	$ 110,505	$ 6,433	$ 116,938
D - Central	3	83	2,322	16	15%	2	694	$ 3,188	$ 200	$ 3,388
E - Coast	7	87	3,047	49	17%	8	632	$ 10,936	$ 623	$ 11,559
F - Central Irvine/University	72	85	727	120	16%	19	1,113	$ 25,192	$ 2,527	$ 27,719
G - Santa Ana Heights/UCI	28	84	1,499	96	16%	15	864	$ 20,079	$ 1,563	$ 21,642
H - Central Irvine/ICD	41	85	438	41	16%	7	936	$ 8,718	$ 736	$ 9,454
Total	**356**	**85**	**1,044**	**853**	**16%**	**135**	**7,764**	**$ 180,563**	**$ 12,315**	**$ 192,878**

Abbreviations

AFY = acre feet per year
CCF = hundred cubic foot
gpd = gallons per day
psi = pounds per square inch
prv = pressure regulating (reducing) valve
kWhr = kilowatt hour
kWhr/AF = kilowatt hour per acre-foot

Note

a) A weighted average embedded energy (without sewer service) was calculated by village group based on the location of landscape irrigation, potable water, accounts.