Single-Family Residential Water Use and Conservation Potential

Solano County Water Agency

810 Vaca Valley Parkway

Vacaville, CA 95688

July 2017
EKI B50067.01

EKI ENVIRONMENT & WATER, INC.

www.ekiconsult.com
577 Airport Blvd, Suite 500 • Burlingame, CA 94010

Single-Family Residential Water Use and Conservation Potential

Solano County Water Agency

Prepared by:
EKI Environment & Water, Inc.*
577 Airport Boulevard, Suite 500
Burlingame, California 94010
(650) 292-9100

July 2017
(EKI B50067.01)

**Formerly known as Erler & Kalinowski, Inc.*

TABLE OF CONTENTS

TABLES (Follow each section)

FIGURES (Follow each section)

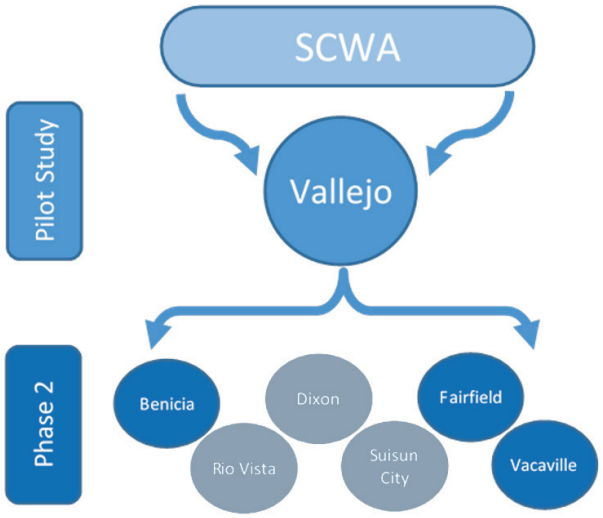
Section 2

Section 3

Section 4

EXECUTIVE SUMMARY

This report documents an assessment of *Single-Family Residential Water Use and Conservation Potential*, conducted on behalf of Solano County Water Agency ("SCWA"). This study builds on the findings and methodology developed in the *Single-Family Residential Water Use and Conservation Potential Pilot Study* ("Pilot Study"), which focused primarily on the City of Vallejo (EKI, 2016). The framework developed in the Pilot Study was expanded and applied to four cities (or "member units"), specifically Vallejo, Benicia, Fairfield, and Vacaville, which together represent over 80% of the single-family residential ("SFR") accounts in the County. The goals of this study were to gain a greater understanding of SFR water use throughout the SCWA service area, evaluate SFR customer response to the historic 2012 to 2016 drought, evaluate the effectiveness of SCWA's water conservation programs, identify remaining water conservation potential in the SFR sector, and identify methods that could be used to better target and refine SFR conservation program offerings.

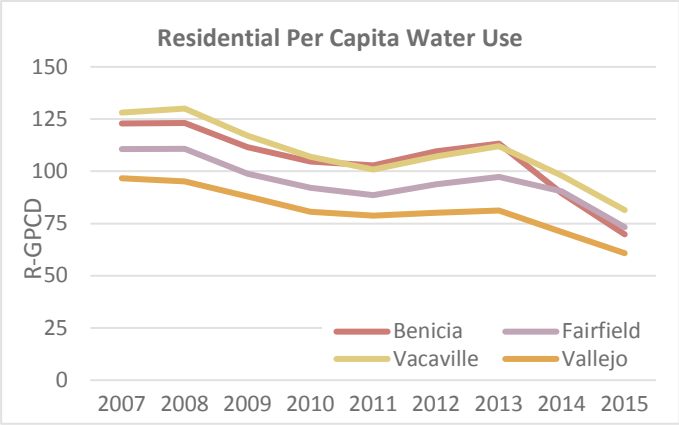


An introduction to the study, including the study's purpose and objectives, is provided in Section 1 of this report. The SCWA service area and characteristics are described in Section 2. The findings of the study are addressed in Sections 3 through 9, and summarized below.

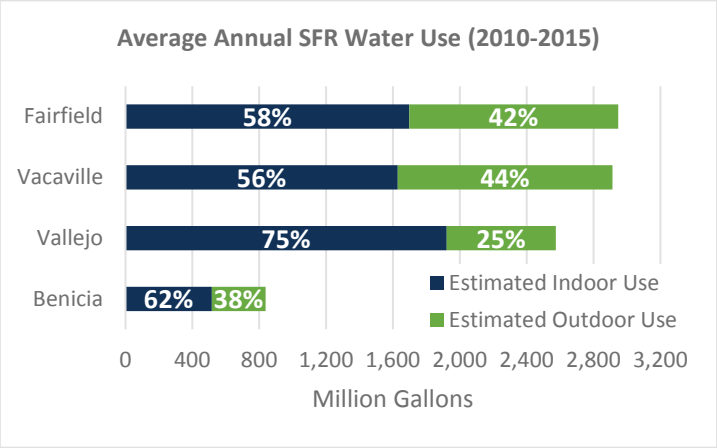
Member Unit Water Use Profiles

The demographics and water use profiles of the SCWA member units were evaluated, and to the extent that data were available, water use was summarized in terms of water use by sector and over time, SFR monthly indoor and outdoor consumption, and annual total and per capita consumption for residential accounts (Section 3.0). Key findings based on these data include:

- The SFR sector uses the most water of any customer category within the SCWA service area, ranging from approximately 56% of total water use in Vallejo to 85% in Rio Vista.
- Residential per capita water demand has declined significantly in recent years (see chart to the right). This reduction in water use



can be attributed to active and passive water conservation, regulatory requirements, drought conditions, economic influences, and a greater public awareness of responsible water use.



- SFR consumption is highest in the summer. In general, the farther a city is located from San Francisco Bay, the higher both its overall and seasonal water use is (see Figure below). These observations suggest that climate has a substantial effect on the amount of water used for outdoor irrigation, and that cities in the easternmost portions of the SCWA service area have the greatest potential to save water through conservation programs that target SFR outdoor water use.

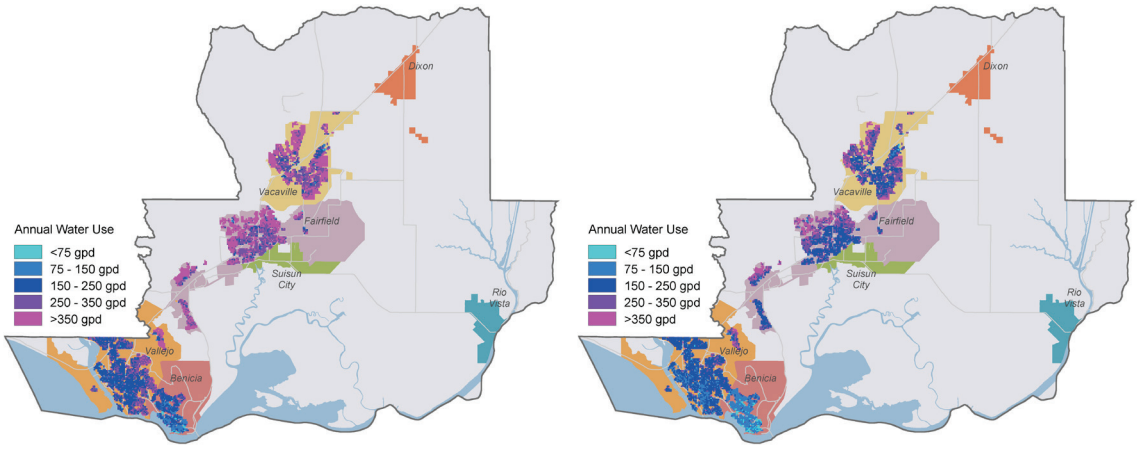


Figure ES-1: SFR water use per account in 2013 and 2015.

Water Use Changes During the Drought

The drought of 2012-2016 was one of the worst in recorded history. In order to understand the drought response by SFR customers, differences in SFR water use between 2013 and 2015 were evaluated for the Cities of Vallejo, Benicia, Fairfield, and Vacaville (Section 3.0). Water use changes were evaluated by account and summarized geographically for each of the cities.

Water savings by SFR accounts was demonstrated across the SCWA service area. Approximately 62% of SFR accounts reduced their water use by more than 20%, resulting in approximately 3,000 million gallons (MG) of savings in approximately 3,000 million gallons (MG) of savings in 2015, as compared water use by the same accounts in 2013. However,

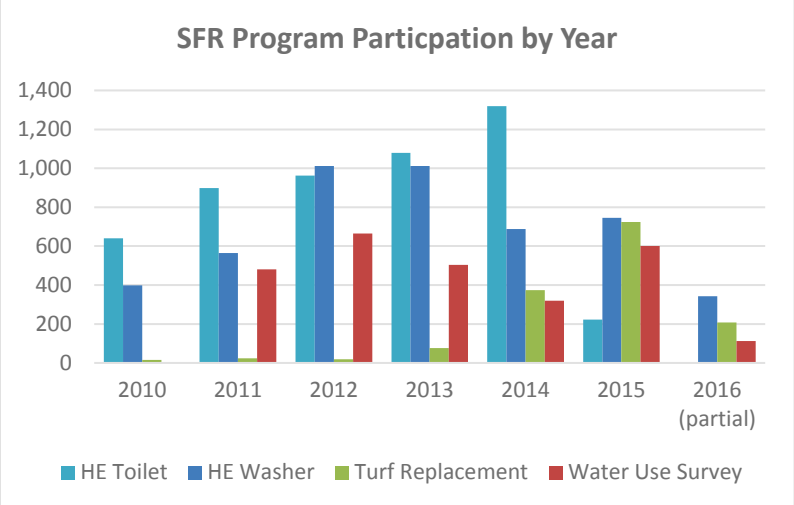
approximately 20% of SFR accounts actually increased in water use from 2013 to 2015, amounting to approximately 470 MG of increased water use by those accounts.

SFR water use savings from 2013 to 2015 ranged from 27% in Vacaville to 40% in Benicia. Of the four cities, Benicia demonstrated the lowest water use in 2013. Given this lower starting point, it might be expected that SFR accounts in Benicia would be more demand-hardened and not have as much capacity to reduce their water use during the drought. However, SFR water use in Benicia declined the greatest percentage of the four cities, with a savings of 40%. This is likely due in large part to the comprehensive customer outreach campaign by the City of Benicia and highlights the importance of public outreach as an effective drought response tool.

City	Water Savings by SFR Accounts in 2015	Cumulative Water Savings (System-wide)[1]	2015 SWRCB Mandated Conservation Standard
Vallejo	32%	21%	16%
Benicia	40%	38%	20%
Fairfield	31%	23%	20%
Vacaville	27%	33%	32%

Water Conservation Program Participation by SFR Accounts

This study evaluated participation by SFR accounts in the four main SFR water conservation programs administered by SCWA (i.e., High-efficiency ("HE") Toilet Rebates, HE Washer Rebates, Turf Replacement Rebates, Residential Water Use Surveys), including analysis of changes in program participation rates over time, and on a geospatial basis. The results of this are presented in Section 4.0.

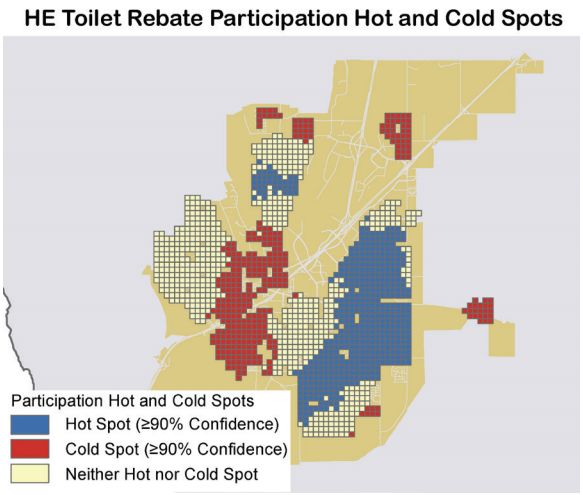


As shown in the Chart to the right participation in the Turf Replacement Rebate Program has increased since 2013, while participation in the HE Washer Rebate Program has declined 2013. Participation in the HE Toilet Rebate program steadily increased until the program was ended in 2015. Participation in the Residential Water Survey Program has shown a general decline from 2012 through 2014, with an increase in participation in 2015.

[1] Cumulative water savings for the purposes of SWRCB-reporting represents the time period of June – December 2015, as compared water use in the same months in 2013 (SWRCB, 2016).

Geospatial Trends in Program Participation

The geospatial cluster or "hot spot" analyses performed for each of the four member units, revealed several participation trends for the programs. In many cases, very low levels of participation in the HE Toilet and HE Washer Rebate Programs were observed in areas dominated by older homes. Given that these older homes are more likely to have old, high-water-using fixtures and appliances, these neighborhoods represent prime areas to target with outreach and education for any future HE toilet or HE washer-focused programs.



In contrast, participation in the Turf Replacement Rebate Program tended to follow more of a discrete clustering pattern. These data provide evidence for a "cluster effect" wherein observing that a neighbor has replaced their landscaping motivates additional accounts within a neighborhood to undertake similar projects, or a "neighbors seeing neighbors" effect. These data further allow us to begin to quantify the additional public outreach and education benefits of the highly-visible turf replacement programs.

Areas of high participation in the Residential Water Use Surveys program tended to correspond to areas of high water users, indicating that the program is being effectively implemented by reaching the highest water using accounts.

Household Income and Water Conservation Program Participation

During the Pilot Study, it was observed that lower levels of conservation program participation were generally correlated with older, lower income neighborhoods. In order to further understand the relationship between income and water conservation program participation, SFR participation in each of the four conservation programs was analyzed relative to household income, and is discussed in detail in Section 5.0. A greater level of participation in each of the four SFR conservation programs was observed by SFR accounts located in high income areas than those in low income areas. In some cases, SFR accounts in high income areas also had notably higher levels of participation than those in medium income areas. Given the consistently low level of participation by SFR accounts in low income areas, water conservation outreach and education that targets accounts in these areas may increase the success of such programs and provide those low income customers with a mechanism to save money on their water bills.

Water Conservation Program Savings and Cost-Effectiveness

Water use by SFR customers has declined across the SCWA service area during the last several years by as much as 40%. To assess the contribution of SCWA's water conservation programs

to these water savings, the amount of water savings directly resulting from participation by SFR accounts in each of SCWA's four major conservation programs was estimated and is presented in Section 6.0.

The amount of water savings resulting from participation in each of the SCWA's major water conservation programs was estimated by comparing water use by conservation program participants in each city to that of representative cohorts for periods before and after participation in a given program. Based on the results of this analysis, participation in water conservation programs by SFR water customers resulted in measurable water savings.

SFR Conservation Program	Program Implemented	Total Number of Interventions	Estimated Annual Water Savings
HE Toilet Rebates	2007 – Jan. 2015	5,764	46.2 MG
HE Washer Rebates	2007 – 2016	4,763	22.9 MG
Turf Replacement Rebates	2013 – 2016	1,441	22.5 MG
Residential Water Use Surveys	2011 – 2016	2,681	53.8 MG
Smart Irrigation Controller Rebates	2011 – 2016	37	n/a

To understand the relative cost-effectiveness of each program, the table below summarizes the weighted average water annual water savings and associated rebate costs.

SFR Conservation Program	Average Annual Water Savings Per Account	Rebate Cost per 100 Gallons of Water Saved
HE Toilet Rebates	8,000 gallons	$0.18
HE Washer Rebates	4,800 gallons	$0.65
Turf Replacement Rebates	16,000 gallons	$0.57
Water Use Surveys	20,000 gallons	n/a

Based on results of this analysis, the Residential Water User Survey program results in the highest amount of water saved per account, followed by the Turf Replacement Rebate Program. The HE Washer Rebate Program appears to result in the least water savings achieved and is associated with the highest relative cost compared to the other rebate programs. The HE Toilet Rebate Program has the lowest relative cost per rebate dollar spent, and results in approximately half the amount of water savings as the turf replacement program, at only one third the cost.

Remaining Water Conservation Potential

The SCWA's SFR water conservation programs have each reached thousands of customers across the service area and successfully reduced water use at those participating accounts. However, different factors contribute to the degree of water savings achieved through implementation of each program, resulting in varying amounts of water saved by customers

within and between different cities (e.g., the water savings associated with the Turf Replacement Rebate Program increase as you move eastward and into the hotter, drier portions of SCWA's service area). There is also variance in what the future water savings potential may be through continued offering of these same programs.

To understand the potential for future water savings in the SFR sector though continued offering of SCWA's water conservation programs, SFR accounts were screened against key characteristics to identify accounts that had the highest potential for water savings for program participation (Section 7.0). The results of this analysis are shown in the table below, and indicate that with targeted outreach, messaging and program engagement, SCWA could still achieve significant water savings through potentially-modified program offerings (e.g., replacing HE Toilet rebates with a targeted direct-install program).

SFR Conservation Program	Estimated Annual Water Savings Per Account	Potential Target SFR Accounts	Remaining Conservation Potential
HE Toilet Replacement	8,000 gallons	2,299	18 MG/year
HE Washer Replacement	4,800 gallons	2,393	12 MG/year
Turf Replacement Rebate	16,000 gallons	3,206	50 MG/year
Residential Water Use Survey	20,000 gallons	1,768	36 MG/year

Conservation Program Considerations and Potential Next Steps

Based on the information and analysis conducted in this study, options for the strategic refinement of SCWA SFR water conservation programs, potential future conservation programs, and additional actions that will support SCWA and its member units with long-term water conservation and drought response planning are presented in Section 8.0 and summarized below.

- **Continue to Pilot a Direct Install HE Toilet Program for Low-Income and Seniors:** SCWA is currently performing a pilot study of a new HE toilet-focused program that replaces rebates with the direct installation of HE toilets. Given the historically low participation levels in the HE Toilet Rebate Program by SFR accounts in low income neighborhoods, this focused direct-install program is expected to reach SFR customers that would not have otherwise replaced their old high-water-use toilet. Results of the pilot, including an analysis of participation, cost and perceived effectiveness will be conducted in 2018 and the decision will be made whether to expand this program beyond the pilot phase.
- **Offer Ultra HE Toilet Rebates:** Another toilet-focused option that SCWA could consider, is providing a rebate incentive to replace 1.6 gallons per flush ("gpf") or higher toilets with ultra HE toilets (i.e., toilets that use 0.8 to 1.0 gpf). Given the recent changes in minimum efficiency standards for toilets sold in California, toilet rebates could be used to incentivize the purchase of a 0.8 gpf toilet instead of a 1.28 gpf toilet, resulting in a potential incremental savings of approximately 0.48 gpf, or nearly 900 gallons per

person per toilet annual water savings.[2] While such a rebate program could be offered, the resultant water savings may not be as high as those that could be achieved by other programs.

- **Modify HE Washer Programs:** Based on the analyses, a broadly offered HE Waster Rebate program would not likely be very cost-effective compared to other program options. However, refinements to a future HE Washer-based program could include targeting lower income and/or senior household with outreach and education materials and/or offering tiered rebate amounts relative to the level of efficiency.
- **Targeted Messaging for Turf Replacement Rebate Program:** A key strategy to maintain the success of the Turf Replacement Rebate Program is to implement targeted outreach to key SFR accounts, focusing on those with the highest potential for water savings. Options for targeted public outreach include, among other things: (1) distributing door hangers in neighborhoods with large numbers of target accounts, (2) hosting turf replacement educational workshops in neighborhoods with large numbers of target accounts, or (3) advertising the program through bill inserts to neighborhoods with a large number of target accounts. Given that the program has the largest effect in the hotter, drier parts of the service area, SCWA could also consider promoting the program most aggressively in the easternmost cities via social media programs that allow for limited localized messaging such as Facebook and Nextdoor.
- **Identify Barriers to Participation in Turf Replacement Program:** A turf replacement project is a significant undertaking for most SFR customers and many real and perceived hurdles can stop a customer from moving forward with a new project. With a better understanding of the particular barriers to implementation facing customers, SCWA could then tailor the program and/or outreach to specifically address these hurdles. For example, if one of the most significant barriers is found to be a lack of knowledge of drought tolerant plants, SCWA could specifically focus its outreach materials to plant education resources such as the ReScape California website (http://rescapeca.org/).
- **Residential Water Use Survey Program:** Of the four SFR water conservation programs evaluated, the Residential Water Use Survey Program resulted in the highest amount of water savings on a per account basis. In order to increase participation, SCWA could consider reaching out to organized community groups, to the degree they are active in neighborhoods with many high-water-using accounts and promoting the program through social media services that allow for localized messaging such as Facebook and Nextdoor. SCWA could consider expanding the program, offer Residential Water Use Surveys to customers located in low income areas, who have high levels of water use, but may not fall within the top 10% tier of water users (Section 7.5).
- **Smart Irrigation Controller Rebate Program:** Smart Irrigation Controllers automatically adjust the amount of water applied to a landscape based on changes in weather over

[2] This calculation assumes 5 flushes per person per toilet per day (BAWSCA, 2013).

the course of the year. Such controllers have the potential to provide the most water savings when used by households that irrigate their landscape at the same rate over the course of the year. SCWA could therefore conduct additional analysis of water use histories to identify high-water using SFR accounts where the water use remains relatively constant over the course of the year, i.e., accounts that do not currently reduce their landscape irrigation during wetter months. Such accounts could then be targeted with education and outreach materials.

Given the results of this analysis, additional potential new programs and actions that SCWA may consider are summarized below.

- Build a database of customer email addresses to facilitate cost-effective and direct targeted customer outreach and messaging by SCWA and the member units.
- Evaluate the level of effectiveness and customer-use of the WaterSmart Software program implemented by Benicia, and if the program has been found to have sustained value, evaluate the feasibility of implementing WaterSmart Software or other similar customer feedback software systems on a regional basis.
- Expand the conservation and drought response analysis to other customer sectors, particularly to the commercial, industrial, and institutional ("CII") sector. The results of such a study could facilitate (1) development projections of future water demands, (2) planning for and response to future drought events, and (3) development of more accurate California Environmental Quality Act- ("CEQA-") required Water Supply Assessments, among other things.
- Expand the drought response analysis to evaluate the particular drought response actions implemented by member units as well as the timing of State-level drought response actions and associated media attention during this last drought and the corresponding customer responses. The results of such a study could be used by the member units to develop more robust Water Shortage Contingency Plans ("WSCPs"), which will be required under by under new State regulations (Executive Order B-37-16 *Making Water Conservation a California Way of Life;* DWR, 2016).

1.0 INTRODUCTION

This report documents the results of the *Study of Single-Family Residential Water Use and Conservation Potential* that was conducted on behalf of Solano County Water Agency ("SCWA"). The intent of this study is to assist SCWA in gaining a greater understanding of single-family residential ("SFR") water use throughout the SCWA service area, evaluate SFR customer response to the historic 2012 to 2016 drought, evaluate the effectiveness of SCWA's water conservation programs, identify remaining water conservation potential in the SFR sector, and to identify options for refining and targeting existing SFR conservation program offerings and for potential new conservation programs and studies.

1.1 Background

The SCWA provides wholesale water to its member units, which include agricultural districts, institutions, and cities. Institutional customers served by SCWA include: the University of California at Davis and California State Prison Solano. The SCWA also provides irrigation water to Solano Irrigation District, Maine Prairie Water District, and Reclamation District 2068. The cities, or "member units", served by SCWA include: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo. The terms "member unit" and "city" are used interchangeably throughout this document.

Single-family residential customers account for approximately 60% of the total urban water use within the SCWA service area, followed by commercial, industrial, and institutional ("CII") customers at roughly 20%, and dedicated irrigation accounts at about 15%. In an effort to reduce urban water use across its service area, SCWA administers County-wide water conservation programs that target the SFR and other customer sectors. In recent years the County-wide programs have included Residential Water Use Surveys, high-efficiency ("HE") Toilet Rebates, HE Washer Rebates, Turf Replacement Rebates, and Smart Irrigation Controller Rebates. In some cases, the member units supplement SCWA's programs with their own locally-administered water conservation programs.

In February 2016, EKI completed the *Single-Family Residential Water Use and Conservation Potential Pilot Study* ("Pilot Study"). The Pilot Study included a high-level overview of SCWA's then-active SFR water conservation programs (i.e., HE Toilet Rebates, HE Washer Rebates, Turf Replacement Rebates, Residential Water Use Surveys, and Smart Irrigation Controller Rebates) and their implementation across the seven cities (or "member units") served by SCWA: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo. The Pilot Study also included a detailed analysis of individual water conservation program impacts, benefits, and opportunities within the City of Vallejo (i.e., the subject of the Pilot Study).

The findings of the Pilot Study indicated that: (1) the SFR water conservation programs that SCWA has implemented in Vallejo have resulted in a significant and measurable amount of water savings; and (2) that additional water conservation potential remains. The Pilot Study also provided a framework to assess water conservation performance and other metrics at SFR accounts within additional SCWA member units, and guided the performance of certain additional analyses conducted herein (i.e., the relationship income level and conservation program participation).

1.2 Study Purpose and Objectives

This study builds from the findings and methodology developed in the Pilot Study, and presents updated analyses for the City of Vallejo and new analyses for three additional SCWA member units: City of Benicia, City of Fairfield, and City of Vacaville. Together, these four cities include over 80% of the SFR accounts in Solano County. The objectives of this study include:

- Evaluation of SFR water use in each of the four subject member units, including the changes in SFR water use observed during the recent, historic drought;
- Evaluation of water savings achieved through implementation of each of four major water conservation programs within each member unit, using the methodology established in the Pilot Study;
- Evaluation of conservation program participation within each member unit, as it relates to household income;
- Evaluation of remaining water conservation potential within each member unit for each major water conservation program, using the methodology established in the Pilot Study; and
- A discussion of the relative similarity and/or difference in amount of water savings measured and other factors across all member units evaluated.

Foundational to SCWA's future water supply and conversation planning efforts is an improved understanding of key water-use and related information at the County-wide and member unit-specific levels. The results of the study provide SCWA and its member units with valuable information that assists them to better:

- Analyze customer demographics and behavior;
- Quantify the benefits of the water conservation programs administered to date;
- Develop water demand forecasts;
- Identify opportunities for targeted outreach and more effective water conservation program implementation; and
- More directly evaluate the need for and support for, developing alternative supplies (e.g., recycled water).

1.3 Report Organization

The information and analysis provided herein addresses the objectives described above. Specifically, the following information is included in this study:

- *Section 1 – Introduction* provides background information on the previously completed Pilot Study and presents the overall objectives on this study.
- *Section 2 – Summary of SCWA's Service Area* provides an overview of SCWA's responsibilities, water supply sources, service area characteristics, and water conservation program services. The service area characteristics, including population, climate, and housing characteristics, explain some of the variability observed in the subsequent analyses of water conservation program participation, savings and opportunities.
- *Section 3 – Analysis of SFR Water Use and Drought Response* presents an analysis of SFR water characteristics and trends for each of the four member units included in this study and an evaluation of the changes in water use and savings achieved by SFR accounts during the unprecedented 2012-2016 drought. This analysis utilized account-level water use data to understand how water savings by SFR accounts was distributed across each city, including identifying the level of water savings achieved by accounts and identifying geospatially what areas of each member unit contributed the most savings during the drought. This understanding of SFR water use and drought response characteristics provides context for evaluating the trends in water conservation program and participation, as well as the potential for future water savings through targeted conservation programs.
- *Section 4 – Conservation Program Participation* documents the trends in participation for each of the four major SFR water conservation programs. This analysis included an evaluation of both temporal and geospatial trends for each of the four focus member units and County-wide. A key component of this evaluation is a geospatial statistical analysis that identifies neighborhoods that have had either very high or very low levels of program participation (referred to as "hot" and "cold" spots of participation), and allows for comparison of other SFR account characteristics such as housing age and income that have a strong geographical correlation. The identification of high and low participation neighborhoods informed the evaluation of potential conservation program targeting.
- *Section 5 – Household Income and Program Participation* evaluates the trends in program participation as it relates to income levels, based on the median household income for neighborhoods in each of the four member units.
- *Section 6 – Estimated Program Water Savings and Cost-Effectiveness* describes the methodology and findings of an analysis of water savings achieved by each of the four programs. This analysis utilized account-level water use data for SFR program participants and compares the changes in water use to that of similar accounts that

have not participated in SCWA's water conservation programs. Variation in water savings achieved by accounts in each of the four cities evaluated is discussed with respect to key household and climate characteristic differences evaluated in previous sections.

- *Section 7 – Remaining Water Conservation Potential* presents the results of an evaluation of potential SFR accounts to target with future water conservation programs. The findings from the evaluations described in previous sections were used to identify SFR accounts that could be targeted by future conservation programs and to estimate the potential water savings that may be achieved through these programs. Key factors that were found to influence program participation and success were layered geographically to identify SFR accounts with the highest potential opportunities for savings.
- *Section 8 – Conservation Program Considerations and Potential Next Steps* presents options to refine and target the four SFR water conservation programs discussed herein, presents options for additional water conservation programs and evaluations that may benefit SCWA and its member units, and discusses how the analysis presented herein will facilitate compliance with new state UWMP and WSCP requirements.
- *Section 9 – Conclusions* presents a summary the key findings of the study.
- *Section 10 – References* provides key references used in this study.

2.0 SUMMARY OF SCWA'S SERVICE AREA

The SCWA was formed in 1951 to provide water supply and flood management services for the Solano County region. The SCWA provides wholesale water to its member units, which include agricultural districts, institutions, and cities. Institutional customers served by SCWA include: the University of California at Davis and California State Prison Solano. The SCWA also provides irrigation water to Solano Irrigation District, Maine Prairie Water District, and Reclamation District 2068. The cities, or "member units", served by SCWA include: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo.

2.1 Water Supplies

The SCWA has surface water rights from two sources: the Solano Project administered by the United States Bureau of Reclamation ("USBR") and the State Water Project ("SWP") administered by California Department of Water Resources ("DWR"). The Solano Project stores water in Lake Berryessa and delivers water to local agencies through the Putah South Canal. The SCWA's contracted water supply for the Solano Project is 207,350 acre-feet per year ("AFY"), which it delivers untreated to its member unit cities (Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo), as well as Solano Irrigation District, Maine Prairie Water District, University of California at Davis, and California State Prison – Solano (SCWA, 2016).

The SCWA has a contract with DWR for delivery of up to 47,756 AFY of SWP water through the North Bay Aqueduct ("NBA"). In turn, SCWA has contracts with Solano County cities for provision of this water supply. The NBA contracting cities are Benicia, Vacaville, Fairfield, Vallejo, Suisun City, Rio Vista, and Dixon. Suisun City has an allocation of NBA water, but has no facilities to take NBA water at this time. The Cities of Rio Vista and Dixon have the right to obtain a specified amount of NBA water in the future, but have no facilities to take NBA water at this time; they rely solely on groundwater for supply.

2.2 Service Area

As shown on Figure 2-1, the SCWA service area comprises the entirety of Solano County. Additionally, SCWA serves agricultural water to the University of California at Davis, located in Yolo County. The population, climate, demographics, and housing characteristics of the SCWA service area in Solano County are summarized in the following sections.

2.2.1 *Population*

The most recent available population data for the seven member units were obtained from the 2014 United States ("US") Census Bureau Subcounty Total Resident Population Estimates. Population growth projections through the year 2040 were obtained from data published by the Association of Bay Area Governments ("ABAG") in 2013.

The majority of residential customers in SCWA's service area reside in the Cities of Vallejo, Fairfield, and Vacaville, with these three cities containing approximately 75% of the County's population (Census, 2014). The combined population of the seven member units is projected to grow by 19% from 431,131 in 2014 to 511,600 in 2040 (ABAG, 2013). While growth is expected within each city during this time frame, the majority of the growth is projected to take place in the City of Fairfield, with an estimated 32% increase in population by 2040 (i.e., from 111,125 in 2014 to 146,500 in 2040). During the same time period, the cities of Dixon and Rio Vista are projected to have the smallest rate of growth with increases of 8% and 9%, respectively (ABAG, 2013).

2.2.2 *Climate*

Climatic factors such as temperature, precipitation, and evapotranspiration can have a significant impact on residential water demand (Pacific Institute, 2012). Solano County spans two hydrologic regions, with the western part of the County in the San Francisco Bay Region and the eastern portion in the Sacramento River Region. As such, key climatic factors vary across SCWA's service area, with the western portion of the County experiencing and mild summers and the eastern portions if the County experiencing very hot summers (SCWA, 2016).

The DWR California Irrigation Management Information System ("CIMIS") identifies three distinct evapotranspiration zones within Solano County, as shown on Figure 2-2. Total average annual reference evapotranspiration ("ET_0") rates range from 39 inches per month in the western portion of Vallejo to 57 inches per month on the eastern portion of the county (DWR, 1999). Likewise, average annual precipitation range significantly across the county, from 25 to 40 inches in the western portion to 15 to 25 inches in the eastern portion of the County (SCWA, 2016).

2.2.3 *Housing Characteristics*

The distribution of SFR parcels in Solano County is shown on Figure 2-3. The majority of the SFR parcels are located within the member units' service areas, with the exception of rural residential areas in the western and northwestern portions of the County. Very few SFR parcels are located in the unincorporated areas in the eastern and southern portions of the County.

Certain characteristics related to housing construction date and type can influence, or at least be correlated with, water use. In general, older homes 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;[3] these accounts can present an opportunity for water

[3] Cumulative water savings for the purposes of SWRCB-reporting represents the time period of June – December 2015, as compared water use in the same months in 2013 (SWRCB, 2016).

conservation savings through fixture replacement. Larger lots tend to use more water because they have larger irrigated landscaped areas. Similarly, larger homes tend to have more occupants and, therefore, more water use.

In order to assess the distribution of housing stock and other key water use characteristics across the SCWA service area, County-wide data were evaluated based on data provided by the Solano County Assessor's Office. These data included SFR lot and house sizes, the number of bedrooms and bathrooms at each account, and the housing construction date. These data are summarized in Tables 2-1 and 2-2 and on Figure 2-3 by member unit and on a County-wide basis. Figures 2-4 through 2-7 show the age of SFR housing stock in Vallejo, Benicia, Fairfield, and Vacaville, respectively.

Based on review of these data, it appears that the Cities of Vacaville and Dixon tend to have the largest average lot and house sizes, while the lot and house sizes in the Cities of Suisun City and Vallejo are, on average, the smallest in the County.

Additionally, while development has occurred throughout the County in the past 25 years, approximately 70% of housing in the County was built prior to 1990. Notably, only 2% of housing stock in the County was built in the past five years.

The age of housing stock varies from city to city. The cities of Benicia, Dixon, Suisun City, and Vacaville contain houses predominantly built after 1970. The date of house construction in Fairfield is relatively evenly distributed between the 1950s to present. New development has occurred in the unincorporated area in the southwestern portion of the County, as well as in Rio Vista, where over 70% of the city was built after 1990. The City of Vallejo has the largest proportion of houses built before 1950 (25%).

2.3 Water Conservation Programs

In order to reduce water demand and promote public awareness of responsible water use, SCWA works with its member units to provide a wide range of water conservation programs to retail water customers across the County. As discussed in detail in Section 4.0, the primary conservation programs that have targeted SFR water users include the HE Toilet Rebate, HE Washer Rebate, Turf Replacement Rebate, Residential Water Use Survey, and Smart Irrigation Controller Rebate Programs. SCWA also provides education and outreach programs for member unit communities, such as those through schools. Additionally, the member units conduct a number of local public outreach and education programs, including conducting local school outreach programs, distributing flyers and brochures as bill inserts, offering landscape and greywater classes to the public, and providing water conservation resources through their city websites, among other activities. The SCWA and its member units also provide many conservation programs that target multi-family residential ("MFR"), CII, and

California Green Building Standards Code (Cal. Code Regs. tit. 24 pt. 11).

dedicated irrigation water users; however, analysis of these programs are outside of the scope of this study.

Table 2-1
Summary of Solano County SFR Housing Stock
Solano County Water Agency, California

Housing Age	Number of SFR Accounts							
	Benicia	Dixon	Fairfield	Rio Vista	Suisun City	Vacaville	Vallejo	Unincorporated County
pre-1950	1,032	379	371	309	112	611	7,565	93
1950-1969	536	696	6,773	486	57	4,152	7,616	88
1970-1989	4,424	1,706	10,320	186	5,126	13,097	10,311	405
1990-2009	1,376	2,319	8,565	2,437	2,681	8,097	4,796	1,163
2010-2015	32	6	456	307	50	350	55	1,027
Total	**7,400**	**5,106**	**26,485**	**3,725**	**8,026**	**26,307**	**30,343**	**2,776**

Abbreviations:

SFR = single-family residential

Notes

(a) Housing age is summarized per information provided by the Solano County Assessor's Office, August 2015.

Table 2-2
Summary of SFR Parcel Characteristics
Solano County Water Agency, California

City	Number of SFR Parcels	Average Year Built	Average Lot Size (sq ft)	Average Interior Space (sq ft)	Average Number of Bedrooms	Average Number of Bathrooms
Benicia	7,403	1975	9,467	2,003	3.5	2.4
Dixon	5,143	1966	48,165	1,801	3.4	2.1
Fairfield	26,494	1981	25,990	1,911	3.6	2.3
Rio Vista	3,729	1988	29,432	1,683	2.5	2.1
Suisun City	8,030	1985	7,311	1,652	3.4	2.2
Vacaville	26,348	1979	54,470	1,802	3.4	2.2
Vallejo	30,361	1965	7,315	1,599	3.3	2.0
Unincorporated County	2,800	1982	93,729	2,275	2.6	2.5
County-Wide	**110,308**	**1978**	**27,534**	**1,785**	**3.4**	**2.2**

Abbreviations:
SFR = single-family residential
sq ft = square feet

Notes
(a) Parcel characteristics are summarized per information provided by the Solano County Assessor's Office, August 2015.

Solano County

Dixon

Allendale

Elmira

Vacaville

Mankas Corner

Fairfield

Travis AFB

Green Valley

Rockville

Suisun City

Cordelia

Rio Vista

Vallejo

Benicia

South Vallejo

Birds Landing

Montezuma

Collinsville

San Francisco Bay

0 4 8

(Approximate Scale in Miles)

N

Legend

- Other Solano County Communities

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Area

Notes

1. All locations are approximate.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_1_County-Service Area.mxd

Solano County Water Agency (SCWA)
Service Area

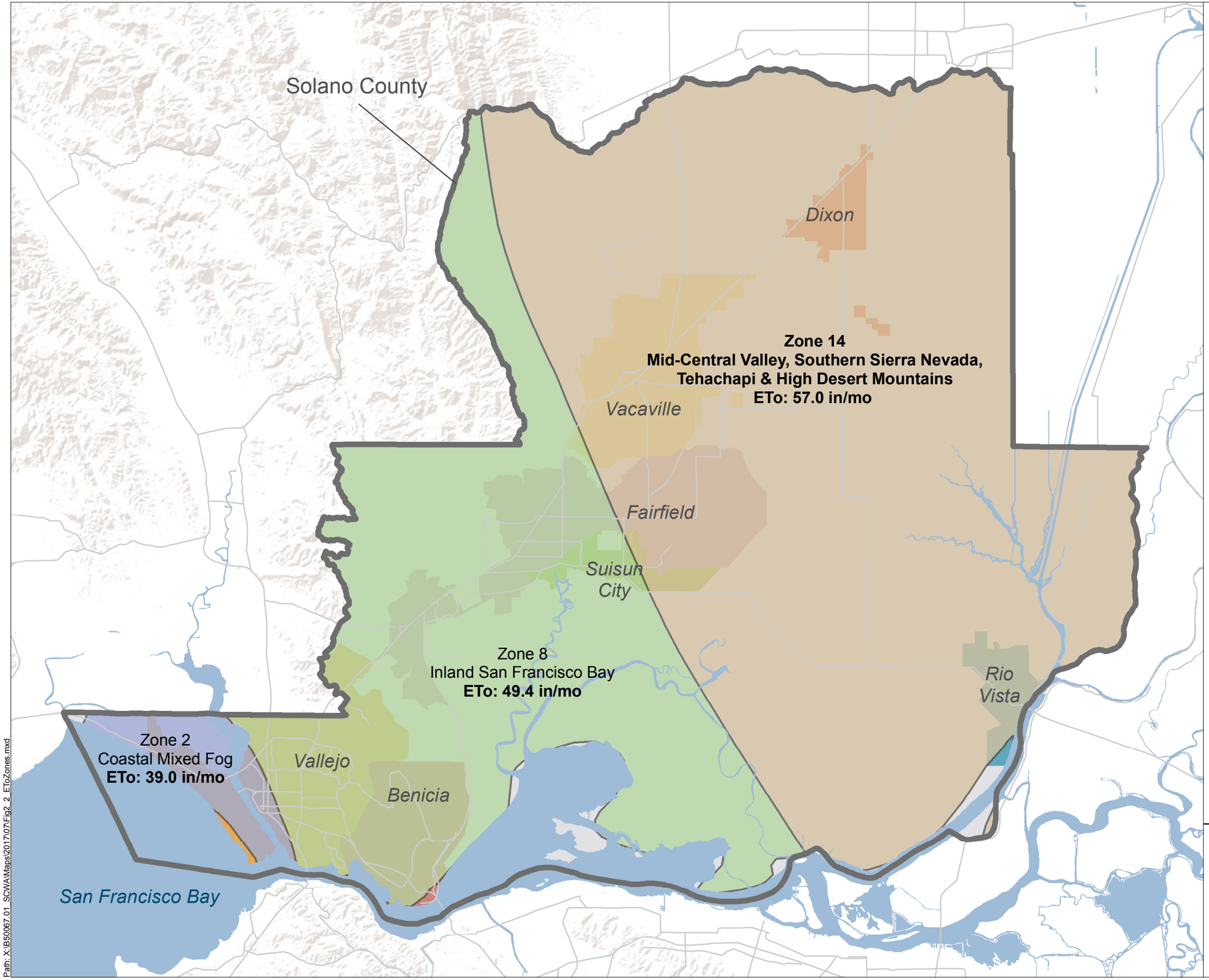
Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-1

eki environment & water



0 4 8

(Approximate Scale in Miles)

N

Legend

Evapotranspiration Zones

- Zone 2 - Coastal Mixed Fog
- Zone 8 - Inland San Francisco Bay
- Zone 15 - Mid-Central Valley, Southern Sierra Nevada, Tehachapi & High Desert

Abbreviations

ETo - reference evapotranspiration rate
in/mo - inches per month, total ETo

Notes

1. All locations are approximate.
2. California Irrigation Management Information System (CIMIS) Reference Evapotranspiration Zones.

Sources

1. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_2_ETozones.mxd

Evapotranspiration Zones in Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA
July 2017
EKI B50067.01
Figure 2-2

eki environment & water

Solano County

Dixon

Vacaville

Fairfield

Suisun City

Rio Vista

Vallejo

Benicia

San Francisco Bay

0 4 8

(Approximate Scale in Miles)

N

Legend

SFR Parcels

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Area

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. SFR parcels are as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_3_CountyLandUse.mxd

SFR Parcels in Solano County

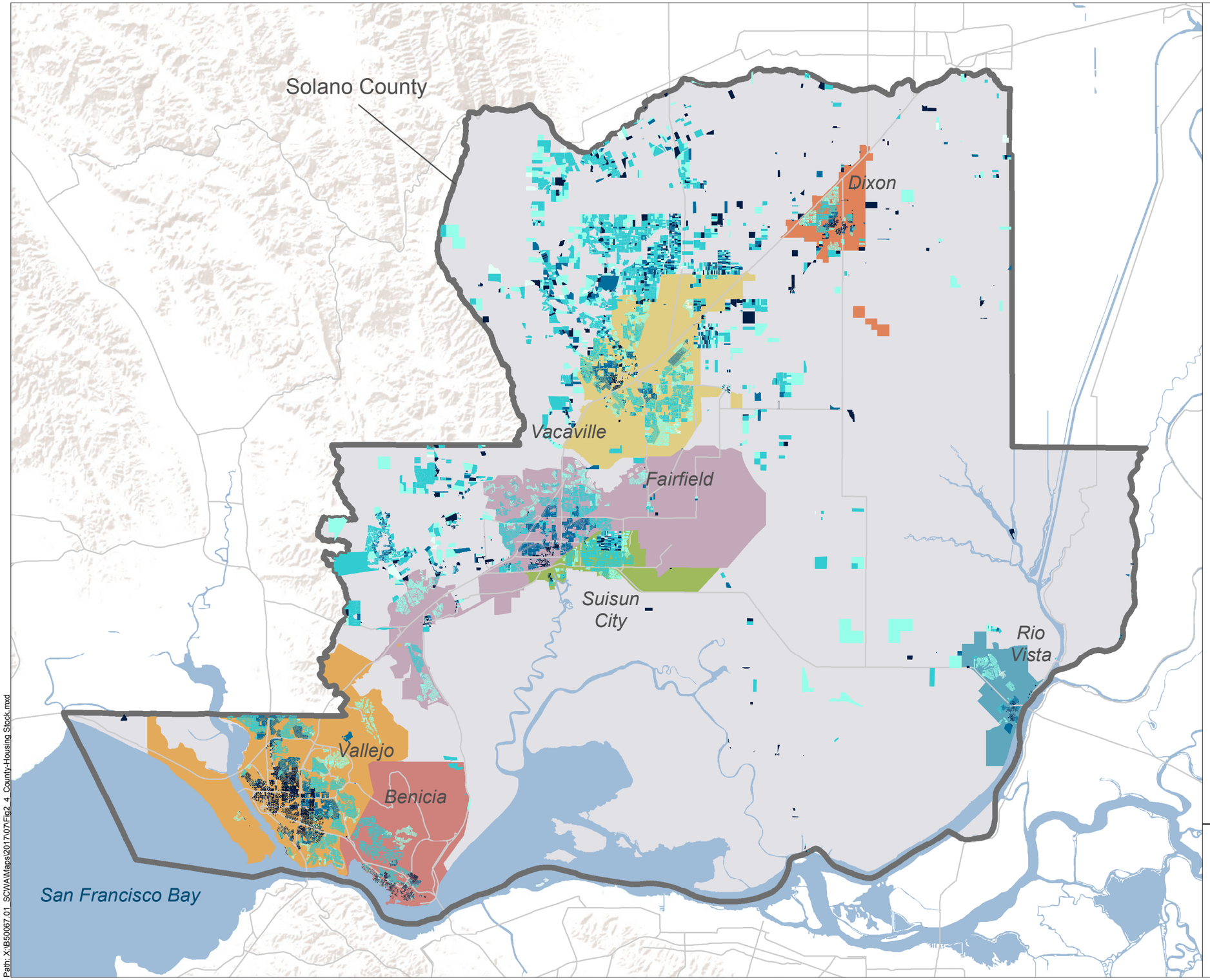
Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-3

eki environment & water



0 4 8

(Approximate Scale in Miles)

N

Legend

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Area

Date of Construction

- 1950 or Before
- 1951 - 1970
- 1971 - 1990
- 1991 - 2010
- 2011 or After

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Date of housing construction is as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Age of SFR Housing Stock in Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

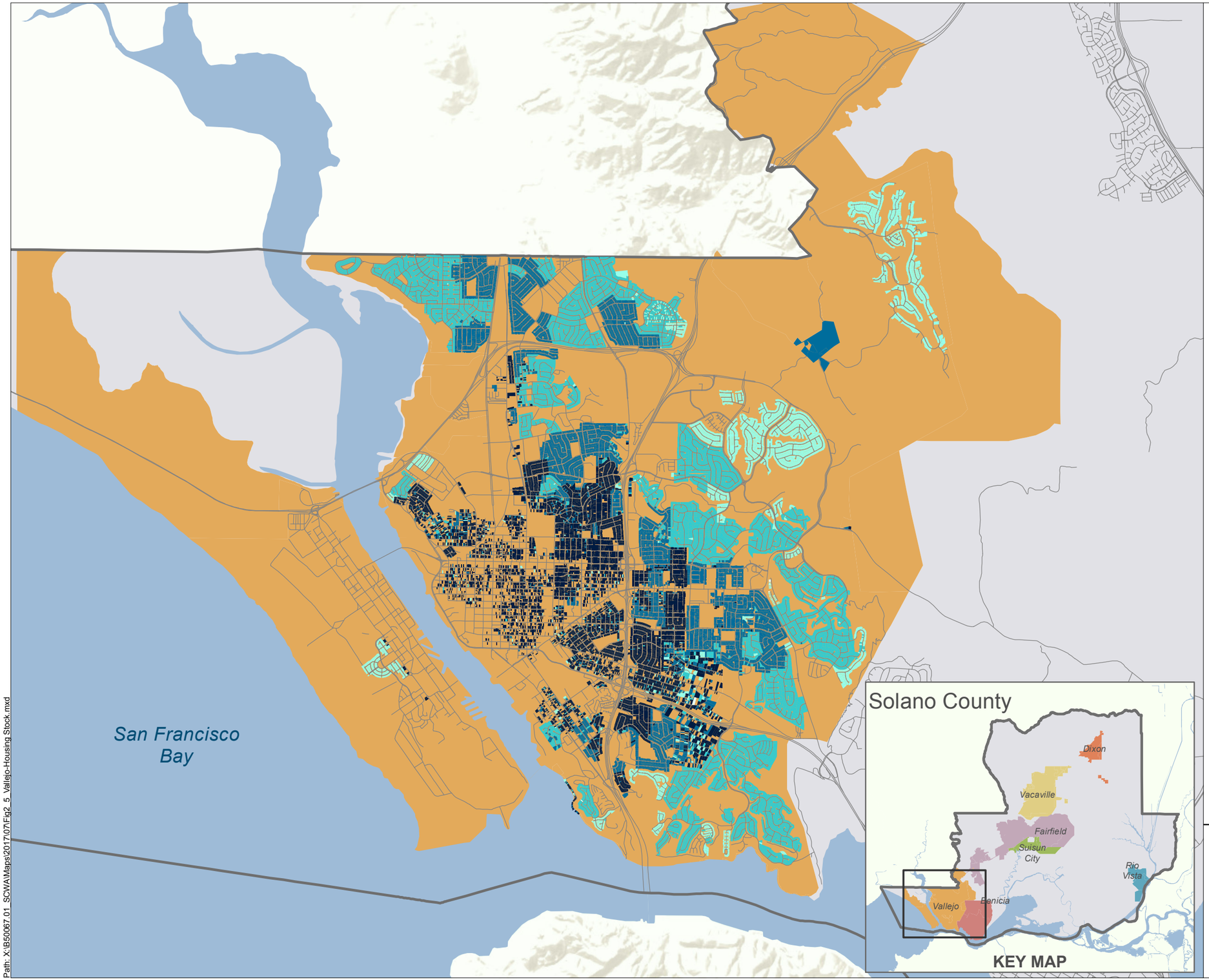
July 2017

EKI B50067.01

Figure 2-4

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_4_County-Housing Stock.mxd



0 1 2

(Approximate Scale in Miles)

N

Legend

- Vallejo
- Other Solano County Area

Date of Construction

- 1950 or Before
- 1951 - 1970
- 1971 - 1990
- 1991 - 2010
- 2011 or After

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Date of housing construction is as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Age of SFR Housing Stock in City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-5

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_5_Vallejo-Housing Stock.mxd

0 1 2

(Approximate Scale in Miles)

N

Legend

- Benicia
- Other Solano County Area

Date of Construction

- 1950 or Before
- 1951 - 1970
- 1971 - 1990
- 1991 - 2010
- 2011 or After

Abbreviations

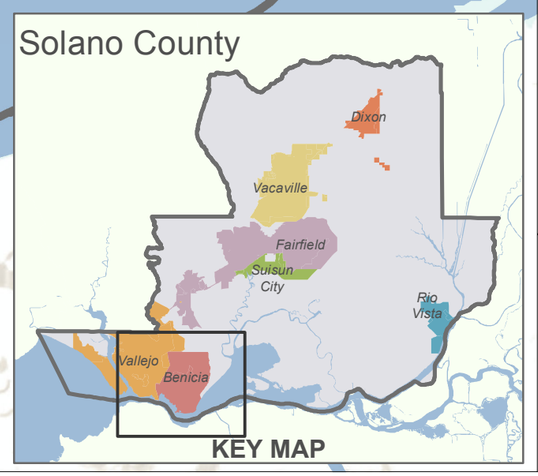
SFR - single-family residential

Notes

1. All locations are approximate.
2. Date of housing construction is as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.



Age of SFR Housing Stock in City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-6

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_6_Benicia_HousingStock.mxd

0 1 2

(Approximate Scale in Miles)

N

Legend

- Fairfield
- Other Solano County Area

Date of Construction

- 1950 or Before
- 1951 - 1970
- 1971 - 1990
- 1991 - 2010
- 2011 or After

Abbreviations

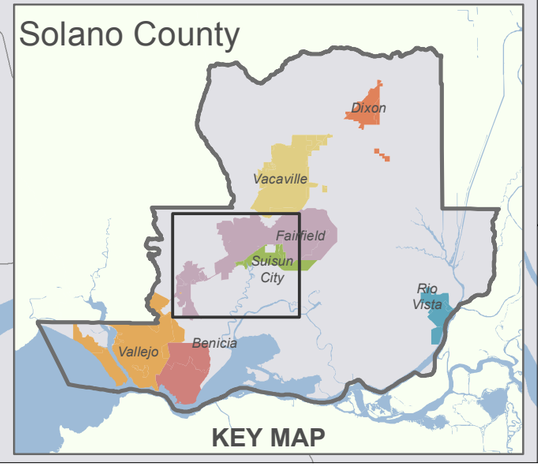
SFR - single-family residential

Notes

1. All locations are approximate.
2. Date of housing construction is as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.



Age of SFR Housing Stock in City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-7

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_7_Fairfield-Housing Stock.mxd

0 1 2

(Approximate Scale in Miles)

N

Legend

- Vacaville
- Other Solano County Area

Date of Construction

- 1950 or Before
- 1951 - 1970
- 1971 - 1990
- 1991 - 2010
- 2011 or After

Abbreviations

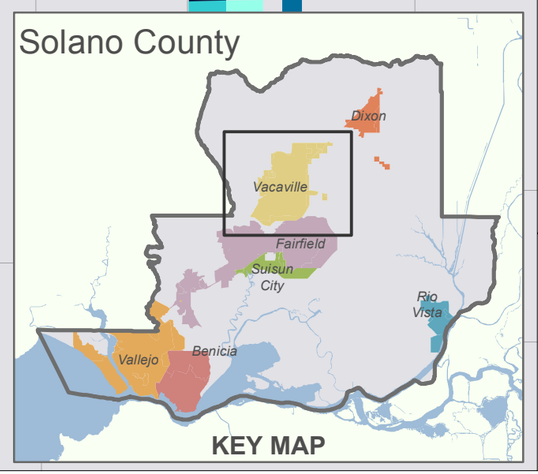
SFR - single-family residential

Notes

1. All locations are approximate.
2. Date of housing construction is as identified in data provided by the Solano County Assessor's Office, August 2015.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.



Age of SFR Housing Stock in City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 2-8

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig2_8_Vacaville-Housing Stock.mxd

3.0 ANALYSIS OF SFR WATER USE AND DROUGHT RESPONSE

As discussed in Section 2.0 the SCWA serves a diverse area, with substantial differences in population, climate, housing stock, and other factors that can significantly affect SFR customer water use. The diversity in SCWA's service area results in substantial differences between member units in terms of total water use and water use patterns. The unique characteristics of each member unit, and in their response to the historic drought of 2012-2016 are described below. This analysis was performed for each of the four member units that were able to provide account-level water use for this study: the Cities of Vallejo, Benicia, Fairfield, and Vacaville.

3.1 Analytical Methodology

The methodology for evaluating water use patterns and response to the historic 2012-2016 drought by SFR customers is described below. Data compiled from several sources are used, including account-level SFR water use data provided by each member unit, data reported to the California State Water Resources Control Board ("SWRCB"), and information provided in the member units' Urban Water Management Plans ("UWMPs").

3.1.1 *SFR Water Use Profile Methodology*

In order to compare water use patterns within and between member units, "Water use Profiles" were developed for each City as shown on Figures 3-1 through 3-4. Summaries of the Water Use profile elements are provided below:

- **Solano County Map:** A county wide map is provided, with a star indicated the location of the member unit presented on the Water Use Profile.
- **2015 Water Use by Sector:** Water use in 2015 for each member unit was summarized in terms of the percentage of water use by each of the following sectors: SFR, MFR, CII, and dedicated irrigation.[4] These data were summarized from each member unit's 2015 UWMP. The customer sector with the highest water use for each city is the SFR sector, ranging from approximately 50% in Fairfield to 63% in Benicia.
- **Population:** Population for each of the SCWA member units is shown from 2000 through 2015. Population data for 2000 through 2010 was interpolated linearly from US Census Bureau data. Population data for 2011 through2015 were obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates (Census, 2016).
- **SFR Monthly Consumption:** Water use, or "consumption", by SFR accounts by month was provided by each member unit based on water billing records. Data are shown for selected years, ranging from the earliest year available through 2015. For member

[4] Non-revenue water was not included when calculating water use by sector for each city.

units with bi-monthly billing, water use is shown as a two-month running average. These charts show the variability in water use by season and by year.

- **SFR Annual Consumption:** Estimated annual indoor and outdoor water use (consumption) were calculated on an annual basis, based on billing records provided by each member unit. Annual indoor water use is estimated as the amount of water used during the lowest water use month, normalized by the number of days in the month, and projected over the year. Annual outdoor water use was estimated to be the difference between total annual water use and the estimated annual indoor water use. Estimated per-capita residential water use is also shown on the chart as gallons per capita per day ("R-GPCD"). Population and residential water use data for each member unit was used to calculate annual R-GPCDs for the years 2000 through 2015[5]. These estimates of R-GPCD do not include system losses or other unaccounted for water, and are therefore not expected to be the same as the R-GPCD values reported to the SWRCB.

3.1.2 *Drought Response Analysis Methodology*

In response to the historic 2012-2016 drought, each member unit reduced its per capital residential water use (R-GPCD)[6] significantly in 2015 and 2016 relative to their 2013 use (i.e., to comply with conservation targets set by the SWRCB in accordance with Executive Order B-29-15). Cumulative water savings through December 2015 ranged from 38% in Benicia to 21% in Vallejo. These savings persisted through 2016 at relatively consistent rates for Benicia, Dixon, and Suisun City; however, water savings for other cities were reduced (SWRCB, 2016).

	2015 SWRCB Conservation Standard	Cumulative Drought Water Savings	
		Through Dec. 2015	Through Dec. 2016
Benicia	20%	38%	40%
Dixon (CalWater)	28%	32%	31%
Fairfield	20%	23%	15%
Rio Vista	36%	31%	23%
Suisun City (SSWA)	28%	27%	27%
Vacaville	32%	33%	24%
Vallejo	16%	21%	16%

In order to better understand the differences in water use between 2013 and 2015, water use was evaluated for SFR accounts in the Cities of Vallejo, Benicia, Fairfield, and Vacaville, based on the provided water billing system data. The change in water use was evaluated by account and summarized geographically for each of the cities. For the purposes of mapping and evaluating spatial trends, water use by SFR accounts was summarized based on a 500-

[5] Population data interpolated linearly from US Census Bureau data for 2000 and 2010. Population data for 2011-2015 obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates. (Census, 2016).

[6] The SWRCB calculates R-GPCD as the total water consumption by residential accounts, including both SFR and MFR, divided by the total population.

foot grid, as shown on Figures 3-5 through 3-8. These figures show average water use by active SFR accounts located within each grid cell for 2013 and 2015, as well as the average percent water reduction between 2013 and 2015 by grid cell. The change in water use by account is also shown in a bar chart on each figure. For the purposes of this analysis, water accounts for which no water use was billed in 2013 or 2015 were excluded. Accounts for which the Assessor's Parcel Number ("APN") could not be positively attributed were also excluded from this analysis.

3.2 City of Vallejo

3.2.1 *Water Use Profile*

The SFR water use profile for Vallejo is presented on Figure 3-1. Approximately 56% of water use in 2015 was attributed to the SFR sector, with the remainder split between the CII (19%), MFR (15%), and dedicated irrigation (10%) sectors. Total SFR water consumption generally decreased from 2000 to 2015. Overall, total SFR water consumption decreased by nearly 1,340 million gallons ("MG"), or approximately 40%, over the 15-year period from 2000 to 2015. As of 2015, per capita SFR water use in Vallejo was the lowest among the SCWA member units that provided water use data.

In Vallejo, higher water use is observed in the summer and fall months, with the highest SFR water use occurring between June and October. In general, however, Vallejo experiences less significant seasonal variability in water consumption than other SCWA member units. In part, this may be due to the cooler climate observed in this area (Section 2.2.2). Estimated indoor water usage generally comprised between 60% and 70% of water consumption in Vallejo over the period 2000 to 2014, and outdoor water use comprised the remaining 30% to 40%. However, as the recent drought progressed, this balance shifted in 2015 to just over 20% outdoor water use, and nearly 80% indoor water use.

Residential per capita water use generally decreased over the period of 2000 to 2015.[7] Given the relatively low population increase (4%) over this period, trends in per capita water use are not likely influenced strongly by population growth.

3.2.2 *Drought Response*

In response to a 16% conservation standard mandated by the SWRCB, Vallejo achieved a 20.6% reduction in total water use, between 2013 and 2015, which declined to a cumulative reduction of 15.6% through December 2016 (SWRCB, 2017). Average annual water use by SFR accounts in Vallejo was 237 gallons per day ("gpd") in 2013 and dropped to 180 gpd in 2015, for an overall reduction of nearly 32%.

[7] Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the total population.

As shown on Figure 3-5, SFR accounts located in the northern and eastern portions of the city tended to have higher rates of water usage than those accounts in the western portion of the city, and this pattern remained consistent in 2015. Water savings by SFR accounts was demonstrated across the city, with accounts in the southern portion having a more consistently high level of savings. Over half of the SFR accounts reduced their water use by more than 20%, resulting in approximately 770 MG of savings in 2015. Approximately one-quarter of the SFR accounts demonstrated an increase in water use from 2013 to 2015, amounting to approximately 180 MG of increased water use.

3.3 City of Benicia

3.3.1 *Water Use Profile*

The SFR water use profile for the Benicia is presented on Figure 3-2. Approximately 63% of water use in 2015 was attributed to the SFR sector, with the remainder split roughly evenly between the MFR, CII, and dedicated irrigation sectors. Total SFR water use over the period 2002 to 2015 ranged from its highest value of over 1,100 MG in 2004 to its lowest value approximately 585 MG in 2015, with water use generally declining over this period. Overall, total SFR water consumption decreased by approximately 500 MG, or nearly 50% over the 11-year period from 2004 to 2015.

The highest SFR water use in Benicia typically occurs between July and October; water use during these months was more than double the use during the lower-water use months of January to April. Outdoor water usage generally constituted half of total SFR water use over the period 2002 to 2012. In recent drought years, however, the percentage of outdoor water use has decreased to approximately 30%. This decrease in outdoor water use may be a result of behavioral changes encouraged by public outreach on the part of SCWA and Benicia, and the emergency outdoor water restrictions mandated by Ordinance 14-4, which was adopted by the Benicia City Council on 15 July 2014.

Residential per capita water use generally decreased over the period of 2002 to 2015, with small increase observed in 2012 and 2013.[8] Given the relatively low population increase (4%) over this period, trends in per capita water use are not likely influenced strongly by population growth.

3.3.2 *Drought Response*

Of all the member units, Benicia has achieved the greatest reduction (36.2%) in water use through 2015, and 39.5% through December 2016, nearly twice its SWRCB-mandated

[8] Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the total population.

conservation standard of 20% (SWRCB, 2017). Average annual water use by SFR accounts in Benicia was approximately 161 gpd in 2013 and dropped to 97 gpd in 2015, for an overall reduction of 40%.

As shown on Figure 3-6, water use by SFR accounts showed a slight increasing trend running from south to north, with the highest water users generally located in the northern portion of the city. The spatial distribution of water savings by SFR accounts was generally very consistent across the city. Three-quarters of the SFR accounts reduced their water use by more than 20%, resulting in approximately 186 MG of savings in 2015. Approximately 12% of the SFR accounts demonstrated an increase in water use from 2013 to 2015, amounting to approximately 9.3 MG of increased water use. During the drought, the City of Benicia implemented a comprehensive customer outreach campaign to encourage customers to use less water. This campaign included providing drought education materials via door-hangers and website updates and providing additional City-matched funds for rebates issued by SCWA, among other things. This level of drought outreach was more extensive than the drought outreach and messaging campaigns implemented by other Solano County member units. Given the significant savings demonstrated by SFR accounts in Benicia, this campaign appears to have been quite successful.

3.4 City of Fairfield

3.4.1 *Water Use Profile*

The SFR water use profile for Fairfield is presented on Figure 3-3. Approximately 50% of water use in 2015 is attributed to the SFR sector, with the remainder split between the CII (22%), dedicated irrigation (18%), and MFR (10%) sectors. Total SFR water use over the period 2007 to 2015 ranged from its highest value of more than 3,500 MG in 2007 to its lowest value of approximately 2,500 MG in 2015. Water use generally declined over the period of 2007 to 2015, with a short period of increased water use in 2012 and 2013. Overall, total SFR water consumption decreased by approximately 1,000 MG, or nearly 40% over the eight year period from 2007 to 2015.

The highest SFR water use in Fairfield typically occurs between July and September. This water use pattern is likely due in part to the warmer climate observed in this area compared to Benicia or Vallejo, however the climate is still cooler than eastern Solano County(Section 2.2.2). Indoor water usage generally constituted half of total SFR water use over the period 2007 to 2015, although this percentage was higher in 2009 (63%), 2011 (56%), and 2014 (58%). Unlike the cities of Vallejo, Benicia, and Vacaville, this proportion of estimated indoor to outdoor water use remained the same in Fairfield during drought years, although the overall SFR water use declined.

Residential per capita water use followed a similar trend as total water use over the study period, generally decreasing from 2007 to 2015, with a slight increase in 2012 and 2013.

Notably, Fairfield has experienced the highest growth rate of the member units, with an approximately 10% increase in population from 2007 to 2015.

3.4.2 *Drought Response*

In response to a 20% conservation standard mandated by the SWRCB, Fairfield achieved a 23.6% reduction in total water use, between 2013 and 2015, which declined to a cumulative reduction of 14.6% through December 2016 (SWRCB, 2017). Average annual water use by SFR accounts in Fairfield was approximately 369 gpd in 2013 and dropped to 254 gpd in 2015, for an overall reduction of 31%.

As shown on Figure 3-7, water use by SFR accounts showed a slight increasing trend running from south to north, with the highest water users generally located in the northern portion of the city; the northern portion of the city also tends to have larger sized homes. This northerly trend becomes more pronounced in 2015, although the spatial distribution of water savings by SFR accounts was generally consistent across the city, with a somewhat higher degree of savings demonstrated in the southeastern portion of the city. Two-thirds of the SFR accounts reduced their water use by more than 20%, resulting in approximately 1,180 MG of savings in 2015. Approximately 17% of the SFR accounts demonstrated an increase in water use from 2013 to 2015, amounting to approximately 144 MG of increased water use.

3.5 City of Vacaville

3.5.1 *Water Use Profile*

The SFR water use profile for the Vacaville is presented on Figure 3-4. Approximately 58% of water use in 2015 was attributed to the SFR sector. The second highest consuming sector is CII (19%), followed by MFR (12%) and dedicated irrigation (11%). Water use generally declined over the period of 2007 to 2015, with a short period of increased water use in 2012 and 2013. Total SFR water use over the period 2007 to 2015 ranged from its highest value of more than 3,660 MG in 2008 to its lowest value of nearly 2,400 MG in 2015. Overall, total SFR water consumption decreased by approximately 1,300 MG, or roughly 35% over the eight year period from 2007 to 2015.

The highest SFR water use in Vacaville typically occurs between July and September. This water use pattern is likely due in part to the warmer climate observed in this area, as described in Section 2.2.2. Indoor water usage generally constituted half of total SFR water use over the period 2007 to 2015, although this percentage was slightly higher in 2012 (58%) and significantly higher 2015 (78%). This suggests that substantial SFR sector water savings during the drought resulted from cutbacks in outdoor water use.

Residential per capita water use in Vacaville followed a similar trend as total water use, falling from 130 R-GPCD in 2008 to 82 R-GPCD in 2015, while the population grew from approximately 91,700 to approximately 96,800[9]

3.5.2 *Drought Response*

In response to a 32% conservation standard mandated by the SWRCB, Vacaville achieved a 33.0% reduction in total water use, between 2013 and 2015, and 24.4% through December 2016 (SWRCB, 2017). Average annual water use by SFR accounts in Vacaville was approximately 369 gpd in 2013 and dropped to 270 gpd in 2015, for an overall reduction of 27%.

The other three cities showed a general trend of higher water use by accounts in the northern portions of their service areas as compared to those in the southern portions of their service areas. As shown on Figure 3-8, water use by SFR accounts in Fairfield showed a different trend, of higher water use in the outer northwestern and eastern portions of the city, and lower water use in the center of the city, particularly in 2015. The spatial distribution of water savings by SFR accounts was generally consistent across the city. Nearly two-thirds of the SFR accounts reduced their water use by more than 20%, resulting in approximately 845 MG of savings in 2015. Nearly 20% of the SFR accounts demonstrated an increase in water use from 2013 to 2015, amounting to approximately 135 MG of increased water use.

3.6 Summary of SCWA Water Use and Drought Response

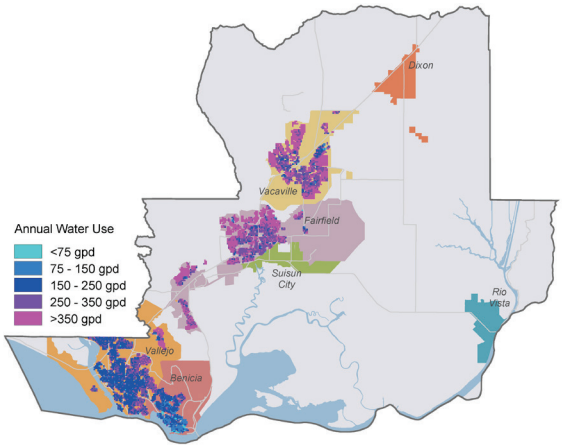
City	Water Savings by SFR Accounts in 2015	Cumulative Water Savings in 2015 (System-wide)[10]	2015 SWRCB Conservation Standard
Vallejo	32%	21%	16%
Benicia	40%	37%	20%
Fairfield	31%	23%	20%
Vacaville	27%	33%	32%

Water use generally increases from west to east, both within individual city water service areas, and across the four cities analyzed (Figure below). As discussed in Section 2.2.2 above and shown on Figure 2-2, Solano County is climatically diverse, with a dramatic increase in ET_0 between the western and eastern portions of the County (SCWA, 2016). This increasing easterly trend in water use is apparent at both the beginning of the drought (2013) and the end (2015) and corresponds with increasing ET_0, suggesting that outdoor water use demands are significantly driving SFR water use.

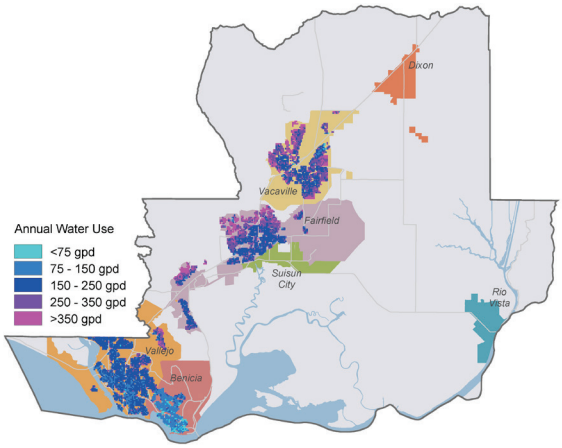
[9] Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the total population.

[10] Cumulative water savings for the purposes of SWRCB-reporting represents the time period of June – December 2015, as compared water use in the same months in 2013 (SWRCB, 2016).

2013 Water Use



2015 Water Use

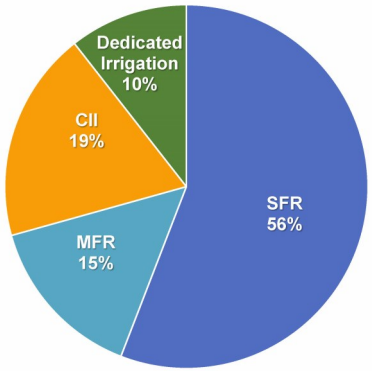


SFR water use per account in 2013 and 2015.

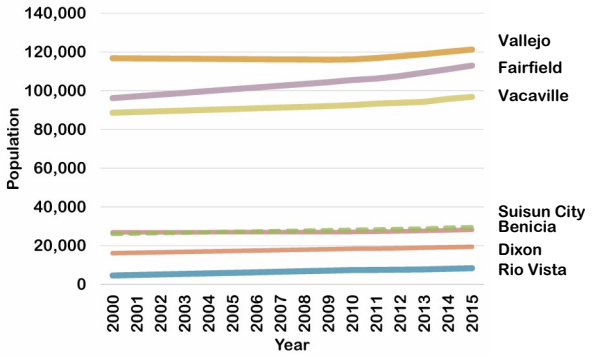
Water savings at SFR accounts ranged from approximately 27% in Vacaville to 40% in Benicia. Of the four cities, Benicia demonstrated the lowest water use in 2013. Given this lower starting point, it might be expected that SFR accounts in Benicia would be more demand-hardened and not have as much capacity to reduce their water use during the drought. However, SFR water use in Benicia declined the greatest percentage of the four cities, with a savings of 40%. This is likely due in large part to the comprehensive customer outreach campaign by the City of Benicia and highlights the importance of public outreach as an effective drought response tool.

CITY OF VALLEJO WATER USE PROFILE

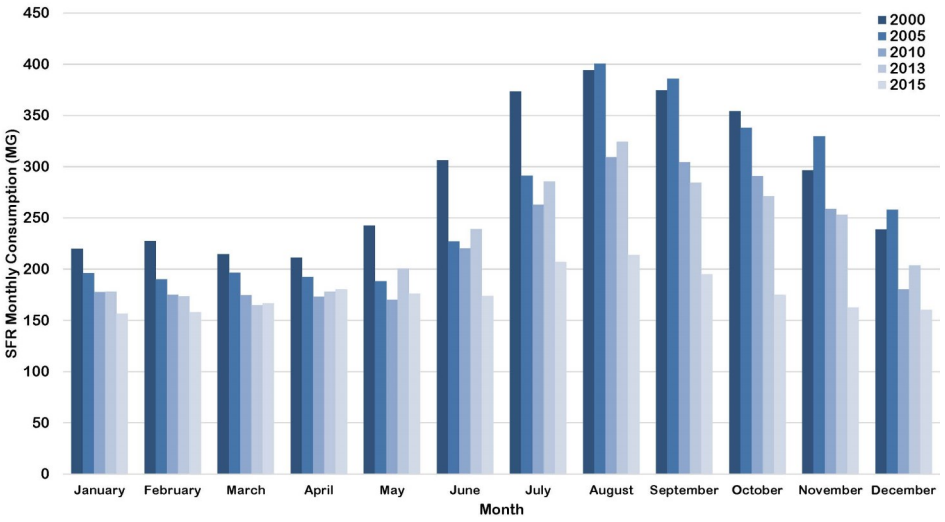
2015 Water Use by Sector



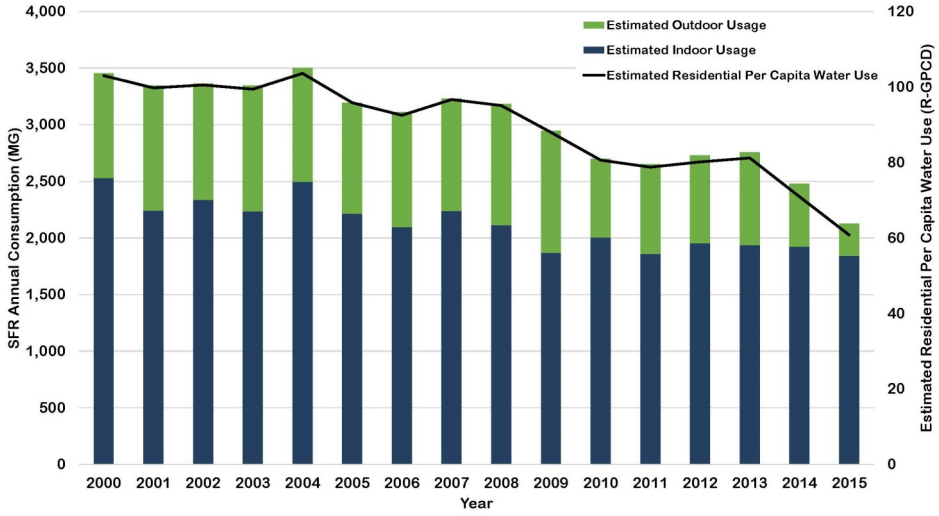
Population



SFR Monthly Consumption



SFR Annual Consumption



Abbreviations

CII = commercial, industrial, and institutional
HCF = one hundred cubic feet
MFR = multi-family residential
SFR = single-family residential
UWMP = Urban Water Management Plan

Notes

1. Non-revenue water is not included in "Water Use by Sector" chart.
2. Annual indoor water use is estimated as the amount of water used during the lowest water use month, normalized by the number of days in the month and projected over the year. Annual outdoor water use is estimated to be the difference between total annual water use and the estimated annual indoor water use.
3. Residential per capita water use is estimated by summing SFR water use with estimated MFR water use, which is approximated based upon the percentage of SFR and MFR water use in 2015, and dividing by population. This estimate does not include water loss and other unaccounted for water, and therefore is expected to be different from estimates used for State reporting purposes.

Sources

1. Data for water use by sector from Vallejo's 2015 UWMP. All other water use data provided by the City of Vallejo.
2. Population data interpolated linearly from US Census Bureau data for 2000 and 2010. Population data for 2011-2015 obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates.

City of Vallejo
Water Use Profile

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

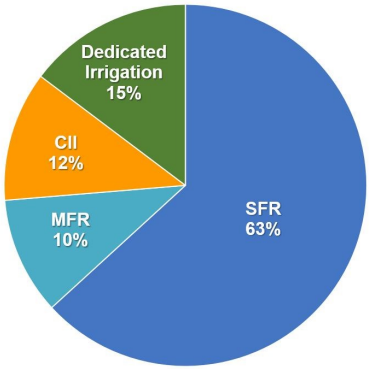
July 2017
EKI B50067.01

eki environment & water

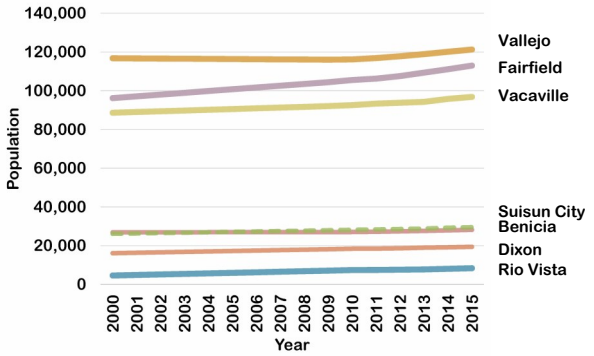
Figure 3-1

CITY OF BENICIA WATER USE PROFILE

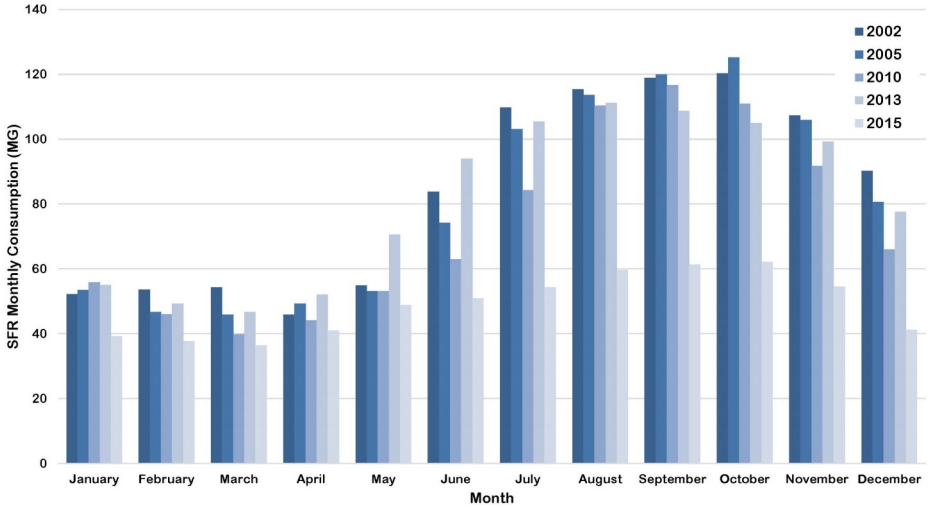
2015 Water Use by Sector



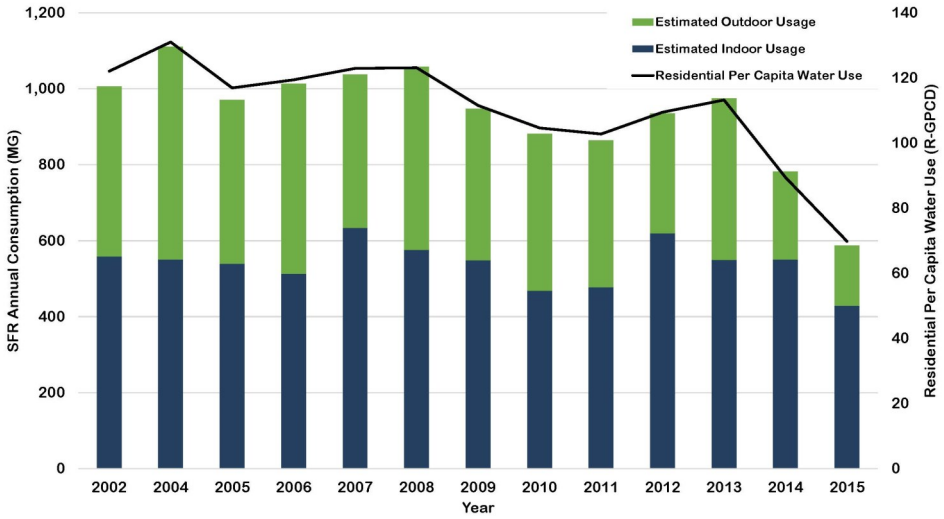
Population



SFR Monthly Consumption



SFR Annual Consumption



Abbreviations

CII = commercial, industrial, and institutional
HCF = one hundred cubic feet
MFR = multi-family residential
SFR = single-family residential
UWMP = Urban Water Management Plan

Notes

1. Non-revenue water is not included in "Water Use by Sector" chart.
2. Water use data for 2003 are unavailable.
3. Annual indoor water use is estimated as the amount of water used during the lowest water use month, normalized by the number of days in the month and projected over the year. Annual outdoor water use is estimated to be the difference between total annual water use and the estimated annual indoor water use.
4. Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the total population. This estimate does not include water loss and other unaccounted for water, and therefore is expected to be different from estimates used for State reporting purposes.

Sources

1. Data for water use by sector from Benicia's 2015 UWMP. All other water use data provided by the City of Benicia.
2. Population data interpolated linearly from US Census Bureau data for 2000 and 2010. Population data for 2011-2015 obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates.

City of Benicia
Water Use Profile

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

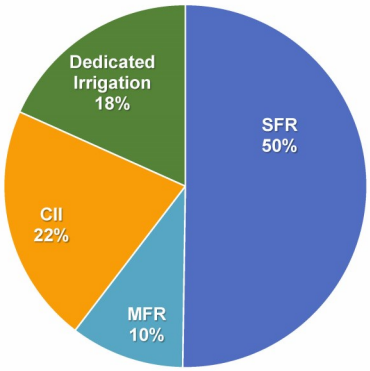
July 2017
EKI B50067.01

eki environment & water

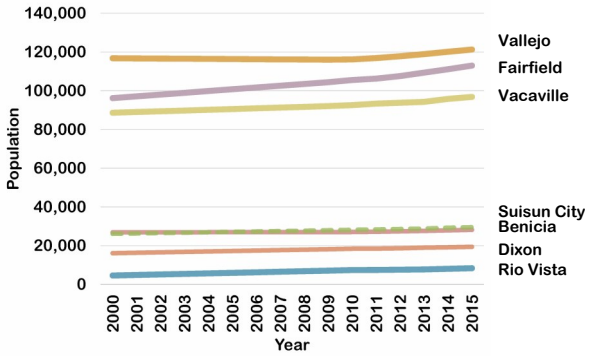
Figure 3-2

CITY OF FAIRFIELD WATER USE PROFILE

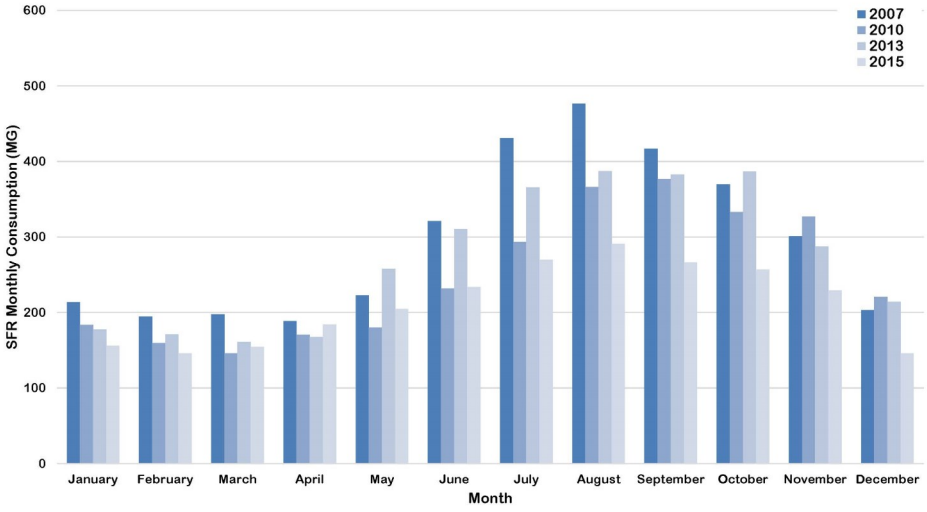
2015 Water Use by Sector



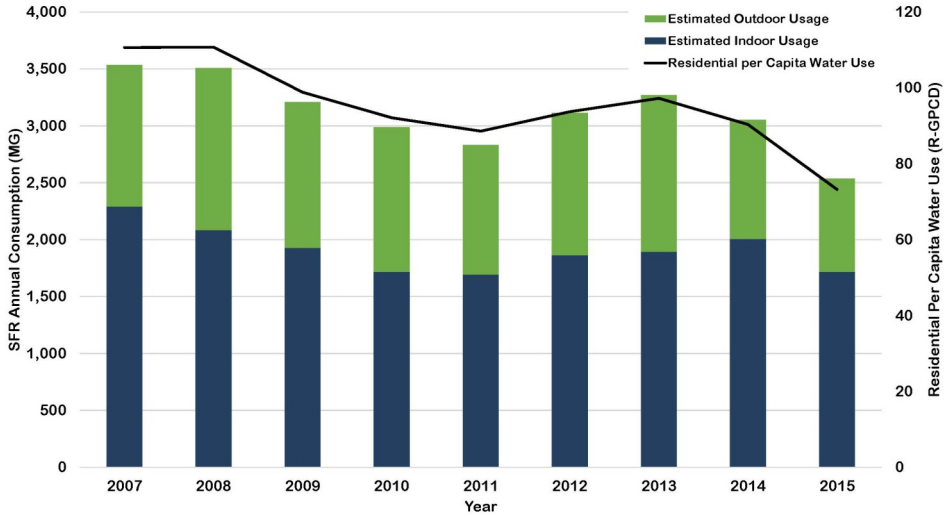
Population



SFR Monthly Consumption



SFR Annual Consumption



Abbreviations

CII = commercial, industrial, and institutional
HCF = one hundred cubic feet
MFR = multi-family residential
SFR = single-family residential
UWMP = Urban Water Management Plan

Notes

1. Non-revenue water is not included in "Water Use by Sector" chart.
2. Annual indoor water use is estimated as the amount of water used during the lowest water use month, normalized by the number of days in the month and projected over the year. Annual outdoor water use is estimated to be the difference between total annual water use and the estimated annual indoor water use.
3. Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the population. This estimate does not include water loss and other unaccounted for water, and therefore is expected to be different from estimates used for State reporting purposes.

Sources

1. Data for water use by sector from Fairfield's 2015 UWMP. All other water use data provided by the City of Fairfield.
2. Population data interpolated linearly from US Census Bureau data for 2000 and 2010. Population data for 2011-2015 obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates.

City of Fairfield
Water Use Profile

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

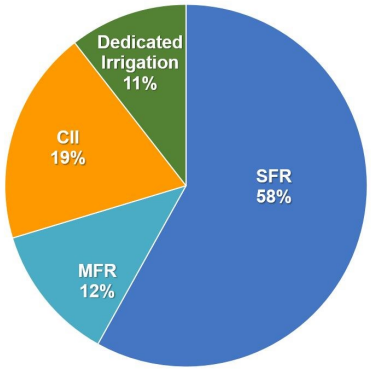
July 2017
EKI B50067.01

eki environment & water

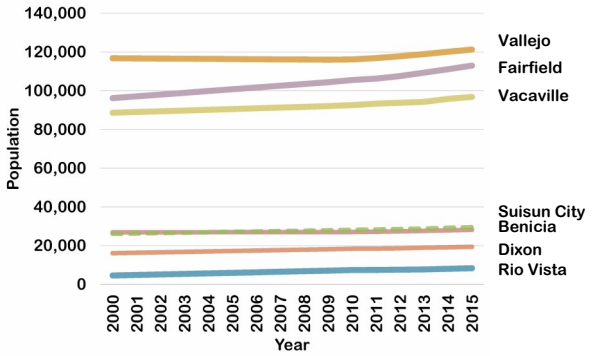
Figure 3-3

CITY OF VACAVILLE WATER USE PROFILE

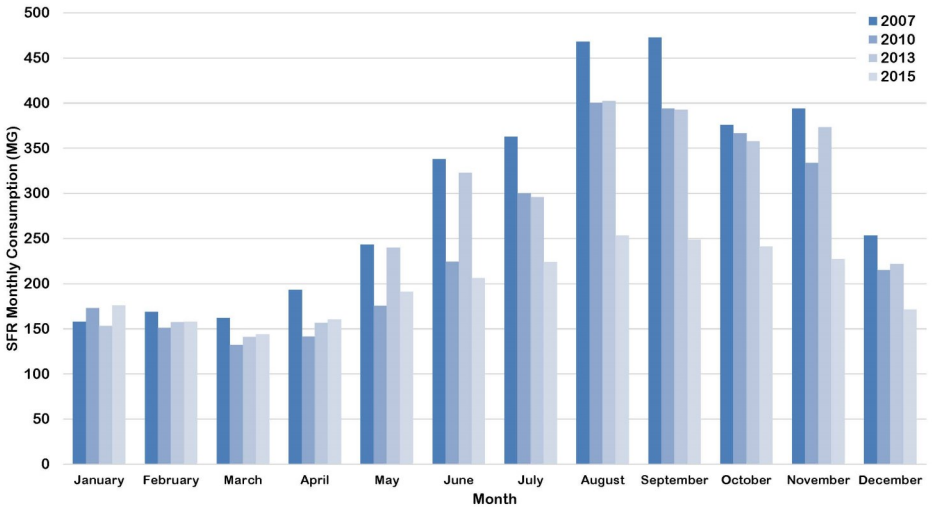
2015 Water Use by Sector



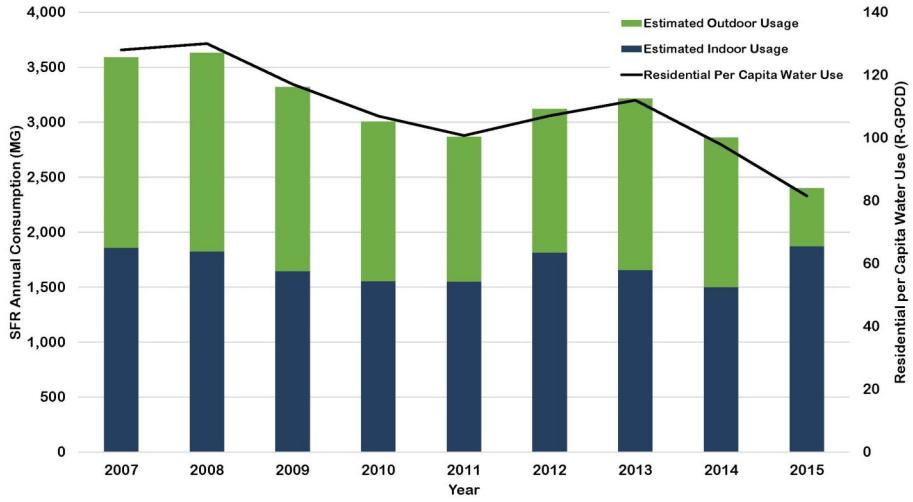
Population



SFR Monthly Consumption



SFR Annual Consumption



Abbreviations

CII = commercial, industrial, and institutional
HCF = one hundred cubic feet
MFR = multi-family residential
SFR = single-family residential
UWMP = Urban Water Management Plan

Notes

1. Non-revenue water is not included in "Water Use by Sector" chart.
2. A small portion of the City of Vacaville's SFR accounts (approximately 0.3%) include separate dedicated meters for irrigation. The estimated indoor and outdoor water usage is based on usage by SFR meters, not including the dedicated irrigation meters, which may result in a slight underestimation of outdoor water use relative to indoor water use.
3. Annual indoor water use is estimated as the amount of water used during the lowest water use month, normalized by the number of days in the month and projected over the year. Annual outdoor water use is estimated to be the difference between total annual water use and the estimated annual indoor water use.
4. Residential per capita water use is calculated as the total water consumption by both SFR and MFR accounts divided by the total population. This estimate does not include water loss and other unaccounted for water, and therefore is expected to be different from estimates used for State reporting purposes.

Sources

1. Data for water use by sector from Vacaville's 2015 UWMP. All other water use data provided by the City of Vacaville.
2. Population data interpolated linearly from US Census Bureau data for 2000 and 2010. Population data for 2011-2015 obtained from US Census Bureau Annual Estimates of the Resident Population 2015 Population Estimates.

City of Vacaville
Water Use Profile

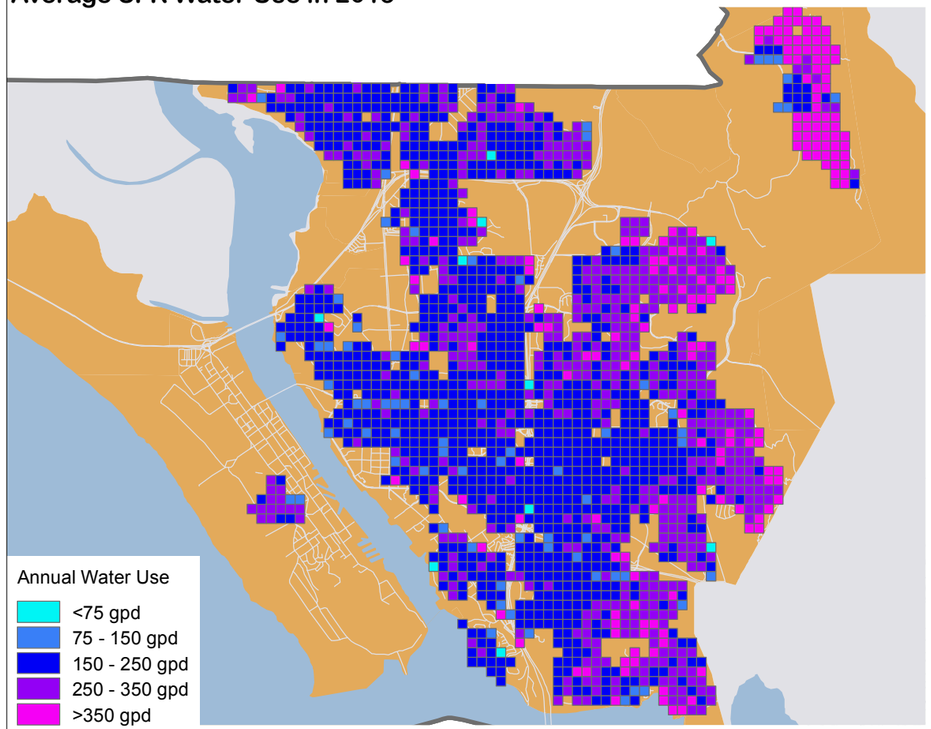
Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01

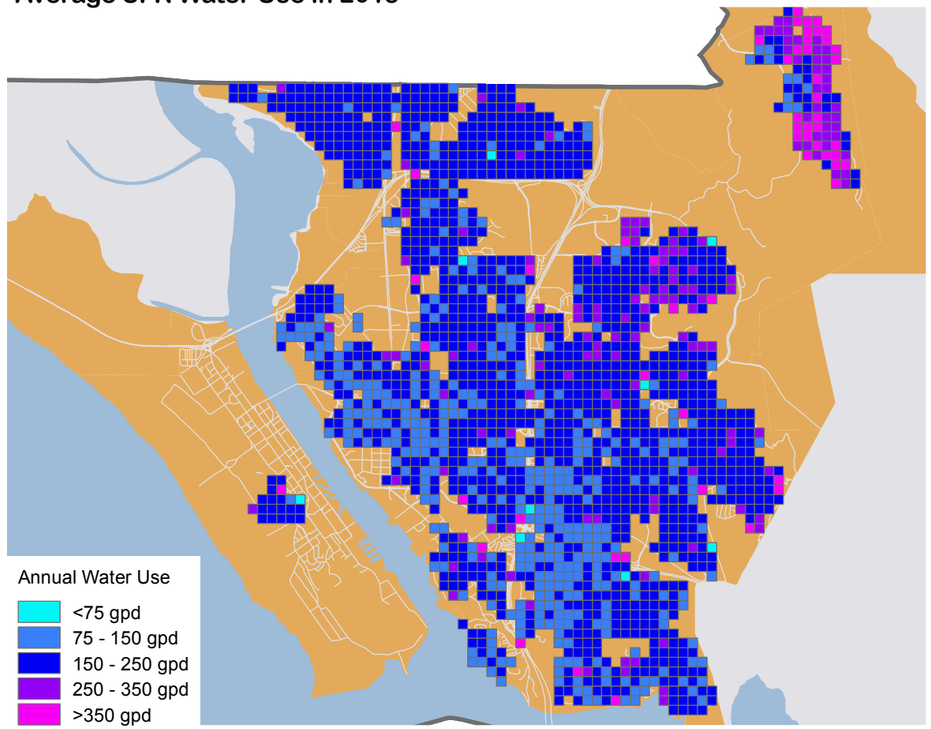
eki environment & water

Figure 3-4

Average SFR Water Use in 2013



Average SFR Water Use in 2015



0 1.5 3

(Approximate Scale in Miles)

N

Legend

- Vallejo
- Other Solano County Areas

Abbreviations

gpd - gallons per day
SFR - single-family residential

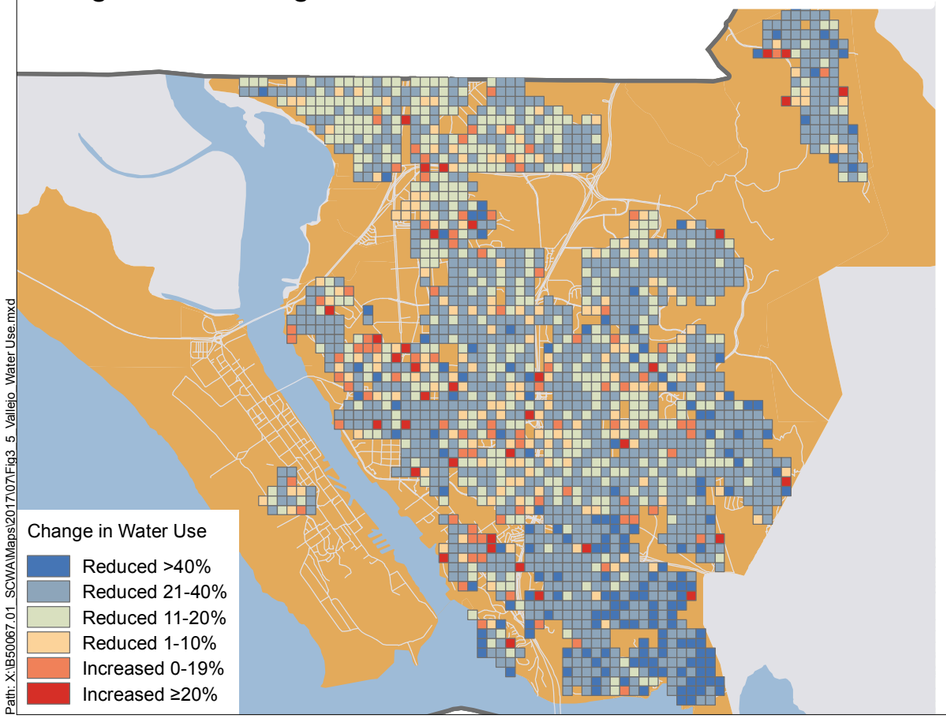
Notes

1. All locations are approximate.
2. Average annual water use is calculated as the average water use of all SFR parcels within a grid cell, and is shown in gpd per account. Grid length and width are equal to 500 feet.

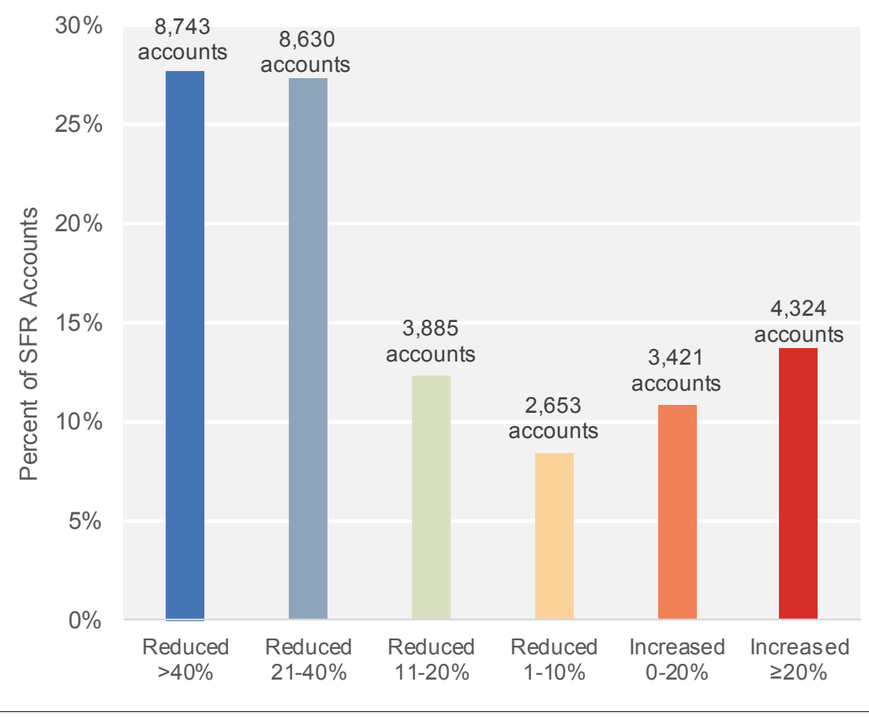
Sources

1. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.
2. Water use data provided by the City of Vallejo.

Average Percent Change in SFR Water Use from 2013 to 2015



Percent Change in SFR Water Use by Account from 2013 to 2015



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig3_5_Vallejo_Water Use.mxd

Average Annual SFR Water Use in 2013 and 2015 – City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

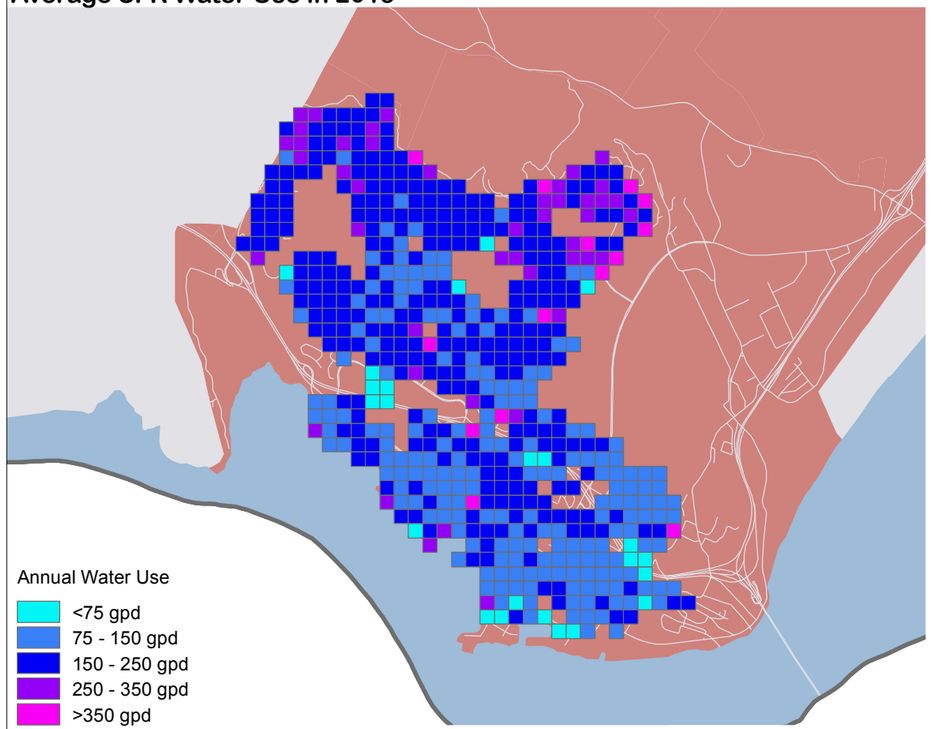
July 2017

EKI B50067.01

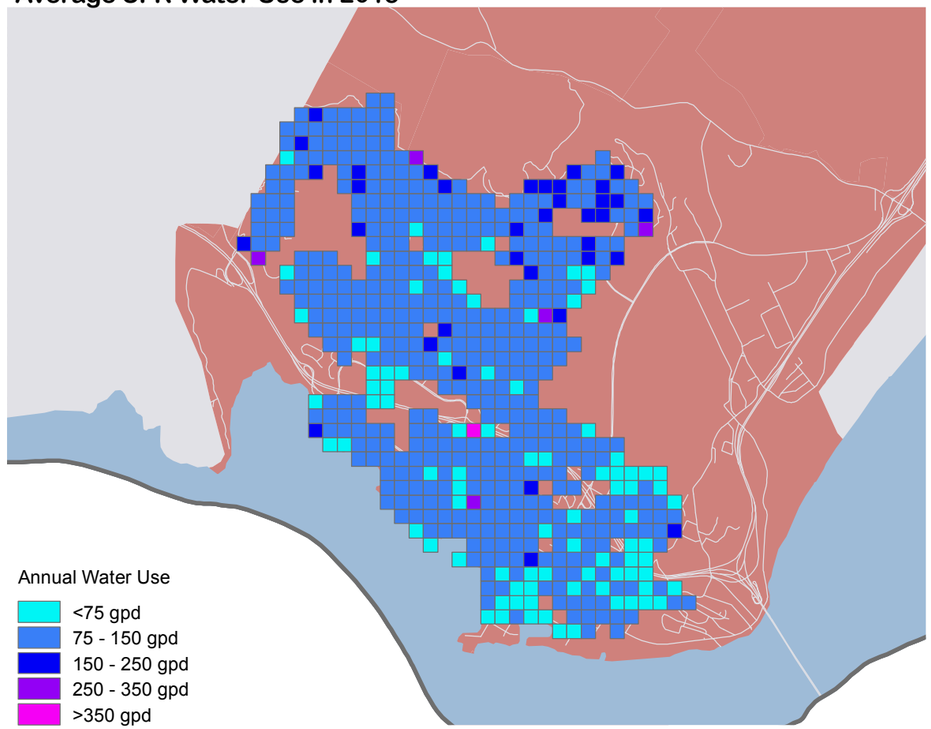
Figure 3-5

eki environment & water

Average SFR Water Use in 2013



Average SFR Water Use in 2015



0 1 2

(Approximate Scale in Miles)

N

Legend

- Benicia
- Other Solano County Areas

Abbreviations

gpd - gallons per day
SFR - single-family residential

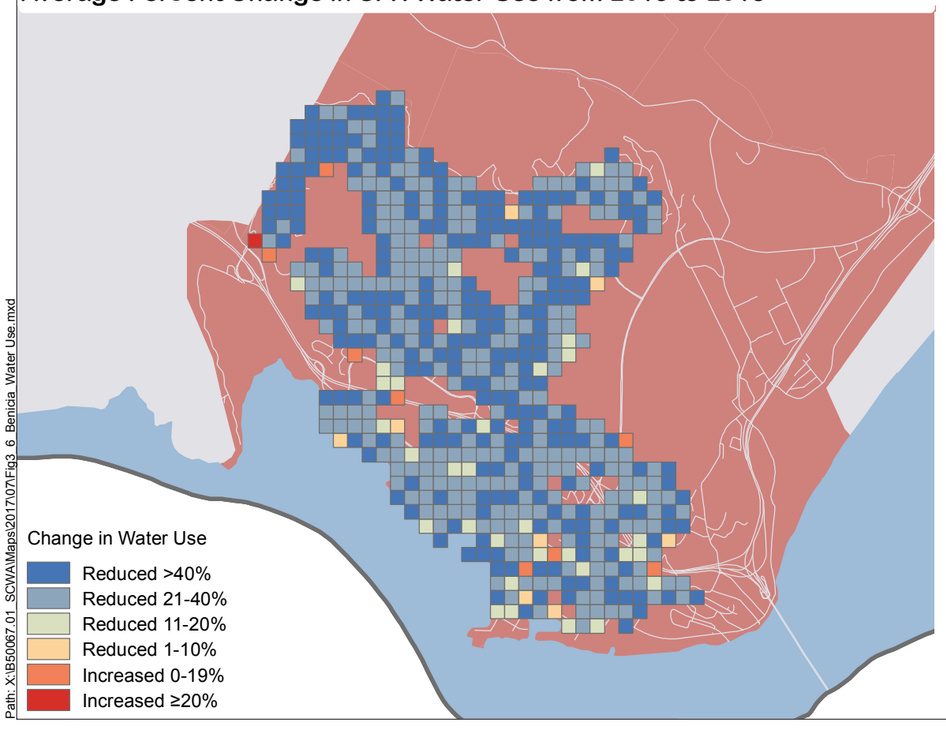
Notes

1. All locations are approximate.
2. Average annual water use is calculated as the average water use of all SFR parcels within a grid cell, and is shown in gpd per account. Grid length and width are equal to 500 feet.

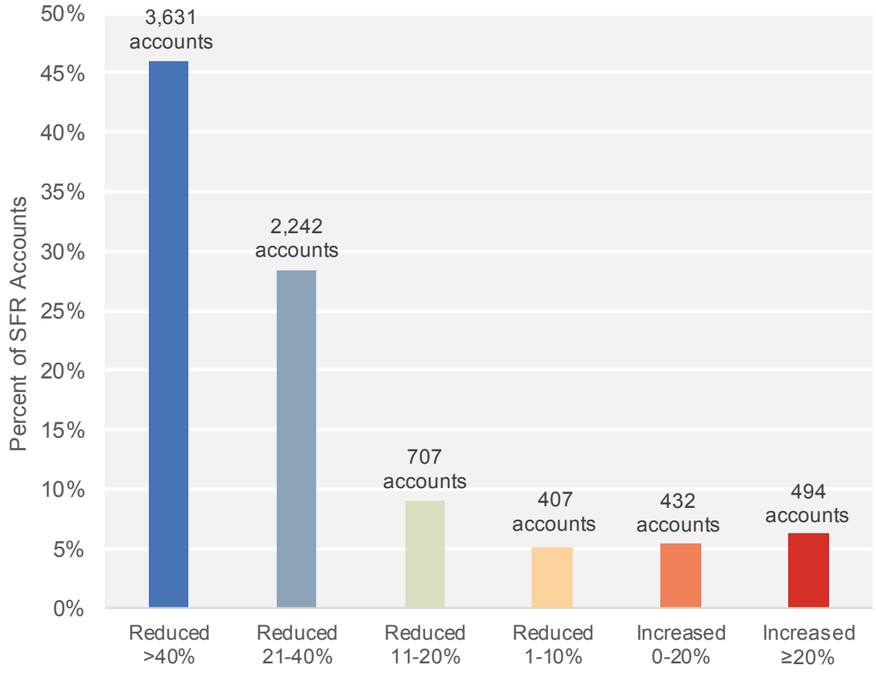
Sources

1. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.
2. Water use data provided by the City of Benicia.

Average Percent Change in SFR Water Use from 2013 to 2015



Percent Change in Water Use by Account from 2013 to 2015



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig3_6_Benicia_Water Use.mxd

Average Annual SFR Water Use in 2013 and 2015 – City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

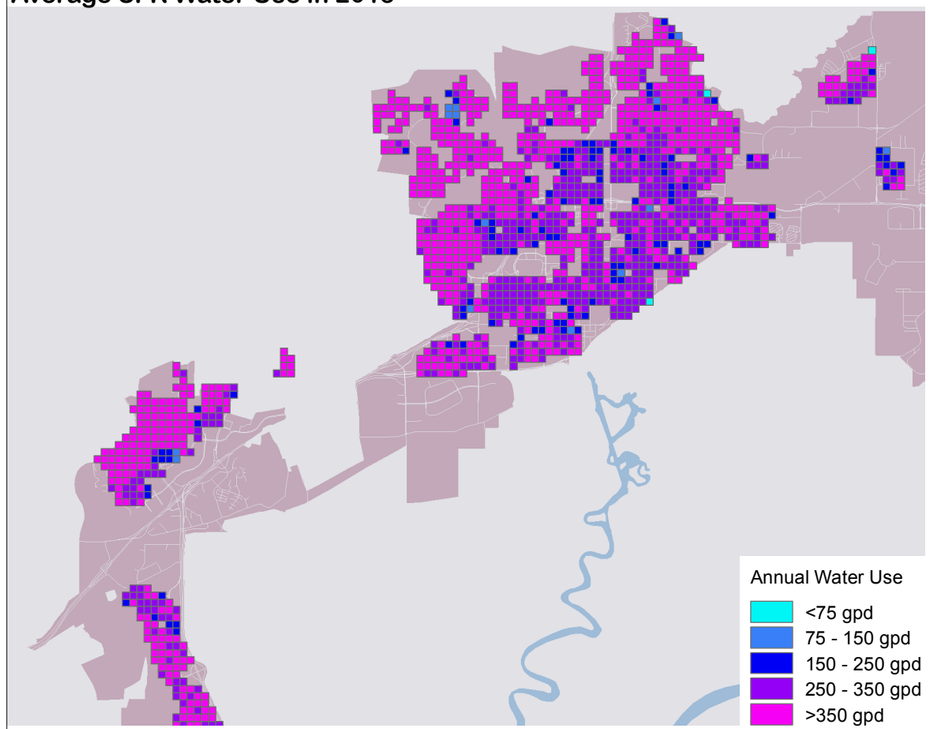
July 2017

EKI B50067.01

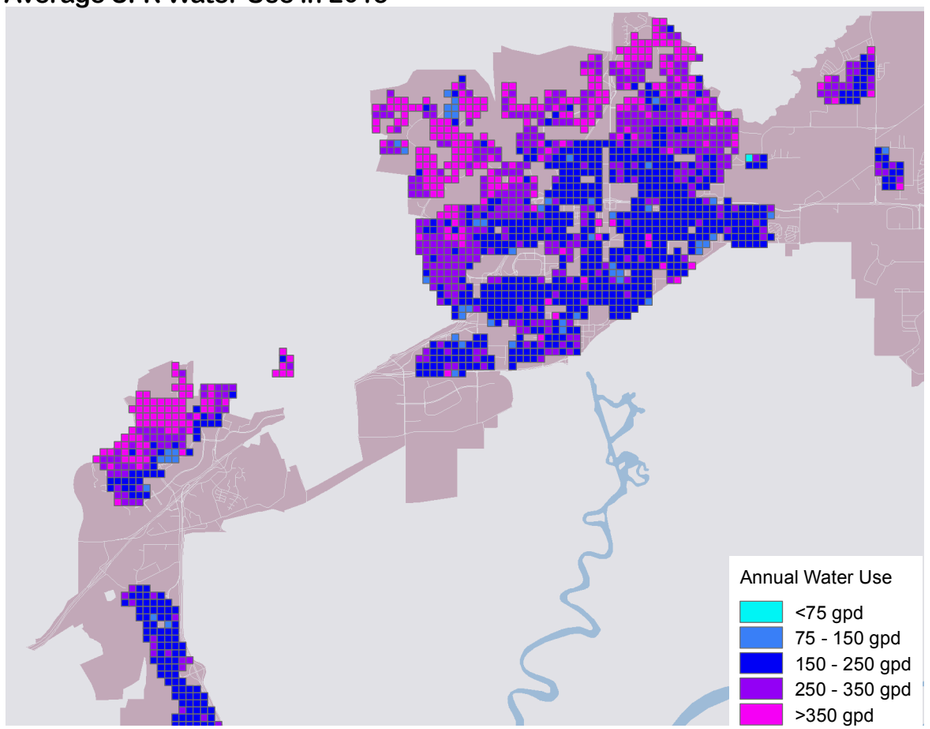
Figure 3-6

eki environment & water

Average SFR Water Use in 2013



Average SFR Water Use in 2015



0 2 4

(Approximate Scale in Miles)

N

Legend

- Fairfield
- Other Solano County Areas

Abbreviations

gpd - gallons per day
SFR - single-family residential

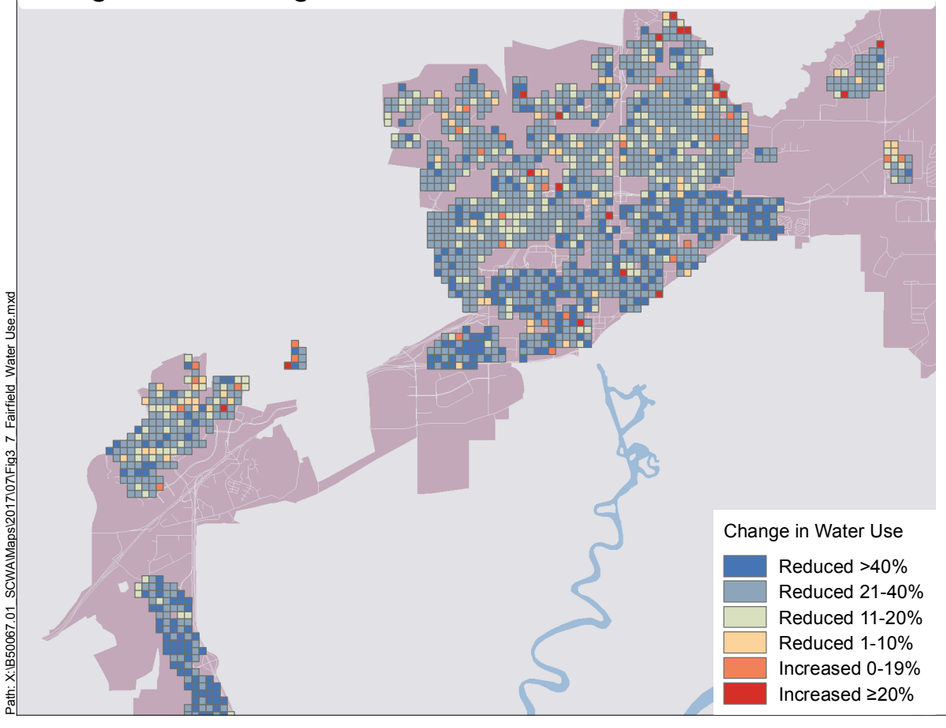
Notes

1. All locations are approximate.
2. Average annual water use is calculated as the average water use of all SFR parcels within a grid cell, and is shown in gpd per account. Grid length and width are equal to 500 feet.

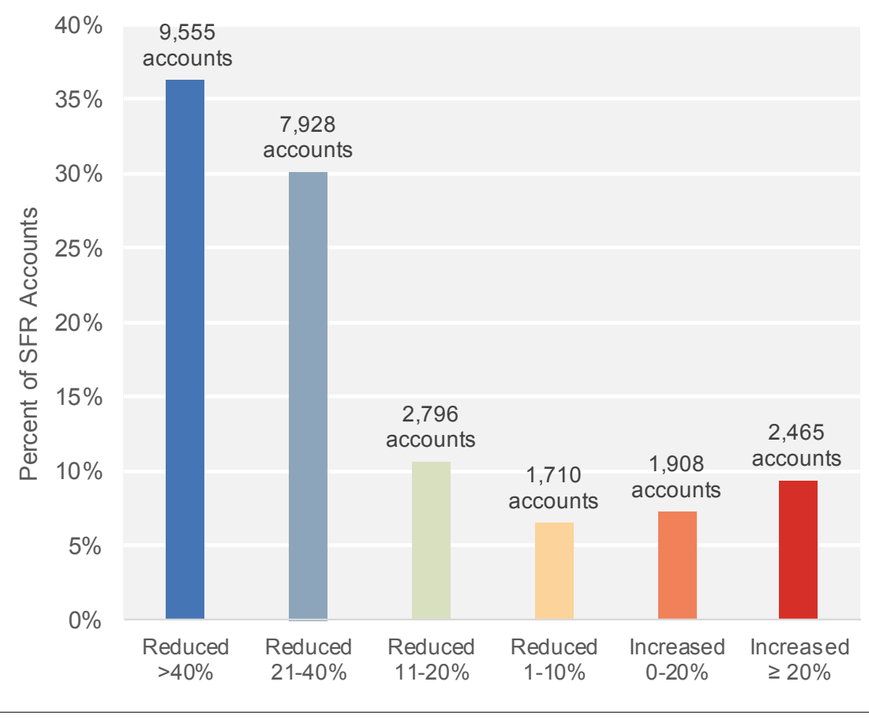
Sources

1. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.
2. Water use data provided by the City of Fairfield.

Average Percent Change in SFR Water Use from 2013 to 2015



Percent Change in SFR Water Use by Account from 2013 to 2015



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig3_7_Fairfield_Water_Use.mxd

Average Annual SFR Water Use in 2013 and 2015 – City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

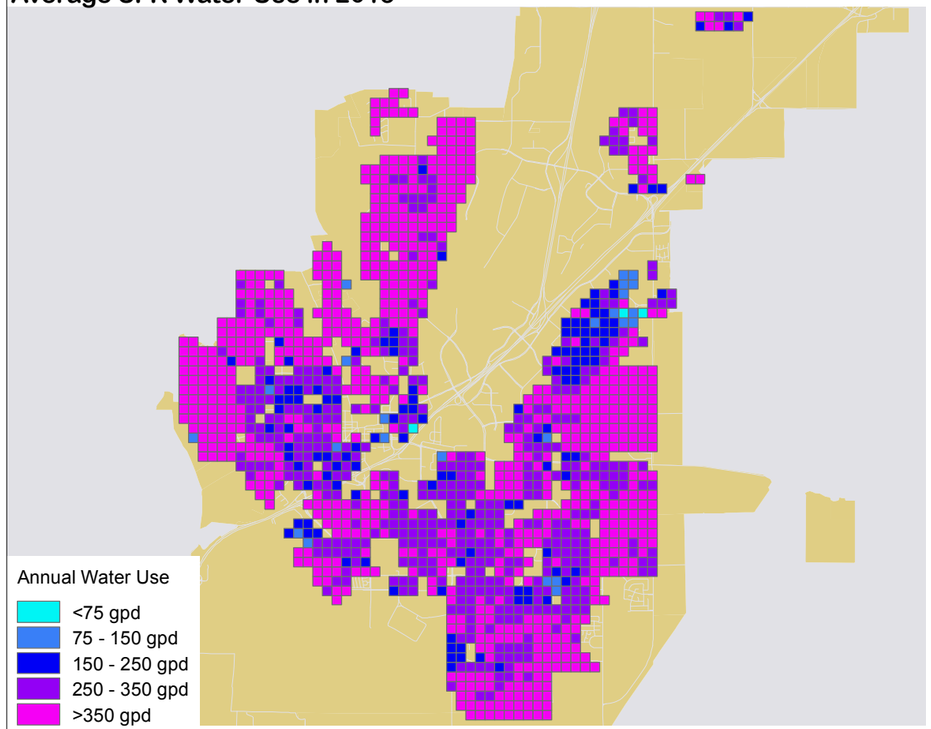
July 2017

EKI B50067.01

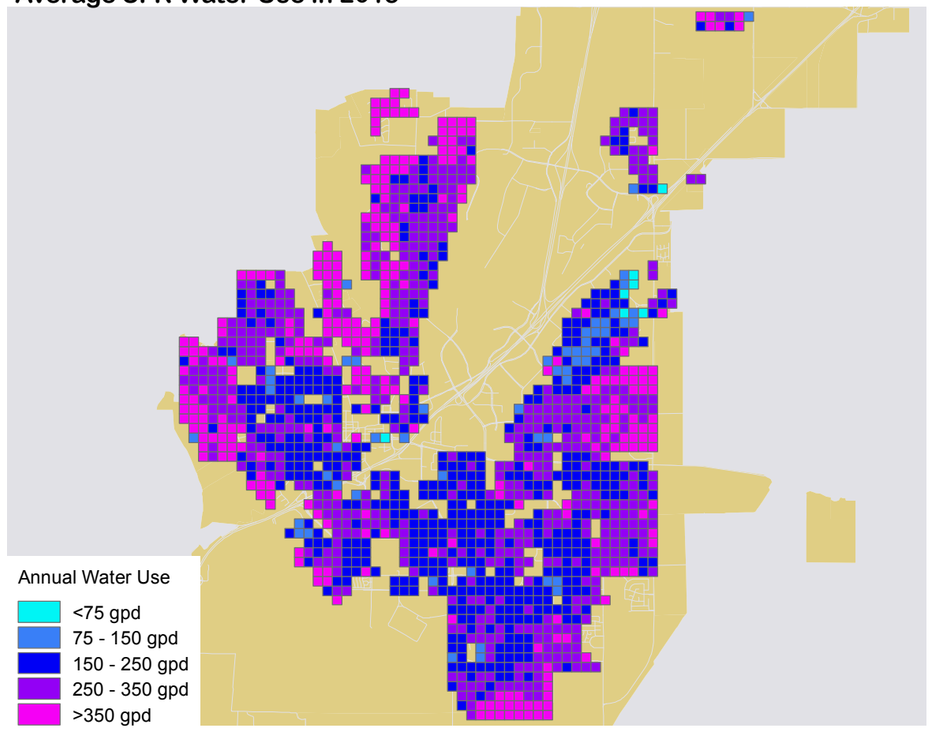
Figure 3-7

eki environment & water

Average SFR Water Use in 2013



Average SFR Water Use in 2015



0 1.5 3

(Approximate Scale in Miles)

N

Legend

- Vacaville
- Other Solano County Areas

Abbreviations

gpd - gallons per day
SFR - single-family residential

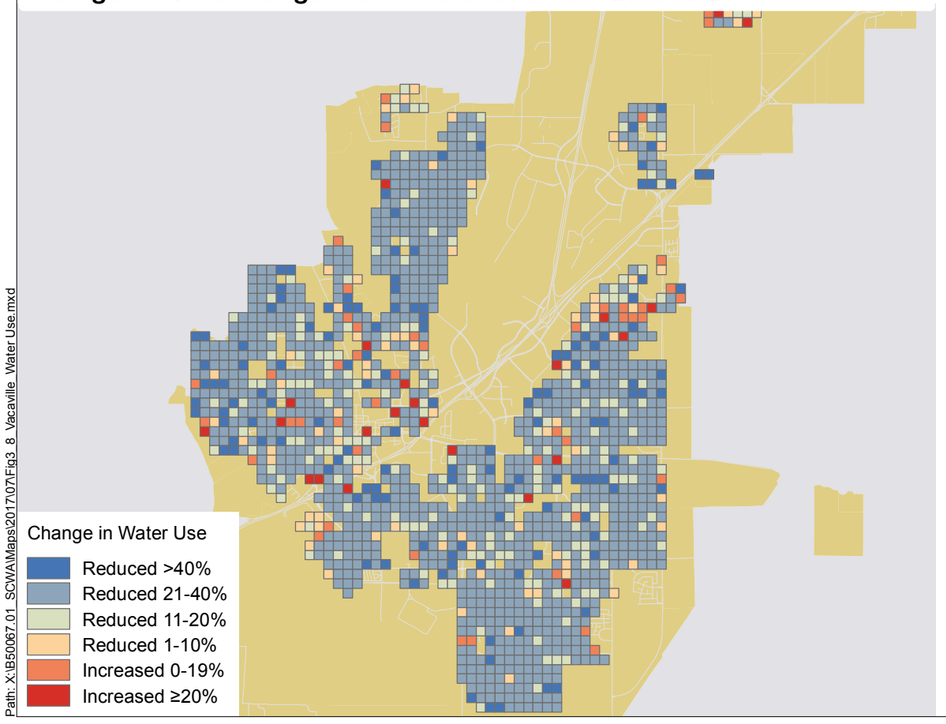
Notes

1. All locations are approximate.
2. Average annual water use is calculated as the average water use of all SFR parcels within a grid cell, and is shown in gpd per account. Grid length and width are equal to 500 feet.

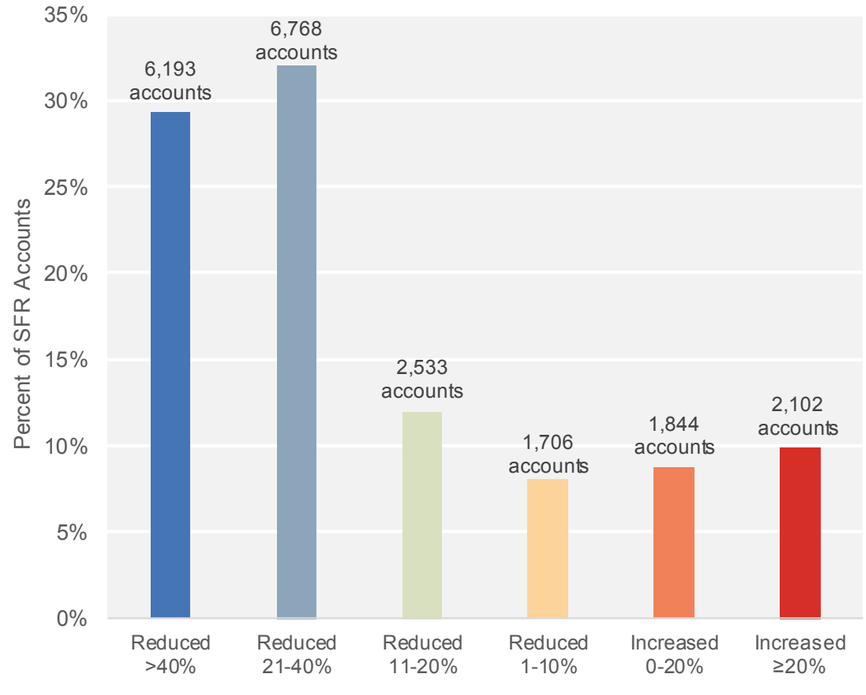
Sources

1. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.
2. Water use data provided by the City of Vacaville.

Average Percent Change in SFR Water Use from 2013 to 2015



Percent Change in SFR Water Use by Account from 2013 to 2015



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig3_8_Vacaville_Water Use.mxd

Average Annual SFR Water Use in 2013 and 2015 – City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 3-8

eki environment & water

4.0 CONSERVATION PROGRAM PARTICIPATION

In order to reduce water demand and promote public awareness of responsible water use, SCWA works with its member units to provide a wide range of water conservation programs to water customers across its service area. The primary conservation programs that target SFR water users include the HE Toilet Rebate, HE Washer Rebate, Turf Replacement Rebate, Residential Water Use Survey, and Smart Irrigation Controller Rebate Programs. Additionally, the member units conduct a number of local public outreach and education programs, including school outreach programs, distributing flyers and brochures as bill inserts, offering landscape and greywater classes to the public, and providing water conservation resources through their city websites, among other activities. The SCWA and its member units also provide many conservation programs that target MFR, CII, and dedicated irrigation water users; however, analysis of these programs are outside of the scope of this study. This section presents information related to analysis of temporal and geospatial trends in participation for each of the four major SFR water conservation programs. This analysis was performed for each of the four member units that were able to provide account-level water use for this study: the Cities of Vallejo, Benicia, Fairfield, and Vacaville.

4.1 Analytical Methodology

4.1.1 *County-Wide Analysis*

Total participation in each of the four major SFR water conservation programs and the Smart Irrigation Controller rebate program are tabulated by member unit and presented in Tables 4-1 through 4-5. These tables include the total number of participating SFR accounts, number of rebates issued, total rebate dollars spent, and in the case of the Turf Replacement Rebate program, the total amount of turf square footage replaced. Participation in each of the four major programs was plotted on a County-wide basis on Figures 4-1 through 4-4. These figures also include bar charts summarizing the total participation in each program by SFR accounts over time, which provides a perspective on program trends and drivers.

4.1.2 *City-Wide Analysis*

Participation in each of the programs is also presented on a city-wide basis for the four member units on Figures 4-5 through 4-20. These figures present spatial and temporal trends in program participation within a city, and facilitate comparison to other neighborhood-scale characteristics such as housing age.

For each of the four subject cities and conservation programs, a spatial cluster analysis was performed to evaluate the spatial distribution of program participants across SFR parcels in

each city, and to identify the presence of participation clusters, or "hot spots".[11] A participation hot spot is an area where a higher density of participation is observed than would be expected if participation was randomly distributed. Similarly, "cold spots," or areas of lower than expected participation, were identified. This analysis was conducted in order to identify the areas where limited program participation has occurred to date. This analysis is presented in the bottom right hand panel of Figures 4-5 through 4-20; areas of high participation are indicated in blue and areas of low participation are indicated in red. As discussed in Section 7.0, this information is used to identify areas that could be targeted for future implementation of SCWA conservation programs.

4.2 HE Toilet Rebate Program

The HE Toilet Rebate Program was launched by SCWA in 2007 to provide member unit customers a financial incentive to replaced older, inefficient toilets (typically 3.5 gallons per flush, "gpf") with new, higher efficiency toilets (using a maximum of 1.28 gpf). The HE Toilet Rebate Program was offered to all SFR households through January 2015. New legislation was passed in California, specifically Senate Bill 407, requiring the replacement of pre-1994 water fixtures with new water-efficient fixtures beginning in 2017, and new water fixture standards set by the California Energy Commission in 2015 mandate that only high-efficiency toilets (1.28 gpf or less) can be sold in California. Given that only high efficiency toilets are available on the market, the previous HE Toilet Rebate Program no longer serves as an incentive to steer customers towards more efficient toilets.

4.2.1 *Solano County*

Participation in the HE Toilet Rebate Program in Solano County is summarized in Table 4-1 and on Figure 4-1. From the beginning of the program in 2007 through March 2015, a total of 5,764 rebates were issued to 3,622 unique SFR accounts, totaling $638,086 in rebates (or roughly $111 per rebate).[12] Over the period of record, the most rebates were issued in Vacaville (1,789), and the fewest rebates were issued in Rio Vista (48). As a percentage of the total SFR accounts in each city, the highest participation rate occurred in the cities of Benicia and Vacaville (4.7%), and the lowest participation rate occurred in Rio Vista (0.8%).

[11] The ESRI ArcGIS 10.3.1 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. Areas with very large SFR parcels (i.e., generally larger than 0.5 acres) and areas with isolated parcels (e.g., no or very few SFR neighbors) were excluded from the analysis so that these more rural areas would not skew the results.

[12] Although the program was suspended in January 2015, applications received prior to this date were processed and rebates were issued until March 2015; a total of 222 rebates were issued in 2015.

The SCWA is currently piloting a new HE toilet-focused program, which focuses on the direct-installation of HE toilets for low income and senior households. The strategic program opportunity analysis presented in Section 7.0 can be used to support implementation of this pilot program.

4.2.2 *City of Vallejo*

Over the period of 2007 through March 2015, 1,068 HE toilet rebates were issued to 678 unique SFR accounts within Vallejo, totaling $117,513 in rebates. Approximately 2.2% of SFR accounts participated in the HE Toilet Rebate Program during this time. Prior to the program's suspension in January 2015, participation increased in every year except 2011.

As illustrated by the distribution of hot and cold spots on Figure 4-5, the eastern and southern portions of the city exhibited the strongest interest in the HE Toilet Rebate Program. Conversely, the western and northeastern portions of the city demonstrated below average participation in the program. These areas of the city include mostly older houses (Figure 2-5), which are more likely to have older, high-water-use toilets, and represent a potential target area for any future HE toilet programs. The lower level of participation in the northeast portion of the city corresponds to an area of newer SFR development where fewer high-water-use toilets would be expected (Figure 2-5).[13]

4.2.3 *City of Benicia*

Over the period of 2007 through March 2015, 697 HE toilet rebates were issued to 404 unique SFR accounts within Benicia, totaling $79,196 in rebates. Approximately 4.7% of SFR accounts participated in the HE Toilet Rebate Program during this time. Participation increased between 2007 and 2010, dropped in 2011 and 2012, and then increased again through 2014.

As illustrated by the distribution of hot and cold spots on Figure 4-6, the northwestern portions of the city exhibited the strongest interest in the HE Toilet Rebate Program. Conversely, the northeastern and southeastern portions of the city demonstrated below average participation in the program. The southeastern area of the city includes mostly older houses (Figure 2-6), which are more likely to have older, high-water-use toilets, and represent a potential target area for any future HE toilet programs. The lower level of participation in the northeastern portion of the city corresponds to an area of newer SFR development where fewer high-water-use toilets would be expected (Figure 2-6).

[13] The 1992 Federal Energy Policy Act (effective 1994) required that all new toilets sold in the United States be 1.6 gpf or more efficient.

4.2.4 *City of Fairfield*

Over the period of 2007 through March 2015, 1,607 HE toilet rebates were issued to 1,016 unique SFR accounts within Fairfield, totaling $178,015 in rebates. Approximately 4.0% of SFR accounts participated in the HE Toilet Rebate Program during this time. Participation increased between 2007 and 2011, dropped in 2012 and 2013, and then increased again in 2014.

As illustrated by the distribution of hot and cold spots on Figure 4-7, the central portion of the city exhibited the strongest interest in the HE Toilet Rebate Program.[14] Conversely, the western portions of the city demonstrated below average participation in the program. The central area of the city is largely composed of houses built between 1951 and 1970 (Figure 2-7). These older homes are more likely to have high-water-use toilets, and represent a potential target area for any future HE toilet programs. The lower level of participation in the western portion of the city corresponds to an area of newer SFR development where fewer high-water-use toilets would be expected (Figure 2-7).

4.2.5 *City of Vacaville*

Over the period of 2007 through March 2015, 1,789 HE toilet rebates were issued to 1,143 unique SFR accounts within Vacaville, totaling $197,617 in rebates. Approximately 4.7% of SFR accounts participated in the HE Toilet Rebate Program during this time. Participation increased between 2007 and 2014 and peaked in 2014 with 443 rebates given that year. There is one large hot spot displayed on Figure 4-8 that corresponds with an area of households constructed between 1991 and 2010 (Figure 2-8).

4.3 HE Washer Rebate Program

The SCWA partnered with Pacific Gas and Electric Company ("PG&E") to provide a combined rebate of $150[15] to customers within the SCWA service area who purchase a washing machine included on the ENERGY STAR Most Efficient list. The PG&E HE Washer Rebate Program concluded at the end of 2016, but the SCWA HE Washer Rebate Program is anticipated continue through the end of 2017. The water efficiency of new washers currently available for purchase on the market ranges more broadly than for other water-using fixtures such as toilets. Given the way the HE Washer Rebate Program is structured, only the most efficient washers are eligible for rebates, although all washers currently available for sale are significantly more efficient than their older counterparts. The HE Washer Rebate Program was launched in 2007, but rebate participation records prior to 2010 are not available.

[14] Areas of very low density housing (i.e., generally areas where parcels are greater than 1-acre in size) were excluded from the hot spot analysis for all programs in Fairfield.
[15] The SCWA contributed $100 to the rebate and PG&E contributed $50.

4.3.1 *Solano County*

Participation in the HE Washer Rebate Program in Solano County is summarized in Table 4-2 and on Figure 4-2. Interest in the program has been strong; out of the five SCWA conservation programs described in Section 4.0, the HE Washer Rebate Program has the highest aggregate rate of participation, as a percentage of total SFR accounts. From 2010 through July 2016, a total of 4,763 rebates were issued, totaling $440,750 in rebates. Over this period, the most rebates were issued in Fairfield (1,472) and the fewest rebates were issued in Dixon (94). As a percentage of the total SFR accounts in each city, the highest participation rate occurred in Fairfield (5.7%), and the lowest participation rate occurred in Rio Vista (2.4%). The county-wide participation rate in the HE Washer Rebate Program increased from 2010 to 2012 and has been declining since. This decline may be influenced by factors such as the decreasing rebate amount and the fact that the most efficient washers available on the market tend to be the most expensive. According to the ENERGY STAR Most Efficient 2017 website[16], rebate-eligible large (larger than 2.5 cubic feet) washers generally cost between approximately $700 and $1,500 (ENERGY STAR, 2017). New washers that do not meet this higher efficiency standard are available on the market for as low as about $300. Given this cost difference, the rebate amount of $150 may not be the primary motivating factor for selecting a higher efficiency washer rebate-eligible washer over a comparable less efficient option.

4.3.2 *City of Vallejo*

From 2010 through July 2016, 908 HE washer rebates were issued to unique SFR accounts in Vallejo, totaling $84,750 in rebates. Approximately 2.9% of SFR accounts participated in the HE Washer Rebate Program. Consistent with the overall county-wide trend, participation in Vallejo increased until about 2012 and then subsequently declined (Section 4.3.1).

As illustrated by the distribution of hot and cold spots on Figure 4-9, the western portion of the city demonstrated below average participation in the program. This area of the city includes mostly older houses (Figure 2-5), which are more likely to have older, high-water-use clothes washers. This area is a good candidate for targeted outreach and increased program participation for a future HE washer program. High participation was observed in the northwest and northeast portions of the city.

4.3.3 *City of Benicia*

From 2010 through July 2016, 425 HE washer rebates were issued to unique SFR accounts in Benicia, totaling $40,225 in rebates. Approximately 4.9% of SFR accounts participated in the HE Washer Rebate Program. Consistent with the overall county-wide trend, participation in Benicia increased until about 2012 and then subsequently declined (Section 4.3.1).

[16] https://www.energystar.gov/products/most_efficient

As illustrated by the distribution of hot and cold spots on Figure 4-10, the southern and northeastern portions of the city demonstrated below average participation in the program. These areas of the city include mostly older houses (Figure 2-6), which are more likely to have older, high-water-use clothes washers. These areas are good candidates for targeted outreach and increased program participation for a future HE washer program. High participation was observed in the northwest portion of the city.

4.3.4 *City of Fairfield*

From 2010 through July 2016, 1,472 HE washer rebates were issued to unique SFR accounts in Fairfield, totaling $136,650 in rebates. Approximately 5.7% of SFR accounts participated in the HE Washer Rebate Program. Consistent with the overall county-wide trend, participation in Fairfield increased until about 2013 and then subsequently declined (Section 4.3.1).

As illustrated by the distribution of hot and cold spots on Figure 4-11, western and central portions of Fairfield demonstrated below average participation in the program. These areas of the city include mostly older houses (Figure 2-7), which are more likely to have older, high-water-use clothes washers. These areas are good candidates for targeted outreach and increased program participation for a future HE washer program. High participation was observed in neighborhoods in the central portion of the city.

4.3.5 *City of Vacaville*

From 2010 through July 2016, 1,357 HE washer rebates were issued to unique SFR accounts in Vacaville, totaling $123,400 in rebates. Approximately 5.6% of SFR accounts participated in the HE Washer Rebate Program. Consistent with the overall county-wide trend, participation in Vacaville increased until about 2013 and then subsequently declined (Section 4.3.1).

As illustrated by the distribution of hot and cold spots on Figure 4-12, the central western portion of Vacaville demonstrated below average participation in the program. This area of the city includes mostly older houses (Figure 2-8), which are more likely to have older, high-water-use clothes washers. These areas are good candidates for targeted outreach and increased program participation for a future HE washer program. High participation was observed in the southeastern portion of the city.

4.4 Turf Replacement Rebate Program

The Turf Replacement Rebate Program was launched in the summer of 2010 as a pilot program to promote water conservation and support the installation of healthy, sustainable, and low-water-use landscapes. The program provides a financial incentive to replace irrigated turf with sustainable, water-efficient landscaping. The cash rebate offered to SFR customers is currently $1.00 per square foot of turf replaced, for up to a maximum of 1,000 square feet

of turf.[17] In order to receive a rebate, new landscaping must consist of drought-tolerant plants with at least three inches of mulch that are irrigated by a low-volume, drip method. Alternatively, SFR customers may install permeable hardscaping, such as decomposed granite, provided that the converted area includes a sufficient number of plants to ensure at least 50% of the area is covered when the plants are fully grown. Turf replacement projects are inspected upon completion by SCWA staff to ensure compliance with these requirements prior to the rebate being issued.

4.4.1 *Solano County*

Participation in the Turf Replacement Rebate Program in Solano County is summarized in Table 4-3 and on Figure 4-3. Although the program was created more recently than the HE Toilet and HE Washer Rebate Programs discussed in Sections 4.2 and 4.3, participation has been significant. In 2010 through September 2016, a total of 1,441 rebates were issued to SFR accounts, totaling 1,331,241 square feet of turf replaced, 1,325,259 square feet of turf rebated, and $1,060,266 in rebates. The area of turf replaced per rebate was generally between 900 and 1,000 square feet, with the lowest average occurring in Rio Vista (approximately 690 square feet) and highest in Suisun City (approximately 1,070 square feet). Even though the maximum turf area eligible for a rebate amount is 1,000 square feet, approximately 37% of program participants replaced an area of turf greater than 1,000 square feet. Over the seven-year program period, the highest rate of participation has been in Benicia (with 3.4% of SFR accounts participating) and the lowest participation has been in Suisun City and Vallejo, with less than 1% of SFR accounts participating. Most cities experienced similar trends in participation, where limited participation occurred prior to 2013 and participation increased substantially in both 2014 and 2015. Notably, in Benicia there was an increase in program participation from 2014 to 2015, wherein the number of rebates issued to SFR accounts increased from 77 to 147. The significant increase in program participation seen from 2013 onwards is likely influenced in part by: (1) the increase in rebate amount, (2) the increased public awareness and desire to conserve water in response to the extraordinary drought conditions and the associated media attention, and (3) additional public awareness of the program's existence.

4.4.2 *City of Vallejo*

From 2010 through September 2016, turf replacement rebates were issued to 291 unique SFR accounts in Vallejo, totaling $213,137 in rebates and corresponding to 268,539 square feet of turf replaced (266,260 square feet of turf rebated). Approximately 0.93% of SFR accounts in Vallejo have participated in the Turf Replacement Rebate Program. Participation was highest in 2014 (116 rebates issued), with slightly less participation in 2015 (108 rebates

[17] When the program began in 2010, the rebate amount was $0.50/square foot. In 2012, the rebate amount was increased to $0.60/square foot and again increased in 2013 to the current $1.00/square foot.

issued). The trend of increasing participation observed in Vallejo is consistent with the overall County-wide trend discussed above.

Several hot spots, or areas of higher density participation, were identified by the hot spot analysis and are shown on Figure 4-13. Turf replacement projects are far more visible to neighbors than interior improvements such as replacing toilets and washers. The hot spots identified by this analysis may indicate the benefit of a "cluster effect" wherein observing that a neighbor has replaced their landscaping motivates additional accounts within a neighborhood to undertake similar projects, or a "neighbors seeing neighbors" effect. This observation of the apparent cluster effect reinforces the additional public outreach and education elements of turf replacement programs, which are difficult to quantify, but important never-the-less.

4.4.3 *City of Benicia*

From 2010 through September 2016, turf replacement rebates were issued to 289 unique SFR accounts in Benicia, totaling $210,698 in rebates and corresponding to 252,200 square feet of turf replaced (251,300 square feet of turf rebated). Approximately 3.4% of SFR accounts in Benicia have participated in the Turf Replacement Rebate Program. Participation increased from 2010 and was highest in 2015 (147 rebates issued). The trend of increasing participation observed in Benicia is consistent with the overall County-wide trend discussed above.

One hot spot area was identified by the hot spot analysis in the northwestern portion of the city, as shown on Figure 4-14. This hot spot may be the result of the "cluster effect" described in Section 4.4.2.

4.4.4 *City of Fairfield*

From 2010 through September 2016, turf replacement rebates were issued to 276 unique SFR accounts in Fairfield, totaling $204,804 in rebates and corresponding to 268,646 square feet of turf replaced (268,647 square feet of turf rebated). Approximately 1.08% of SFR accounts in Fairfield have participated in the Turf Replacement Rebate Program. Participation increased from 2010 and was highest in 2015 (148 rebates issued). The trend of increasing participation observed in Fairfield is consistent with the overall County-wide trend discussed above.

Two small hot spots, in west and east of the central portion of the city, were identified by the hot spot analysis and are shown on Figure 4-15. These hot spots may be the result of the a "cluster effect," as discussed in Section 4.4.2. The hot spots generally correspond to areas of houses constructed in the 1970s and 1980s. Cold spot areas (or areas of low participation) were identified in the western portion of the city, in the Green Valley area. These areas may be potential candidates for targeted outreach to increase program participation.

4.4.5 *City of Vacaville*

From 2010 through September 2016, turf replacement rebates were issued to 393 unique SFR accounts in Vacaville, totaling $290,455 in rebates and corresponding to 365,307 square feet of turf replaced (362,502 square feet of turf rebated). Approximately 1.61% of SFR accounts in Vacaville have participated in the Turf Replacement Rebate Program. Participation increased from 2010 and was highest in 2015 (210 rebates issued). The trend of increasing participation observed in Vacaville is consistent with the overall County-wide trend discussed above.

Two substantial hot spots in the eastern portion of the city were identified in the hot spot analysis and are shown on Figure 4-16. Houses in this area are were generally constructed between 1970 and 2010 (Figure 2-8). Areas of cold spots were identified in the western portion of the city, corresponding to the area of oldest homes in the city. These areas may be potential candidates for targeted outreach to increase program participation.

4.5 Residential Water Use Survey Program

The Residential Water Use Survey Program has been implemented by SCWA since 2010. As part of this program, the top 10% of residential water users within each member unit's service area are offered a free water survey intended to identify ways that a customer can save water. Additionally, new SFR accounts are offered a free residential water use survey. Depending on the findings of a water use survey, hardware is often distributed to the SFR customer at no cost. Examples of hardware distributed by SCWA include: kitchen and bathroom sink aerators, showerheads, hose nozzles, hose timers, and dye tablets to identify toilet leaks. An initial review of the program found that 34% of resulting water savings came from fixing irrigation leaks and leaking toilets (SCWA, 2013). The most common area of potential water savings identified in SFR water use surveys is overwatering. In 70% of SFR homes visited, the surveyor found that altering the occupants' watering schedule would save water.

4.5.1 *Solano County*

Participation in the Residential Water Use Survey Program in Solano County is summarized in Table 4-4 and on Figure 4-4. Although the program was created in 2010, only one survey was performed that year. From 2010 through September 2016, a total of 2,681 surveys were conducted at SFR accounts. Over this period, the most surveys were conducted in Fairfield (957) and the fewest surveys were conducted in Dixon (29). As a percentage of the total SFR accounts in each city, the highest participation rate occurred in Benicia (4.5%), and the lowest participation rate occurred in Dixon (1.1%). The county-wide participation rate has varied from year to year after 2010, ranging from a low of 320 surveys performed in 2014 to a high of 665 surveys in 2012. The trend in participation varies from city to city, however. For

example, participation in the cities of Fairfield and Benicia was highest in the 2011 and 2012, whereas 66 of the 69 surveys conducted in Rio Vista occurred in 2015.

4.5.2 *City of Vallejo*

Over the period 2010 through 12 September 2016, 457 residential water use surveys were conducted in Vallejo, representing participation by 1.5% of SFR accounts. Participation in the Residential Water Use Survey Program increased during the initial years, peaking at 151 surveys conducted in 2012, and decreased each year through the partial year 2016. The hot spot analysis presented on Figure 4-17 identified three areas of high participation: the southeast portion of the city, the northeast portion of the central block of the city, and the northeast portion of the city. These hot spots generally correspond to areas with high water use accounts as shown on Figure 3-5, which confirms that the program is being effectively implemented (i.e., targeting the higher water using accounts)

4.5.3 *City of Benicia*

Over the period 2010 through September 2016, 385 residential water use surveys were conducted in Benicia, representing participation by 4.5% of SFR accounts. Participation in the Residential Water Use Survey Program increased during the initial years, peaking at 145 surveys conducted in 2012, and decreased each year through the partial year 2016. The hot spot analysis presented on Figure 4-18 identified one area of high participation in the northeast portion of the central block of the city and two cold spots of low participation: one in the southern portion of the city and one in the northeastern portion. These hot spots generally correspond to areas with high water use accounts as shown on Figure 3-6, and the cold spot corresponds to an area with some of the lowest water use in the city. Taken together, these data indicate that the program is being effectively implemented by reaching the highest water using accounts.

4.5.4 *City of Fairfield*

Over the period 2010 through September 2016, 957 residential water use surveys were conducted in Fairfield, representing participation by 3.7% of SFR accounts. Participation in the Residential Water Use Survey Program increased during the initial years, peaking at 258 surveys conducted in 2012, and decreased each year through the partial year 2016. The hot spot analysis presented on Figure 4-19 identified two areas of high participation in the northwest and northeast portions of the central block of the city and one main cold spot of low participation in the western portion of the city. These hot spots generally correspond to areas with high water use accounts. Notably, these areas also showed the least water savings during the drought (Figure 3-7). Given the high water use in these areas, particularly at the end of the drought, these areas may be valuable to target with educational and outreach programs in the event of another significant drought.

4.5.5 *City of Vacaville*

Over the period 2010 through September 2016, 457 residential water use surveys were conducted in Vacaville, representing participation by 1.5% of SFR accounts. Participation in the Residential Water Use Survey Program increased during the initial years, peaking at 151 surveys conducted in 2012, and decreased each year through the partial year 2016. The hot spot analysis presented on Figure 4-20 identified three areas of high participation: one in the north, one in the west, and one in the south. These hot spots generally correspond with areas of high water use accounts as shown on Figure 3-8 and indicate that the program is being effectively implemented by reaching the highest water using accounts.

4.6 Smart Irrigation Controller Rebate Program

The Smart Irrigation Controller Rebate Program offers customers a financial incentive to install a qualifying smart controller to irrigate existing landscaping. These weather-based controllers determine the total amount of time required to operate each irrigation station based on various factors, including the prevailing weather conditions, soil moisture levels, sunlight, temperature, and humidity. The rebate amount depends on the number of station timers that are installed: $300 for 4-12 station timers, $700 for 13-24 station times, and $1,000 for more than 25 station timers.

The Smart Irrigation Controller Rebate Program was launched in 2008 and SFR participation in the program through August 2016 is summarized in Table 4-5. Participation in the program has been minimal, with a total of 37 rebates issued to SFR accounts since program inception. No SFR accounts in the cities of Rio Vista or Suisun City have received a rebate. Due to limited participation in the Smart Irrigation Controller Program to date, the program is not included in study analyses. Suggestions for program refinements and targeting are provided in Section 8.1.5, below.

Table 4-1
SFR HE Toilet Rebate Program Participation
Solano County Water Agency, California

Calendar Year	City							Total
	Benicia	Dixon	Fairfield	Rio Vista (b)	Suisun City	Vacaville	Vallejo	
Number of HE Toilet Rebates Issued to SFR Accounts								
2007	7	0	33	0	3	13	10	66
2008	44	0	69	1	17	56	40	227
2009	83	0	98	0	30	58	79	348
2010	102	0	245	1	74	96	123	641
2011	82	9	315	9	89	275	120	899
2012	66	11	258	9	97	375	147	963
2013	106	11	256	19	94	392	201	1,079
2014	182	18	283	8	85	443	300	1,319
2015	25	0	50	1	17	81	48	222
Total	**697**	**49**	**1,607**	**48**	**506**	**1,789**	**1,068**	**5,764**
Number of SFR Accounts Receiving HE Toilet Rebates (c)								
2007	3	0	13	0	2	6	5	29
2008	27	0	40	1	11	38	20	137
2009	40	0	55	0	17	31	44	187
2010	56	0	155	1	45	59	77	393
2011	47	4	198	5	57	178	71	560
2012	45	7	165	5	65	239	98	624
2013	64	8	172	11	62	248	134	699
2014	108	9	182	7	53	293	193	845
2015 (d)	14	0	36	1	10	51	36	148
Total	**404**	**28**	**1,016**	**31**	**322**	**1,143**	**678**	**3,622**
Total Rebate Dollars Spent								
2007	$948	$0	$5,114	$0	$391	$2,175	$1,700	$10,328
2008	$6,409	$0	$9,933	$125	$3,025	$8,505	$6,600	$34,597
2009	$9,738	$0	$11,090	$0	$2,785	$6,722	$8,593	$38,928
2010	$11,879	$0	$26,929	$125	$8,427	$10,895	$14,100	$72,355
2011	$9,955	$1,125	$36,248	$1,125	$9,892	$32,393	$13,889	$104,627
2012	$7,727	$1,325	$28,593	$946	$10,585	$42,388	$16,755	$108,319
2013	$12,181	$1,150	$28,051	$2,106	$10,172	$44,041	$21,914	$119,616
2014	$18,611	$1,853	$28,554	$813	$8,535	$44,303	$30,294	$132,964
2015 (d)	$1,748	$0	$3,502	$50	$1,190	$6,195	$3,668	$16,353
Total	**$79,196**	**$5,453**	**$178,015**	**$5,290**	**$55,002**	**$197,617**	**$117,513**	**$638,086**
Percentage of Participating Accounts	**4.7%**	**1.1%**	**4.0%**	**0.8%**	**4.1%**	**4.7%**	**2.2%**	**3.5%**

Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Program participation numbers are provided above only for SFR accounts, and only for those records that could be positively matched to Solano County Assessor's parcels.

Table 4-1
SFR HE Toilet Rebate Program Participation
Solano County Water Agency, California

(b) Rio Vista residential accounts included both single- and multi-family accounts.
(c) More than one rebate may be issued to an account.
(d) The HE Toilet Rebate Program ended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.

Table 4-2
SFR HE Washer Rebate Program Participation
Solano County Water Agency, California

Calendar Year	City							Total
	Benicia	Dixon	Fairfield	Rio Vista (b)	Suisun City	Vacaville	Vallejo	
Number of HE Washer Rebates Issued to SFR Accounts								
2010	36	4	135	4	35	104	80	398
2011	37	7	193	16	51	152	109	565
2012	91	7	299	16	102	287	210	1,012
2013	75	19	314	22	81	313	188	1,012
2014	52	15	218	10	67	222	104	688
2015	97	28	220	13	57	196	134	745
2016 (c)	37	14	93	9	24	83	83	343
Total	**425**	**94**	**1472**	**90**	**417**	**1357**	**908**	**4,763**
Total HE Washer Rebate Dollars Spent								
2010	$4,500	$500	$16,875	$500	$4,375	$13,000	$10,000	49,750
2011	$3,925	$775	$20,125	$1,650	$5,425	$15,800	$11,500	59,200
2012	$8,400	$625	$27,725	$1,550	$9,450	$26,075	$19,325	93,150
2013	$5,625	$1,425	$23,550	$1,650	$6,075	$23,475	$14,100	75,900
2014	$4,425	$1,150	$17,100	$950	$5,100	$17,200	$8,200	54,125
2015	$9,650	$2,800	$21,975	$1,325	$5,700	$19,550	$13,325	74,325
2016 (c)	$3,700	$1,400	$9,300	$900	$2,400	$8,300	$8,300	34,300
Total	**$40,225**	**$8,675**	**$136,650**	**$8,525**	**$38,525**	**$123,400**	**$84,750**	**$440,750**
Percentage of Participating Accounts	**4.9%**	**3.6%**	**5.7%**	**2.4%**	**5.3%**	**5.6%**	**2.9%**	**4.6%**

Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Program participation numbers are provided above only for SFR accounts, and only for those records that could be positively matched to Solano County Assessor's parcels.
(b) Rio Vista residential accounts included both single- and multi-family accounts.
(c) Program participation numbers provided for 2016 represent a partial year only. HE washer rebate records are included through 25 July 2016. HE washer rebate records prior to 2010 were not available.

Table 4-3
SFR Turf Replacement Rebate Program Participation
Solano County Water Agency, California

Calendar Year	City							Total
	Benicia	Dixon	Fairfield	Rio Vista (b)	Suisun City	Vacaville	Vallejo	
Number of Turf Replacement Rebates Issued to SFR Accounts								
2010	1	0	7	1	1	3	3	16
2011	2	2	7	0	0	9	4	24
2012	5	2	4	0	2	3	3	19
2013	13	1	19	2	5	16	20	76
2014	77	8	50	21	9	93	116	374
2015	147	43	148	27	41	210	108	724
2016	44	7	41	8	12	59	37	208
Total	**289**	**63**	**276**	**59**	**70**	**393**	**291**	**1,441**
Area of Turf Replaced (square feet)								
2010	1,900	0	11,555	375	1,101	1,310	6,190	22,431
2011	1,564	1,529	4,536	0	0	8,000	3,567	19,196
2012	2,916	1,592	2,561	0	1,960	3,839	5,434	18,302
2013	13,177	1,307	17,720	1,548	4,934	13,784	17,813	70,282
2014	65,320	9,302	44,314	12,615	7,123	90,644	109,333	338,651
2015	134,047	42,204	149,874	20,509	46,848	199,650	94,233	687,365
2016 (c)	33,276	7,539	38,086	5,627	10,438	48,080	31,969	175,015
Total	**252,200**	**63,473**	**268,646**	**40,674**	**72,404**	**365,307**	**268,539**	**1,331,241**
Area of Turf Rebated (square feet) (d)								
2010	1,000	0	11,555	375	1,101	1,310	6,190	21,531
2011	1,564	1,529	4,537	0	0	8,000	3,567	19,197
2012	2,916	1,592	2,561	0	1,960	3,839	3,155	16,023
2013	13,177	1,307	17,720	1,548	4,934	13,784	17,813	70,282
2014	65,320	9,302	44,314	12,615	7,123	90,644	109,333	338,651
2015	134,047	42,204	149,874	20,509	46,848	196,845	94,233	684,560
2016 (c)	33,276	7,539	38,086	5,627	10,438	48,080	31,969	175,015
Total	**251,300**	**63,473**	**268,647**	**40,674**	**72,404**	**362,502**	**266,260**	**1,325,259**
Total Rebate Dollars Spent								
2010	$500	$0	$4,155	$190	$600	$655	$2,800	$8,900
2011	$950	$919	$2,419	$0	$0	$4,109	$1,940	$10,337
2012	$1,812	$956	$1,547	$0	$1,140	$1,800	$1,786	$9,041
2013	$9,934	$1,000	$15,265	$1,384	$4,140	$11,752	$15,269	$58,744
2014	$58,713	$6,760	$37,744	$12,290	$6,605	$76,107	$88,413	$286,632
2015	$108,913	$33,869	$111,335	$17,838	$33,253	$152,746	$76,828	$534,782
2016 (c)	$29,876	$5,755	$32,339	$5,152	$9,321	$43,286	$26,101	$151,830
Total	**$210,698**	**$49,259**	**$204,804**	**$36,854**	**$55,059**	**$290,455**	**$213,137**	**$1,060,266**
Percentage of Participating Accounts	**3.4%**	**2.41%**	**1.08%**	**1.59%**	**0.90%**	**1.61%**	**0.93%**	**1.38%**

Abbreviations:

SFR = single-family residential

Notes:

(a) Program participation numbers are provided above only for SFR accounts, and only for those records that could be positively matched to Solano County Assessor's parcels.

(b) Rio Vista residential accounts included both single- and multi-family accounts.

Table 4-3
SFR Turf Replacement Rebate Program Participation
Solano County Water Agency, California

(c) Turf replacement rebate records are included through September 2016.

(d) Rebates are issued for a maximum of 1,000 square feet of replaced turf for SFR accounts. Approximately 37% of program participants replaced an area of turf greater than 1,000 square feet.

Table 4-4
SFR Residential Water Use Survey Program Participation
Solano County Water Agency, California

Calendar Year	City							Total
	Benicia	Dixon	Fairfield	Rio Vista (b)	Suisun City	Vacaville	Vallejo	
Number of Water Use Surveys Performed at SFR Accounts								
2010	0	0	0	0	1	0	0	1
2011	60	6	221	1	24	54	114	480
2012	145	10	258	0	32	69	151	665
2013	66	12	141	0	21	194	69	503
2014	58	1	111	1	39	58	52	320
2015	47	0	181	66	38	222	46	600
2016 (c)	9	0	45	1	5	27	25	112
Total	**385**	**29**	**957**	**69**	**160**	**624**	**457**	**2,681**
Percentage of Participating Accounts	**4.5%**	**1.1%**	**3.7%**	**1.9%**	**2.0%**	**2.6%**	**1.5%**	**2.6%**

Abbreviations:
SFR = single-family residential

Notes:
(a) Program participation numbers are provided above only for SFR accounts, and only for those records that could be positively matched to Solano County Assessor's parcels.
(b) Rio Vista residential accounts include both single- and multi-family accounts.
(c) Program participation numbers provided for 2015 represent a partial year only. Residential water survey records are included through 12 September 2016.

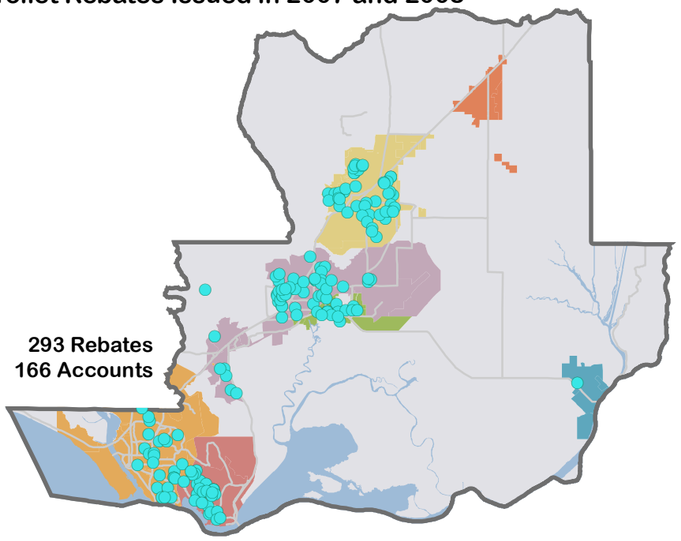
Table 4-5
SFR Smart Irrigation Controller Rebate Program Participation
Solano County Water Agency, California

Calendar Year	Member Unit							Total
	Benicia	Dixon	Fairfield	Rio Vista (b)	Suisun City	Vacaville	Vallejo	
Number of Smart Irrigation Controller Rebates Issued to SFR Accounts								
2011	0	0	1	0	0	0	2	3
2012	0	0	1	0	0	1	1	3
2013	2	0	1	0	0	0	1	4
2014	1	1	2	0	0	0	1	5
2015	1	0	4	0	0	3	3	11
2016 (c)	2	0	2	0	0	5	2	11
Total	**6**	**1**	**11**	**0**	**0**	**9**	**10**	**37**
Percentage of Participating Accounts	**0.07%**	**0.04%**	**0.04%**	**0%**	**0%**	**0.04%**	**0.03%**	**0.04%**

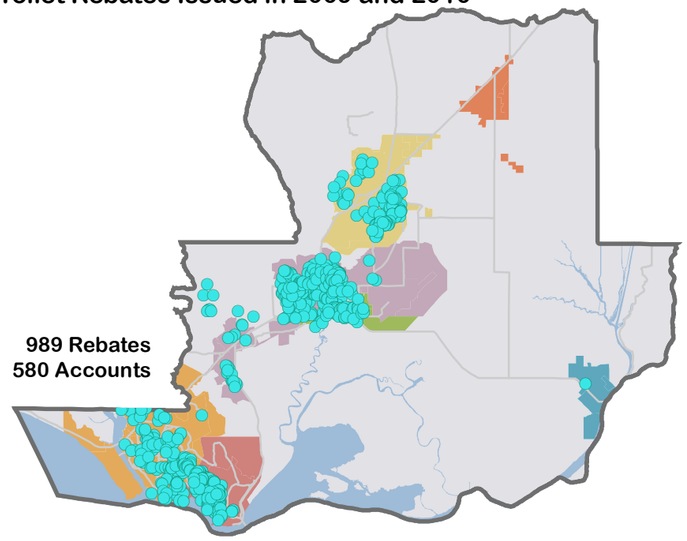
Abbreviations:
SFR = single-family residential

Notes:
(a) Program participation numbers are provided above only for SFR accounts, and only for those records that could be positively matched to Solano County Assessor's parcels.
(b) Rio Vista residential accounts included both single- and multi-family accounts.
(c) Program participation numbers provided for 2016 represent a partial year only. Smart irrigation controller rebate records are included through 4 August 2016.

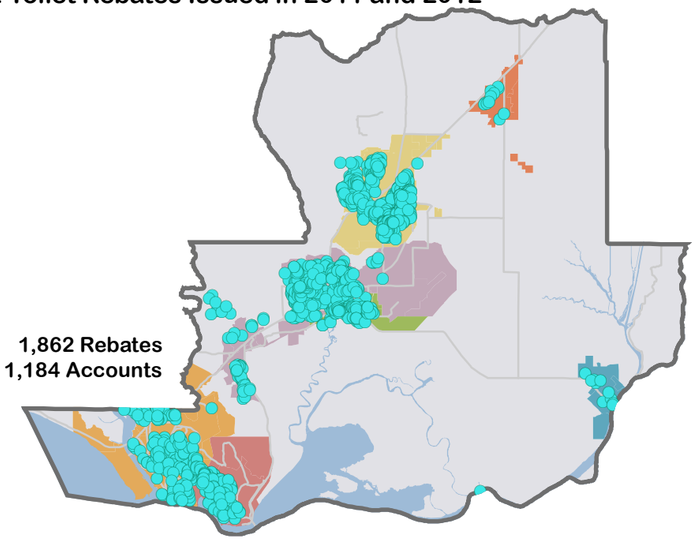
HE Toilet Rebates Issued in 2007 and 2008



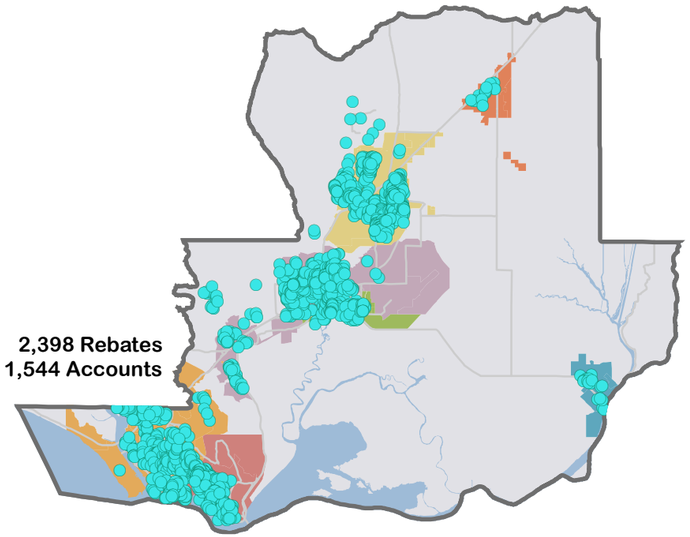
HE Toilet Rebates Issued in 2009 and 2010



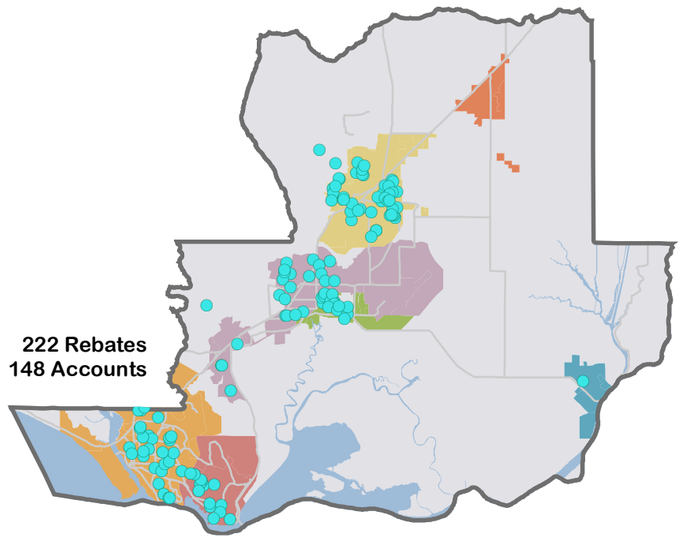
HE Toilet Rebates Issued in 2011 and 2012



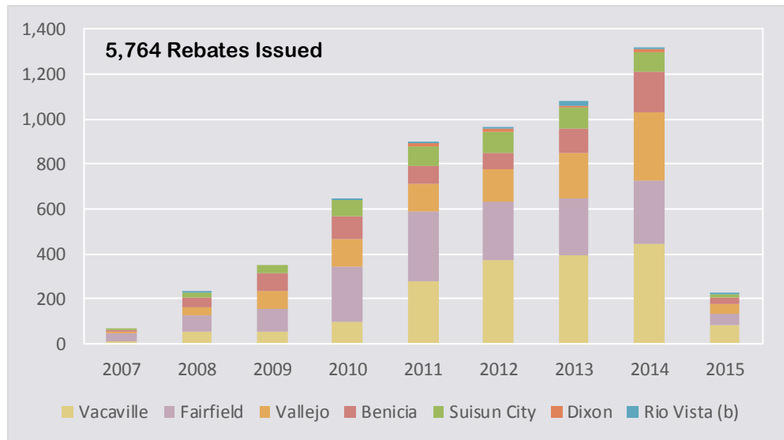
HE Toilet Rebates Issued in 2013 and 2014



HE Toilet Rebates Issued in 2015



Total HE Toilet Rebates Issued by City



Legend

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Areas

HE Toilet Rebate Issued

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. The HE Toilet Rebate Program was suspended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.

N

0 10 20

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet Rebates Issued
Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

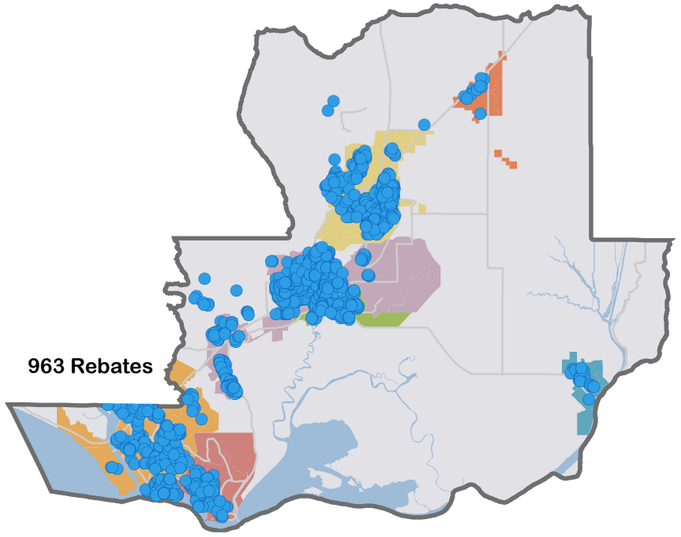
EKI B50067.01

Figure 4-1

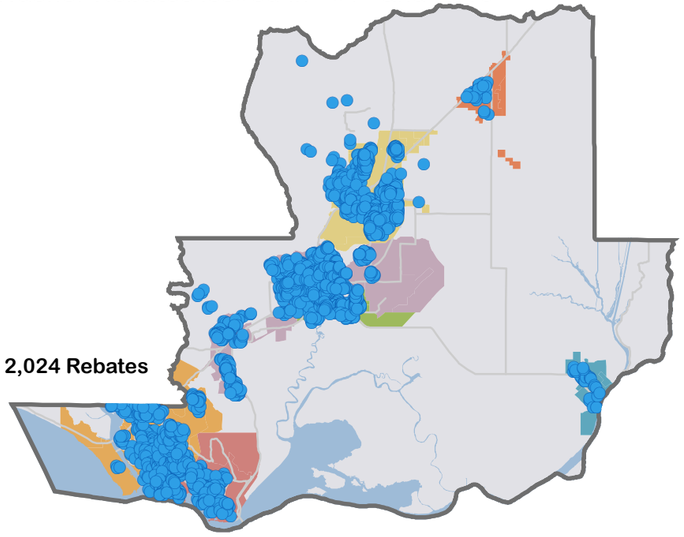
eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_1_CountyHE_Toilets.mxd

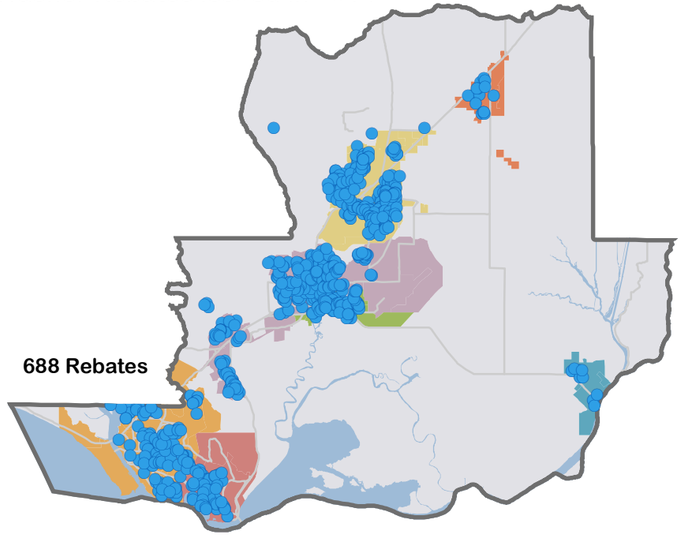
HE Washer Rebates Issued in 2010 and 2011



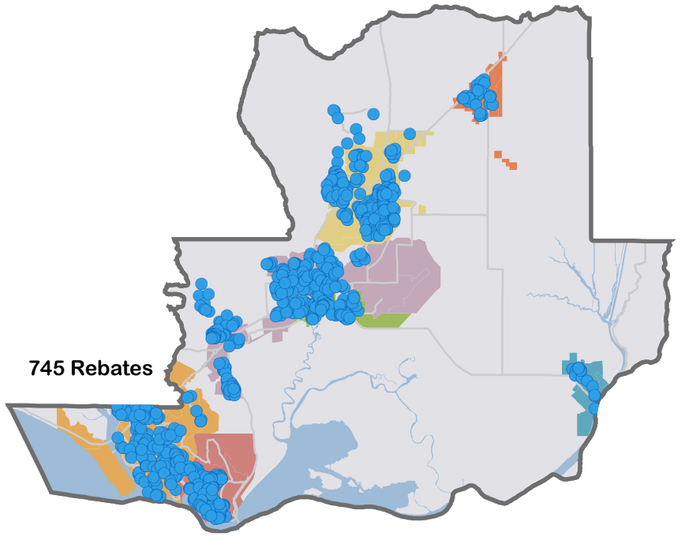
HE Washer Rebates Issued in 2012 and 2013



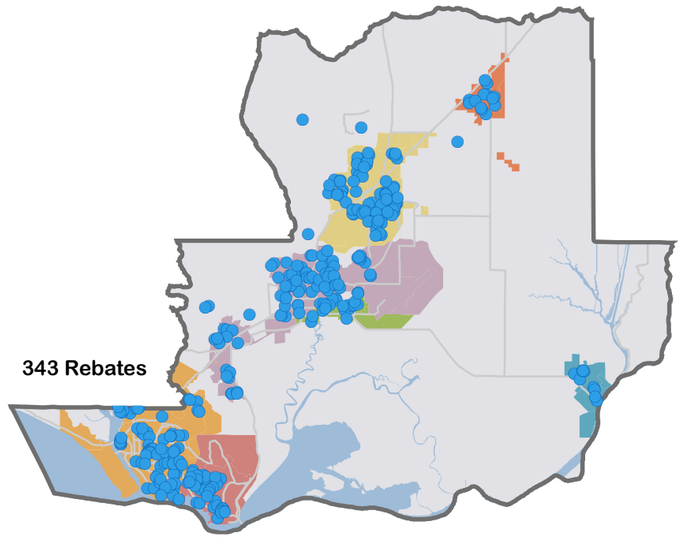
HE Washer Rebates Issued in 2014



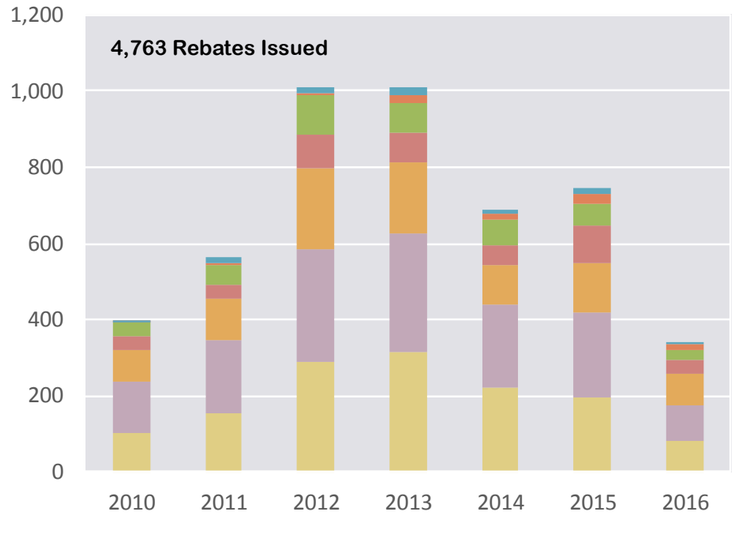
HE Washer Rebates Issued in 2015



HE Washer Rebates Issued in 2016



Total HE Washer Rebates Issued by City



Legend

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Areas

HE Washer Rebate Issued

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's data.
3. HE washer rebates for 2016 represent a partial year only. Rebate records are included through 25 July 2016. Rebate records prior to 2010 are not available.

N

0 10 20

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_2_CountyHE_Washers.mxd

SFR HE Washer Rebates Issued
Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

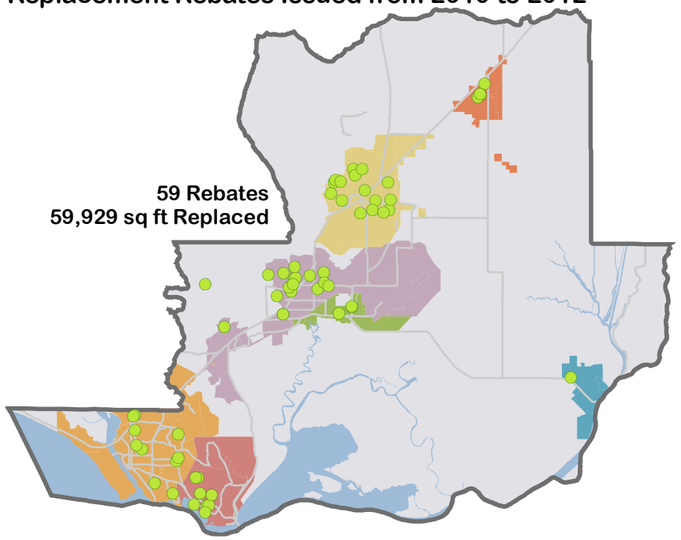
July 2017

EKI B50067.01

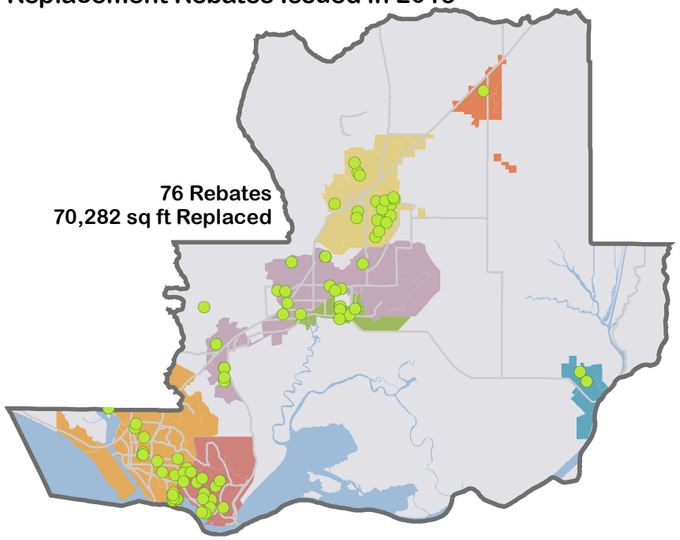
Figure 4-2

eki environment & water

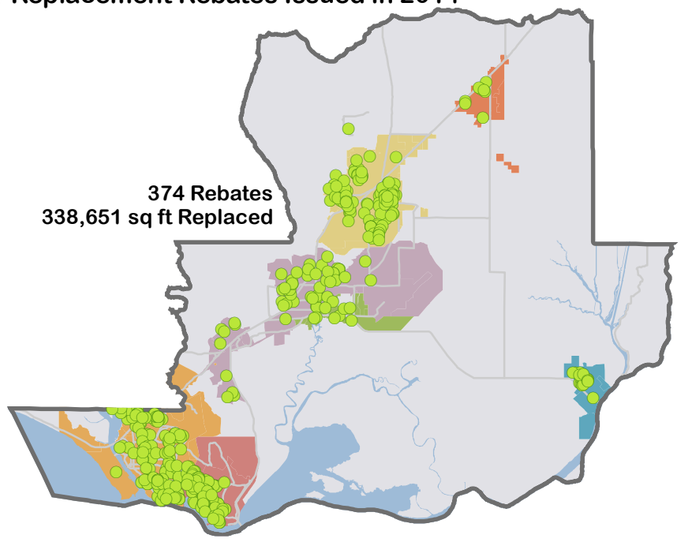
Turf Replacement Rebates Issued from 2010 to 2012



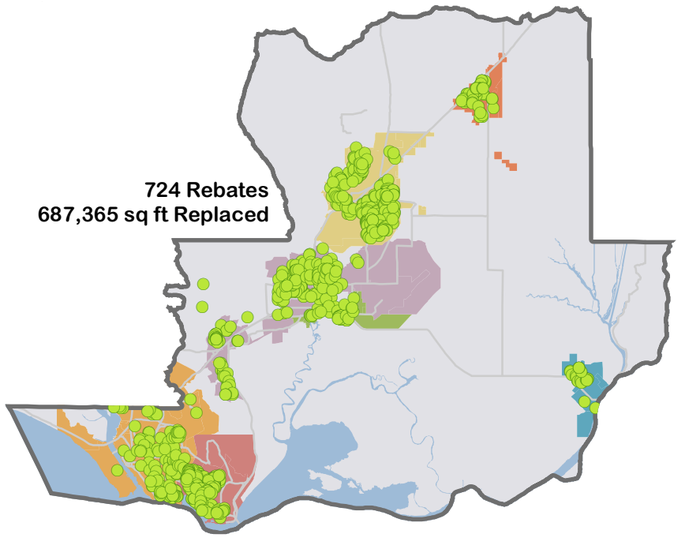
Turf Replacement Rebates Issued in 2013



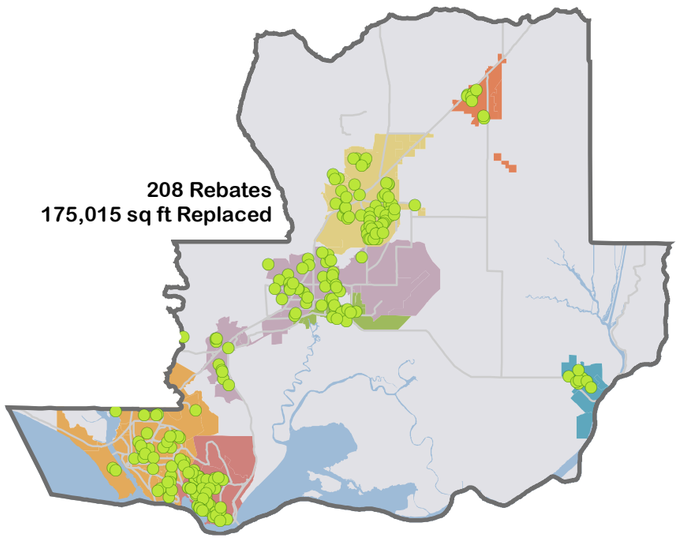
Turf Replacement Rebates Issued in 2014



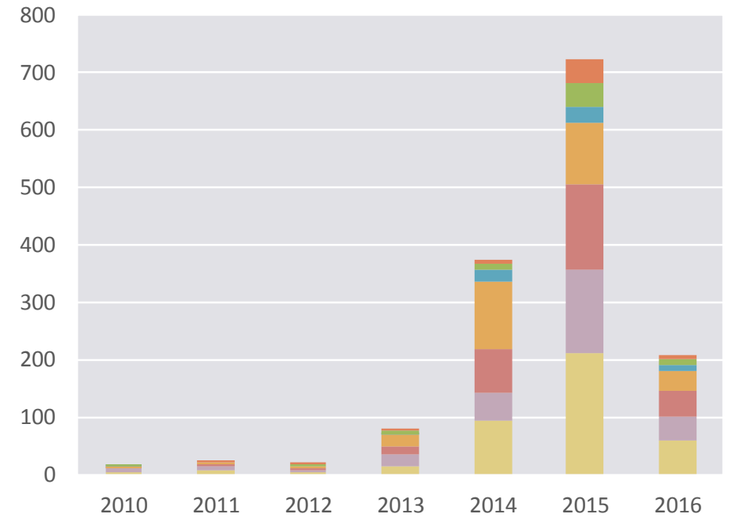
Turf Replacement Rebates Issued in 2015



Turf Replacement Rebates Issued in 2016



Total Turf Replacement Rebates Issued by City



Legend

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Areas
- Turf Replacement Project

Abbreviations

SFR - single-family residential
sq ft - square feet

Notes

1. All locations are approximate.
2. Only program participation by single-family residential households is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. Turf replacement rebate records are included through September 2016. Turf replacement rebate records for 2016 represent a partial year only.

N

0 10 20

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR Turf Replacement Rebates Issued
Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

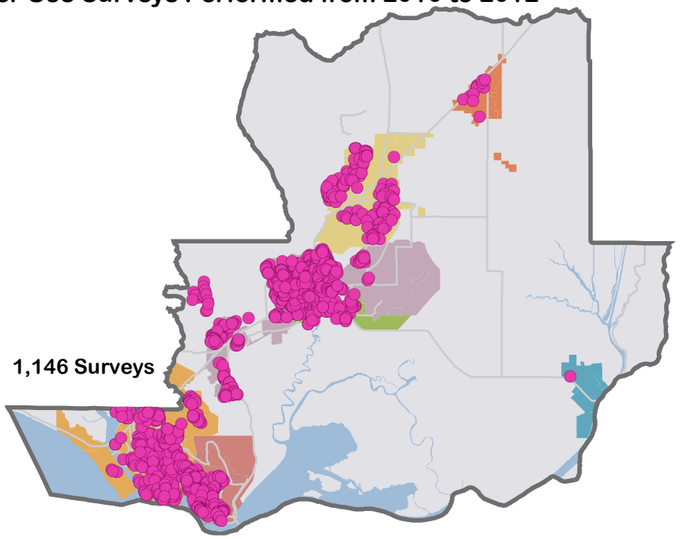
EKI B50067.01

Figure 4-3

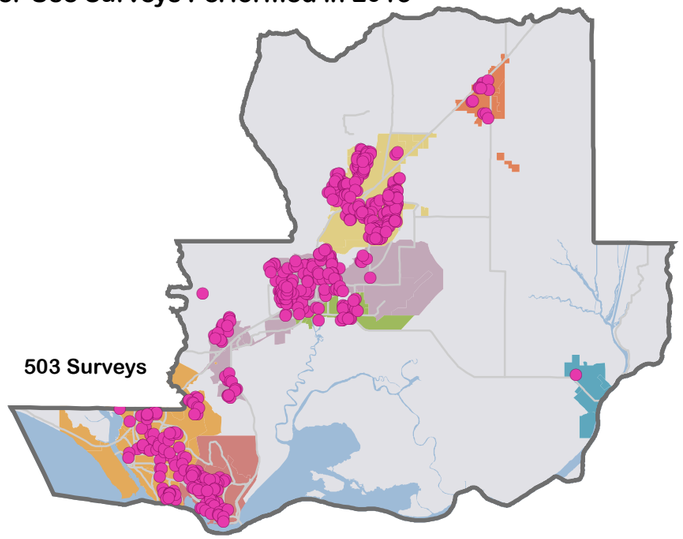
eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_3_CountyTurf_Rplcmnt.mxd

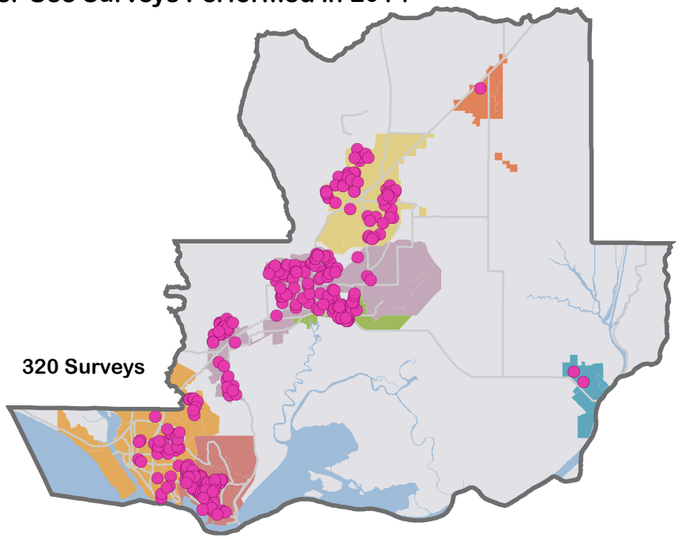
Water Use Surveys Performed from 2010 to 2012



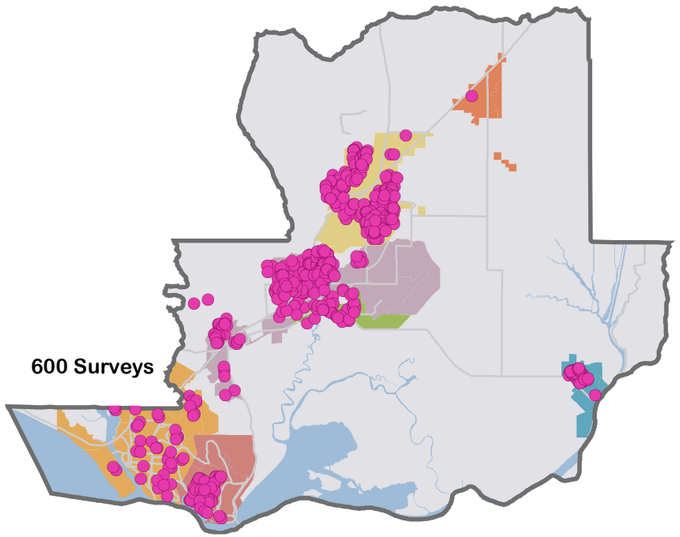
Water Use Surveys Performed in 2013



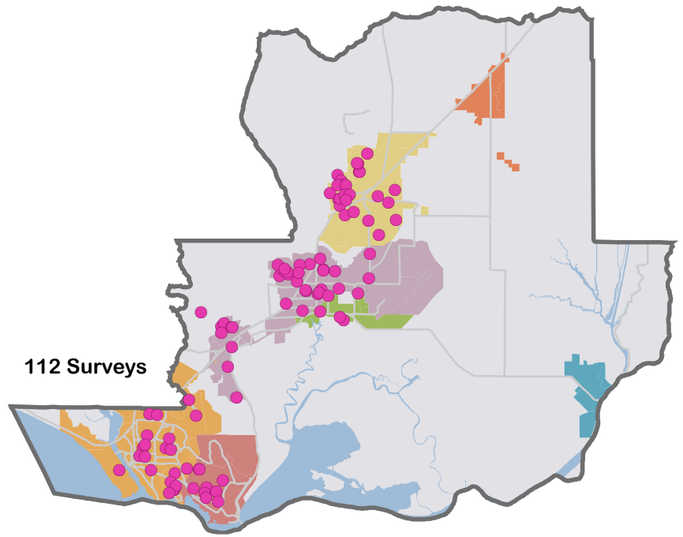
Water Use Surveys Performed in 2014



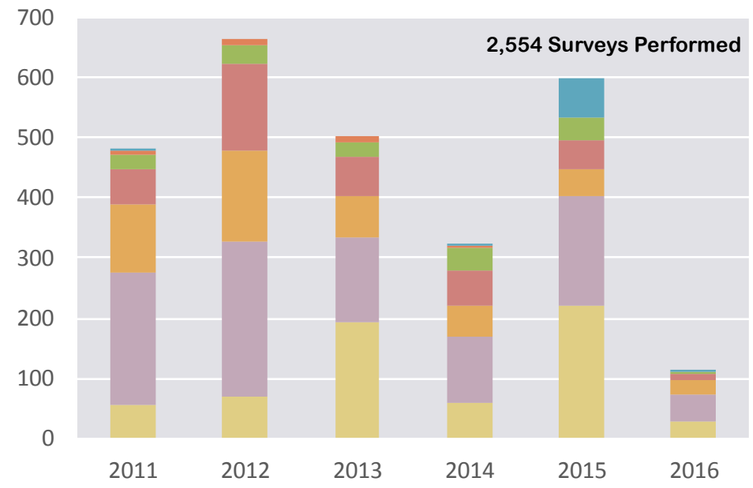
Water Use Surveys Performed in 2015



Water Use Surveys Performed in 2016



Total Water Use Surveys Performed by City



Legend

Cities and Spheres of Influence

- Benicia
- Dixon
- Fairfield
- Rio Vista
- Suisun City
- Vacaville
- Vallejo
- Other Solano County Areas

Water Use Surveys Performed

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's data.
3. Residential water use surveys for 2016 represent a partial year only. Survey records are included through 12 September 2016.

N

0 10 20

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Residential Water Use Surveys Conducted
Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

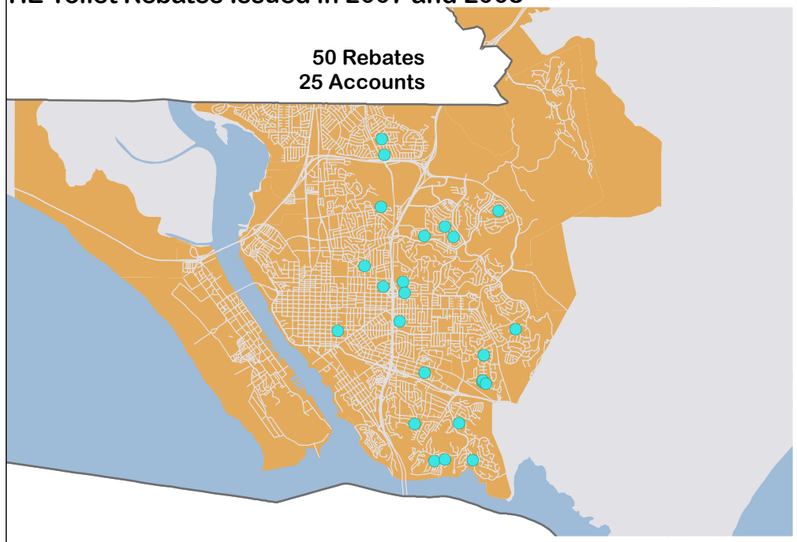
EKI B50067.01

Figure 4-4

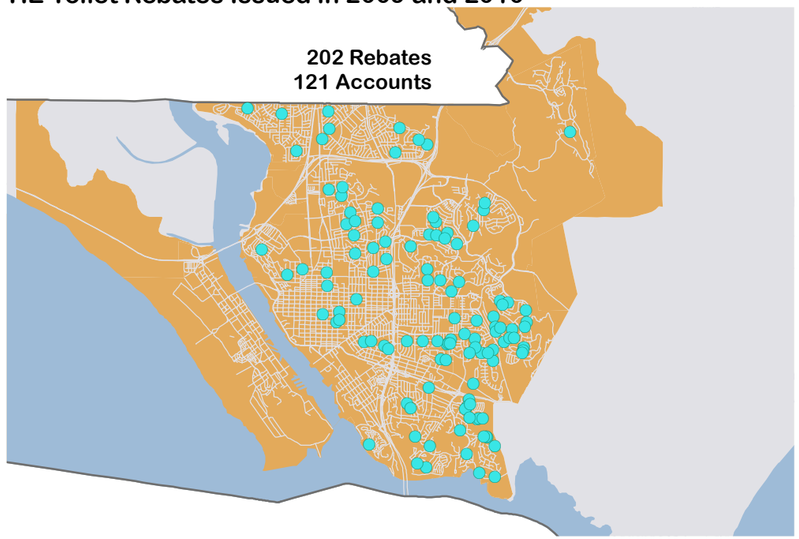
eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_4_CountyWU_Surveys.mxd

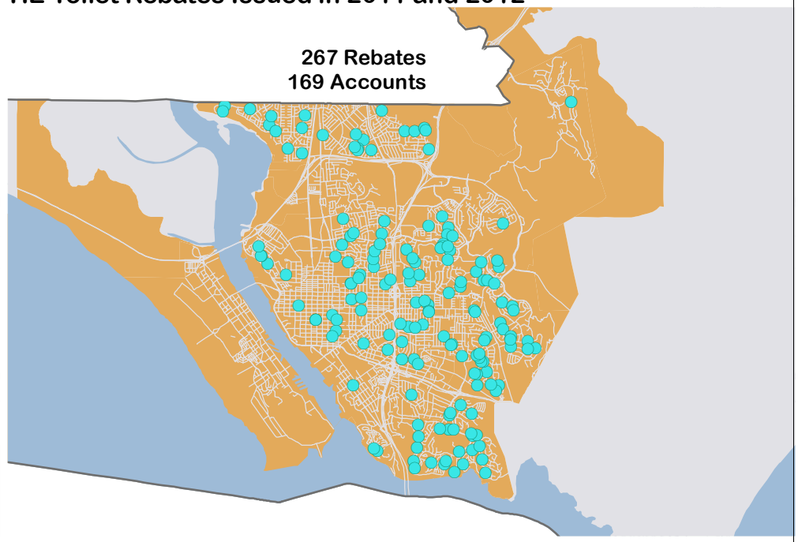
HE Toilet Rebates Issued in 2007 and 2008



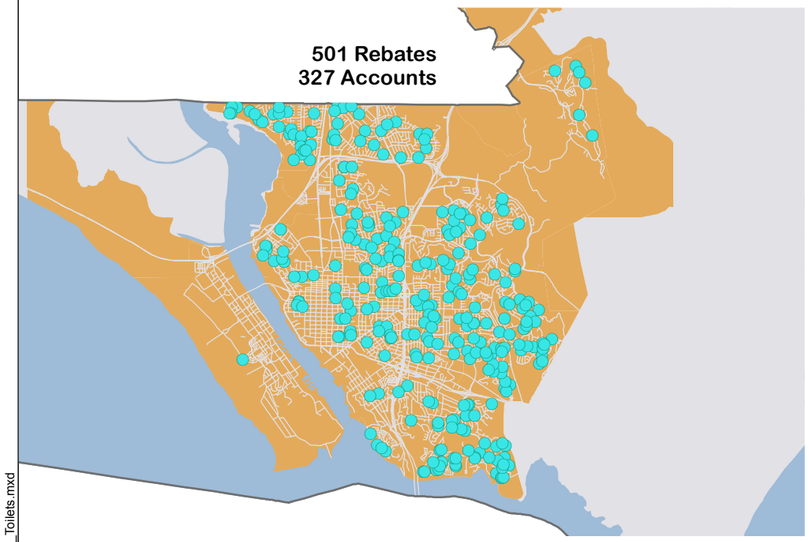
HE Toilet Rebates Issued in 2009 and 2010



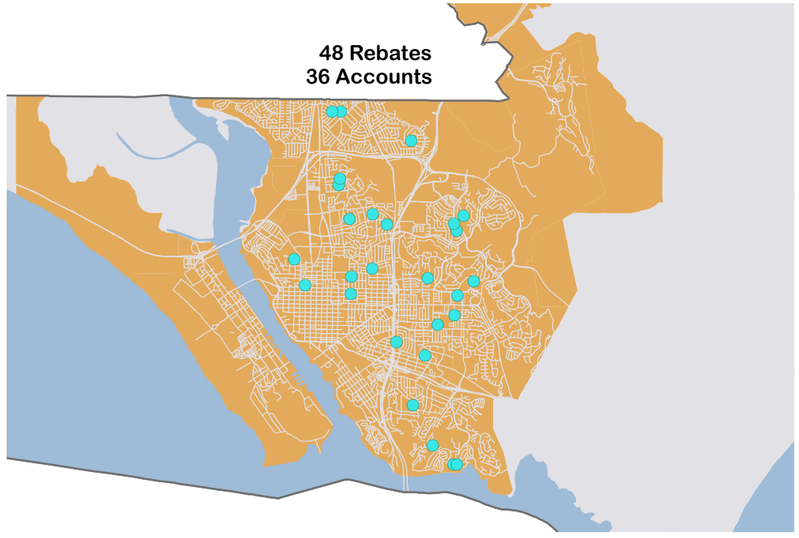
HE Toilet Rebates Issued in 2011 and 2012



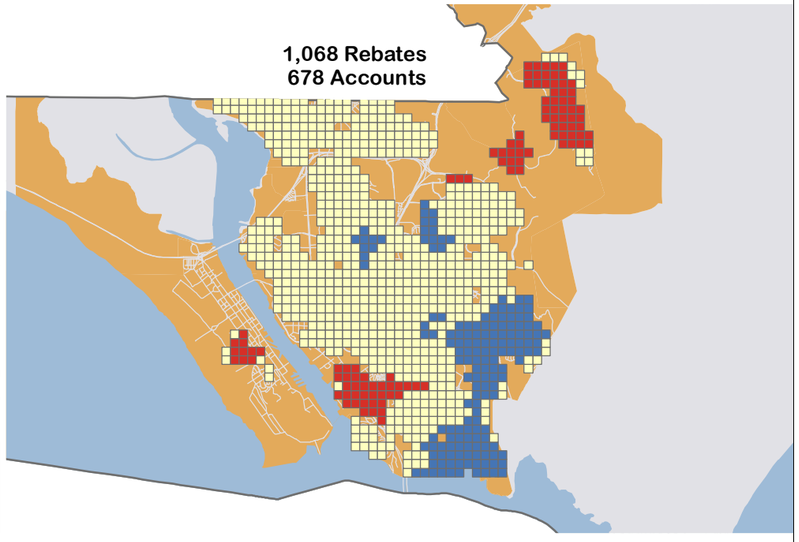
HE Toilet Rebates Issued in 2013 and 2014



HE Toilet Rebates Issued in 2015



HE Toilet Rebate Participation Hot and Cold Spots



Legend

- Vallejo
- Other Solano County Areas
- HE Toilet Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. The HE Toilet Rebate Program ended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet Rebates Issued
City of Vallejo

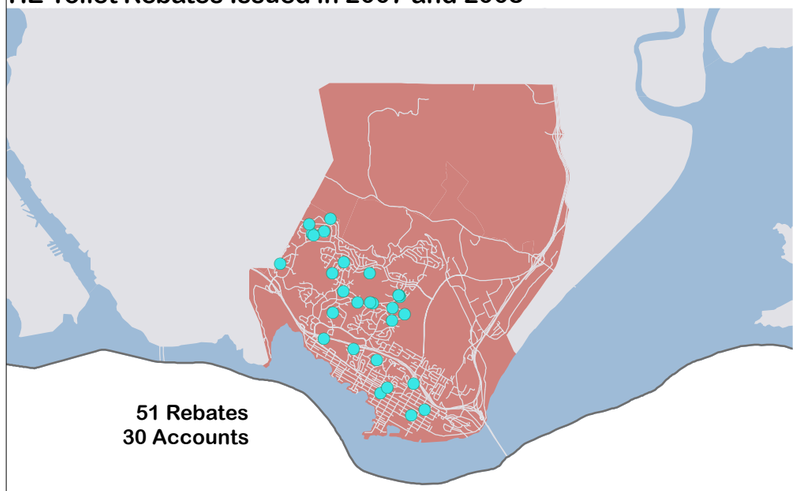
Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01
Figure 4-5

eki environment & water

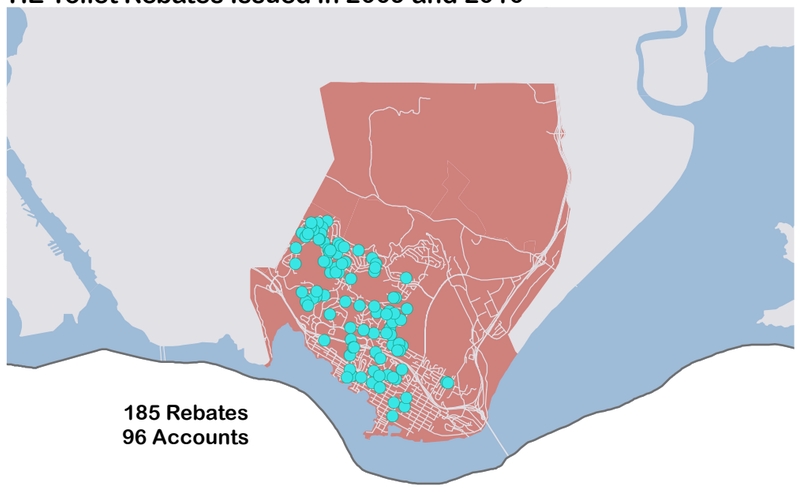
Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_5_Vallejo_HE_Toilets.mxd

HE Toilet Rebates Issued in 2007 and 2008



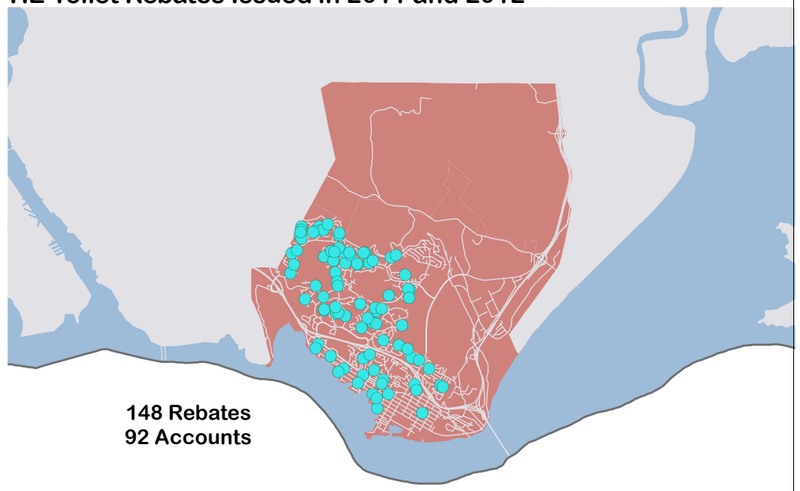
51 Rebates
30 Accounts

HE Toilet Rebates Issued in 2009 and 2010



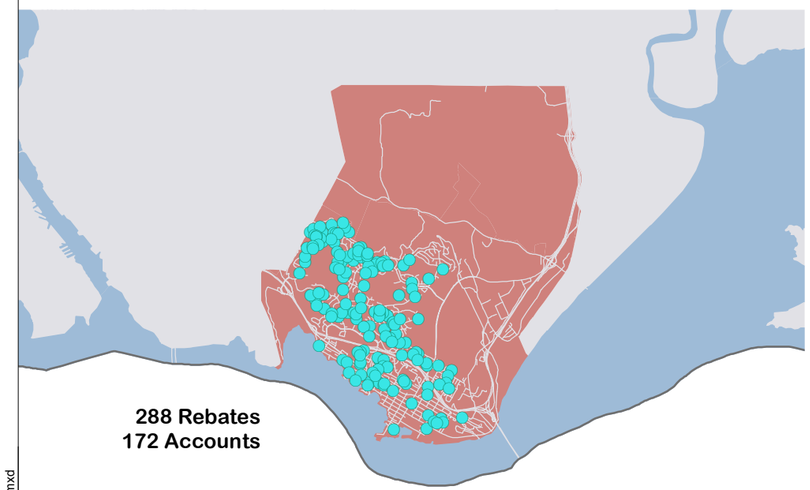
185 Rebates
96 Accounts

HE Toilet Rebates Issued in 2011 and 2012



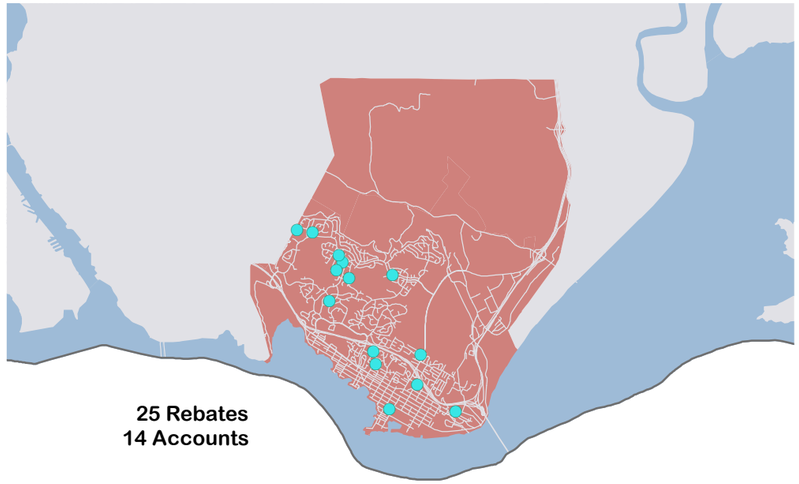
148 Rebates
92 Accounts

HE Toilet Rebates Issued in 2013 and 2014



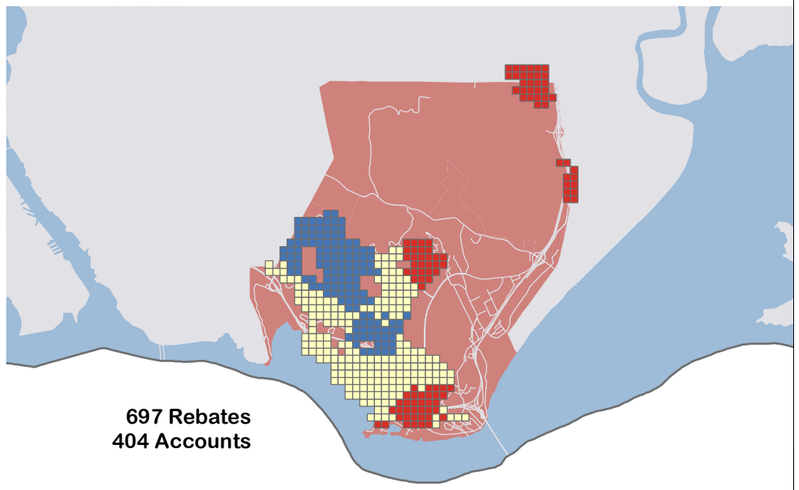
288 Rebates
172 Accounts

HE Toilet Rebates Issued in 2015



25 Rebates
14 Accounts

HE Toilet Rebate Participation Hot and Cold Spots



697 Rebates
404 Accounts

Legend

- Benicia
- Other Solano County Areas
- HE Toilet Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. The HE Toilet Rebate Program ended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet Rebates Issued
City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

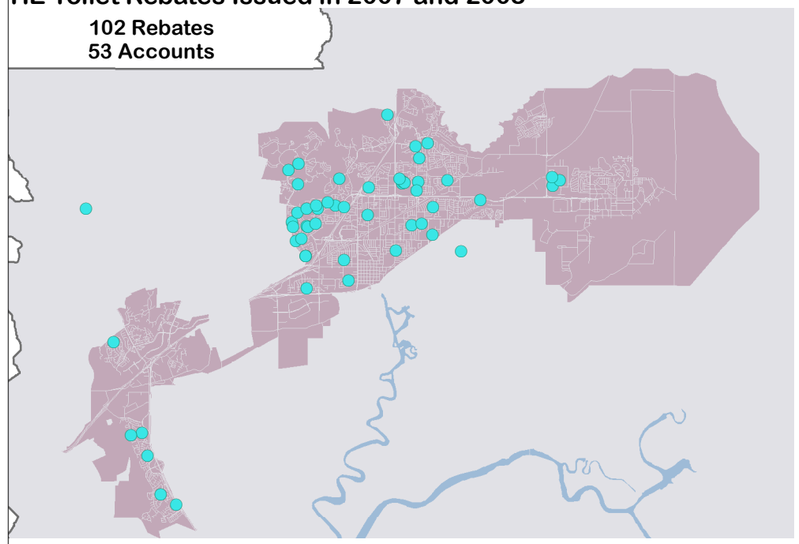
Figure 4-6

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_6_Benicia_HE_Toilets.mxd

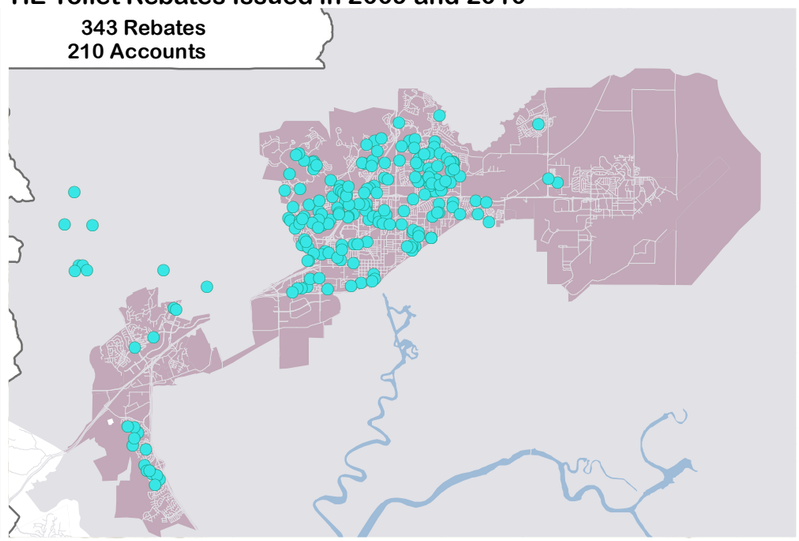
HE Toilet Rebates Issued in 2007 and 2008

102 Rebates
53 Accounts



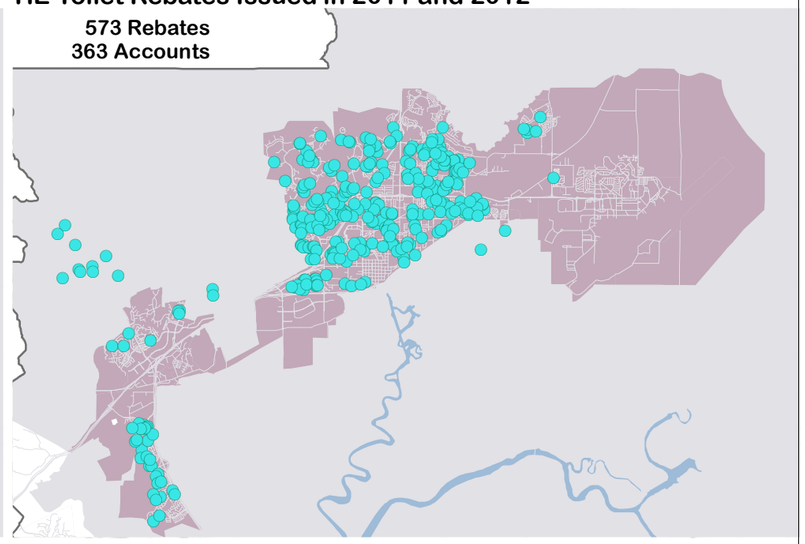
HE Toilet Rebates Issued in 2009 and 2010

343 Rebates
210 Accounts



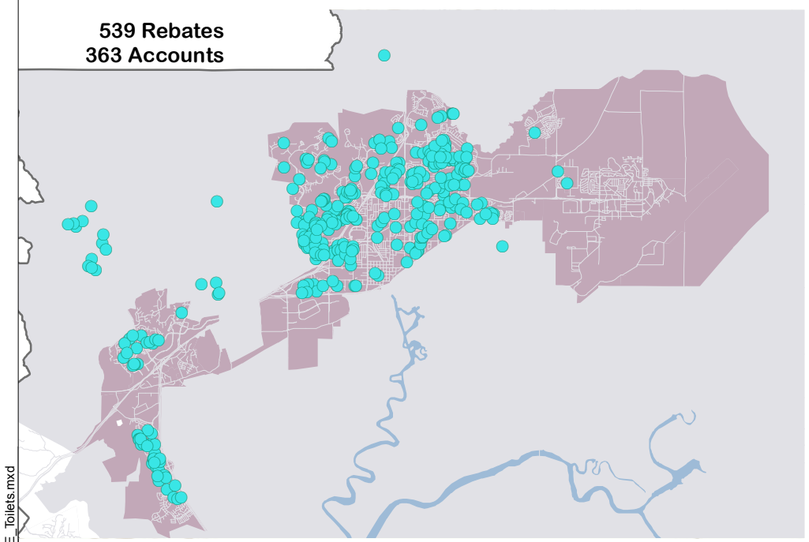
HE Toilet Rebates Issued in 2011 and 2012

573 Rebates
363 Accounts



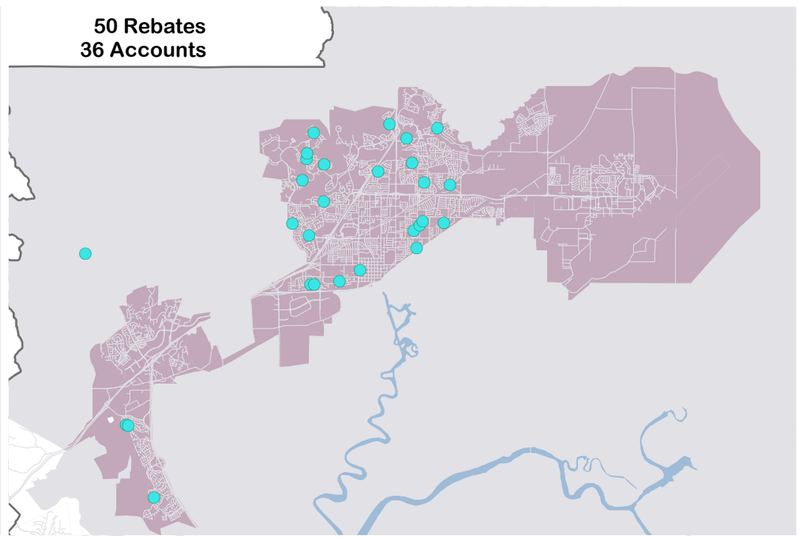
HE Toilet Rebates Issued in 2013 and 2014

539 Rebates
363 Accounts



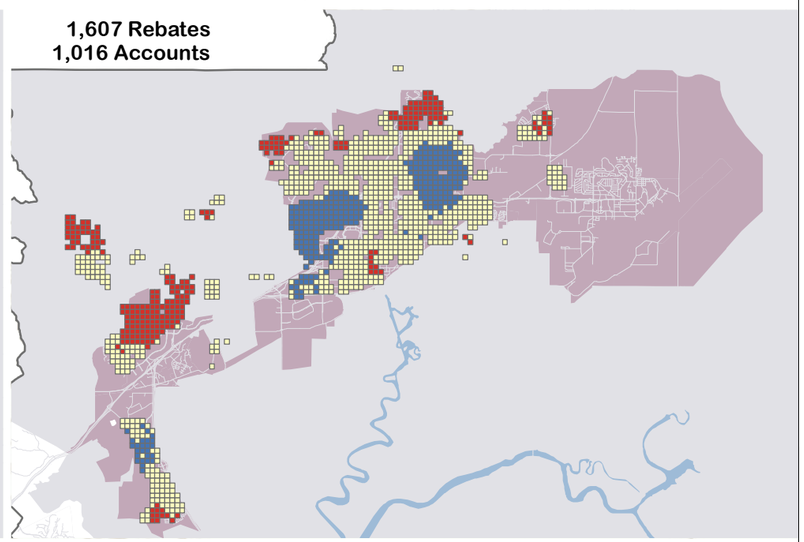
HE Toilet Rebates Issued in 2015

50 Rebates
36 Accounts



HE Toilet Rebate Participation Hot and Cold Spots

1,607 Rebates
1,016 Accounts



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_7_Fairfield_HE_Toilets.mxd

Legend

- Fairfield
- Other Solano County Areas
- HE Toilet Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. The HE Toilet Rebate Program ended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., rural or parcels greater than 1-acre in size) were exlcuded from the analysis.

N

0 3.5 7

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet Rebates Issued
City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

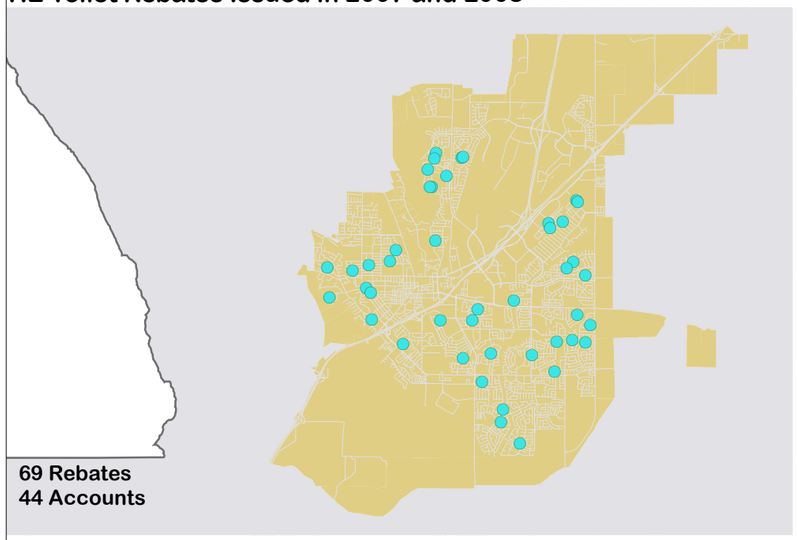
July 2017

EKI B50067.01

Figure 4-7

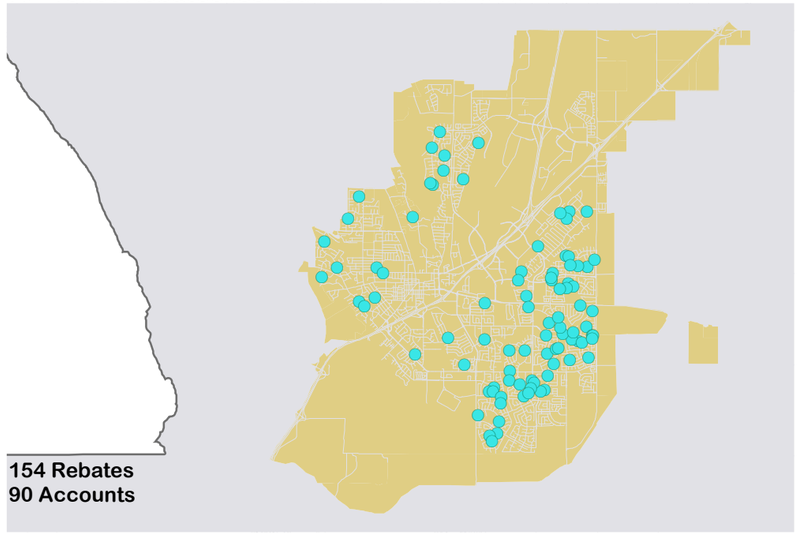
eki environment & water

HE Toilet Rebates Issued in 2007 and 2008



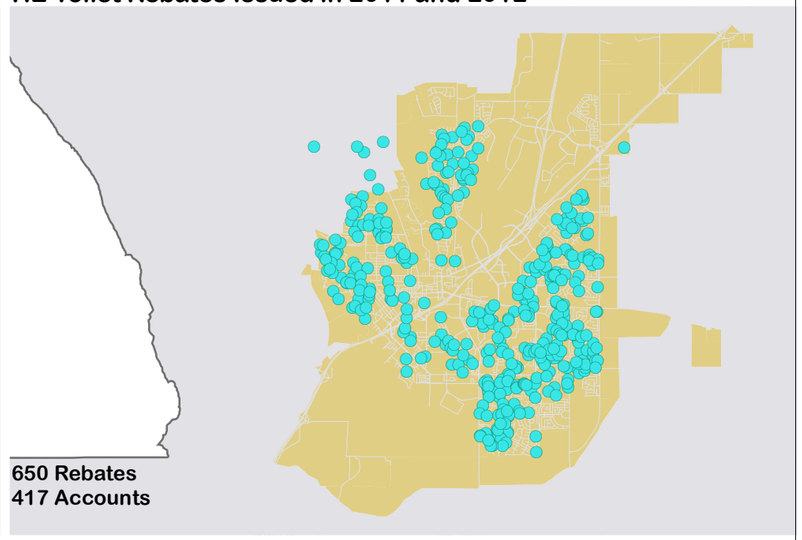
69 Rebates
44 Accounts

HE Toilet Rebates Issued in 2009 and 2010



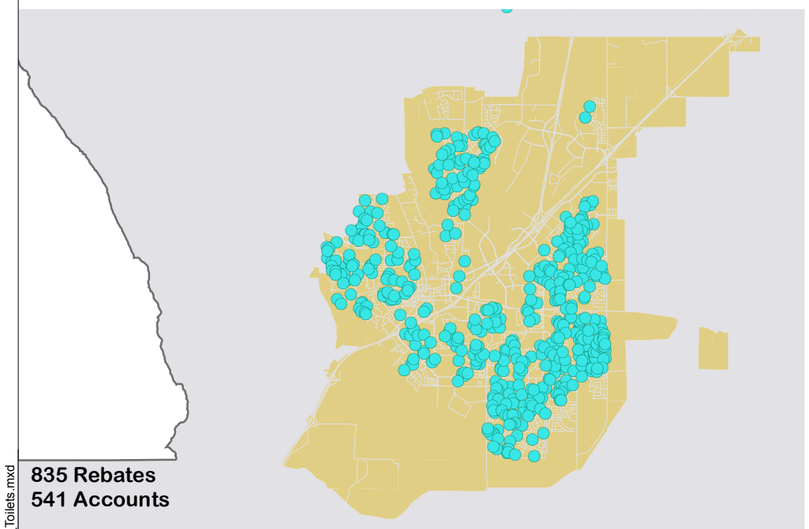
154 Rebates
90 Accounts

HE Toilet Rebates Issued in 2011 and 2012



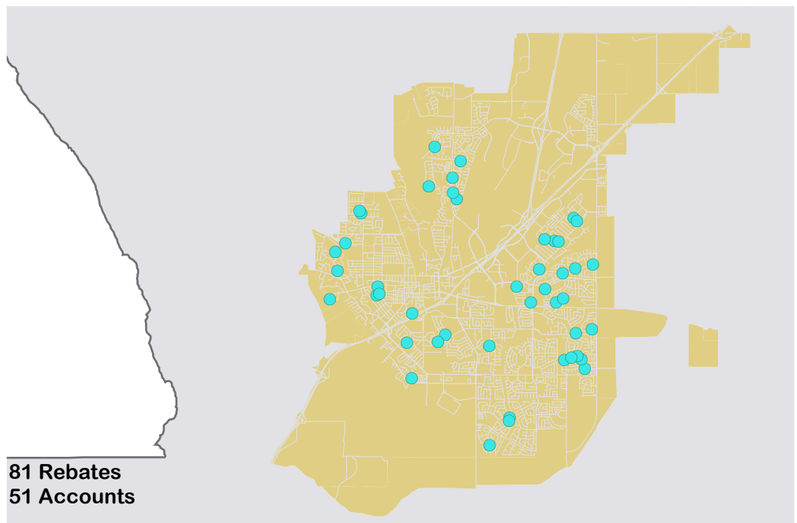
650 Rebates
417 Accounts

HE Toilet Rebates Issued in 2013 and 2014



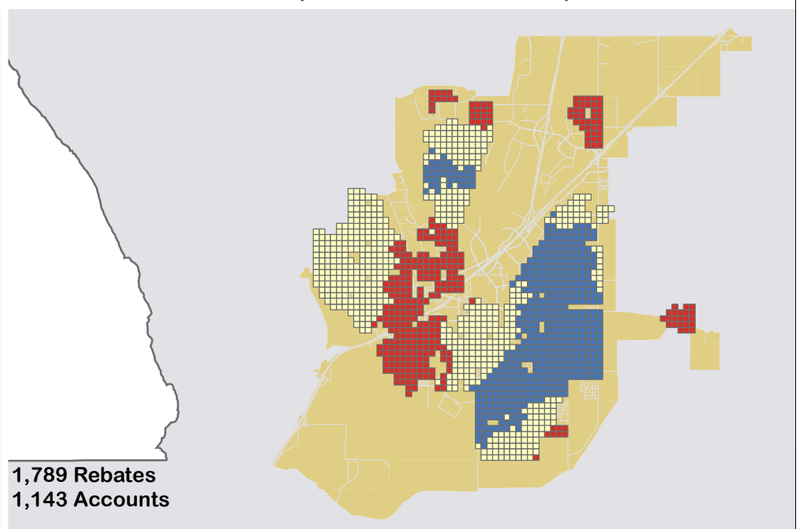
835 Rebates
541 Accounts

HE Toilet Rebates Issued in 2015



81 Rebates
51 Accounts

HE Toilet Rebate Participation Hot and Cold Spots



1,789 Rebates
1,143 Accounts

Legend

- Vacaville
- Other Solano County Areas
- HE Toilet Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. The HE Toilet Rebate Program ended in January 2015, with rebates processed and issued through March 2015. All 2015 records are included.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., generally areas where parcels are greater than 1-acre in size) were exlcuded from the analysis.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet Rebates Issued
City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

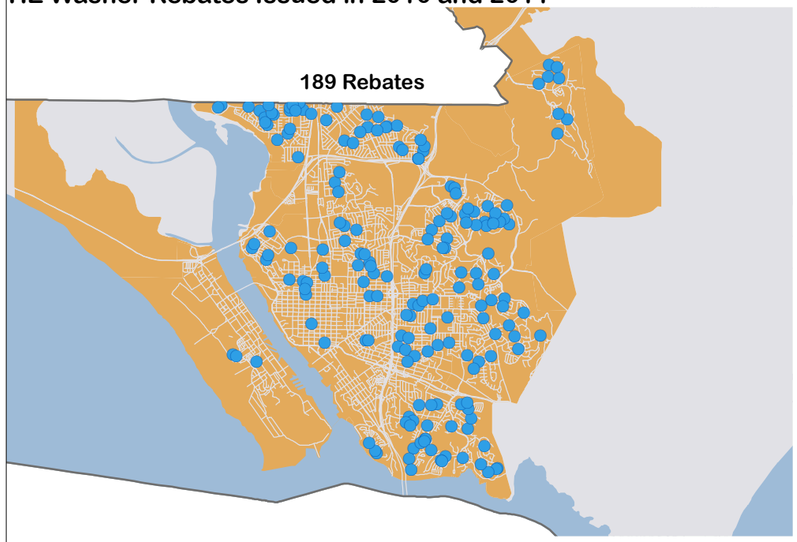
Figure 4-8

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_8_Vacaville_HE_Toilets.mxd

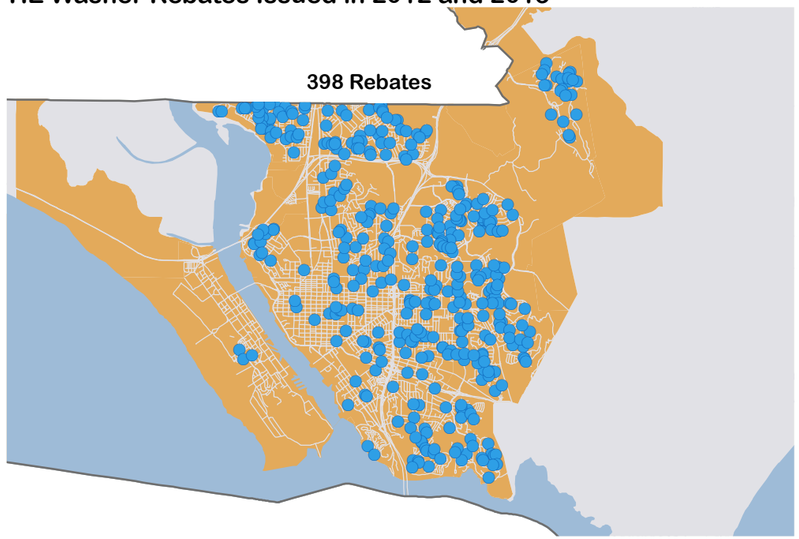
HE Washer Rebates Issued in 2010 and 2011

189 Rebates



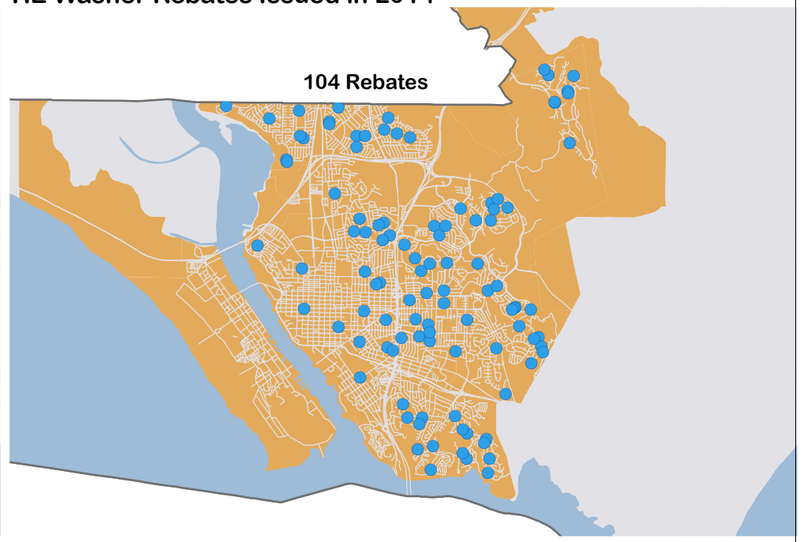
HE Washer Rebates Issued in 2012 and 2013

398 Rebates



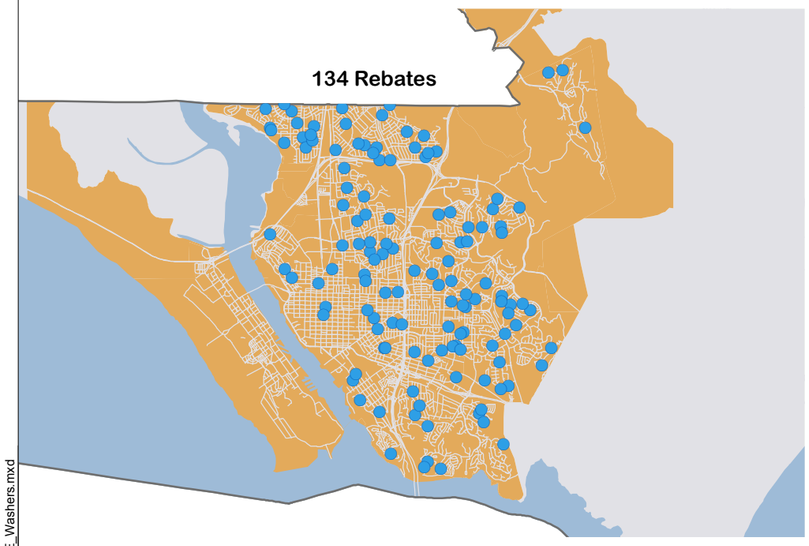
HE Washer Rebates Issued in 2014

104 Rebates



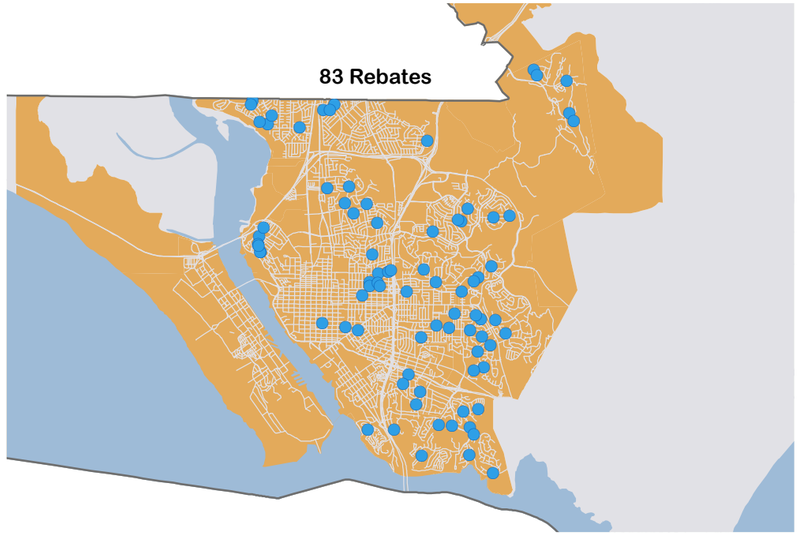
HE Washer Rebates Issued in 2015

134 Rebates



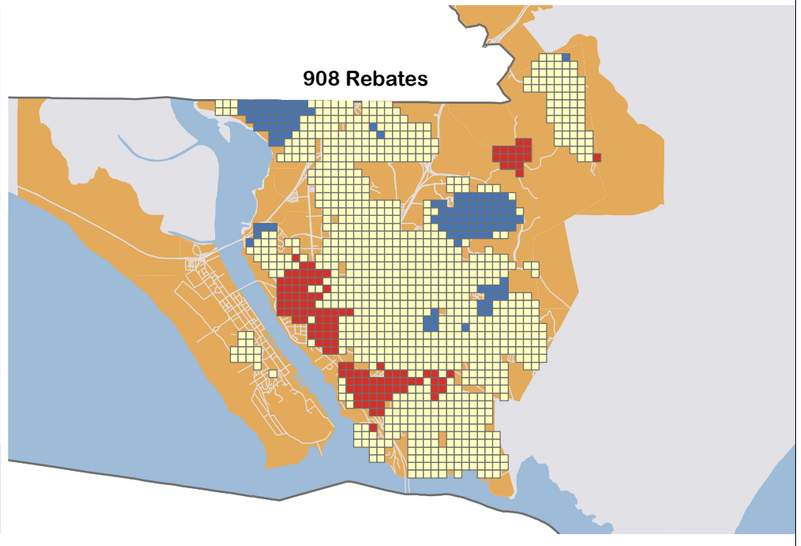
HE Washer Rebates Issued in 2016

83 Rebates



HE Washer Rebate Participation Hot and Cold Spots

908 Rebates



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_9_Vallejo_HE_Washers.mxd

Legend

- Vallejo
- Other Solano County Areas
- HE Washer Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor Office's data.
3. HE washer rebates for 2016 represent a partial year only. Rebate records are included through 25 July 2016. Rebate records prior to 2010 are not available.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Washer Rebates Issued
City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

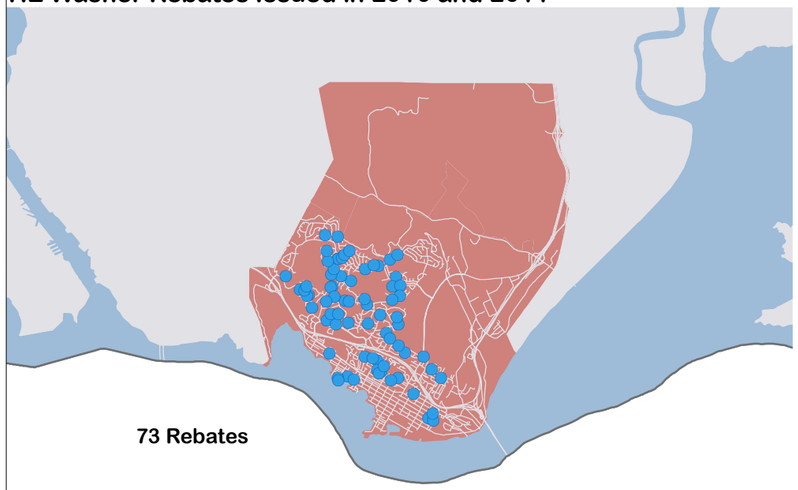
July 2017

EKI B50067.01

Figure 4-9

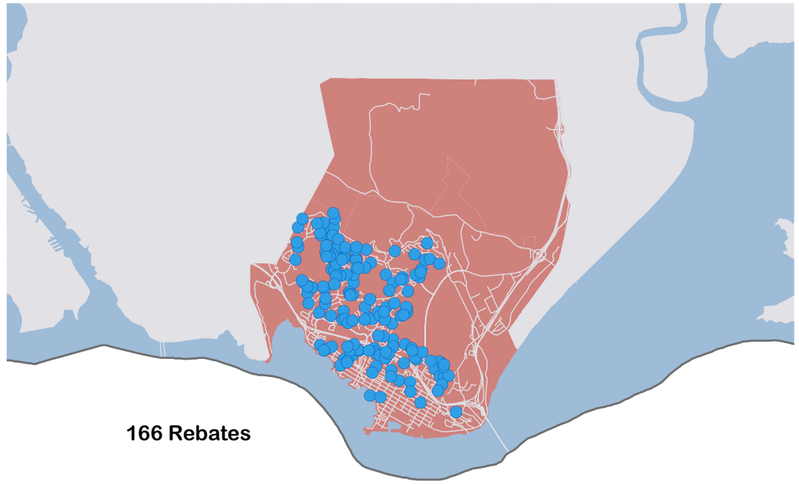
eki environment & water

HE Washer Rebates Issued in 2010 and 2011



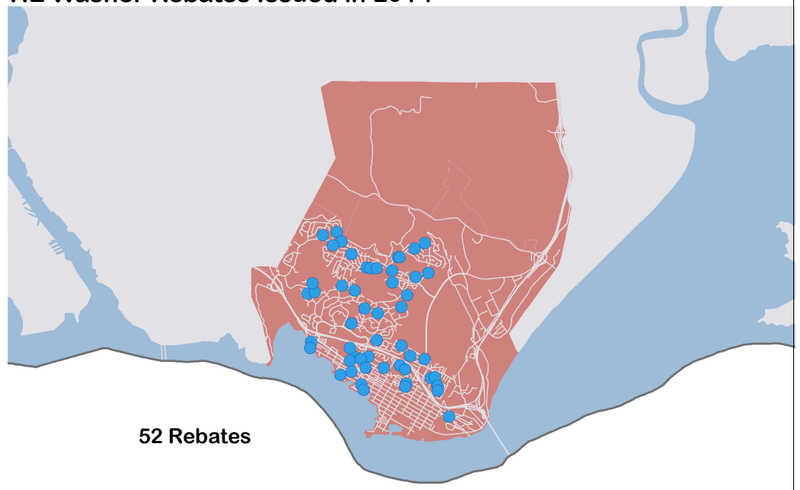
73 Rebates

HE Washer Rebates Issued in 2012 and 2013



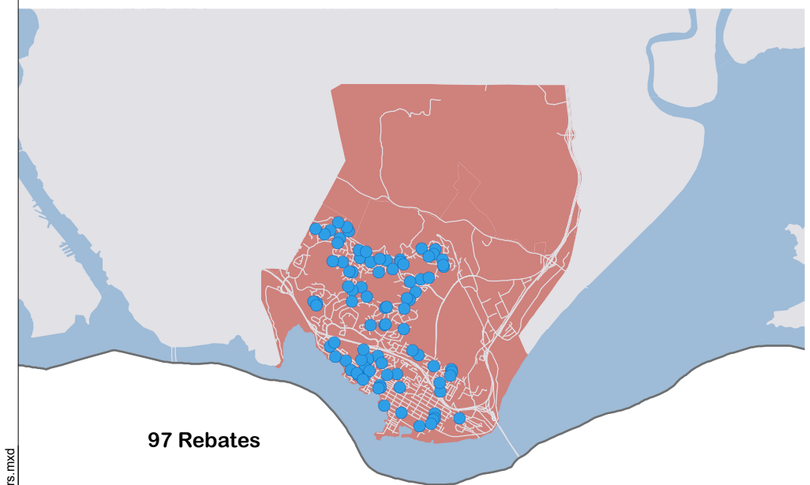
166 Rebates

HE Washer Rebates Issued in 2014



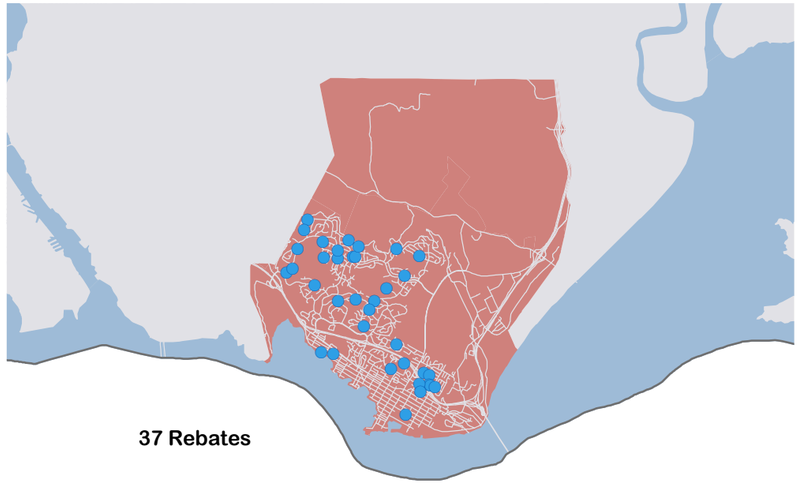
52 Rebates

HE Washer Rebates Issued in 2015



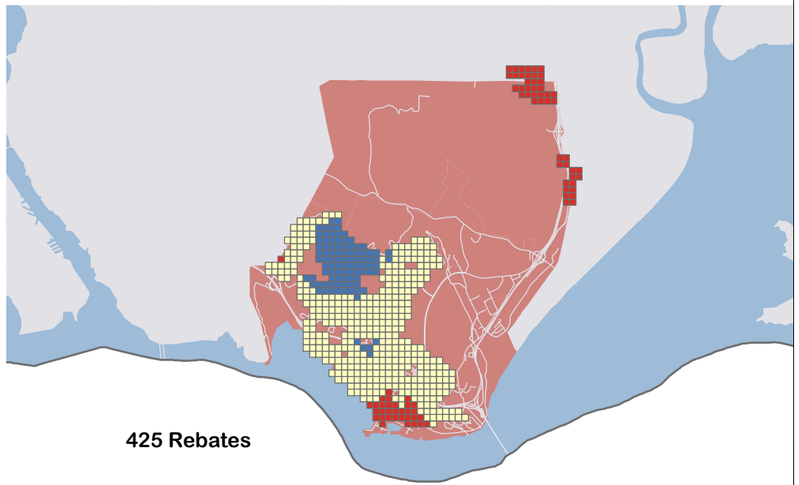
97 Rebates

HE Washer Rebates Issued in 2016



37 Rebates

HE Washer Rebate Participation Hot and Cold Spots



425 Rebates

Legend

- Benicia
- Other Solano County Areas
- HE Washer Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor Office's data.
3. HE washer rebates for 2016 represent a partial year only. Rebate records are included through 25 July 2016. Rebate records prior to 2010 are not available.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Washer Rebates Issued
City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

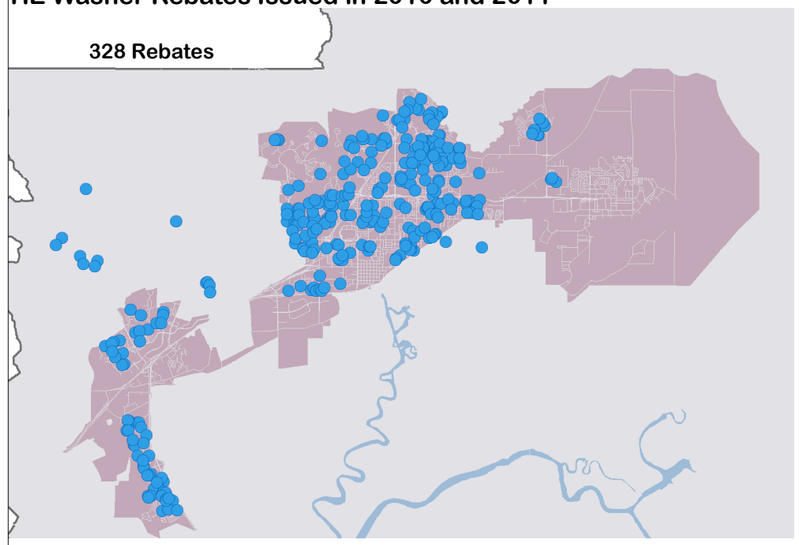
Figure 4-10

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_10_Benicia_HE_Washers.mxd

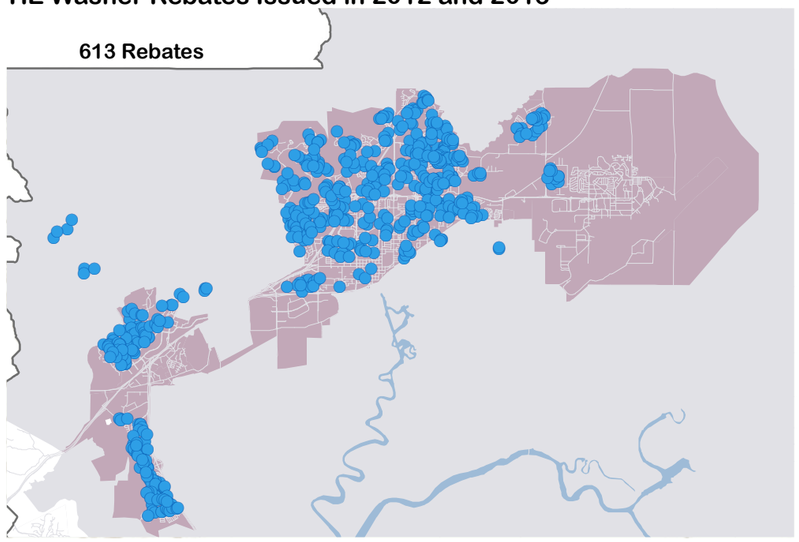
HE Washer Rebates Issued in 2010 and 2011

328 Rebates



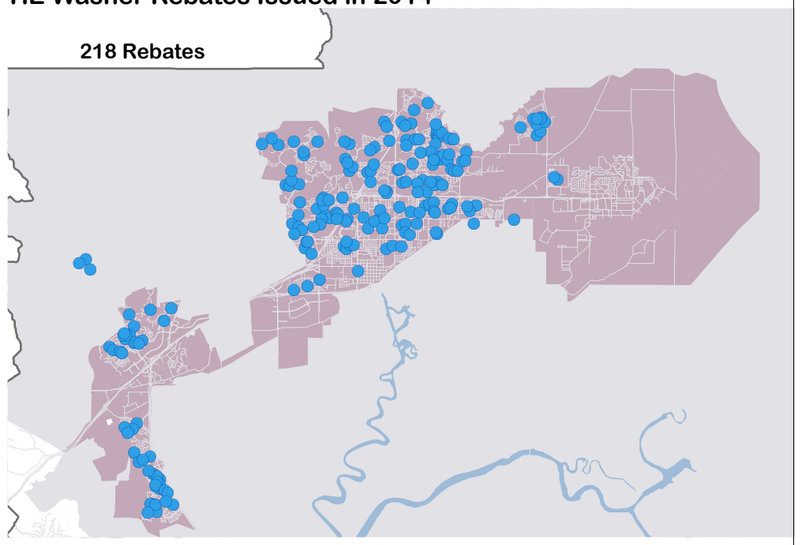
HE Washer Rebates Issued in 2012 and 2013

613 Rebates



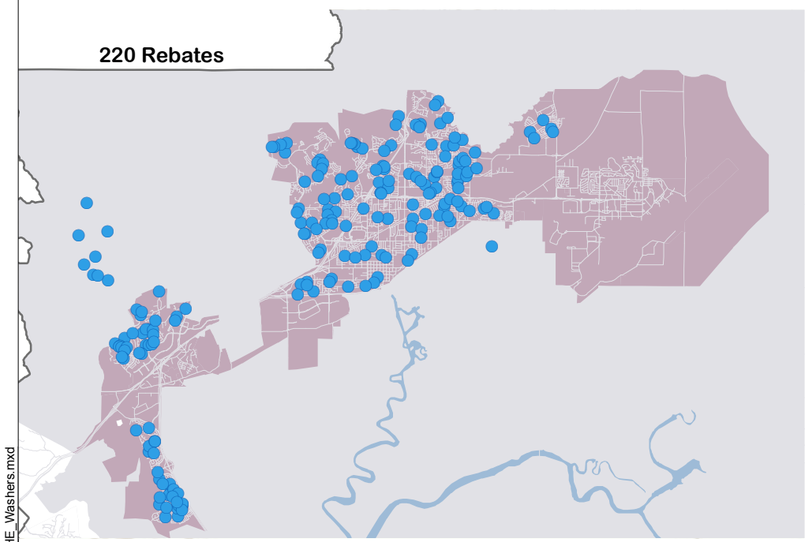
HE Washer Rebates Issued in 2014

218 Rebates



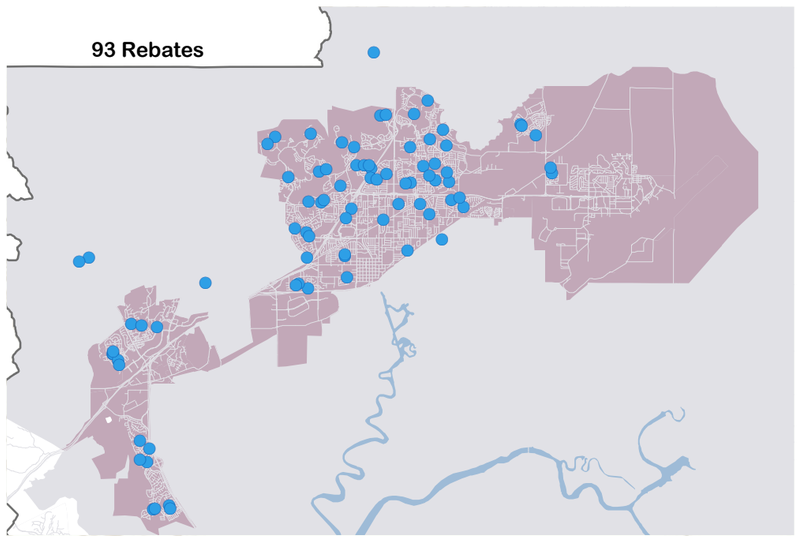
HE Washer Rebates Issued in 2015

220 Rebates



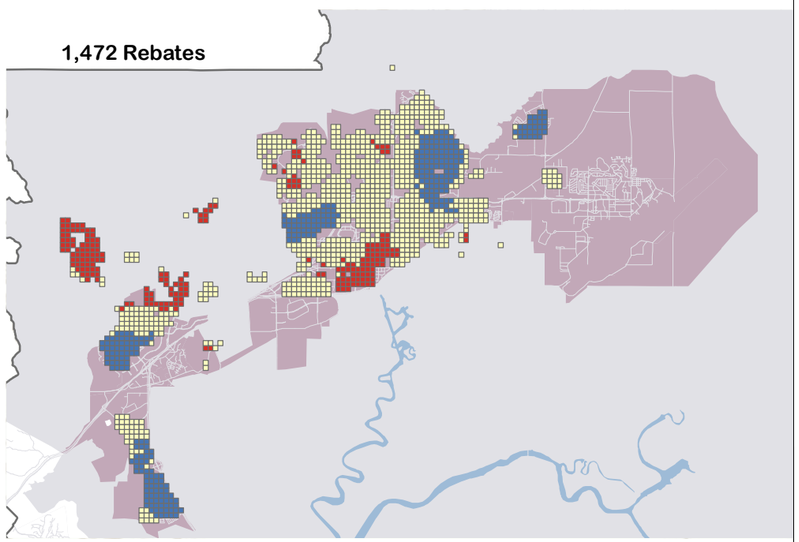
HE Washer Rebates Issued in 2016

93 Rebates



HE Washer Rebate Participation Hot and Cold Spots

1,472 Rebates



Legend

- Fairfield
- Other Solano County Areas
- HE Washer Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor Office's data.
3. HE washer rebates for 2016 represent a partial year only. Rebate records are included through 25 July 2016. Rebate records prior to 2010 are not available.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., rural or parcels greater than 1-acre in size) were exlcuded from the analysis.

N

0 3.5 7

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_11_Fairfield_HE_Washers.mxd

SFR HE Washer Rebates Issued
City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 4-11

eki environment & water

HE Washer Rebates Issued in 2010 and 2011

256 Rebates

HE Washer Rebates Issued in 2012 and 2013

600 Rebates

HE Washer Rebates Issued in 2014

222 Rebates

HE Washer Rebates Issued in 2015

196 Rebates

HE Washer Rebates Issued in 2016

83 Rebates

HE Washer Rebate Participation Hot and Cold Spots

1,357 Rebates

Legend

- Vacaville
- Other Solano County Areas
- HE Washer Rebate Issued

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

HE - high efficiency
SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor Office's data.
3. HE washer rebates for 2015 represent a partial year only. Rebate records are included through 1 May 2015. HE washer rebate records prior to 2010 were not available.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., generally areas where parcels are greater than 1-acre in size) were exlcuded from the analysis.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Washer Rebates Issued
City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

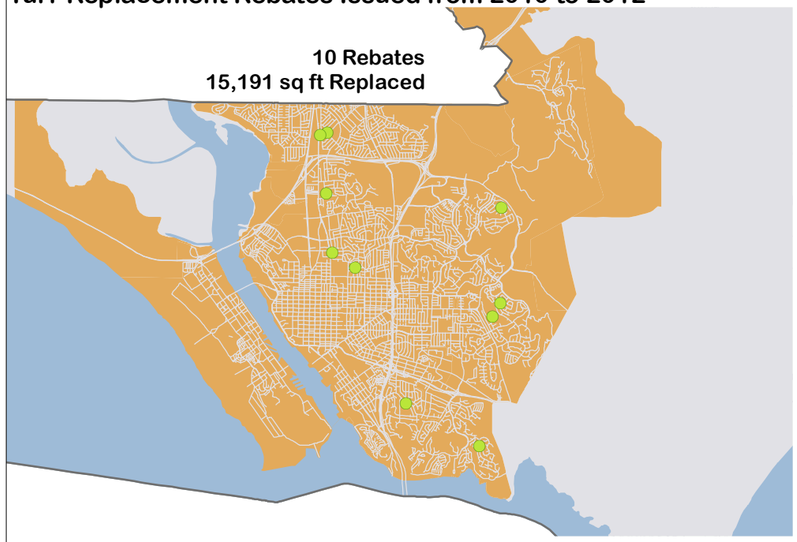
EKI B50067.01

Figure 4-12

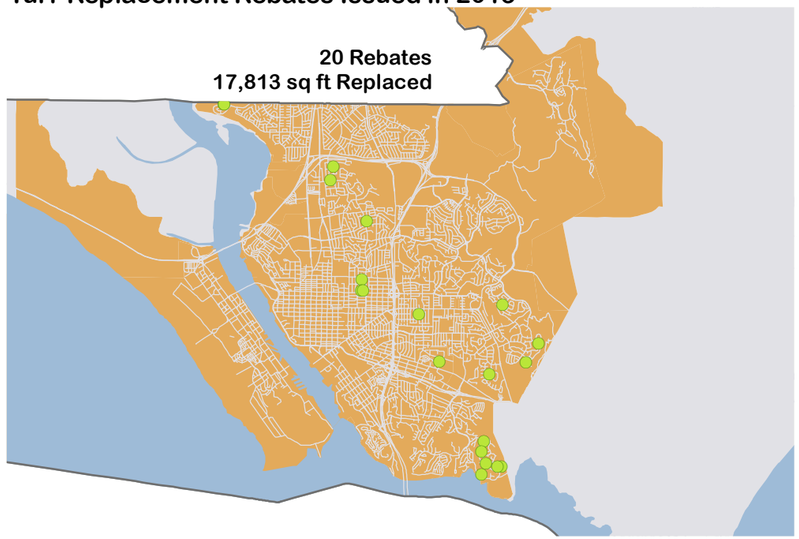
eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_12_Vacaville_HE_Washers.mxd

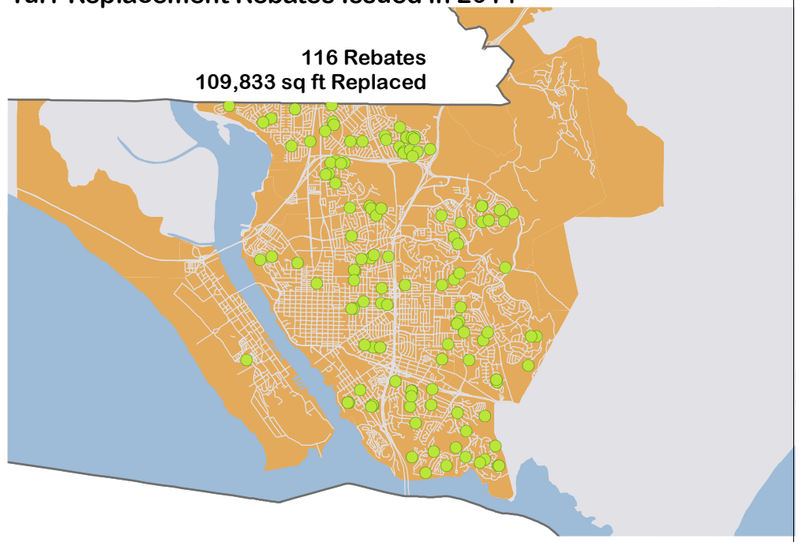
Turf Replacement Rebates Issued from 2010 to 2012



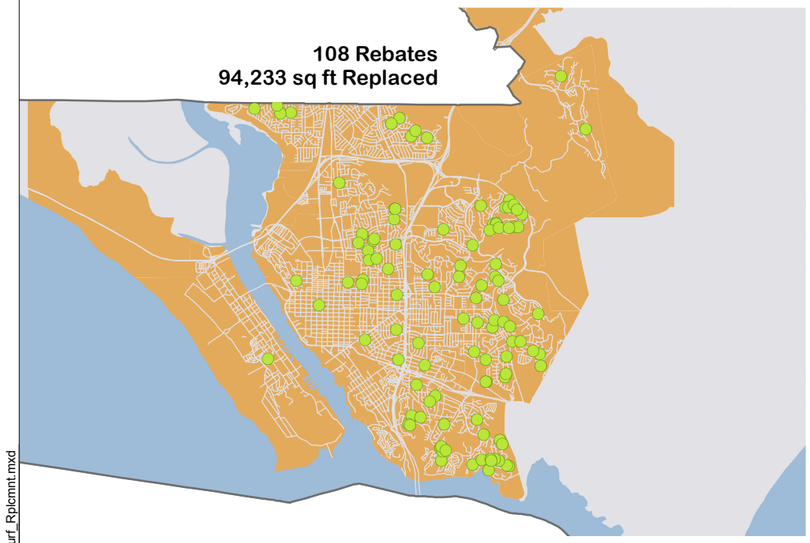
Turf Replacement Rebates Issued in 2013



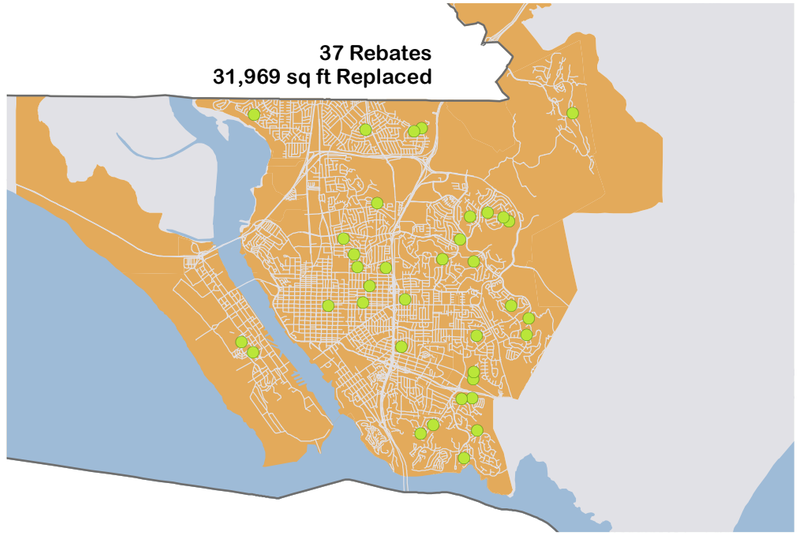
Turf Replacement Rebates Issued in 2014



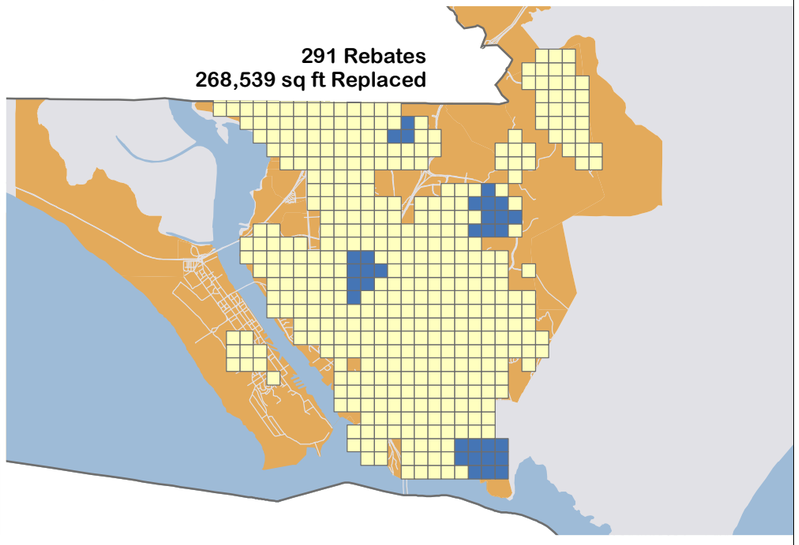
Turf Replacement Rebates Issued in 2015



Turf Replacement Rebates Issued in 2016



Turf Replacement Rebate Participation Hot and Cold Spots



Legend

- Vallejo
- Other Solano County Areas
- Turf Replacement Project

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential
sq ft - square feet

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. Turf replacement rebate records are included through September 2016. Turf replacement rebate records for 2016 represent a partial year only.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_13_Vallejo_Turf_Rplcmnt.mxd

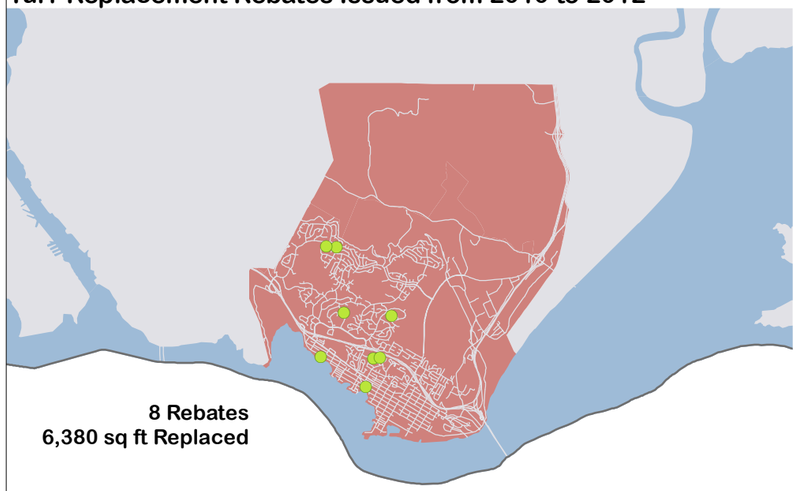
SFR Turf Replacement Rebates Issued
City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01
Figure 4-13

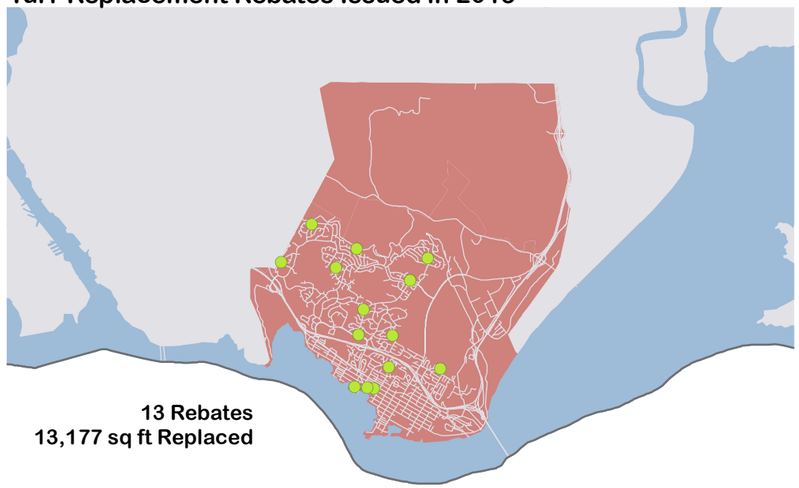
eki environment & water

Turf Replacement Rebates Issued from 2010 to 2012



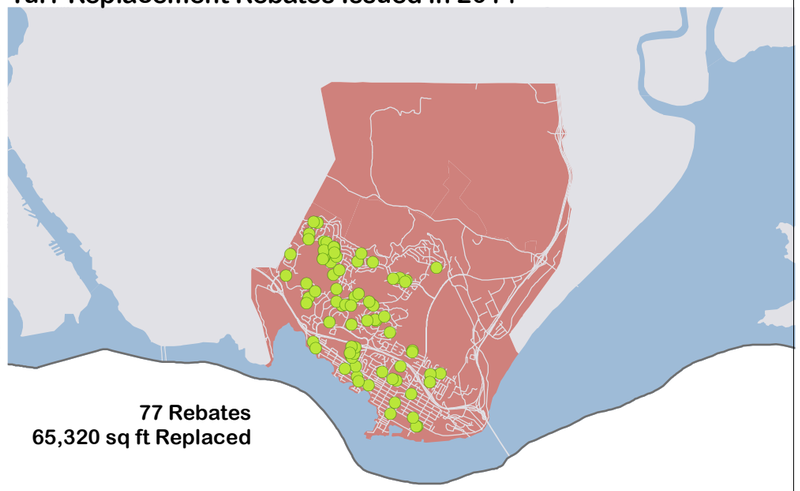
8 Rebates
6,380 sq ft Replaced

Turf Replacement Rebates Issued in 2013



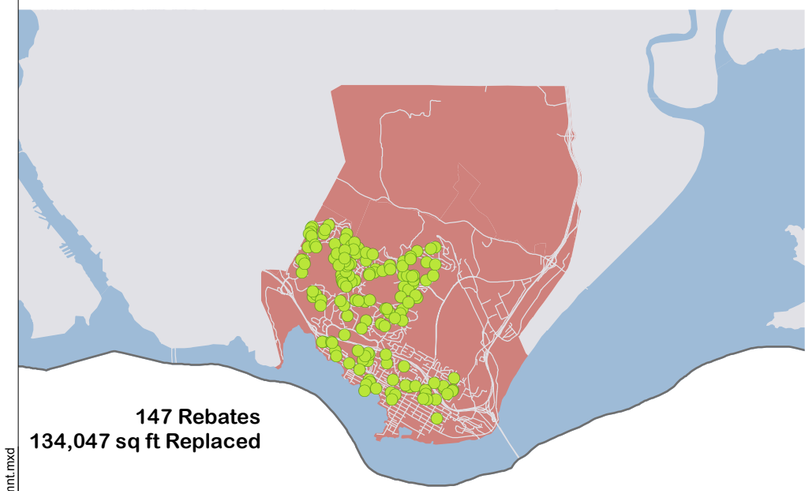
13 Rebates
13,177 sq ft Replaced

Turf Replacement Rebates Issued in 2014



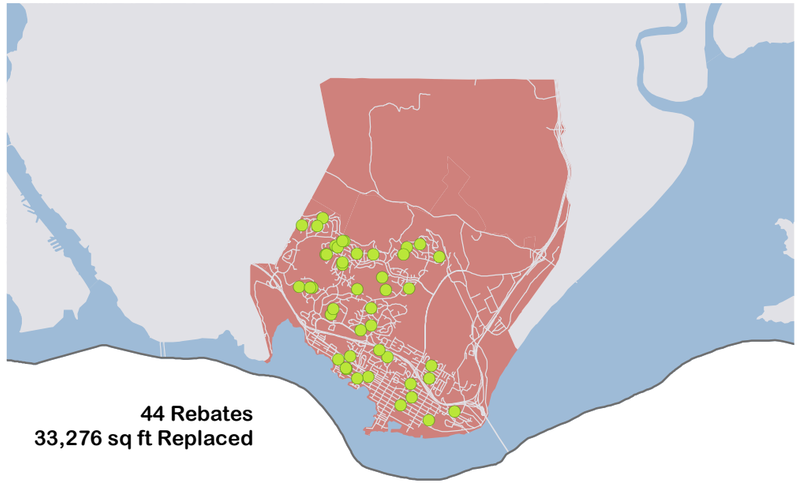
77 Rebates
65,320 sq ft Replaced

Turf Replacement Rebates Issued in 2015



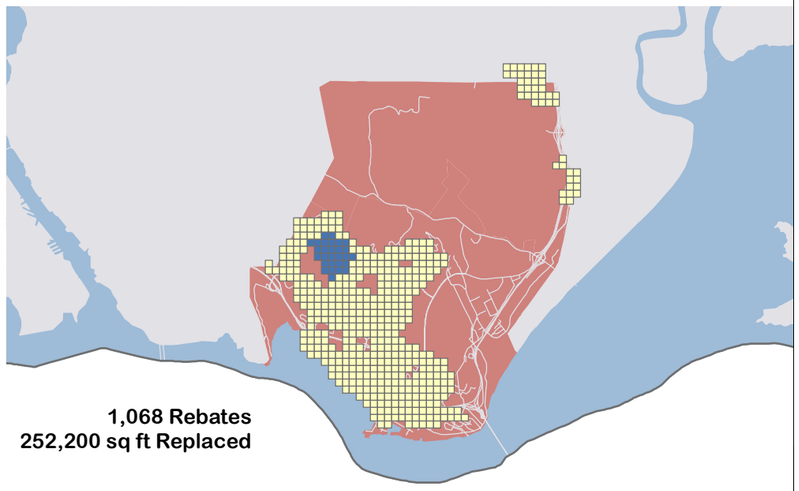
147 Rebates
134,047 sq ft Replaced

Turf Replacement Rebates Issued in 2016



44 Rebates
33,276 sq ft Replaced

Turf Replacement Rebate Participation Hot and Cold Spots



1,068 Rebates
252,200 sq ft Replaced

Legend

- Benicia
- Other Solano County Areas
- Turf Replacement Project

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential
sq ft - square feet

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. Turf replacement rebate records are included through September 2016. Turf replacement rebate records for 2016 represent a partial year only.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_14_Benicia_Turf_Rplcmnt.mxd

SFR Turf Replacement Rebates Issued
City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

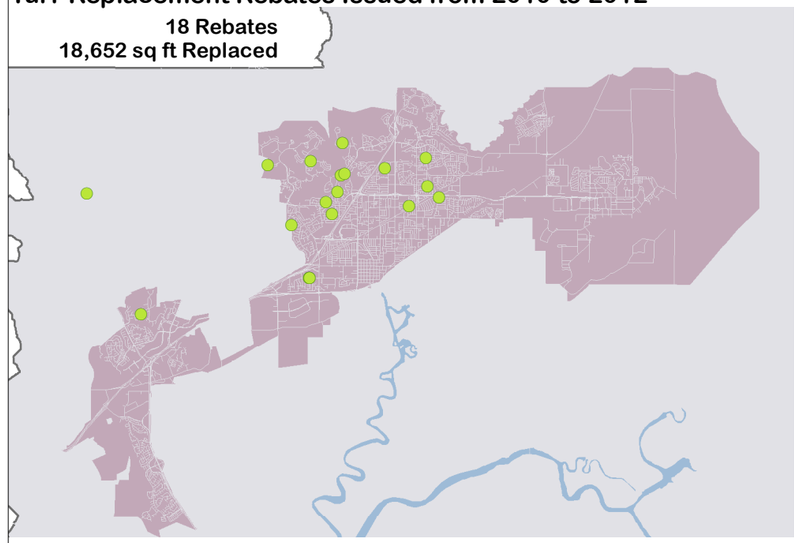
EKI B50067.01

Figure 4-14

eki environment & water

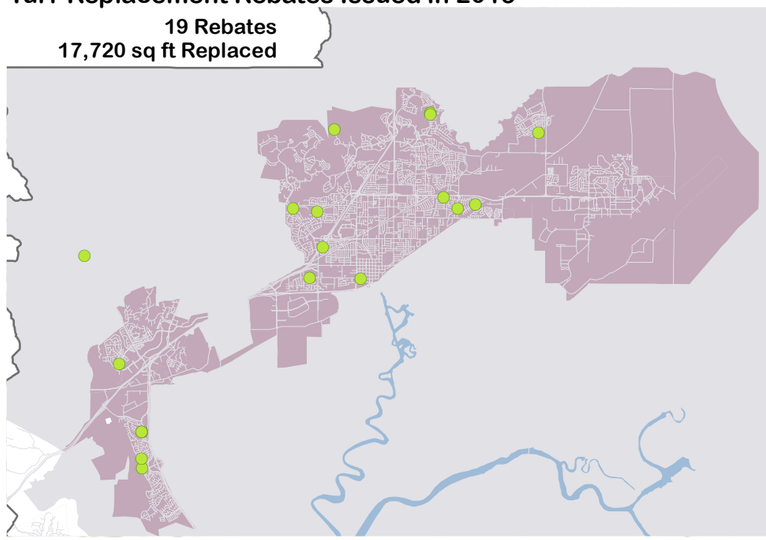
Turf Replacement Rebates Issued from 2010 to 2012

18 Rebates
18,652 sq ft Replaced



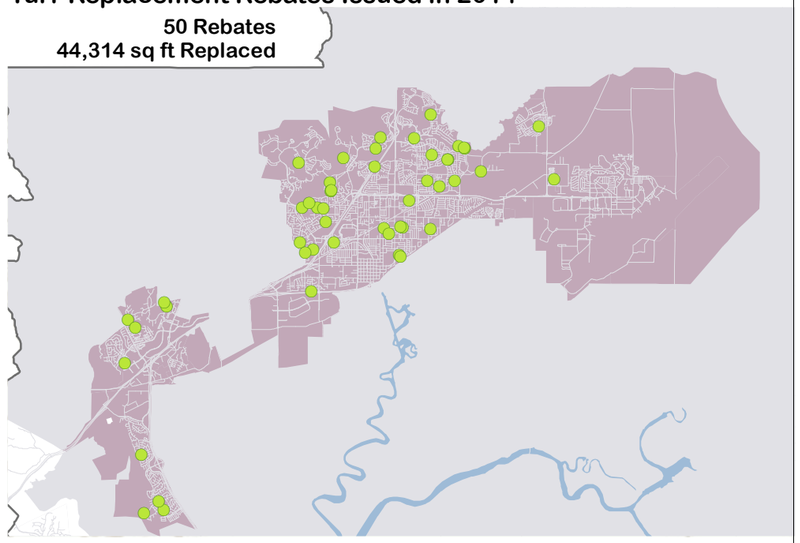
Turf Replacement Rebates Issued in 2013

19 Rebates
17,720 sq ft Replaced



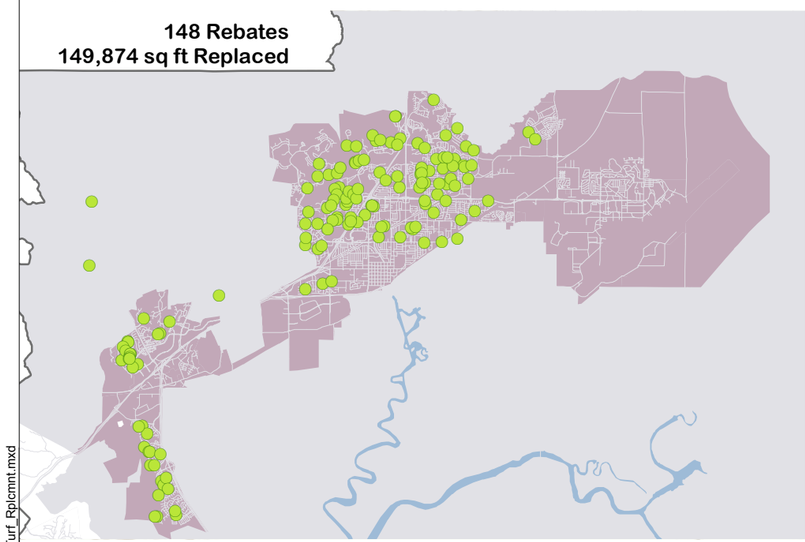
Turf Replacement Rebates Issued in 2014

50 Rebates
44,314 sq ft Replaced



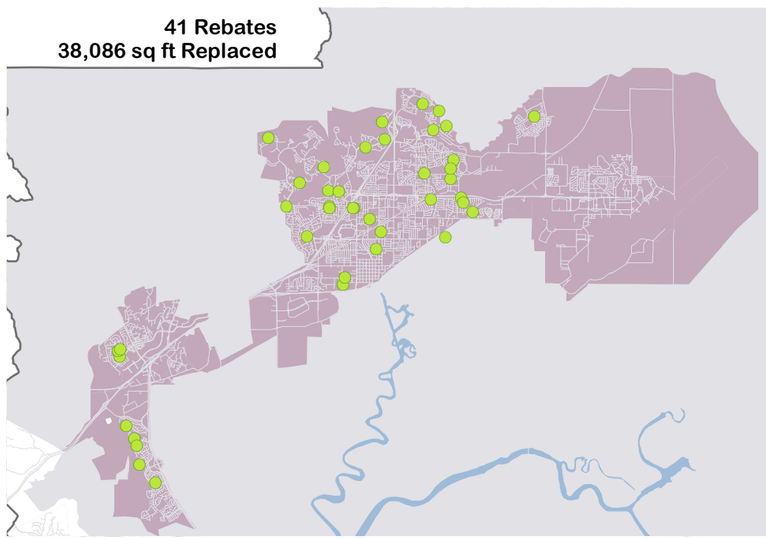
Turf Replacement Rebates Issued in 2015

148 Rebates
149,874 sq ft Replaced



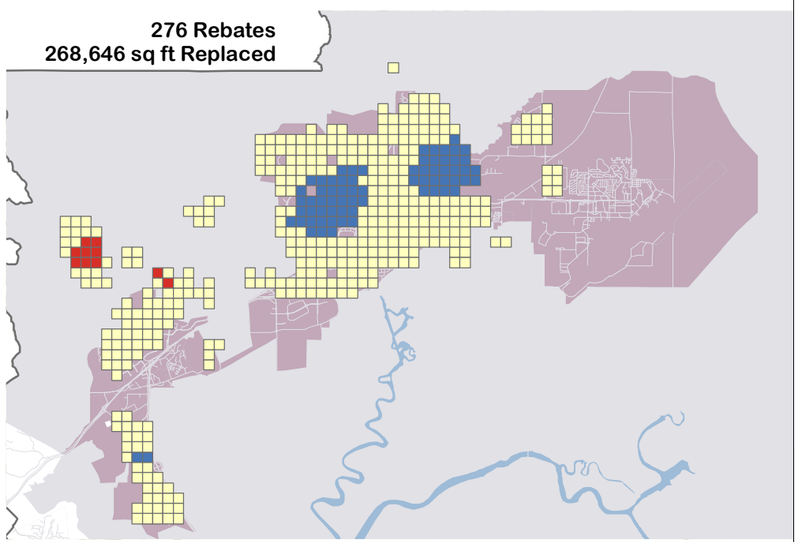
Turf Replacement Rebates Issued in 2016

41 Rebates
38,086 sq ft Replaced



Turf Replacement Rebate Participation Hot and Cold Spots

276 Rebates
268,646 sq ft Replaced



Legend

- Fairfield
- Other Solano County Areas
- Turf Replacement Project

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential
sq ft - square feet

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. Turf replacement rebate records are included through September 2016. Turf replacement rebate records for 2016 represent a partial year only.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of low density housing (i.e., rural or parcels greater than 1-acre in size) were exlcuded from the analysis.

N

0 3.5 7

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

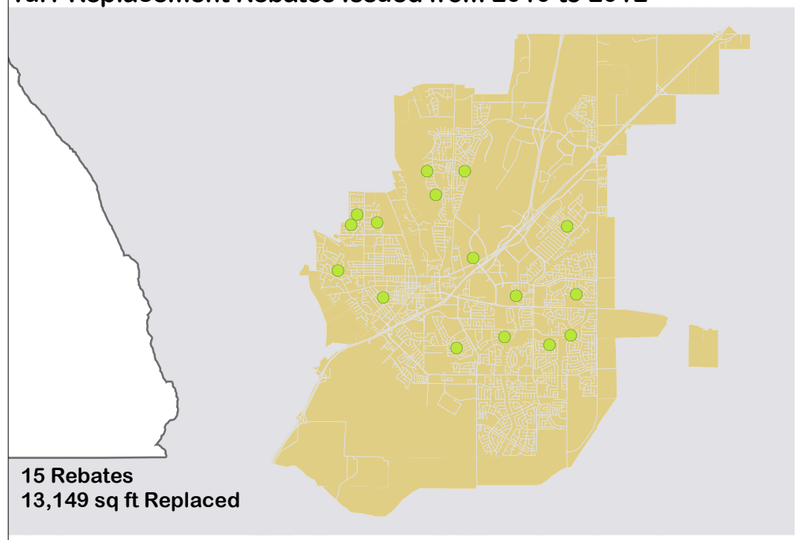
Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_15_Fairfield_Turf_Rplcmnt.mxd

SFR Turf Replacement Rebates Issued
City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA
July 2017
EKI B50067.01
Figure 4-15

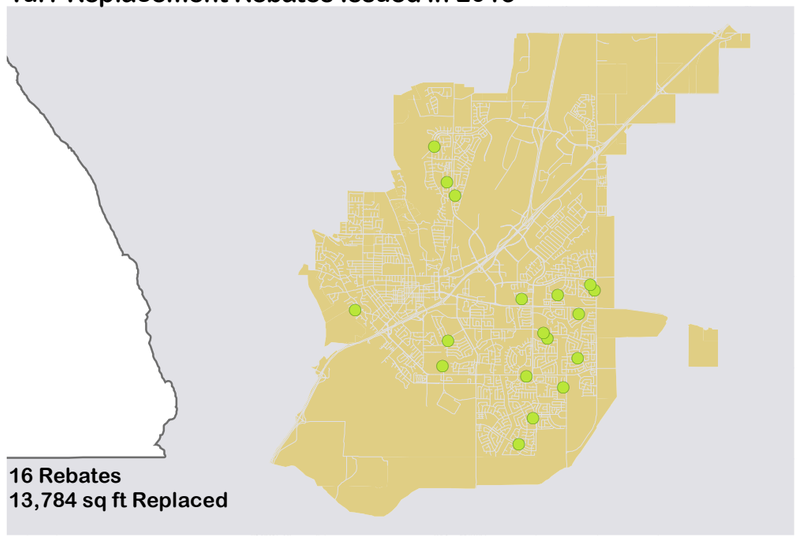
eki environment & water

Turf Replacement Rebates Issued from 2010 to 2012



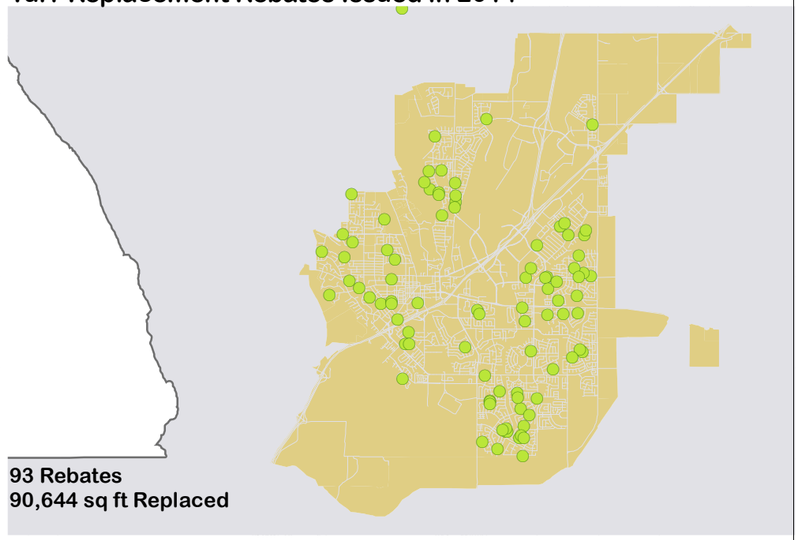
15 Rebates
13,149 sq ft Replaced

Turf Replacement Rebates Issued in 2013



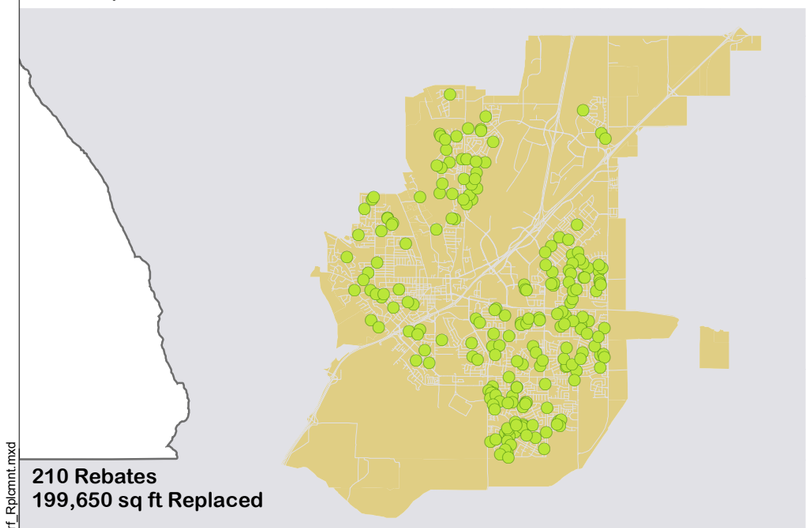
16 Rebates
13,784 sq ft Replaced

Turf Replacement Rebates Issued in 2014



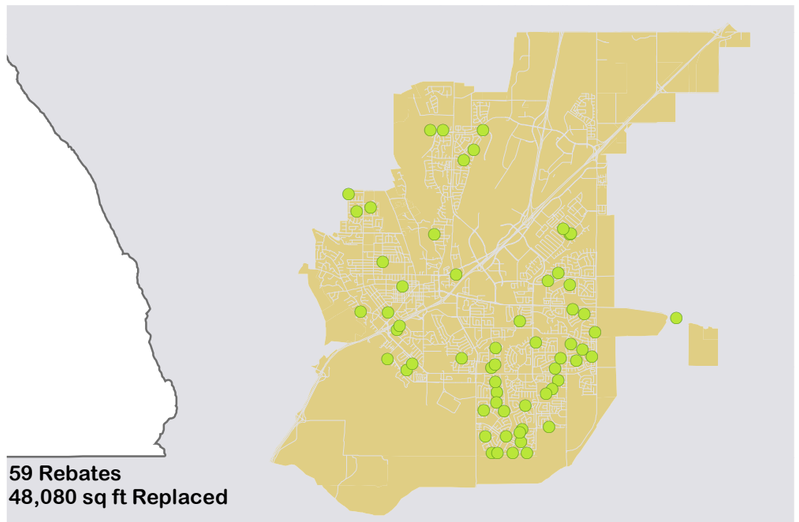
93 Rebates
90,644 sq ft Replaced

Turf Replacement Rebates Issued in 2015



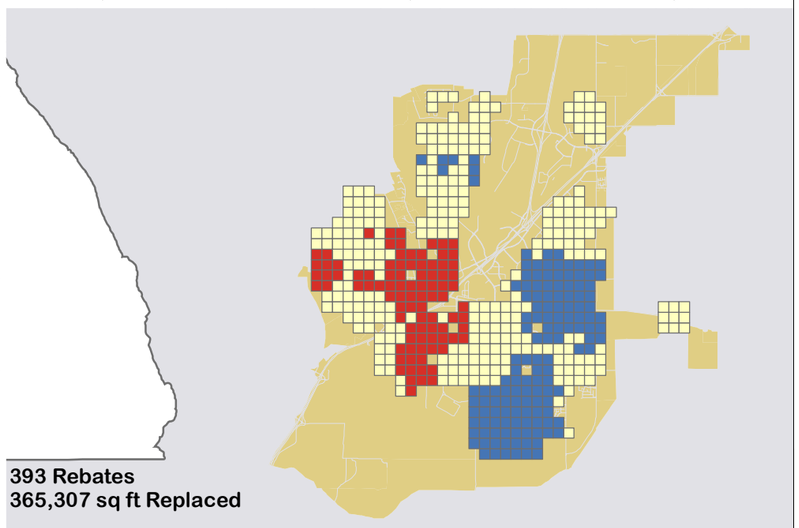
210 Rebates
199,650 sq ft Replaced

Turf Replacement Rebates Issued in 2016



59 Rebates
48,080 sq ft Replaced

Turf Replacement Rebate Participation Hot and Cold Spots



393 Rebates
365,307 sq ft Replaced

Legend

- Vacaville
- Other Solano County Areas
- Turf Replacement Project

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential
sq ft - square feet

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. Turf replacement rebate records are included through December 2015.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., rebates) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., generally areas where parcels are greater than 1-acre in size) were exlcuded from the analysis.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2015.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_16_Vacaville_Turf_Rplcmnt.mxd

SFR Turf Replacement Rebates Issued
City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

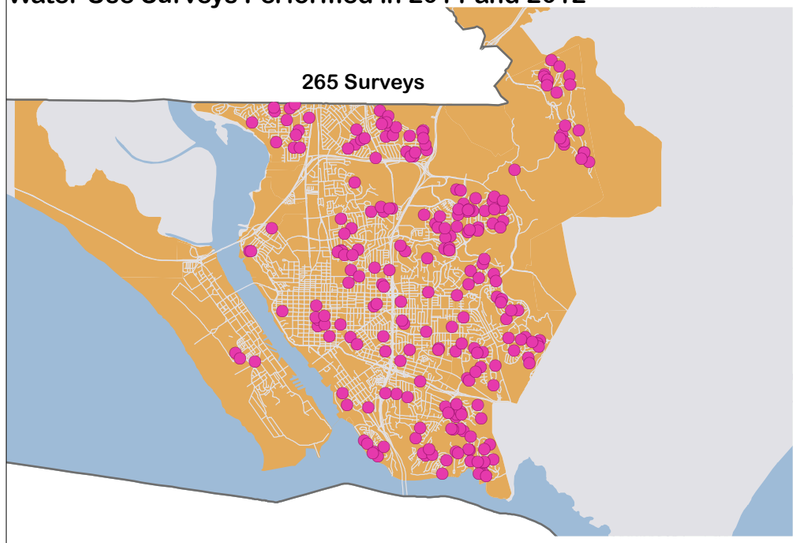
July 2017

eki environment & water

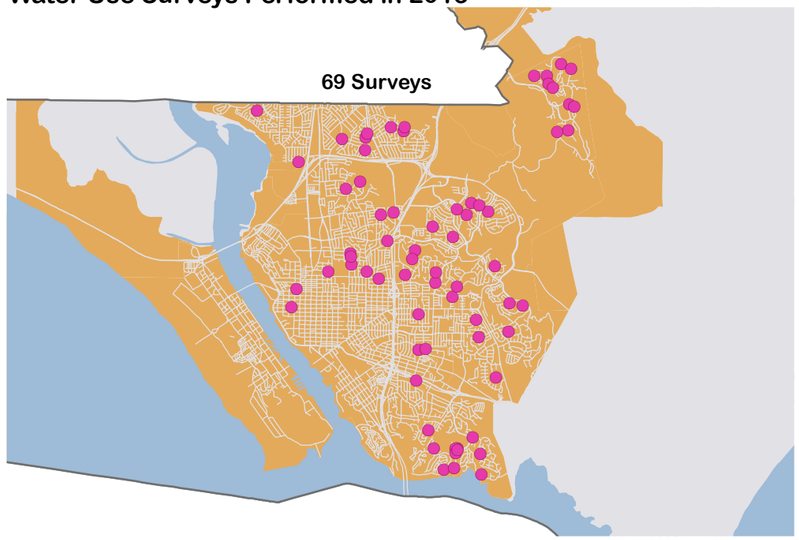
EKI B50067.01

Figure 4-16

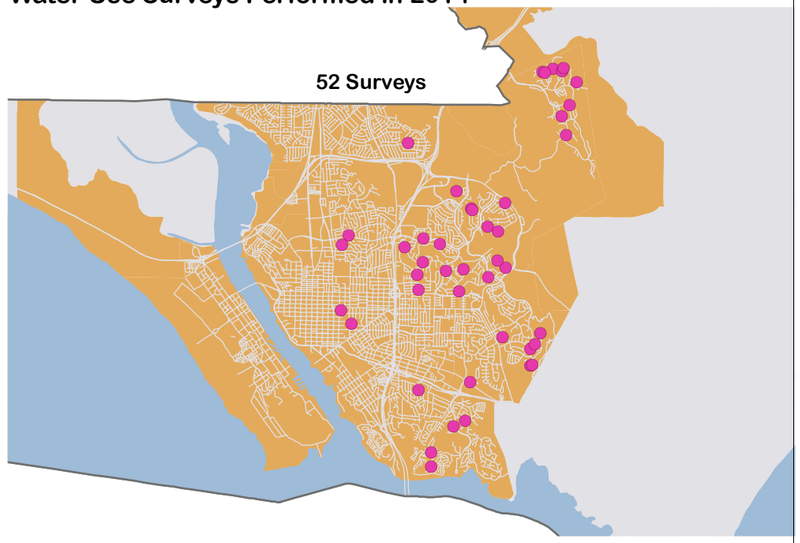
Water Use Surveys Performed in 2011 and 2012



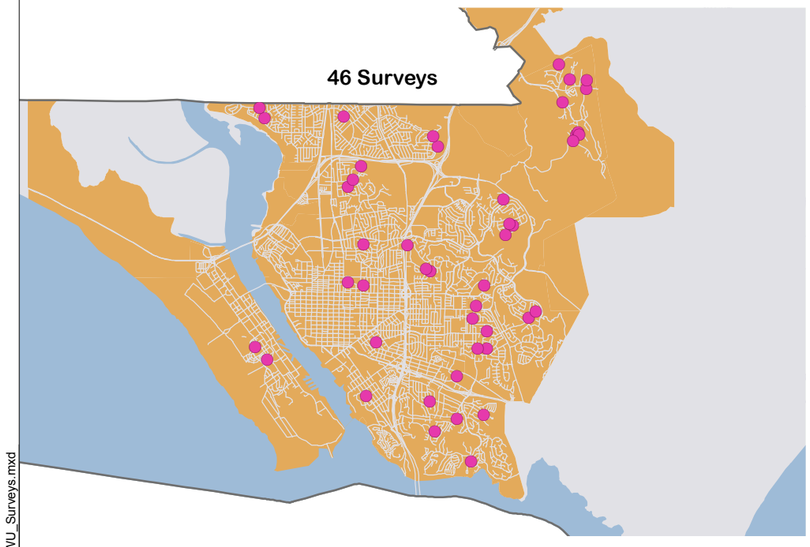
Water Use Surveys Performed in 2013



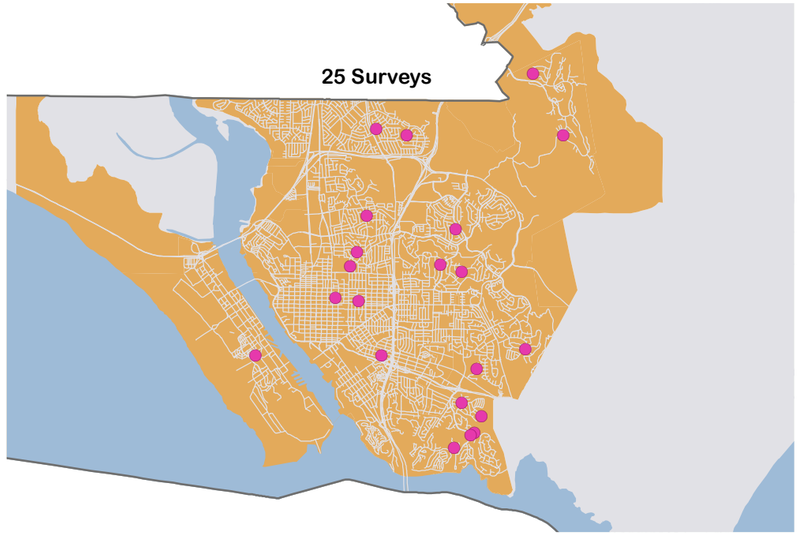
Water Use Surveys Performed in 2014



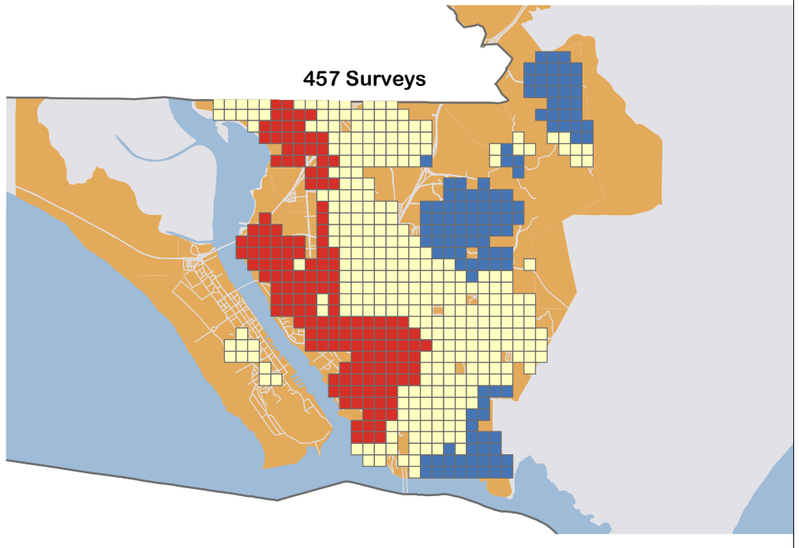
Water Use Surveys Performed in 2015



Water Use Surveys Performed in 2016



Water Use Surveys Participation Hot and Cold Spots



Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_17_Vallejo_WU_Surveys.mxd

Legend

- Vallejo
- Other Solano County Areas
- Water Use Survey Performed

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. SFR water use surveys for 2016 represent a partial year only. Survey records are included through 12 September 2016.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., surveys) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Residential Water Use Surveys Conducted
City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

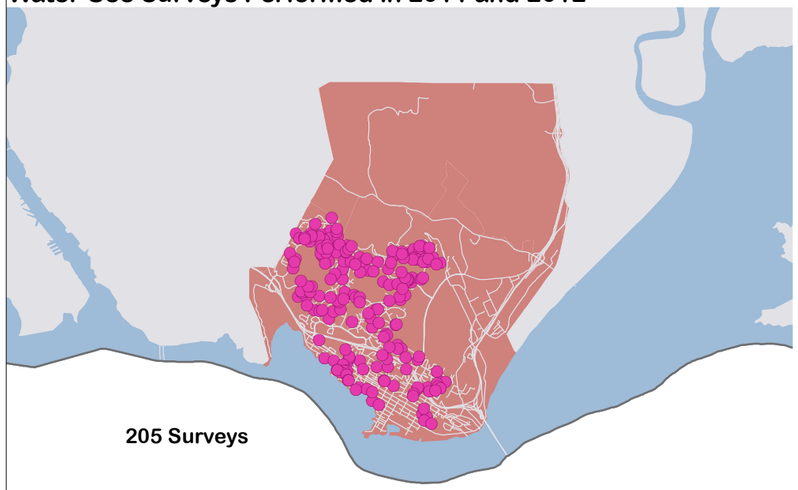
July 2017

EKI B50067.01

Figure 4-17

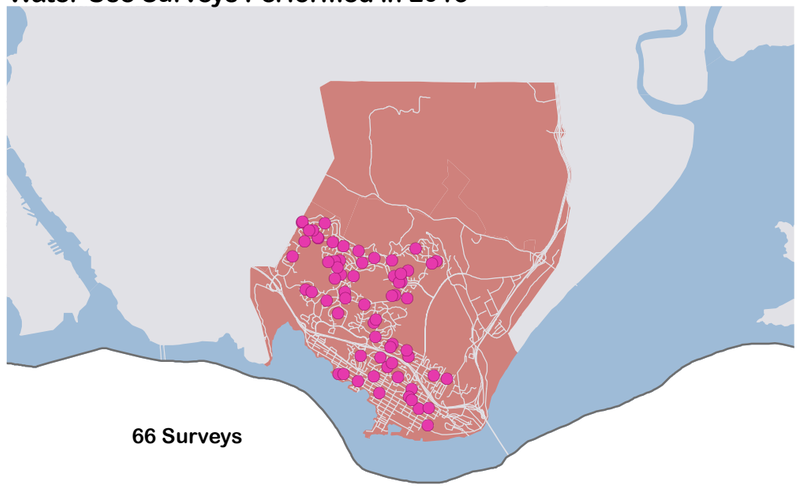
eki environment & water

Water Use Surveys Performed in 2011 and 2012



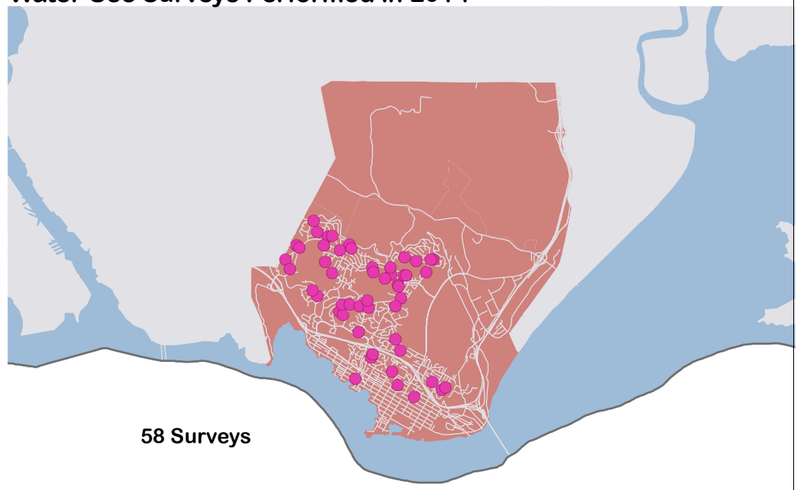
205 Surveys

Water Use Surveys Performed in 2013



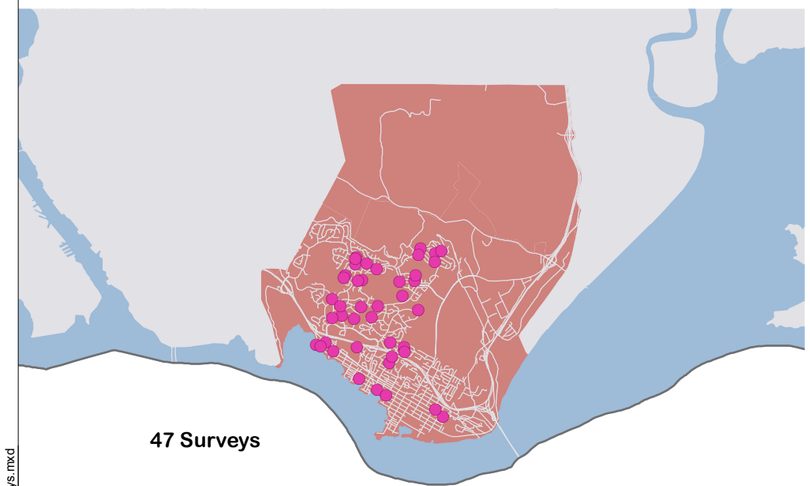
66 Surveys

Water Use Surveys Performed in 2014



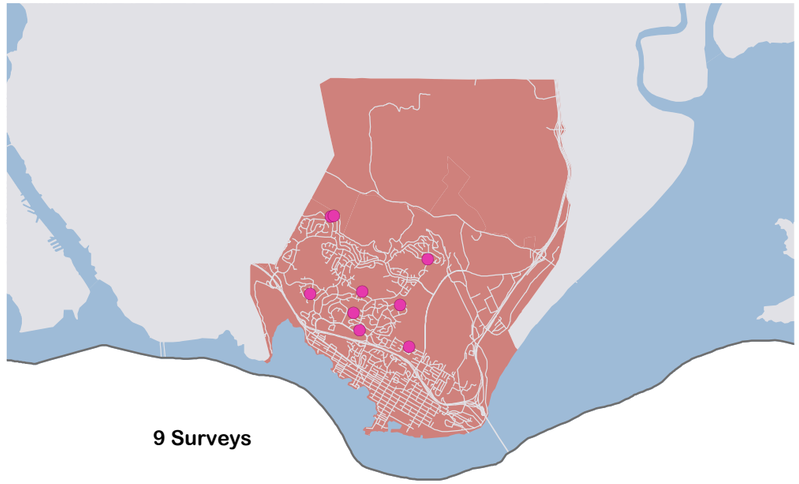
58 Surveys

Water Use Surveys Performed in 2015



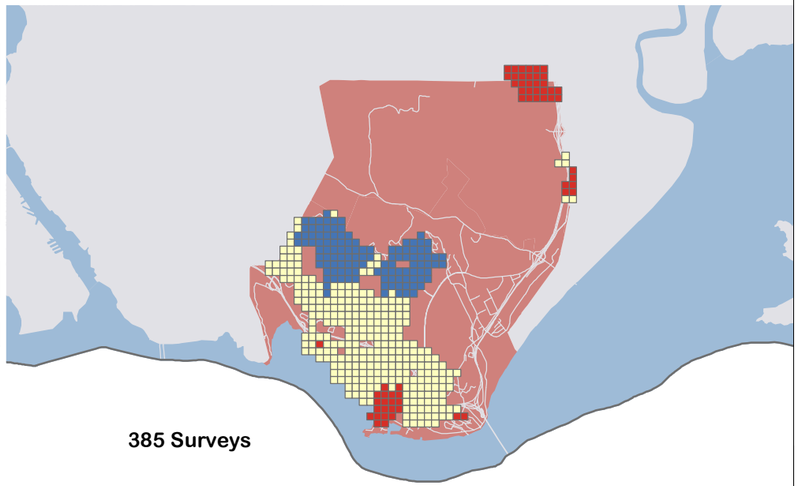
47 Surveys

Water Use Surveys Performed in 2016



9 Surveys

Water Use Surveys Participation Hot and Cold Spots



385 Surveys

Legend

- Benicia
- Other Solano County Areas
- Water Use Survey Performed

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. SFR water use surveys for 2016 represent a partial year only. Survey records are included through 12 September 2016.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., surveys) relative to a random, equally spaced distribution.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Residential Water Use Surveys Conducted
City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

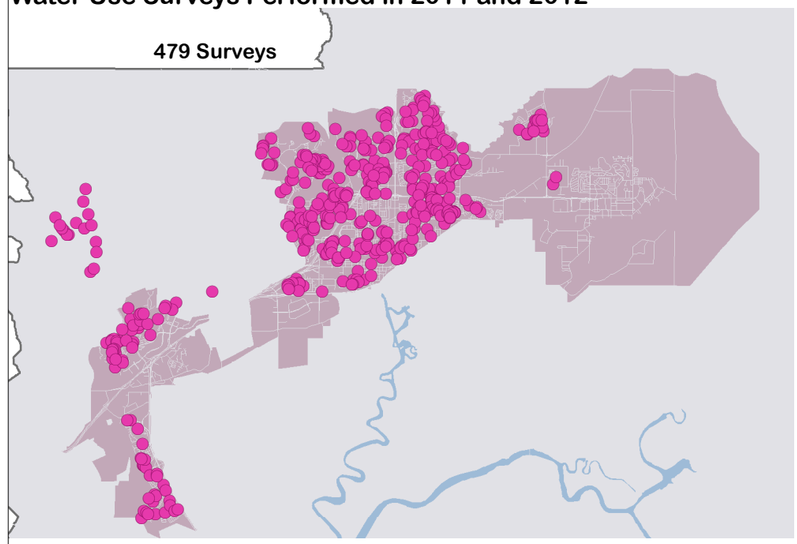
July 2017

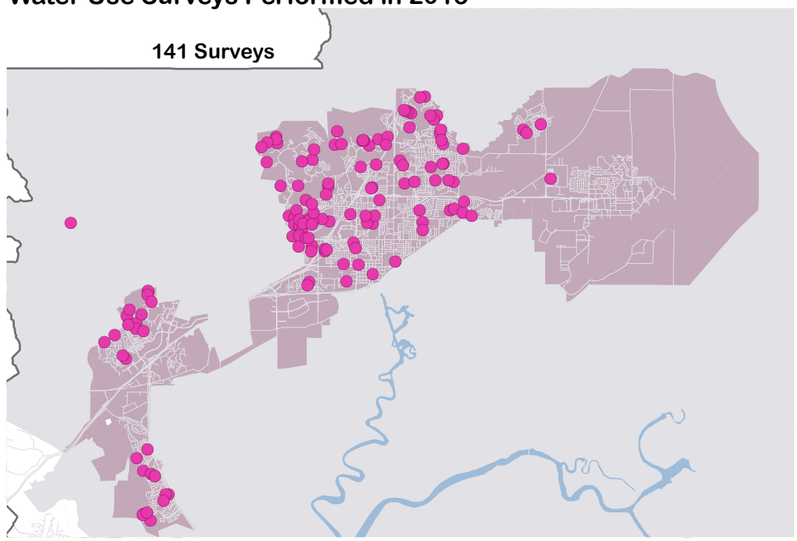
EKI B50067.01

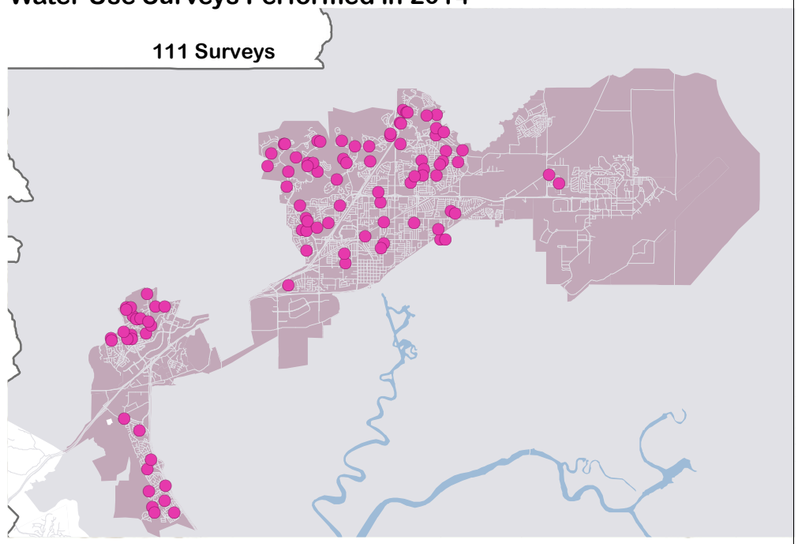
Figure 4-18

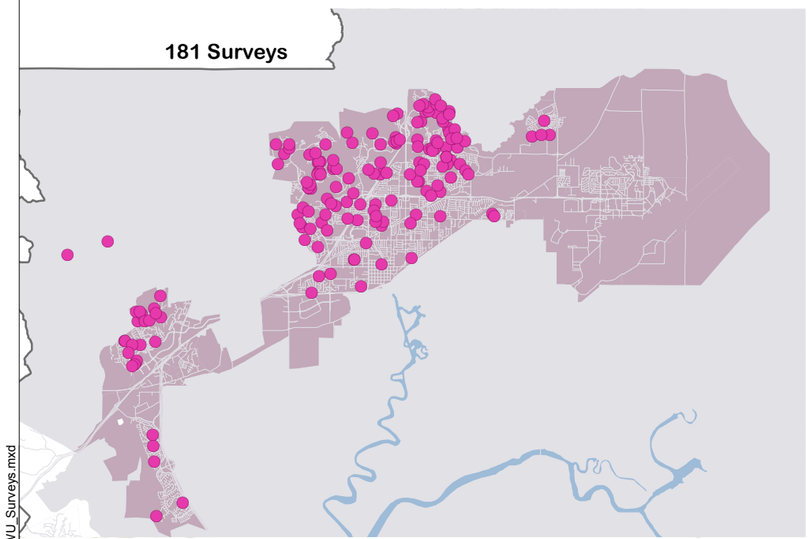
eki environment & water

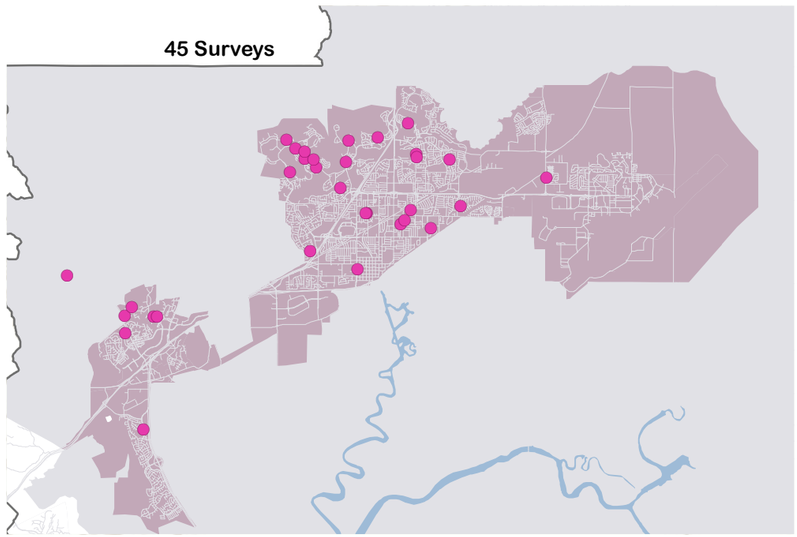
Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_18_Benicia_WU_Surveys.mxd

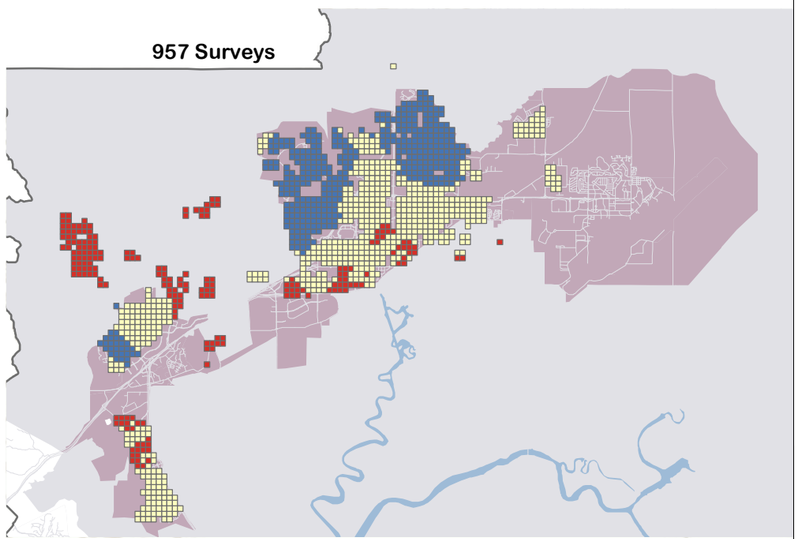












Legend

- Fairfield
- Other Solano County Areas
- Water Use Survey Performed

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. SFR water use surveys for 2016 represent a partial year only. Survey records are included through 12 September 2016.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., surveys) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., rural or parcels greater than 1-acre in size) were exlcuded from the analysis.

N

0 3.5 7

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_19_Fairfield_WU_Surveys.mxd

Residential Water Use Surveys Conducted City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 4-19

eki environment & water

Water Use Surveys Performed in 2011 and 2012

123 Surveys

Water Use Surveys Performed in 2013

194 Surveys

Water Use Surveys Performed in 2014

58 Surveys

Water Use Surveys Performed in 2015

222 Surveys

Water Use Surveys Performed in 2016

27 Surveys

Water Use Surveys Participation Hot and Cold Spots

624 Surveys

Legend

- Vacaville
- Other Solano County Areas
- Water Use Survey Performed

Participation Hot and Cold Spots

- Hot Spot (≥90% Confidence)
- Cold Spot (≥90% Confidence)
- Neither Hot nor Cold Spot

Abbreviations

SFR - single-family residential

Notes

1. All locations are approximate.
2. Only program participation by SFR accounts is shown, and those shown are limited to those records that could be positively matched to a parcel from the Solano County Assessor's Office data.
3. SFR water use surveys for 2016 represent a partial year only. Survey records are included through 12 September 2016.
4. Rebate participation hot and cold spots were evaluated using the ESRI ArcGIS 10.3.1 Optimized Hot Spot Analysis tool, which calculates a Getis-Ord Gi* statistic. This statistic is a measure of the spatial distribution of incidents (i.e., surveys) relative to a random, equally spaced distribution.
5. Areas of very low density housing (i.e., generally areas where parcels are greater than 1-acre in size) were exlcuded from the analysis.

N

0 2.5 5

(Approximate Scale in Miles)

Sources

1. Conservation program data provided by Solano County Water Agency, 2016.
2. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
3. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig4_20_Vacaville_WU_Surveys.mxd

Residential Water Use Surveys Conducted City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 4-20

eki environment & water

5.0 HOUSEHOLD INCOME AND PROGRAM PARTICIPATION

During the Pilot Study, it was observed that lower levels of conservation program participation were generally correlated with older, lower income neighborhoods within the City of Vallejo. In order to understand the relationship between income and water conservation program participation more broadly across the SCWA service area, SFR participation in each of the four conservation programs was analyzed relative to household income within the member units. This analysis was performed for each of the four member units that were able to provide account-level water use for this study: the Cities of Vallejo, Benicia, Fairfield, and Vacaville.

5.1 Income Analysis Methodology

Household income data were based on the estimated 2014 median household income by Census Block Group[18] (Census, 2016). According to current Census data, the average Solano County household consists of 2.89 people (Census, 2017). Therefore, the estimated 2014 median household income was compared to 2014 California Department of Housing and Community Development ("HCD") income levels for a 3-person household in Solano County (HCD, 2014). These income levels are defined as follows: high income (>$89,200/year), moderate income ($58,501-$89,200/year), and low income (<$58,500/year) (HCD, 2014). The following sections discuss the breakdown of program participation by SFR accounts located in low, moderate, and high income areas, for the County and each of the four member units that are the focus of this study.

5.2 Results of Income Analysis

5.2.1 *Solano County*

Figure 5-1 shows the distribution of household income across the SCWA service area. The percentage of participation in conservation programs by homes located in low, moderate, and high income areas are shown in Table 5-1. Countywide, approximately 34% of SFR parcels fall within high income areas, 42% within moderate income areas, and 24% within low income areas. The highest proportion of SFR program participants in the HE Toilet Rebate (45%) and the Turf Replacement Rebate (44%) programs were located in moderate income areas, while the highest proportion of participants for the HE Washer Rebate (44%) and the Residential Water Use Survey Program (50%) programs were located in high income areas. For all four programs, a greater level of participation was observed by SFR accounts located in high income areas than those in low income areas.

[18] Census Block Group is the smallest geographical unit for which the United States Census Bureau publishes income data. In Solano County, Census Block Groups are sized by the Census Bureau to generally represent areas consisting of between 50 to 200 people and 25 to 60 households.

5.2.2 *City of Vallejo*

The SFR participation in each rebate program by income area in Vallejo is summarized in Table 5-2 and on Figure 5-2. In Vallejo, approximately 20% of SFR accounts fall within high income areas, 39% within moderate income areas, and 41% within low income areas. For all four rebate programs, the highest percentage of SFR program participants were in moderate income areas: the HE Toilet Rebate Program (42%), the HE Washer Rebate Program (42%), the Turf Replacement Program (42%), and the Residential Water Use Survey Program (43%). With the exception of the Turf Replacement Rebate Program, program participation by SFR accounts in low income areas was roughly the same as that by SFR accounts in high income areas. The SFR accounts located in high income areas had the highest level of participation in the Turf Replacement Rebate Program, while SFR accounts in low income areas had the lowest level of participation in this program. ***Given the relatively low participation rates to date, conservation programs that target low income households represent considerable potential water savings in Vallejo.***

5.2.3 *City of Benicia*

The SFR participation in each rebate program by income area in Benicia is summarized in Table 5-3 and on Figure 5-3. In Benicia, approximately 61% of SFR accounts are located in high income areas, 32% within moderate income areas, and 8% within low income areas. For all four rebate programs, the highest percentage of SFR program participants were in high income areas: the HE Toilet Rebate Program (68%), the HE Washer Rebate Program (61%), the Turf Replacement Program (67%), and the Residential Water Use Survey Program (69%). The SFR accounts located in moderate income areas have participated in the HE Washer Rebate Program at a relatively higher rate than in the other three programs. The SFR accounts located in low income areas had the lowest levels of participation in all four conservation programs; however, given the relatively few number of SFR accounts located in low income areas in Benicia compared to the other cities discussed, conservation programs that would target low income accounts may present a less significant potential for water savings in Benicia.

5.2.4 *City of Fairfield*

The SFR participation in each rebate program by income are in Fairfield is summarized in Table 5-4 and on Figure 5-4. In Fairfield, approximately 43% of SFR accounts fall within high income areas, 23% within moderate income areas, and 34% within low income areas. For all programs except for the HE Toilet Rebate Program, the majority of participants were located in high income areas: the HE Washer Rebate Program (56%), the Turf Replacement Program (53%), and the Residential Water Use Survey Program (51%). The SFR accounts located in moderate income areas in Fairfield participated in all programs at a high rate and made up the biggest portion of participants in the HE Toilet Rebate Program (45%). Moderate income area households in Fairfield appear to have had higher rates of program participation than in

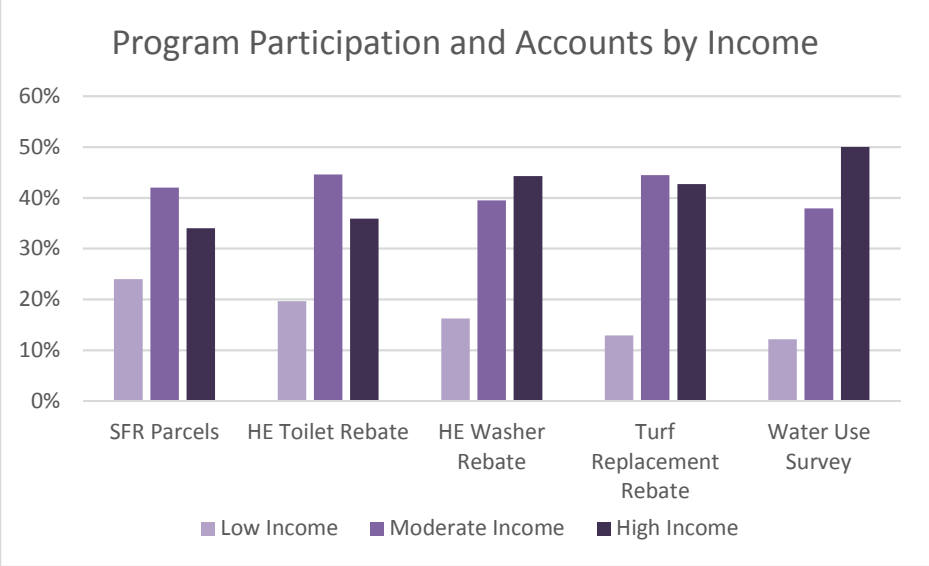
the other cities evaluated. Much like the other cities, accounts in low income areas in Fairfield had a low level of participation – with approximately one third of SFR accounts located in low income areas, but representing only between only 13% to 19% of participation in the individual conservation programs. ***As such, conservation programs that specifically target low income accounts in may present a significant opportunity for water savings in Fairfield.***

5.2.5 *City of Vacaville*

The SFR participation in each rebate program by income area in Vacaville are summarized in Table 5-5 and on Figure 5-5. In Vacaville, approximately 39% of SFR accounts fall within high income areas, 16% within moderate areas, and 45% within low income areas. For all programs except for the Turf Replacement Rebate Program, the majority of participants were located in moderate income areas: the HE Toilet Rebate Program (51%), the HE Washer Rebate Program (45%), and the Residential Water Use Survey Program (51%). The SFR accounts located in high income areas made up the greatest proportion of participants in the Turf Replacement Rebate Program (50%). Although just over half of the SFR accounts are located in high or moderate income areas in Vacaville, accounts in these areas represented between 85% and 94% of participation in each of the conservation programs. Although only 16% of SFR accounts in Vacaville are located in moderate income areas, participation by these accounts represented roughly half of the participants in each of the four conservation programs. On the other hand, approximately 45% of SFR accounts in Vacaville are located in low income areas, but SFR accounts in low income areas had the lowest level of participation in the HE Toilet Rebate (15%) and HE Washer Rebate (11%) programs. ***As such, conservation programs that specifically target low income accounts in may present a significant opportunity for water savings in Vacaville.***

Table 5-1
Program Participation by Median Household Income - Solano County
Solano County Water Agency, California

Median Household Income (a)		Percentage of SFR Accounts	Percentage of Participating Accounts (b)			
			HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate	Water Use Survey
Low Income	<$58,500	24%	20%	16%	13%	12%
Moderate Income	$58,501-$89,200	42%	45%	39%	44%	38%
High Income	>$89,200	34%	36%	44%	43%	50%



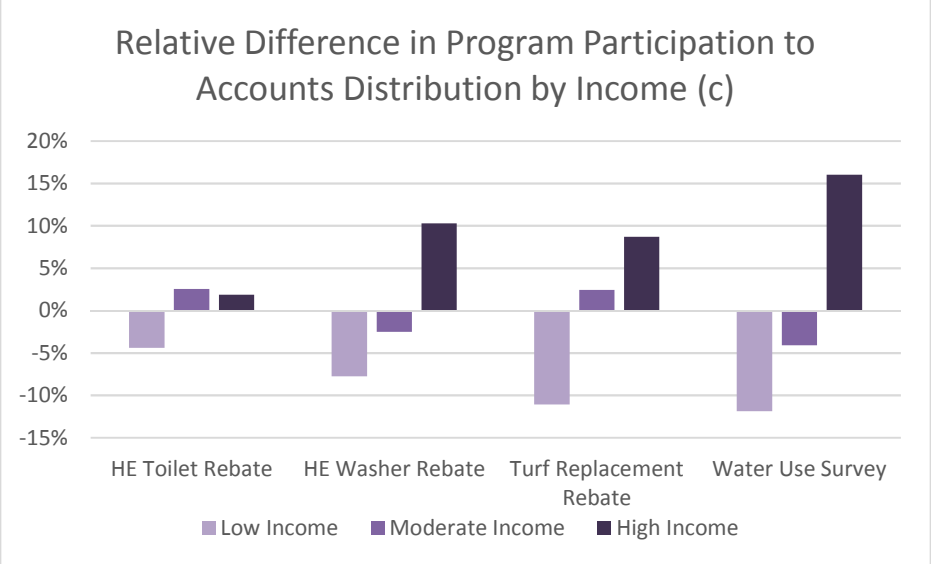


Table 5-1
Program Participation by Median Household Income - Solano County
Solano County Water Agency, California

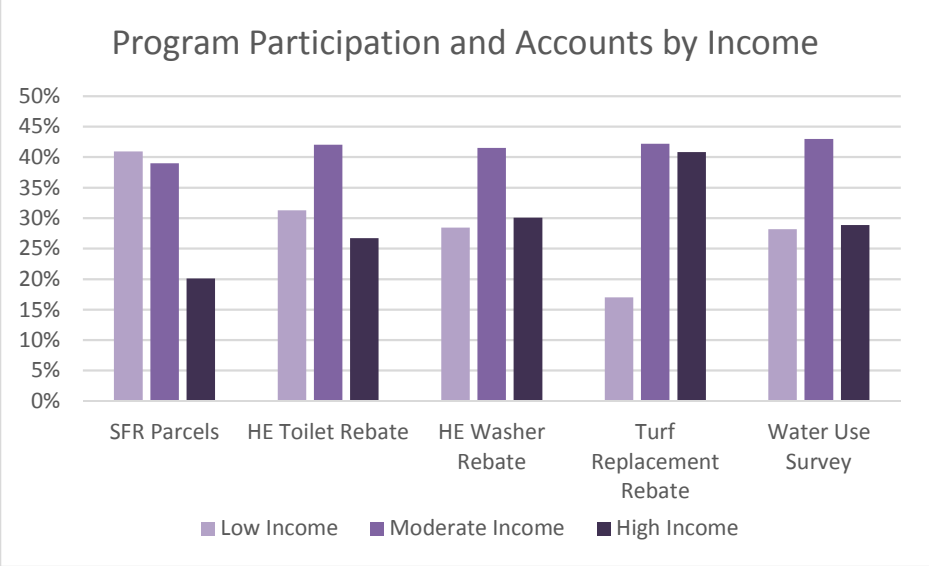
Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HUD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).
(b) Program participation rates are summarized from Tables 5-2 through 5-5.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR parcels by income group.

References:
Census, 2016. *2010-2014 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, accessed 8 September 2016.
Census, 2017. *Solano County Quick Facts,* http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
HCD, 2014. *Memorandum: State Income Limits for 2014,* California Department of Housing and Community Development, dated 28 February 2014.

Table 5-2
Program Participation by Median Household Income - Vallejo
Solano County Water Agency, California

Median Household Income (a)		Percentage of SFR Accounts	Percentage of Participating Accounts (b)			
			HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate	Water Use Survey
Low Income	<$58,500	41%	31%	28%	17%	28%
Moderate Income	$58,501-$89,200	39%	42%	42%	42%	43%
High Income	>$89,200	20%	27%	30%	41%	29%



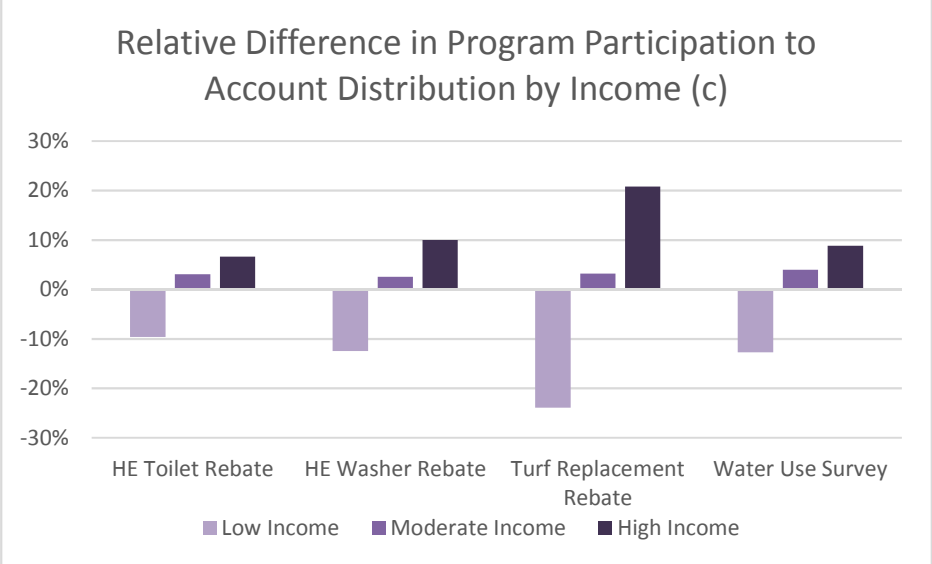


Table 5-2
Program Participation by Median Household Income - Vallejo
Solano County Water Agency, California

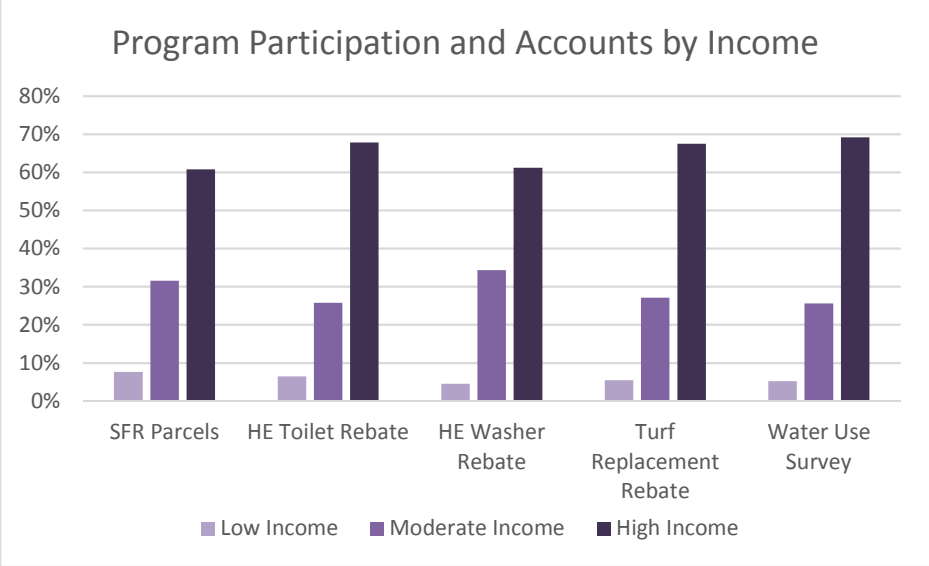
Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HUD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).
(b) Program participation rates are summarized from Tables 5-2 through 5-5.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR parcels by income group.

References:
Census, 2016. *2010-2014 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, accessed 8 September 2016.
Census, 2017. *Solano County Quick Facts,* http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
HCD, 2014. *Memorandum: State Income Limits for 2014,* California Department of Housing and Community Development, dated 28 February 2014.

Table 5-3
Program Participation by Median Household Income - Benicia
Solano County Water Agency, California

Median Household Income (a)		Percentage of SFR Accounts	Percentage of Participating Accounts (b)			
			HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate	Water Use Survey
Low Income	<$58,500	8%	6%	4%	5%	5%
Moderate Income	$58,501-$89,200	32%	26%	34%	27%	26%
High Income	>$89,200	61%	68%	61%	67%	69%



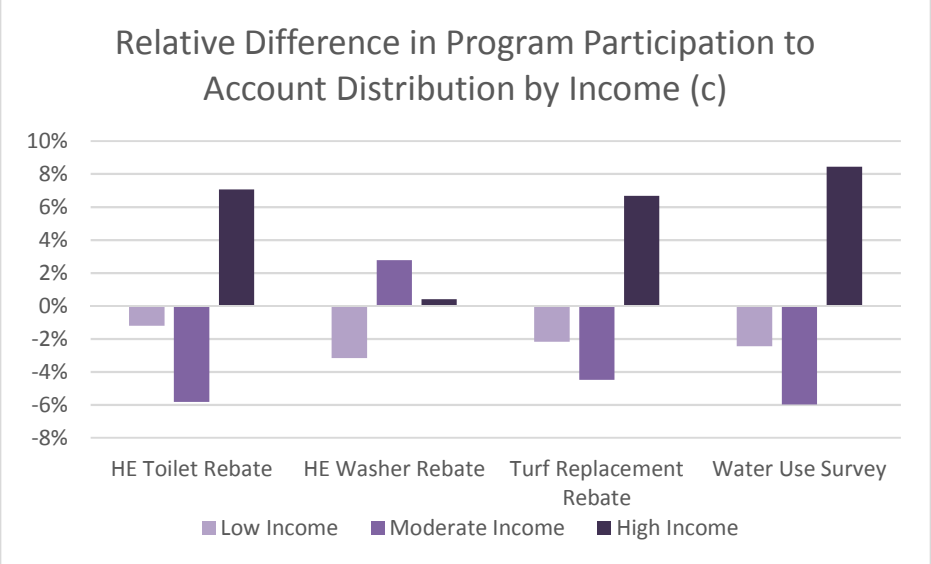


Table 5-3
Program Participation by Median Household Income - Benicia
Solano County Water Agency, California

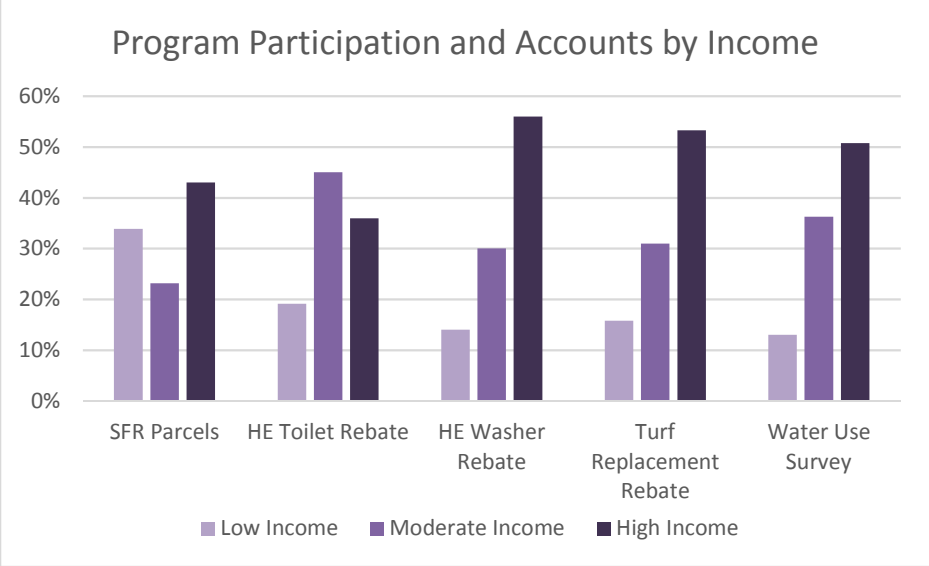
Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HUD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).
(b) Program participation rates are summarized from Tables 5-2 through 5-5.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR parcels by income group.

References:
Census, 2016. *2010-2014 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, accessed 8 September 2016.
Census, 2017. *Solano County Quick Facts,* http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
HCD, 2014. *Memorandum: State Income Limits for 2014,* California Department of Housing and Community Development, dated 28 February 2014.

Table 5-4
Program Participation by Median Household Income - Fairfield
Solano County Water Agency, California

Median Household Income (a)		Percentage of SFR Accounts	Percentage of Participating Accounts (b)			
			HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate	Water Use Survey
Low Income	<$58,500	34%	19%	14%	16%	13%
Moderate Income	$58,501-$89,200	23%	45%	30%	31%	36%
High Income	>$89,200	43%	36%	56%	53%	51%



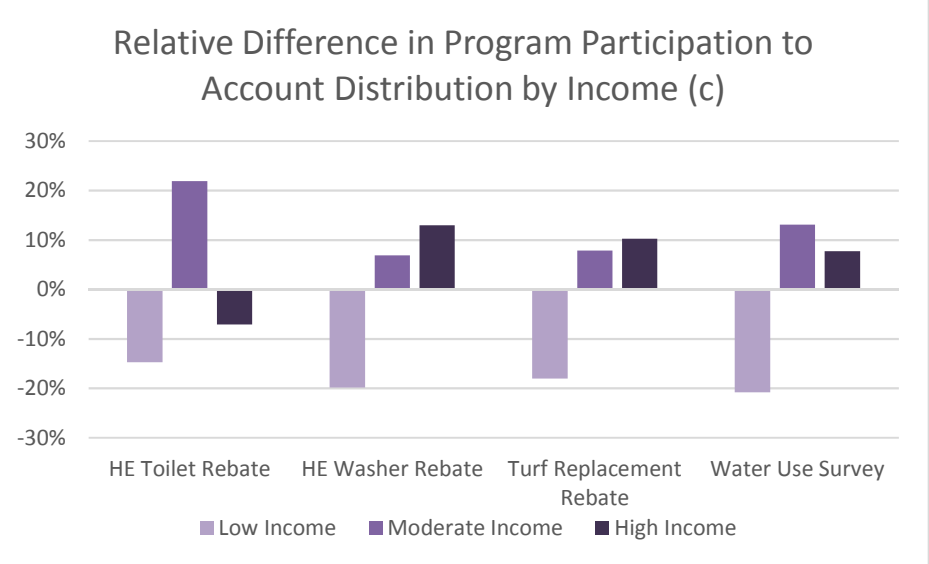


Table 5-4
Program Participation by Median Household Income - Fairfield
Solano County Water Agency, California

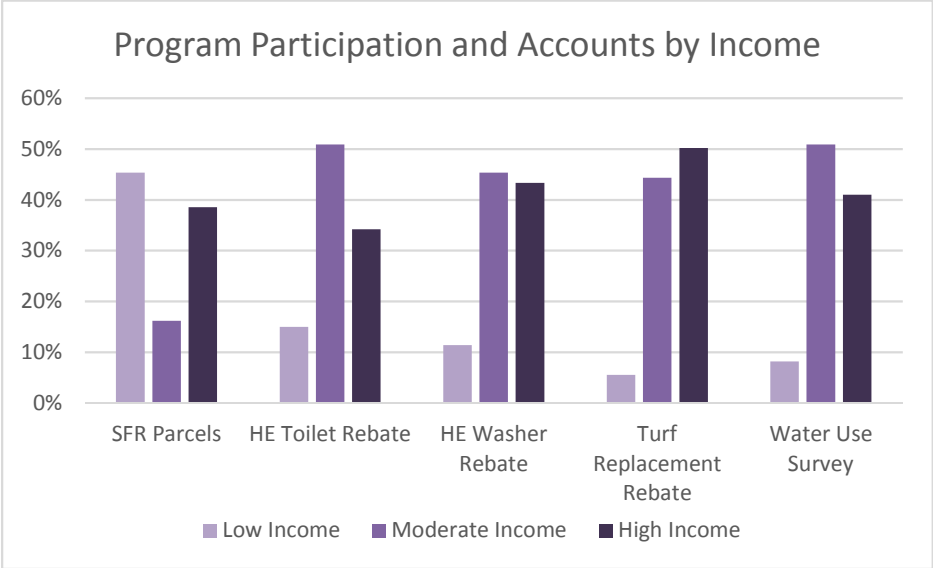
Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HUD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).
(b) Program participation rates are summarized from Tables 5-2 through 5-5.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR parcels by income group.

References:
Census, 2016. *2010-2014 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, accessed 8 September 2016.
Census, 2017. *Solano County Quick Facts,* http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
HCD, 2014. *Memorandum: State Income Limits for 2014,* California Department of Housing and Community Development, dated 28 February 2014.

Table 5-5
Program Participation by Median Household Income - Vacaville
Solano County Water Agency, California

Median Household Income (a)		Percentage of SFR Accounts	Percentage of Participating Accounts (b)			
			HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate	Water Use Survey
Low Income	<$58,500	45%	15%	11%	6%	8%
Moderate Income	$58,501-$89,200	16%	51%	45%	44%	51%
High Income	>$89,200	39%	34%	43%	50%	41%



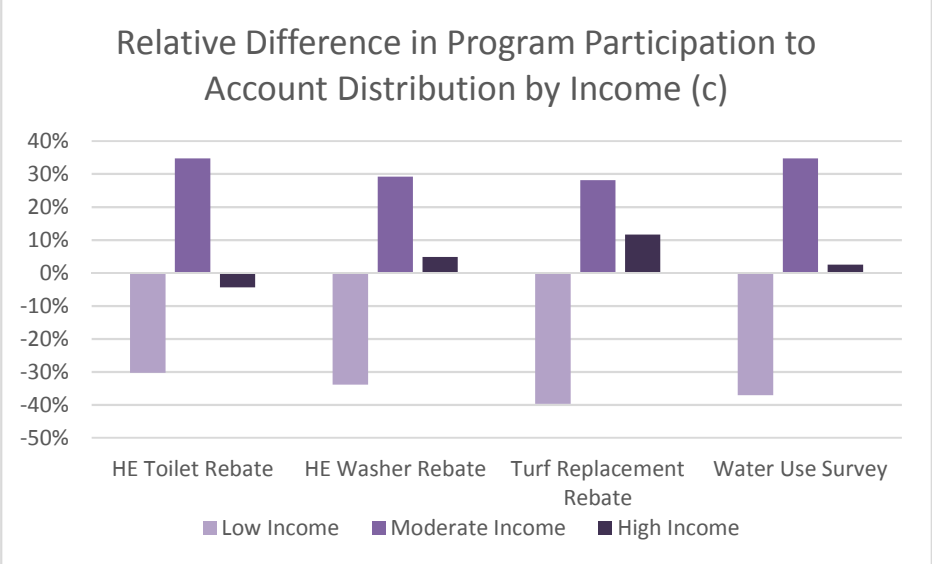
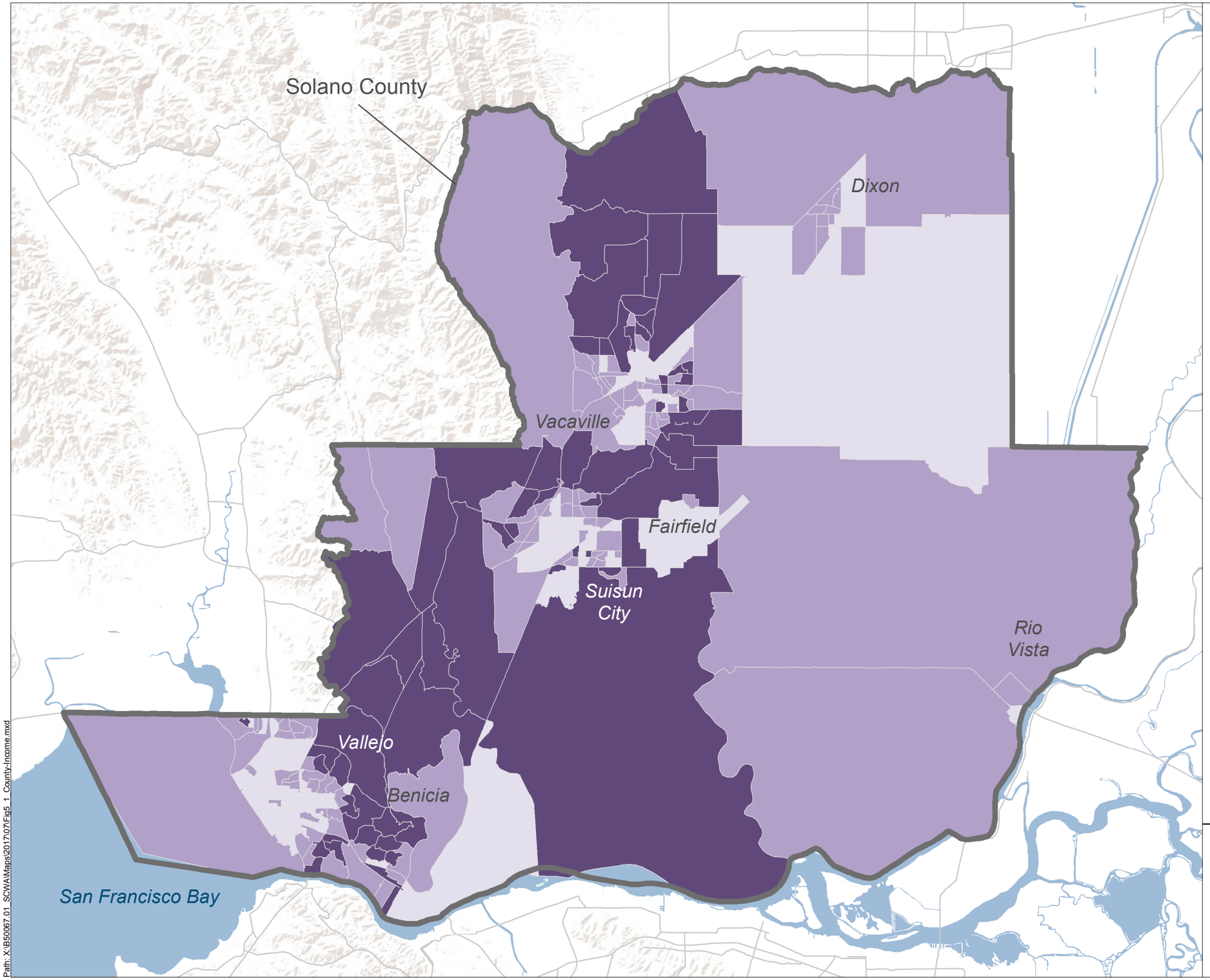


Table 5-5
Program Participation by Median Household Income - Vacaville
Solano County Water Agency, California

Abbreviations:
HE = high efficiency
SFR = single-family residential

Notes:
(a) Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HUD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).
(b) Program participation rates are summarized from Tables 5-2 through 5-5.
(c) Relative difference is calculated as the percentage of program participation by income group minus the overall percentage of SFR parcels by income group.

References:
Census, 2016. *2010-2014 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, accessed 8 September 2016.
Census, 2017. *Solano County Quick Facts,* http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
HCD, 2014. *Memorandum: State Income Limits for 2014,* California Department of Housing and Community Development, dated 28 February 2014.



0 4 8

(Approximate Scale in Miles)

N

Legend

Median Household Income Level by Census Block Group

- Low Income (<$58,500)
- Moderate Income ($58,501-$89,200)
- High Income (>$89,200)

Notes

1. All locations are approximate.
2. Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD 2014). Low income includes HCD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).

Sources

1. Census, 2016. 2010-2014 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, accessed 8 September 2016.
2. Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
3. HCD, 2014. Memorandum: State Income Limits for 2014, California Department of Housing and Community Development, dated 28 February 2014.
4. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Household Income in Solano County

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

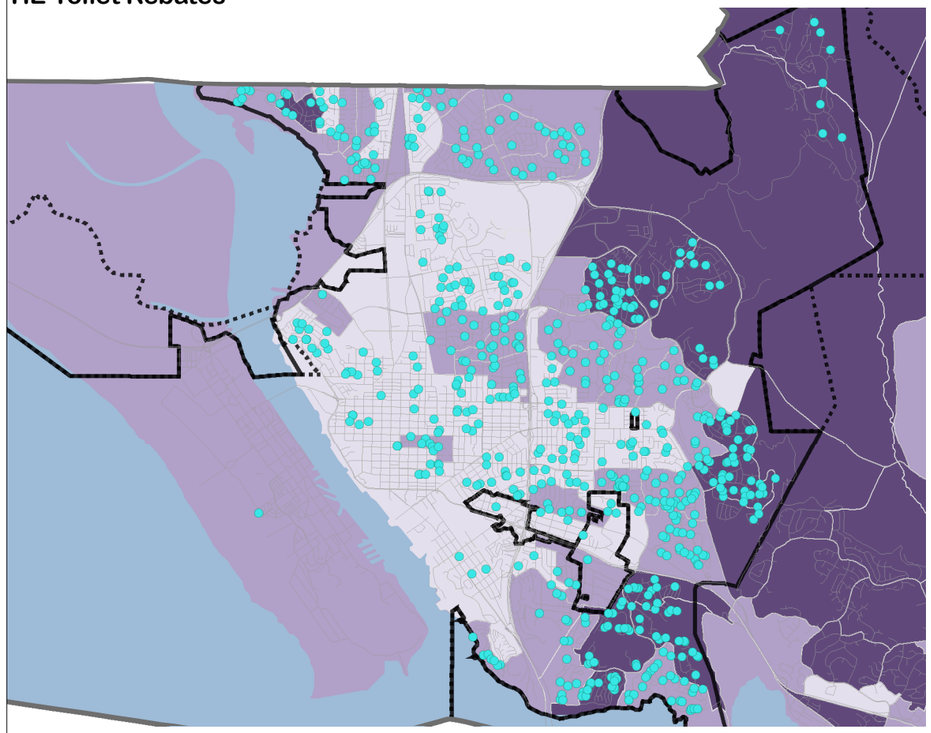
EKI B50067.01

Figure 5-1

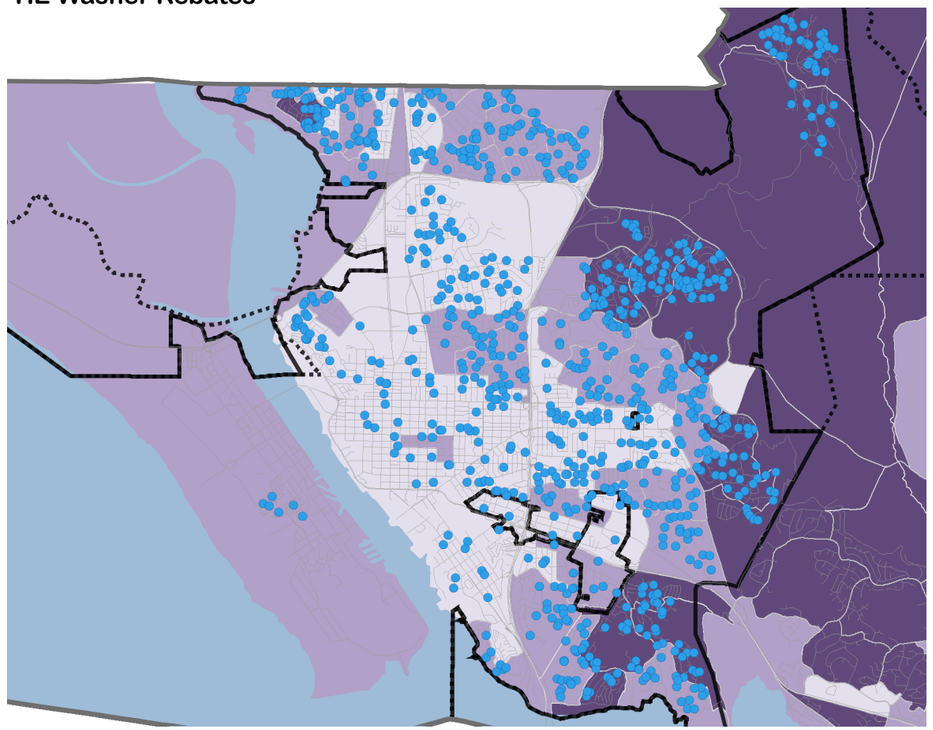
eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig5_1_County-Income.mxd

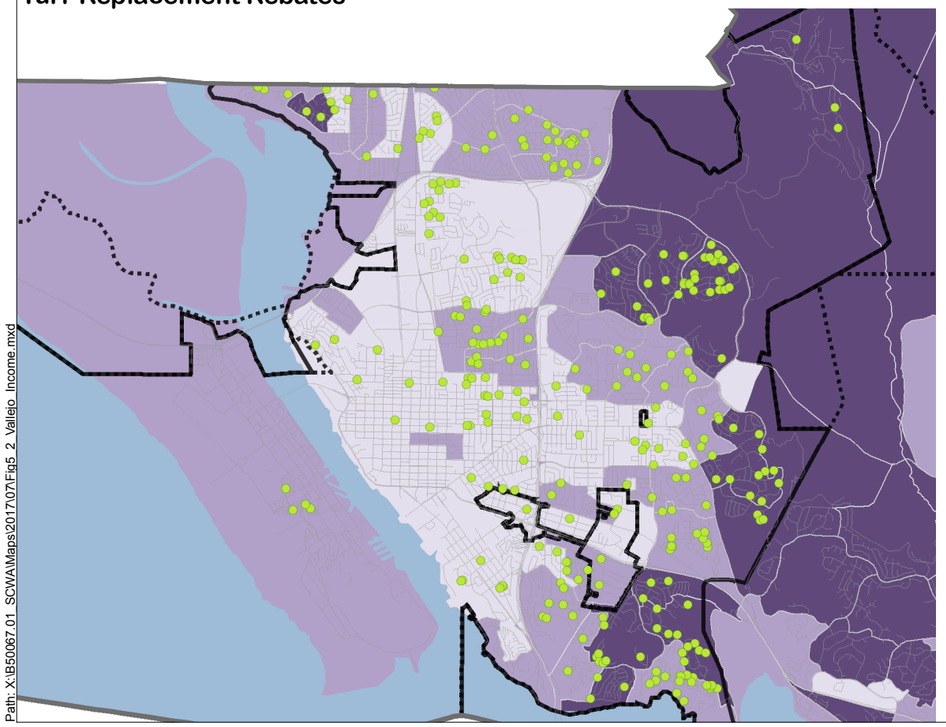
HE Toilet Rebates



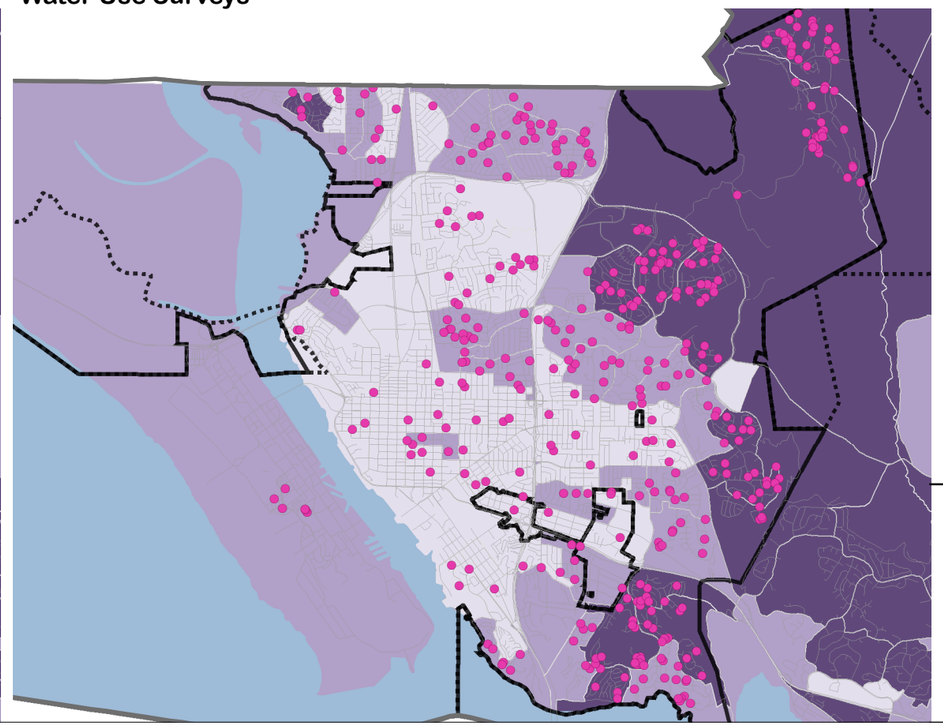
HE Washer Rebates



Turf Replacement Rebates



Water Use Surveys



0 1.5 3

(Approximate Scale in Miles)

N

Legend

- Municipal Boundary
- Sphere of Influence Boundary

Median Household Income Level by Census Block Group

- Low Income (<$58,500)
- Moderate Income ($58,501-$89,200)
- High Income (>$89,200)
- HE Washer Rebate Issued
- HE Toilet Rebate Issued
- Turf Replacement Project
- Water Use Survey Performed

Abbreviations

HE - high efficiency

Notes

1. All locations are approximate.
2. Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HCD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).

Sources

1. Census, 2016. 2010-2014 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, accessed 8 September 2016.
2. Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
3. HCD, 2014. Memorandum: State Income Limits for 2014, California Department of Housing and Community Development, dated 28 February 2014.
4. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig5_2_Vallejo_Income.mxd

Program Participation and Household Income
City of Vallejo

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

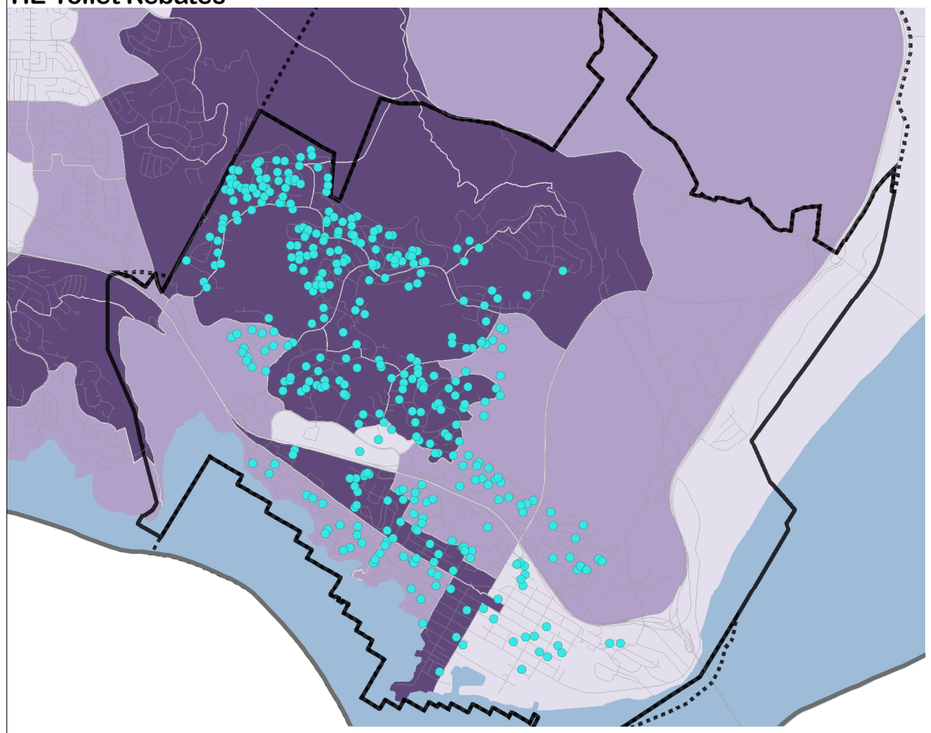
July 2017

EKI B50067.01

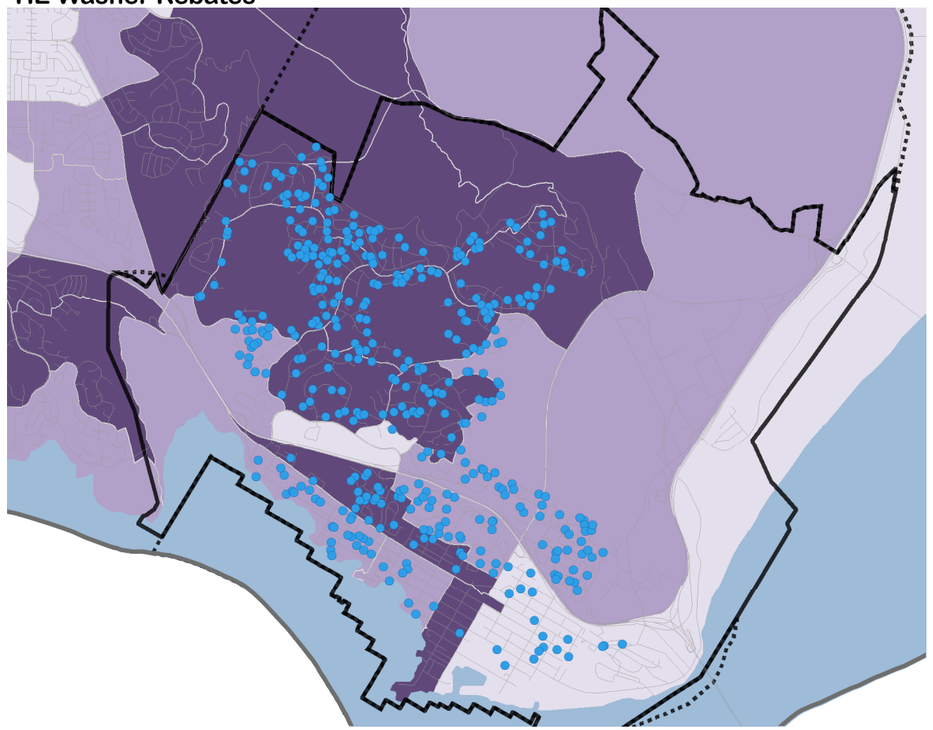
Figure 5-2

eki environment & water

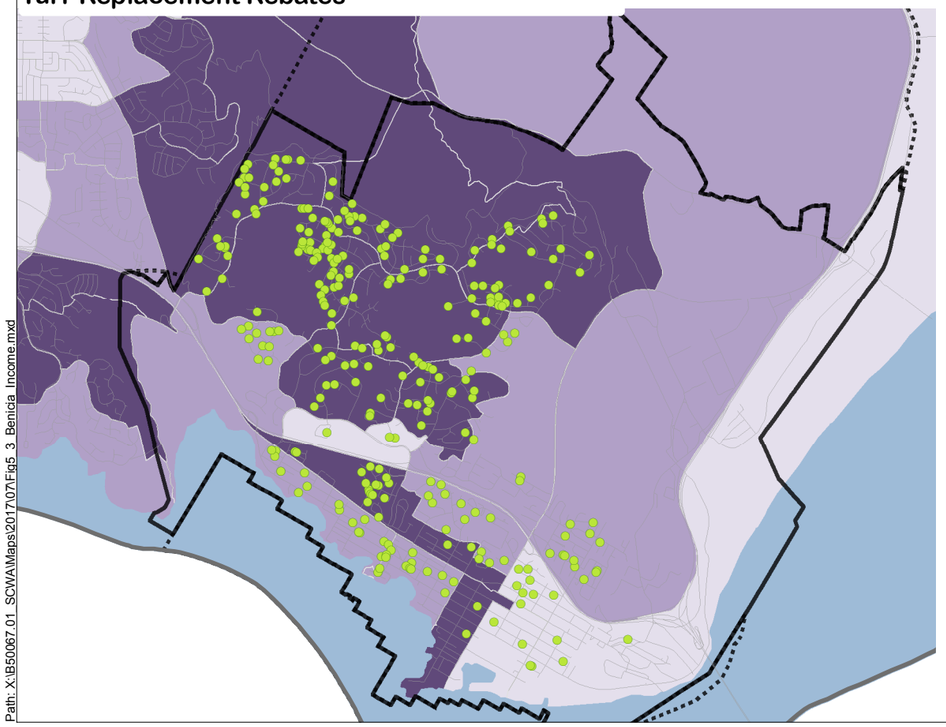
HE Toilet Rebates



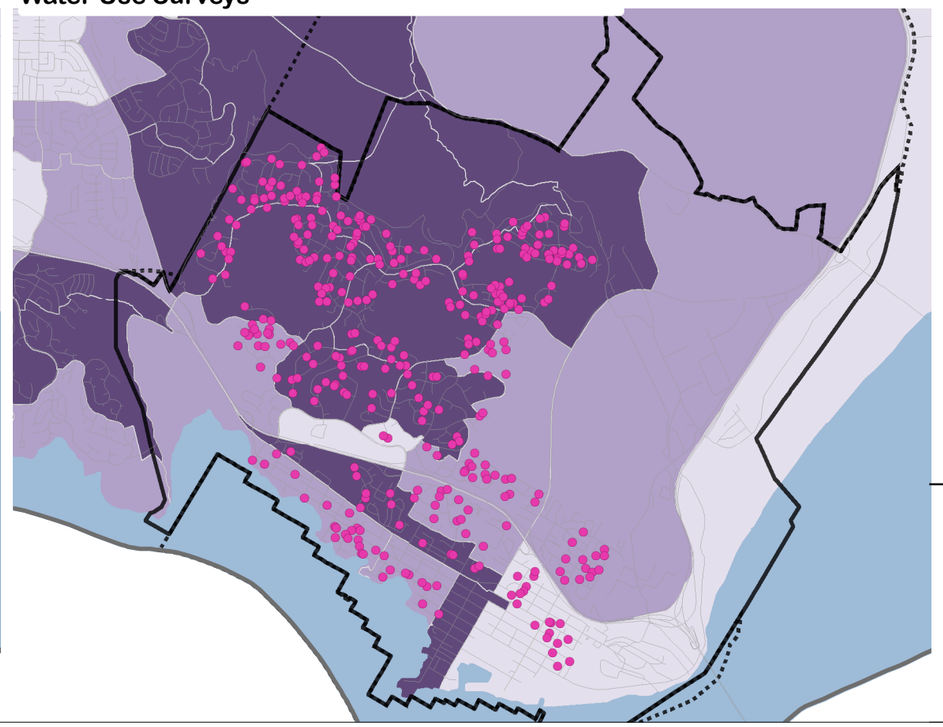
HE Washer Rebates



Turf Replacement Rebates



Water Use Surveys



0 1 2

Approximate Scale in Miles

N

Legend

- Municipal Boundary
- Sphere of Influence Boundary

Median Household Income Level by Census Block Group

- Low Income (<$58,500)
- Moderate Income ($58,501-$89,200)
- High Income (>$89,200)
- HE Washer Rebate Issued
- HE Toilet Rebate Issued
- Turf Replacement Project
- Water Use Survey Performed

Abbreviations

HE - high efficiency

Notes

1. All locations are approximate.
2. Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HCD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).

Sources

1. Census, 2016. 2010-2014 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, accessed 8 September 2016.
2. Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
3. HCD, 2014. Memorandum: State Income Limits for 2014, California Department of Housing and Community Development, dated 28 February 2014.
4. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig5_3_Benicia_Income.mxd

Program Participation and Household Income
City of Benicia

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

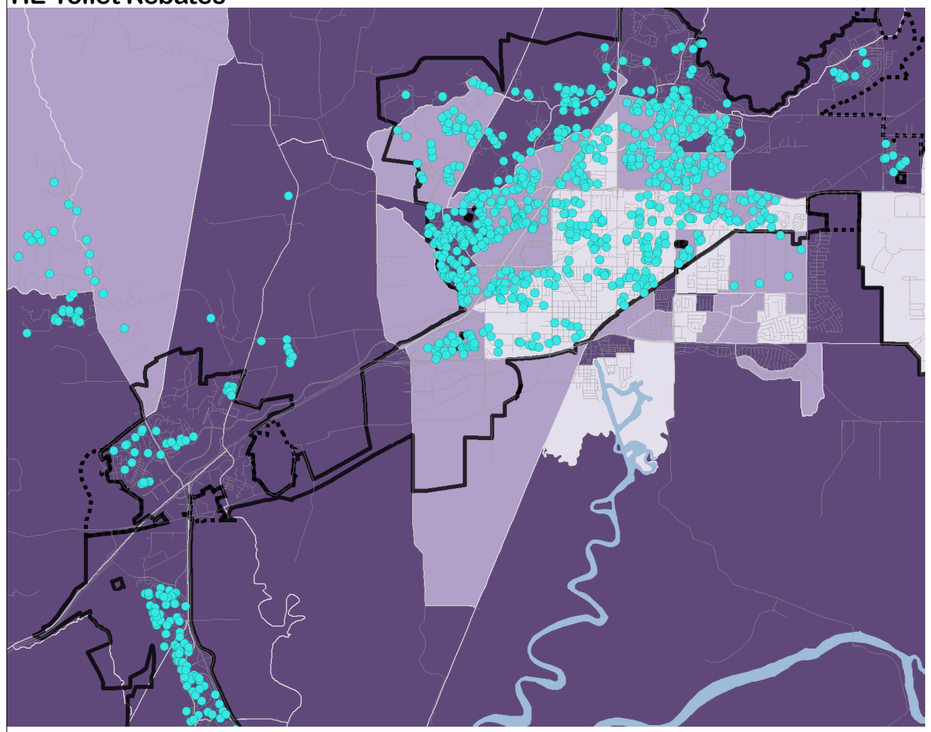
July 2017

EKI B50067.01

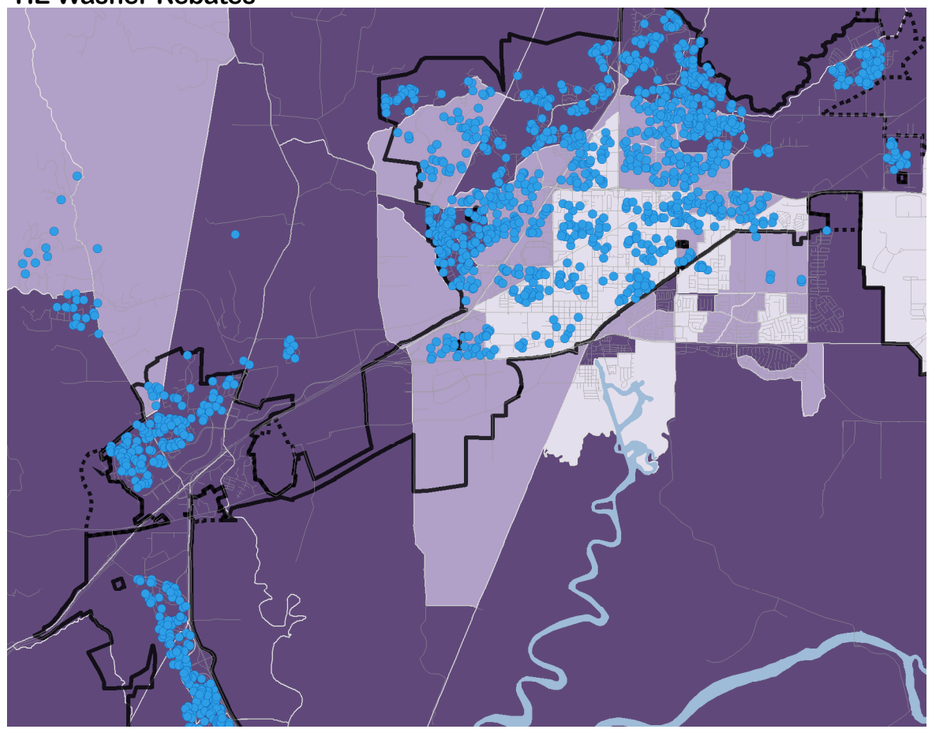
Figure 5-3

eki environment & water

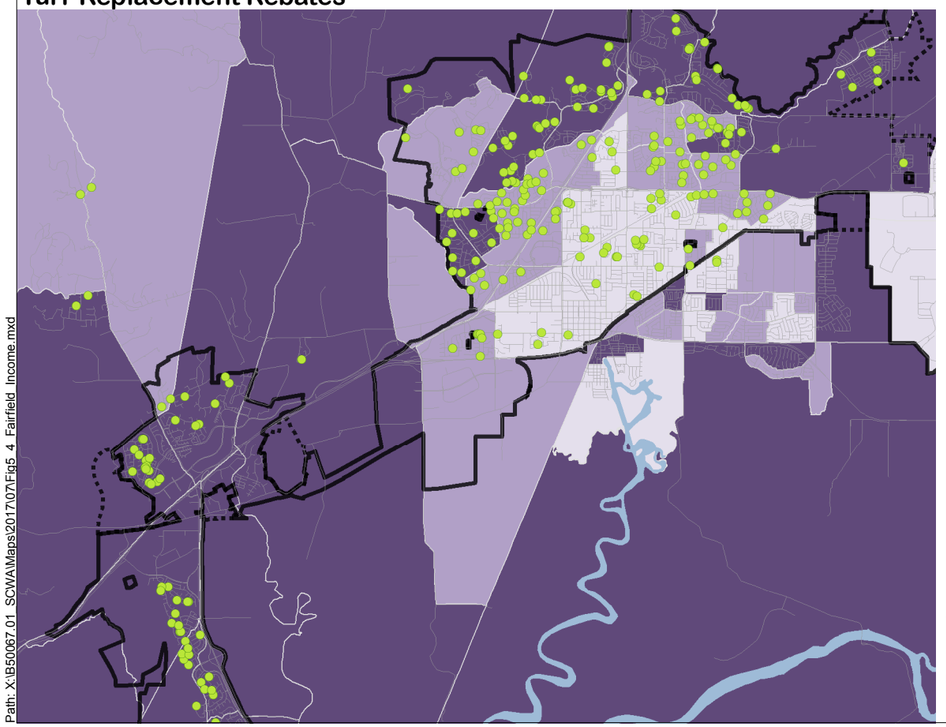
HE Toilet Rebates



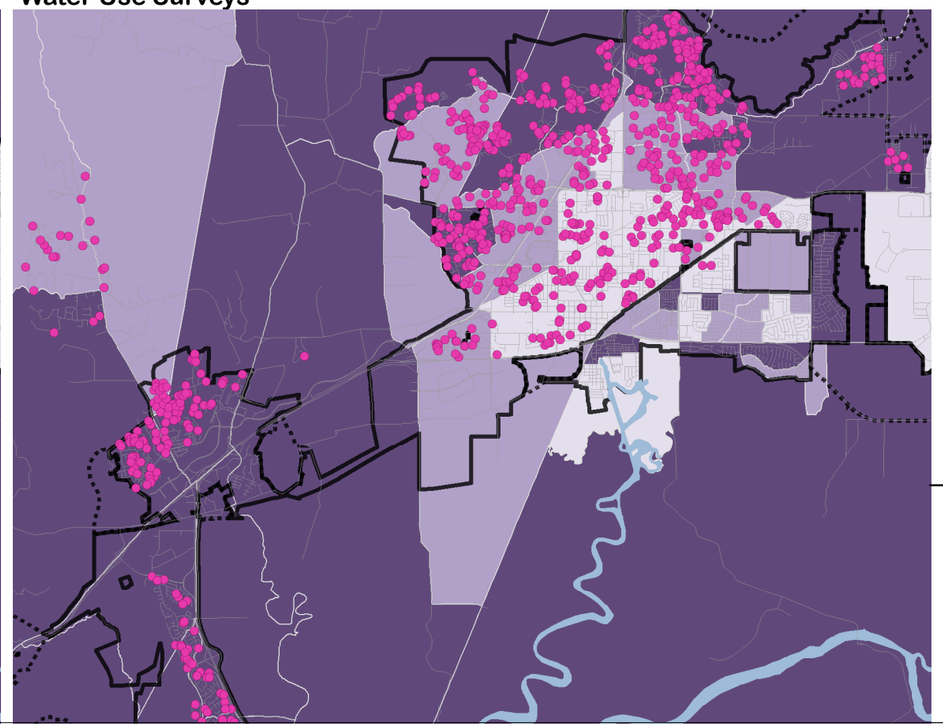
HE Washer Rebates



Turf Replacement Rebates



Water Use Surveys



0 2 4

(Approximate Scale in Miles)

N

Legend

- Municipal Boundary
- Sphere of Influence Boundary

Median Household Income Level by Census Block Group

- Low Income (<$58,500)
- Moderate Income ($58,501-$89,200)
- High Income (>$89,200)
- HE Washer Rebate Issued
- HE Toilet Rebate Issued
- Turf Replacement Project
- Water Use Survey Performed

Abbreviations

HE - high efficiency

Notes

1. All locations are approximate.
2. Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HCD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).

Sources

1. Census, 2016. 2010-2014 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, accessed 8 September 2016.
2. Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
3. HCD, 2014. Memorandum: State Income Limits for 2014, California Department of Housing and Community Development, dated 28 February 2014.
4. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Program Participation and Household Income
City of Fairfield

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

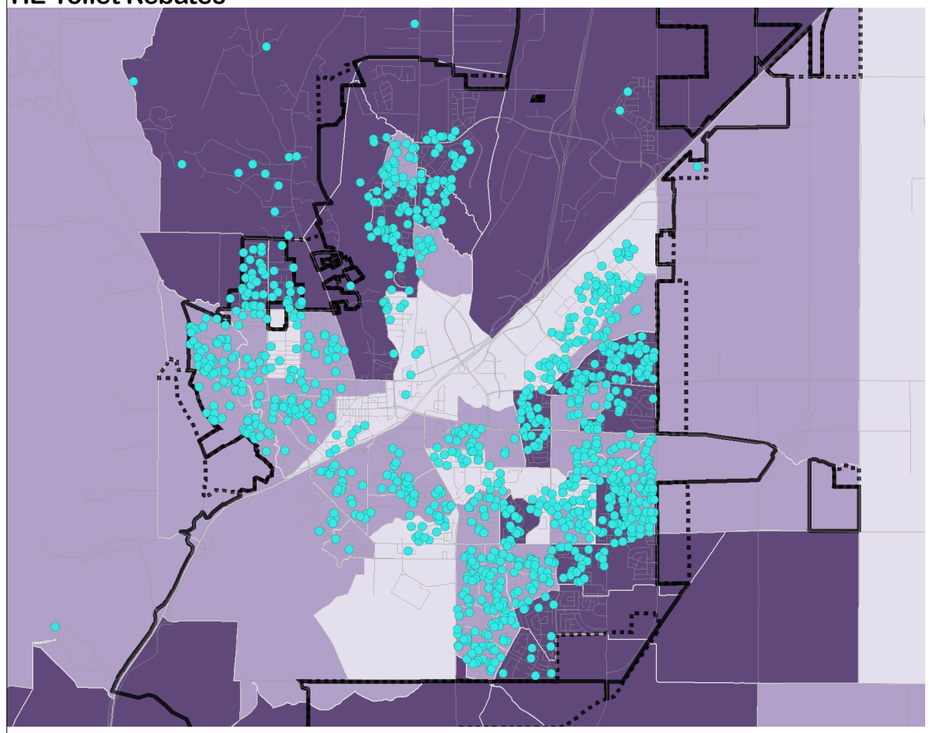
EKI B50067.01

Figure 5-4

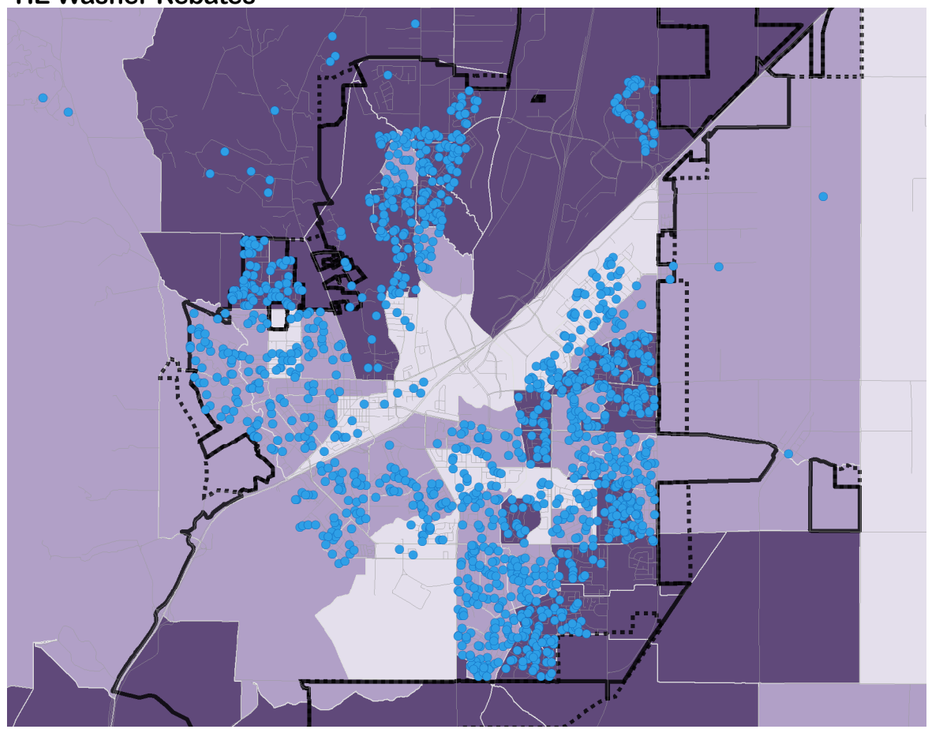
eki environment & water

Path: X:\B50067.01 SCWA\Maps\2017\07\Fig5_4_Fairfield_Income.mxd

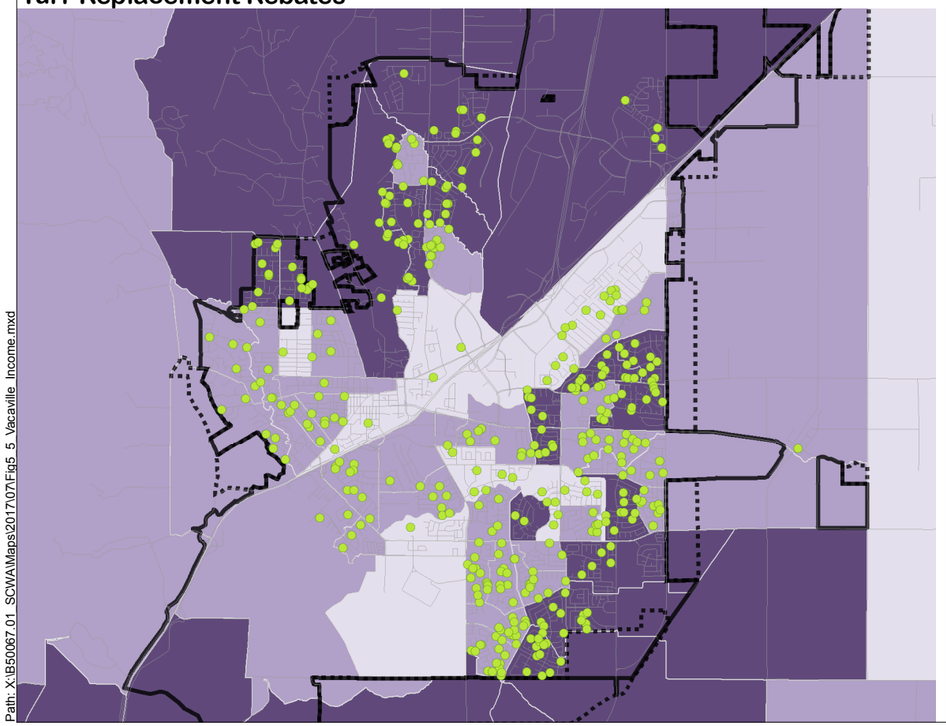
HE Toilet Rebates



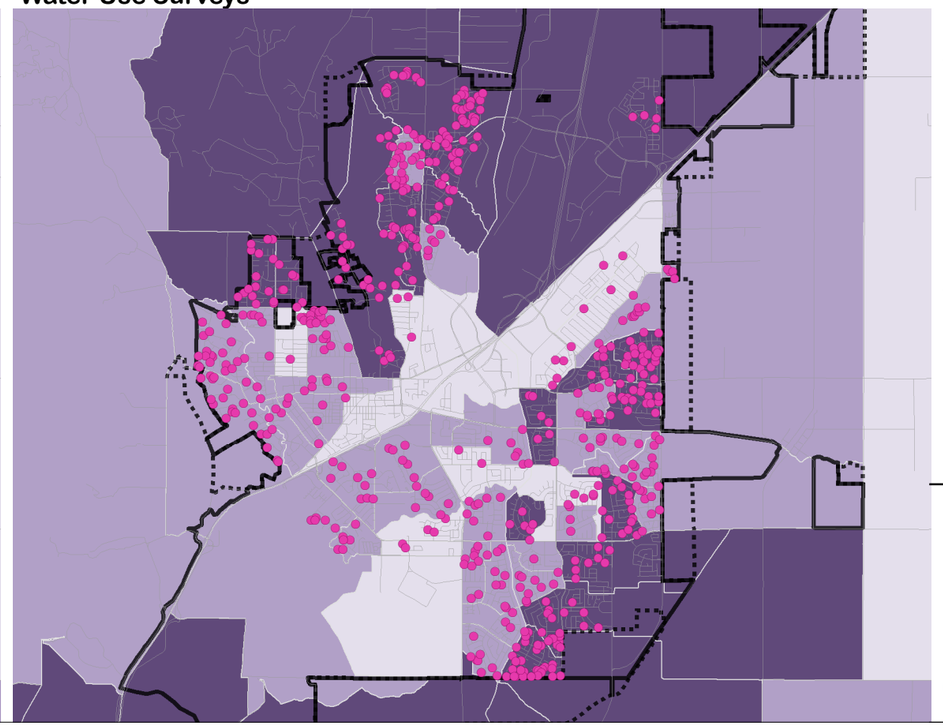
HE Washer Rebates



Turf Replacement Rebates



Water Use Surveys



0 1.5 3

(Approximate Scale in Miles)

N

Legend

- Municipal Boundary
- Sphere of Influence Boundary

Median Household Income Level by Census Block Group

- Low Income (<$58,500)
- Moderate Income ($58,501-$89,200)
- High Income (>$89,200)
- HE Washer Rebate Issued
- HE Toilet Rebate Issued
- Turf Replacement Project
- Water Use Survey Performed

Abbreviations

HE - high efficiency

Notes

1. All locations are approximate.
2. Household income is based on estimated 2014 median household income by Census Block Group, per Census (2016). Income level groupings are based on California Department of Housing and Community Development ("HCD") income levels for Solano County for a 3-person household in 2014 (HCD, 2014). Low income includes HCD extremely low income, and very low income classifications. The average persons per household for Solano County is 2.89 (Census, 2017).

Sources

1. Census, 2016. 2010-2014 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, accessed 8 September 2016.
2. Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.
3. HCD, 2014. Memorandum: State Income Limits for 2014, California Department of Housing and Community Development, dated 28 February 2014.
4. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

Program Participation and Household Income
City of Vacaville

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017

EKI B50067.01

Figure 5-5

eki environment & water

Path: X:\B50067.01_SCWA\Maps\2017\07\Fig5_5_Vacaville_Income.mxd

6.0 ESTIMATED PROGRAM WATER SAVINGS AND COST-EFFECTIVENESS

As discussed in Section 3.0 above and shown on Figures 3-1 through 3-4, water demand by SFR customers has declined across Solano County during the last several years by as much as 40%. While the water conservation programs provided by SCWA 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 assess the benefits of SCWA's water conservation programs, the amount of water savings directly resulting from participation by SFR accounts in each of SCWA's four major conservation programs was estimated and is discussed in the following sections. This analysis was performed for each of the four member units that were able to provide account-level water use for this study: the Cities of Vallejo, Benicia, Fairfield, and Vacaville.

6.1 Methodology Used to Estimate Program-Specific Water Savings

Water use savings were estimated for each SCWA SFR water conservation program, with the exception of the Smart Irrigation Controller Rebate Program, for which participation has been minimal. In order to estimate the water savings associated with participation in each conservation program, water use by program participants was compared to water use by a representative cohort.

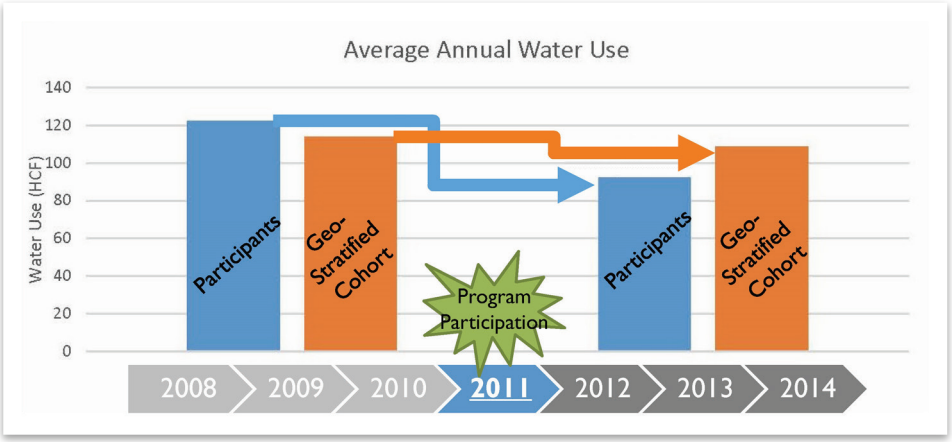
Participant Groups: The SFR accounts included in the participant groups for the HE Toilet Rebate Program, HE Washer Rebate Program, and Residential Water Use Survey Program were limited to those that had participated in only one conservation program, based on available records. That is, an account was only included in the HE Toilet Rebate Program analysis if that account had not participated in any of the other three programs. Participants included for analysis in the Turf Replacement Rebate program were not limited in this way, because the Pilot Study results showed that the amount of water saved by this program was substantially higher than that saved by the other programs, and therefore savings associated with the other programs would not be expected to significantly influence the results.

Comparison Cohort Groups: Given that factors such as age and size of house, size of house, and household income can influence water use, and that these same factors are generally consistent within given neighborhoods, the comparison cohorts were selected and stratified based on Census Block Groups[19] (Census, 2016). For every one participating account in a given Census Block Group, five non-participating accounts were selected within that same Census Block Group. For example, if six HE Toilet Rebate Program participant accounts were located in Census Block Group 060952532043, then 30 SFR accounts that did not receive HE Toilet

[19] Census Block Group is the smallest geographical unit for which the United States Census Bureau publishes income data. In Solano County, Census Block Groups are sized by the Census Bureau to generally represent areas consisting of between 50 to 200 people and 25 to 60 households.

Rebates were randomly selected from Census Block Group 060952532043 and included in the representative cohort. The SFR accounts were included in the cohort only if they were active during each year used for analysis and had not participated in any conservation programs, based on the available records. Accounts were considered active if they had used more than 50 gpd on average over the course of the year.[20]

The water savings attributed to participation in each program was estimated by comparing water use by the participant group and the representative cohort for the three years prior to the year of participation and up to three years following the year of participation[21]. The estimated annual water savings associated with the conservation program was then calculated as the incremental amount of water saved by the program participants over that of the representative cohort accounts. For the three rebate programs, the cost-effectiveness of each program was then estimated as the rebate cost per gallon of water saved over a ten-year period.



The analysis described above was conducted for the HE Toilet Rebate, HE Washer Rebate, and Residential Water Use Survey Programs for the years 2011 and 2013. The year 2011 was selected for analysis because it represents a period after the most significant effects of the economic downturn were felt and prior to the start of the recent drought. The year 2013 was selected for analysis because it is the most recent participation year where two full years of water use data were available post-participation. Because participation in the Turf Replacement Rebate Program was minimal prior to 2013, the analysis for this program was only performed for 2013. Additionally, because account-level water use data for the City of Vacaville were only available for 2012 through 2015, the methodology for the City of Vacaville was modified such that one year of data prior to program participation in 2013 was compared to water use to that of two years following participation. The results of the individual

[20] An average water use of 54 to 64 gallons per capita per day is generally considered to be the minimum indoor residential water use for a fully occupied residence (WDOH, 2009). Therefore, average annual combined indoor and outdoor water use of less than 50 gpd for a SFR account likely indicates that the residence was not fully occupied for an entire year.

[21] When analyzing program participation in 2013, the period of water use data following program participation was less than three years and varied, depending on availability of data.

conservation program savings analyses are presented in Tables 6-1 through 6-25 and described in detail in the following sections. Summaries of program savings by city are presented in Tables 6-26 through 6-29.

Additionally, the total rebate costs for each of the three rebate programs were divided by the water savings over a 10-year period to calculate the rebate cost per 100 gallons of water saved. Estimated rebate costs for each program by city are also shown in Tables 6-1 through 6-29.

The results of this analysis are presented in the following sections as an average program savings per city, and as an average savings value representative of the SCWA service area as a whole. The average savings for the SCWA service area were calculated as a weighted average, based on the relative proportion of SFR parcels located within each city.

6.2 HE Toilet Rebate Program Savings and Costs

The estimated water savings achieved by participation in the HE Toilet Rebate Program by SFR customers in 2011 and 2013 in Vallejo, Benicia, Fairfield, and Vacaville are presented in Tables 6-1 through 6-7. Water savings per account for the cities of Benicia, Fairfield, and Vacaville were all generally consistent, ranging from about 5,100 to 6,100 gallons per year, while the savings measured in Vallejo was more than twice that at nearly 13,000 gallons/year in Vallejo. The amount of water savings measured in Benicia, Fairfield, and Vacaville, is generally consistent with the amount of savings expected when an older toilet is replaced by a new HE toilet[22]. The SFR housing stock in Vallejo is substantially older than those in the other cities, with approximately half of all SFR homes in Vallejo having been built prior to 1970, more than double the proportion of homes built before 1970 in the other three cities. Prior studies have demonstrated that actual operational water use by a toilet may be substantially higher than the expected efficiency (e.g., 3.5 gpf) depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011). Therefore, the older the home in which a toilet change out occurs, the higher the expected water savings.

HE Toilet Rebate Program Water Savings		
City	**Average Water Savings per Account (gallons/year)**	**Average Rebate Cost ($/100 gallons)**
Vallejo	12,877	0.09
Benicia	5,255	0.31
Fairfield	6,100	0.19
Vacaville	5,101	0.22
Weighted SCWA Average	**8,011**	**0.18**

[22] Expected annual water savings per HE toilet change out would be between approximately 4,500 and 5,500 gallon depending household size for the four cities analyzed. The following is an example calculation for Vallejo (BAWSCA, 2013): (3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.85 persons/house / 2.3 toilets/house x 365 days = 5,020 gal. This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

The weighted average annual water savings for the SCWA service area based on these four cities is approximately 8,000 gallons per participating account. The corresponding weighted average rebate cost of water saved is approximately $0.18 per 100 gallons of water saved under the HE Toilet Rebate program.

City	Percentage SFR Houses Built Before 1970	Percentage SFR Houses Built in 1970 or Later
Vallejo	50%	50%
Benicia	21%	79%
Fairfield	27%	73%
Vacaville	18%	82%

When evaluating the success of HE toilet-focused conservation programs, additional factors beyond rebate cost per water savings should be considered. Due to plumbing code and efficiency standard changes, all toilets on the market are currently considered high efficiency, with a rating of 1.28 gpf or lower. The greatest benefit from an HE Toilet Rebate program is seen when it encourages and accelerates the replacement of an older inefficient toilet, rather than when it is utilized to replace a broken fixture (i.e., "free-ridership"). If an HE toilet-based program can be strategically designed and implemented to accelerate the changeout of inefficient toilets and steer the market towards the new ultra-high efficiency toilets (e.g., 1.0 gpf or 0.8 gpf toilets that have recently entered the market), it will continue to be effective in light of plumbing code and efficiency standard changes. Such program refinements could include targeting lower income and/or senior households with outreach and education materials, providing the services of a plumber to install the toilet, and/or providing such households with ultra high-efficiency toilets.

6.3 HE Washer Rebate Program Savings and Costs

The estimated water savings achieved from the HE Washer Rebate Program by SFR customers in 2011 and 2013 in Vallejo, Benicia, Fairfield, and Vacaville are presented in Tables 6-8 through 6-14. Estimated annual water savings per account and rebate costs were averaged between 2011 and 2013 for each city and are shown in the table at the right.

HE Washer Rebate Program Water Savings		
City	Average Water Savings per Account (gallons/year)	Average Rebate Cost ($/100 gallons)
Vallejo	10,221	0.09
Benicia	2,633	0.36
Fairfield	1,081	1.75
Vacaville	2,932	0.26
Weighted SCWA Average	**4,809**	**0.65**

Water savings per account for the cities of Benicia and Vacaville were generally consistent, at about 2,600 to 2,900 gallons per year per account. The measured savings for accounts in Fairfield was about half that at 1,100 gallons per year and the savings measured or Vallejo accounts was substantially higher at over 10,000 gallons per year. In general, the amount of water saved by replacing an older clothes washer with a new more efficient machine would be expected to be about 5,000 gallons per year, and is approximately equal to that of the weighted savings for the SCWA service area of about 4,800 gallons. Some of the variability in observed savings between the cities can be explained by the age of the house of

participants. As shown in the table to the right, the median house age for participants in Vallejo was nearly a decade older than those of participants in Fairfield and Vacaville. Older homes, in general, would be expected to have older appliances, even with a natural rate of appliance change out due to washing machine breakage and upgrade, which would result in higher water savings.

City	Persons per Household (Census, 2017)	Median House Age of Participants (HE Washer Rebate)
Vallejo	2.85	1980
Benicia	2.55	1979
Fairfield	3.1	1988
Vacaville	2.7	1989

The weighted average annual water savings for the SCWA service area per one HE Washer rebate estimated by this study is approximately 4,800 gallons per account and is generally consistent with what one would expect based on a replacing a high-water-use washer with a HE Washer[23]. The corresponding weighted average rebate cost of water saved is approximately $0.65 per 100 gallons of water saved under the HE Washer Rebate program.

Similar to the HE toilet-focused programs discussed above, when evaluating the overall success of HE Washer Rebate Programs additional factors beyond rebate cost per water savings should be considered. Due to plumbing code and efficiency standard changes, all new clothes washers currently on the market are significantly more efficient than those available in the past. Efficiency standards for clothes washers range more broadly than for toilets, and the highest efficient clothes washers available on the market tend to actually be the most expensive to purchase. The way the HE Washer Rebate Program was structured through the partnership with PG&E, only the most efficient washers were eligible for rebates, and the bar was continuously being raised. At the same time, the individual rebate amounts are declining. The greatest benefit from an HE washer rebate program is seen when it encourages and speeds up replacement of an older inefficient washer, rather than when it is utilized to replace a broken appliance (i.e., “free-ridership”). If an HE washer program can be strategically designed and implemented to accelerate the change out of clothes washers and steer the market towards more efficient washers, it will be effective in light of plumbing code and efficiency standard changes. Such program refinements could include targeting lower income and/or senior households with outreach and education materials, and potentially offering larger rebate amounts for the most efficient washers and lower rebate amounts for moderately more efficient washers.

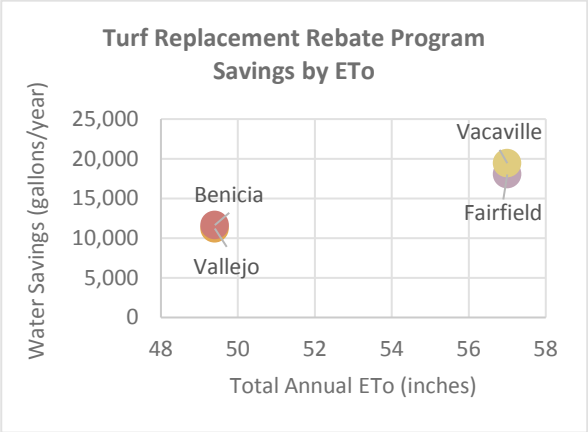
[23] Expected annual water savings per HE washer change out would be between approximately 9,000 and 11,000 gallons depending on persons per household. The following is an example calculation for Vallejo (BAWSCA, 2013): (39 gal/load - 13 gal/load) x 2.85 people/house x 0.37 loads/person/day x 365 days = 10,007 gal. This calculation assumes that a washer rated at 39 gal/load actually operates at 39 gal/load. Persons per household for Vallejo, Benicia, Fairfield and Vacaville are 2.85, 2.55, 3.1, and 2.76, respectively (Census, 2017). However, the operational water use may be substantially higher depending on the condition of the washer and how well it has been maintained (Aquacraft, 2011).

6.4 Turf Replacement Rebate Program Savings and Costs

The estimated water savings achieved from the Turf Replacement Rebate Program by SFR accounts in 2011 and 2013 in Vallejo, Benicia, Fairfield, and Vacaville are presented in Tables 6-15 through 6-18. Estimated annual water savings per account and rebate costs for 2013 for each city and are shown in the table below. The measured water savings ranged from approximately 11,200 gallons per year per 1,000 square feet ("sq ft") of turf replaced by participants in Vallejo to approximately 19,400 gallons per the same area replaced in Vacaville. The amount of water saved by participation in the Turf Replacement Rebate program in the four cities appears to be directly correlated with the increasing evapotranspiration rates and warmer average climates across Solano County. Water savings measured in the two cooler cities located on the San Francisco Bay and having lower ETo rates (Vallejo and Benicia) was approximately 11,500 gallons per year, while water savings in the two warmer cities with higher ETo rates (Fairfield and Vacaville), located closer to the Central Valley was over 18,000 gallons per year.

Turf Replacement Rebate Program Water Savings		
City	**Water Savings per 1,000 sq ft Rebated (gallons/year)**	**Rebate Cost ($/100 gallons)**
Vallejo	11,210	0.76
Benicia	11,640	0.65
Fairfield	18,020	0.50
Vacaville	19,440	0.41
Weighted SCWA Average	**15,630**	**0.57**

Taken together, the weighted average annual water savings for the SCWA service area for 1,000 sq ft of turf replaced is approximately 16,000 gallons, and is generally consistent with what one would expect based on an assumed reduction in applied water of 2.1 acre feet per acre.[24] The corresponding weighted average rebate cost of water saved is approximately $0.57 per 100 gallons of water saved under the Turf Replacement Rebate program.



While the recent drought situation may have contributed to the high level of participation in the Turf Replacement Rebate Program, water savings from the program are anticipated to

[24] Expected annual water savings per 1,000 sq ft turf replacement was calculated using the following equation (BAWSCA, 2013): (3.5 acre-feet/acre - 1.0 acre-feet/acre) /43,560 sq ft/acre x 1,000 sq ft x 325,851 gal/acre-foot = 18,701 gal.

persist now that the drought is over. The SCWA's Turf Replacement Rebate Program is structured such that program participants only receive their rebate after SCWA staff inspect the project and verify that the irrigation system has been altered as appropriate for the new low-water-use plantings (e.g., the overhead sprinkler system that had previously irrigated a lawn has been replaced with a drip irrigation system). Therefore, program participants will not be able to "flip a switch" on their irrigation system and revert to their previous level of water use. To change a yard back to a higher water use landscape would require a significant investment. Furthermore, new landscapes over 500 square feet or rehabilitated landscapes over 2,500 square feet are required to comply with each city's Water-Efficient Landscaping Ordinance, and therefore, would not likely use as much water as landscapes installed prior to participation in the Turf Replacement Rebate Program.

Turf replacement projects are highly visible to the public and therefore result in significant benefits beyond just the observed water savings, much more so than indoor programs such as fixture or appliance replacements. Such benefits include increasing public awareness and encouraging conversations about responsible water use among neighbors. Additionally, it has been observed, particularly in the Southwest United States, that as more homes in a community convert lawn-centric yards to water efficient landscapes, a new norm for landscape aesthetics in a community can be established. The high rates of participation observed in 2014 and 2015 may have been motivated by the historic drought. After the heavy winter rains of 2016-2017, interest in the Turf Replacement Rebate Program may decrease. In order to encourage continued participation in the program, SCWA may consider targeting accounts with outreach and educational materials, such as accounts located in low and median income areas, with larger yard areas. Homeowners who would like to implement a turf replacement project may be hindered by a number of different real or perceived hurdles (e.g., perception of appearance of low water-use plants, landscape design challenges, the landscape design and contractor selection process, etc.) (SMWD, 2016). In order to better understand the most significant barriers to participation, SCWA could conduct a targeted survey of customers, and then, based on the identified barriers of participation, potentially provide additional assistance or resources to address these issues.

6.5 Residential Water Use Survey Program Savings

The estimated water savings achieved from the Residential Water Use Survey Program by SFR customers in 2011 and 2013 in Vallejo, Benicia, Fairfield, and Vacaville are presented in Tables 6-19 through 6-25. Estimated annual water savings per account were averaged between 2011 and 2013 for each city and are shown in the table at right.

Residential Water Use Survey Program Water Savings	
City	**Average Water Savings per Account (gallons/year)**
Vallejo	34,397
Benicia	11,904
Fairfield	9,174
Vacaville	16,845
Weighted SCWA Average	**20,080**

The average water savings per account resulting from residential water use surveys ranged significantly, from approximately 9,200 gallons per year by participants in Fairfield to over 34,000 gallons per year by participants in Vallejo. Water savings achieved by participation in the residential water survey program would be expected to be more highly variable than that in the rebate programs, because the individual interventions performed on each account varies by the needs of that particular home (e.g., whether leaks are detected and corrected, if irrigation settings are adjusted, if the homeowner continues to act on the suggestions provided by the staff performing the survey, etc.).

The weighted average annual water savings per water use survey estimated by this study is approximately 20,000 gallons per year.

Because the Residential Water Use Survey Program specifically targets the highest water users, it is already very focused on accounts with very high water savings potential within each member unit. In order to increase participation, SCWA may consider reaching out to Homeowners Associations ("HOAs"), neighborhood watch groups, and other organized community groups, to the degree they are active in neighborhoods with many high-water-using accounts. The program can be promoted through social media platforms that allow for localized messaging such as Facebook and Nextdoor. SCWA could also consider offering Residential Water Use Surveys to customers located in low income areas, who have high levels of water use, but may not fall within the top 10% tier of water users.

6.6 Water Savings and Costs Summary

The weighted average water annual water savings and associated rebate costs are summarized below. Based on results of this analysis, the Residential Water User Survey Program results in the highest amount of water saved per account, followed by the Turf Replacement Rebate Program. The HE Washer Rebate Program appears to result in the least water savings achieved and is also associated with the highest relative cost compared to the other rebate programs. The HE Toilet Rebate Program has the lowest relative cost per rebate dollar spent, and results in approximately half the amount of water savings as the Turf Replacement Rebate Program, at only one third the cost.

SFR Conservation Program	Average Annual Water Savings Per Account	Rebate Cost per 100 Gallons of Water Saved
HE Toilet Rebate	8,000 gallons	$0.18
HE Washer Rebate	4,800 gallons	$0.65
Turf Replacement Rebate	16,000 gallons	$0.57
Residential Water Use Surveys	20,000 gallons	n/a

Table 6-1
SFR HE Toilet Rebate Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	50	250
Age of Housing	--	1900 - 1999	1890 - 2005
Average House Size	sq ft	1,768	1,525
Average Number of Bedrooms	--	3.5	3.3
Average Number of Bathrooms	--	2.1	1.9
Total Number of Rebates Issued	--	79	n/a
Number of Accounts Receiving 1 Rebate	--	30	n/a
Number of Accounts Receiving 2 Rebates	--	11	n/a
Number of Accounts Receiving 3 Rebates	--	9	n/a
Total Dollar Value of Rebates Issued	$	9,176	n/a
Average Rebate Value	$	116	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	140	134
Average Annual Water Use 2012 - 2015	HCF	108	119
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	33	15
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	18	n/a
	gal	13,150	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	11	n/a
	gal	8,323	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.09	n/a

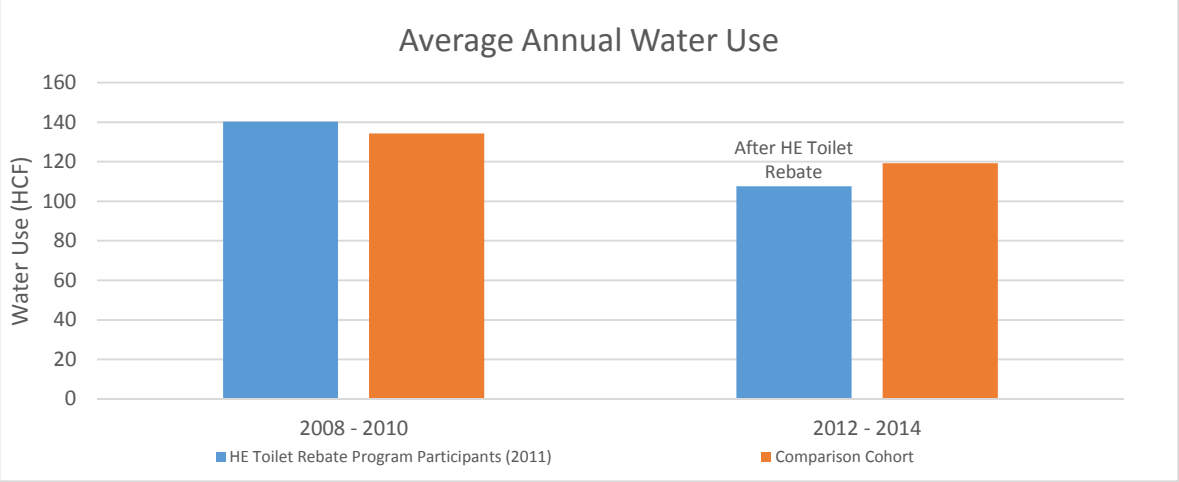


Table 6-1
SFR HE Toilet Rebate Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.
(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.
(d) Expected annual water savings per HE toilet change out would be approximately 5,020 gallons, using following calculation with Vallejo persons per household value of 2.85 (BAWSCA, 2013; Census, 2017):
(3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.85 persons/house / 2.3 toilets/house x 365 days = 5,020 gal
This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).
(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.
(f) Totals may not sum exactly due to rounding.

Table 6-2
SFR HE Toilet Rebate Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	112	560
Age of Housing	--	1910 - 2005	1890 - 2005
Average House Size	sq ft	1,641	1,592
Average Number of Bedrooms	--	3.3	3.2
Average Number of Bathrooms	--	2.1	2.0
Total Number of Rebates Issued	--	168	n/a
Number of Accounts Receving 1 Rebate	--	73	n/a
Number of Accounts Receving 2 Rebates	--	22	n/a
Number of Accounts Receving 3 Rebates	--	17	n/a
Total Dollar Value of Rebates Issued	$	18,433	n/a
Average Rebate Value	$	110	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	117	120
Average Annual Water Use 2014 - 2015	HCF	83	103
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	34	17
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	17	n/a
	gal	12,604	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	11	n/a
	gal	8,403	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.09	n/a

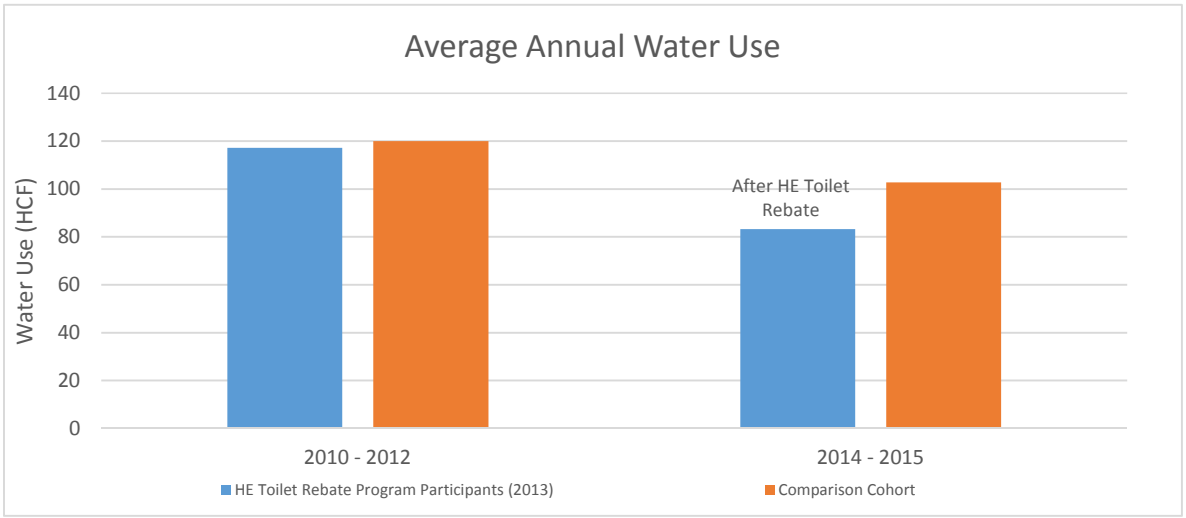


Table 6-2
SFR HE Toilet Rebate Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.
(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.
(d) Expected annual water savings per HE toilet change out would be approximately 5,020 gallons, using following calculation with Vallejo persons per household value of 2.85 (BAWSCA, 2013; Census, 2017):
(3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.85 persons/house / 2.3 toilets/house x 365 days = 5,020 gal
This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).
(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.
(f) Totals may not sum exactly due to rounding.

Table 6-3
SFR HE Toilet Rebate Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	37	185
Age of Housing	--	1900 - 1993	1890 - 2006
Average House Size	sq ft	2,018	2,013
Average Number of Bedrooms	--	3.5	3.5
Average Number of Bathrooms	--	2.4	2.4
Total Number of Rebates Issued	--	62	n/a
Number of Accounts Receiving 1 Rebate	--	19	n/a
Number of Accounts Receiving 2 Rebates	--	11	n/a
Number of Accounts Receiving 3 Rebates	--	7	n/a
Total Dollar Value of Rebates Issued	$	7,830	n/a
Average Rebate Value	$	126	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	169	176
Average Annual Water Use 2012 - 2014	HCF	154	164
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	15	11
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	4	n/a
	gal	2,685	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	2	n/a
	gal	1,603	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.47	n/a

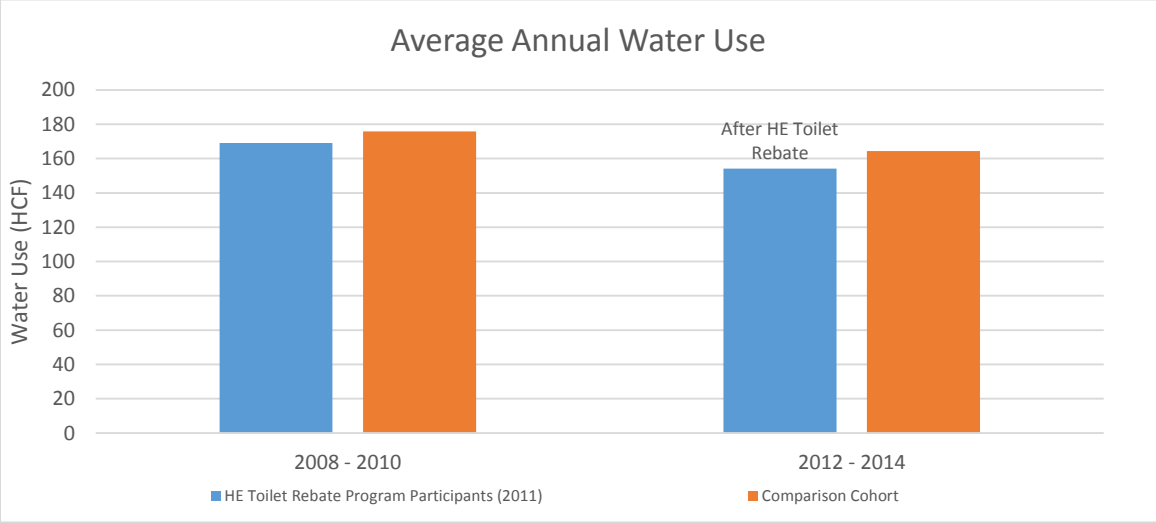


Table 6-3
SFR HE Toilet Rebate Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HE = high efficiency
n/a = not applicable
SFR = single-family residential

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.

(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.

(d) Expected annual water savings per HE toilet change out would be approximately 4,492 gallons, using the following calculation with the Benicia persons per household value of 2.55 (BAWSCA, 2013; Census, 2017):
(3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.55 persons/house / 2.3 toilets/house x 365 days = 4,492 gal
This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period.
Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-4
SFR HE Toilet Rebate Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	46	230
Age of Housing	--	1936 - 2001	1888 - 2006
Average House Size	sq ft	1,868	2,025
Average Number of Bedrooms	--	3.5	3.5
Average Number of Bathrooms	--	2.3	2.4
Total Number of Rebates Issued	--	72	n/a
Number of Accounts Receving 1 Rebate	--	28	n/a
Number of Accounts Receving 2 Rebates	--	10	n/a
Number of Accounts Receving 3 Rebates	--	8	n/a
Total Dollar Value of Rebates Issued	$	8,317	n/a
Average Rebate Value	$	116	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	145	156
Average Annual Water Use 2014 - 2015	HCF	97	119
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	48	38
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	10	n/a
	gal	7,824	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	7	n/a
	gal	4,999	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.15	n/a

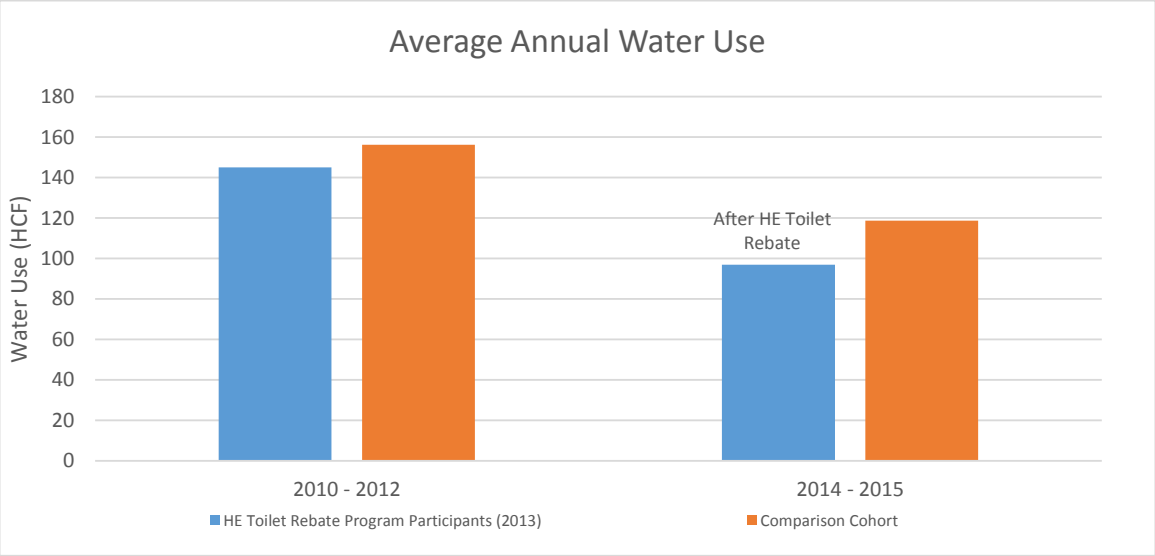


Table 6-4
SFR HE Toilet Rebate Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.

(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.

(d) Expected annual water savings per HE toilet change out would be approximately 4,492 gallons, using the following calculation with the Benicia persons per household value of 2.55 (BAWSCA, 2013; Census, 2017):
(3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.55 persons/house / 2.3 toilets/house x 365 days = 4,492 gal
This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-5
SFR HE Toilet Rebate Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	157	785
Age of Housing	--	1935 - 2005	1926 - 2008
Average House Size	sq ft	1,851	1,815
Average Number of Bedrooms	--	3.7	3.6
Average Number of Bathrooms	--	2.3	2.3
Total Number of Rebates Issued	--	250	n/a
Number of Accounts Receiving 1 Rebate	--	89	n/a
Number of Accounts Receiving 2 Rebates	--	43	n/a
Number of Accounts Receiving 3 Rebates	--	25	n/a
Total Dollar Value of Rebates Issued	$	28,882	n/a
Average Rebate Value	$	116	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	167	172
Average Annual Water Use 2012 - 2014	HCF	159	171
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	7	1
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	7	n/a
	gal	5,124	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	4	n/a
	gal	3,218	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.23	n/a

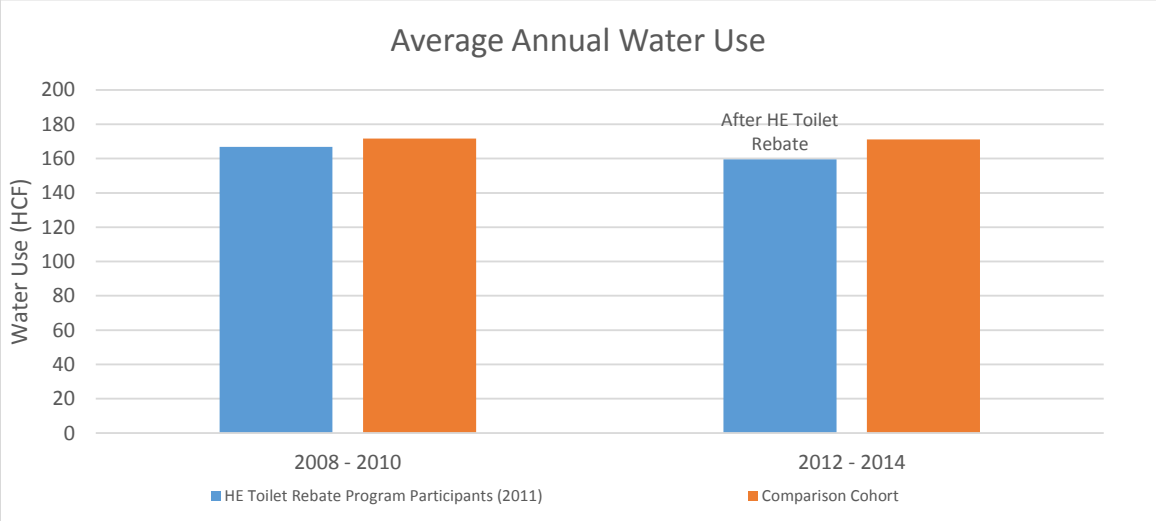


Table 6-5
SFR HE Toilet Rebate Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.

(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.

(d) Expected annual water savings per HE toilet change out would be approximately 5,461 gallons, using the following calculation with the Fairfield persons per household value of 3.1 (BAWSCA, 2013; Census, 2017): (3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 3.1 persons/house / 2.3 toilets/house x 365 days = 5,461 gal This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-6
SFR HE Toilet Rebate Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	137	685
Age of Housing	--	1931 - 2006	1900 - 2007
Average House Size	sq ft	1,784	1,770
Average Number of Bedrooms	--	3.5	3.5
Average Number of Bathrooms	--	2.3	2.2
Total Number of Rebates Issued	--	200	n/a
Number of Accounts Receving 1 Rebate	--	87	n/a
Number of Accounts Receving 2 Rebates	--	37	n/a
Number of Accounts Receving 3 Rebates	--	13	n/a
Total Dollar Value of Rebates Issued	$	21,866	n/a
Average Rebate Value	$	109	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	151	152
Average Annual Water Use 2014 - 2015	HCF	123	133
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	29	19
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	9	n/a
	gal	7,076	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	6	n/a
	gal	4,847	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.15	n/a

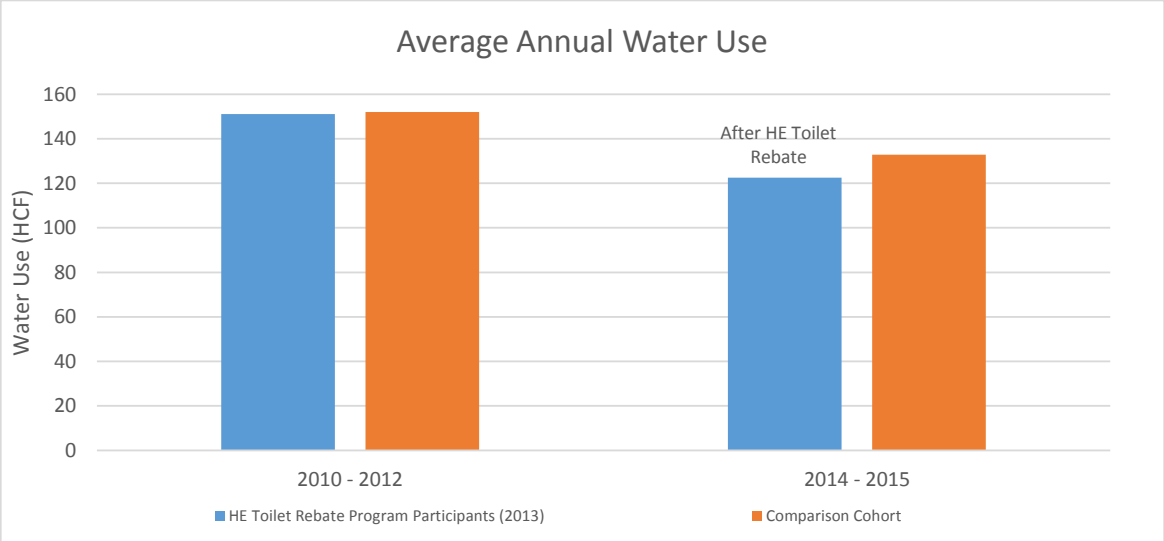


Table 6-6
SFR HE Toilet Rebate Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.

(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.

(d) Expected annual water savings per HE toilet change out would be approximately 5,461 gallons, using the following calculation with the Fairfield persons per household value of 3.1 (BAWSCA, 2013; Census, 2017): (3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 3.1 persons/house / 2.3 toilets/house x 365 days = 5,461 gal This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-7
SFR HE Toilet Rebate Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

	Units	HE Toilet Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	177	885
Age of Housing	--	1929 - 2005	1910 - 2010
Average House Size	sq ft	1,779	1,724
Average Number of Bedrooms	--	3.6	3.5
Average Number of Bathrooms	--	2.3	2.2
Total Number of Rebates Issued	--	272	n/a
Number of Accounts Receving 1 Rebate	--	102	n/a
Number of Accounts Receving 2 Rebates	--	55	n/a
Number of Accounts Receving 3 Rebates	--	20	n/a
Total Dollar Value of Rebates Issued	$	30,495	n/a
Average Rebate Value	$	112	n/a
Water Use			
Average Annual Water Use 2012	HCF	179	183
Average Annual Water Use 2014 - 2015	HCF	139	150
Estimated Water Savings			
Annual Water Use Reduction per Account	HCF	40	33
Annual Water Savings due to HE Toilet Rebate Program Participation per Account (c)	HCF	7	n/a
	gal	5,101	n/a
Annual Water Savings per HE Toilet Rebate Issued (c) (d)	HCF	4	n/a
	gal	3,320	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.22	n/a

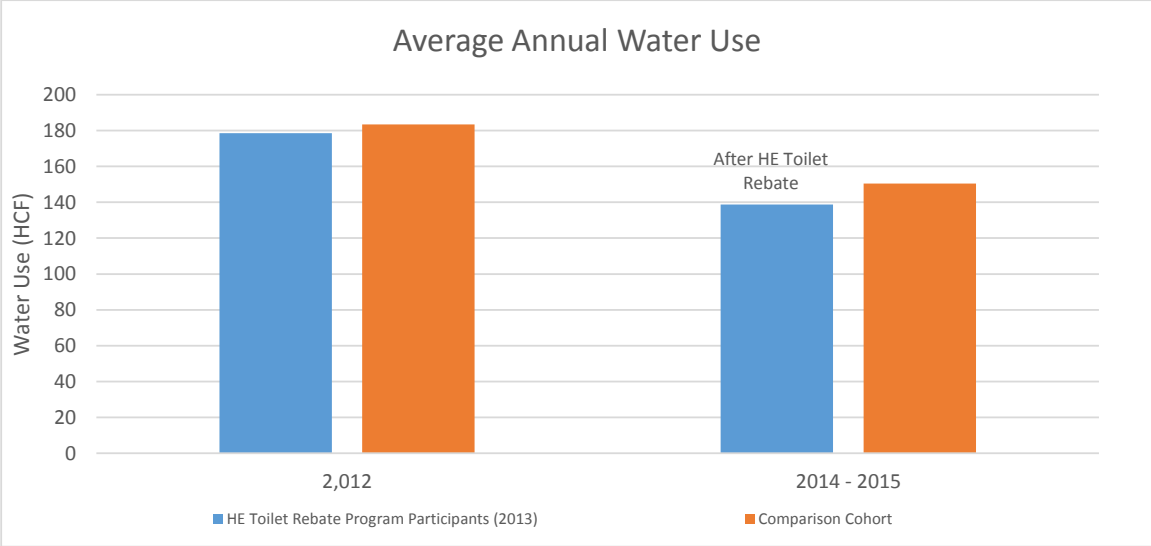


Table 6-7
SFR HE Toilet Rebate Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

Abbreviations

fl = flush
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE toilet rebate program based on available information. Additional HE toilet rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE toilet rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Toilet Rebate Program.

(c) Estimated annual water savings associated with the HE Toilet Rebate Program are calculated as the incremental amount of water saved by the HE Toilet Rebate Program participants over that of the Comparison Cohort accounts, after accounting for those accounts that received multiple rebates.

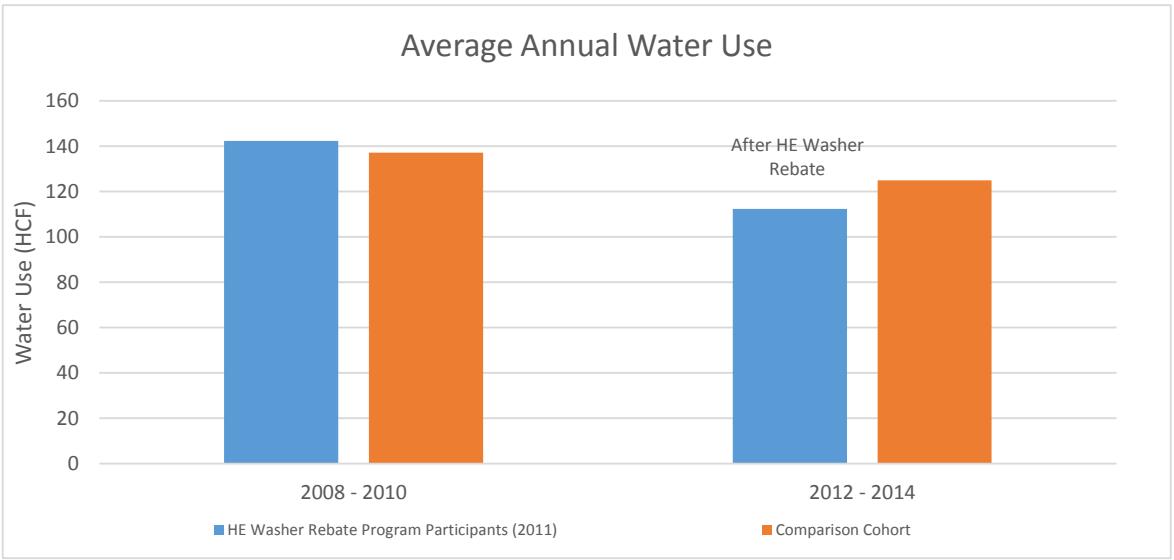
(d) Expected annual water savings per HE toilet change out would be approximately 4,862 gallons, using the following calculation with the Vacaville persons per household value of 2.76 (BAWSCA, 2013; Census, 2017):
(3.5 gal/fl - 1.28 gal/fl) x 5 fl/toilet/day/person x 2.76 persons/house / 2.3 toilets/house x 365 days = 4,862 gal
This calculation assumes that a toilet rated at 3.5 gal/fl actually operates at 3.5 gal/fl. However, the operational water use may be substantially higher depending on the condition of the toilet and how well it has been maintained (Aquacraft, 2011).

(e) Rebate cost per 100 gallons 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 HE toilet rebate extended over a ten-year period.
Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-8
SFR HE Washer Rebate Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	98	490
Age of Housing	--	1915 - 2007	1910 - 2007
Average House Size	sq ft	1,778	1,693
Average Number of Bedrooms	--	3.5	3.3
Total Number of Rebates Issued	--	98	n/a
Total Dollar Value of Rebates Issued	$	10,300	n/a
Average Rebate Value	$	105	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	142	137
Average Annual Water Use 2012 - 2014	HCF	112	125
Estimated Water Savings			
Reduction in Water Use per Account	HCF	30	12
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	18	n/a
	gal	13,344	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.08	n/a



Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-8
SFR HE Washer Rebate Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

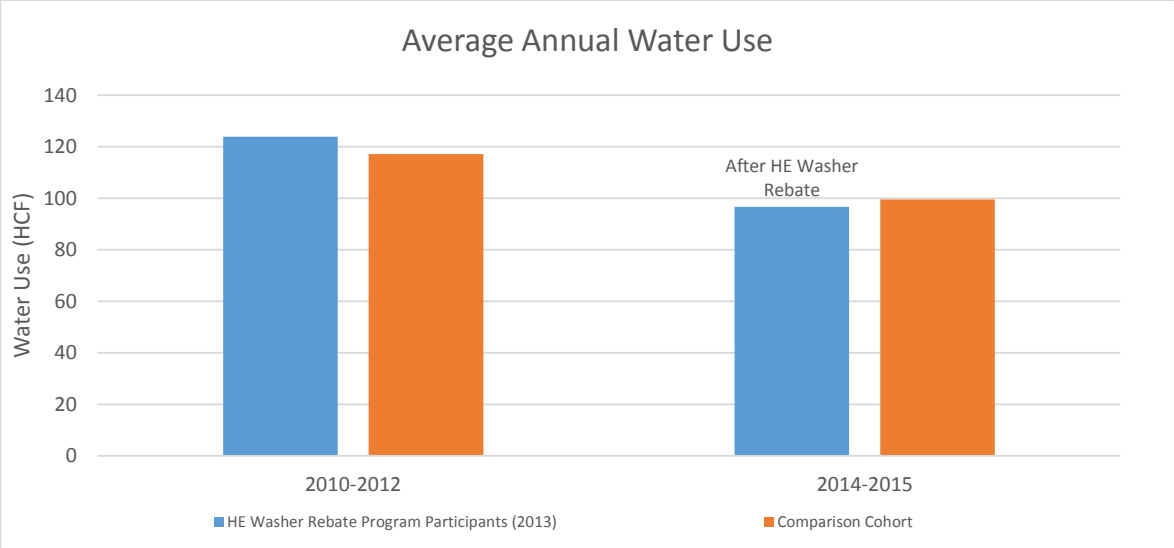
(d) Expected annual water savings per HE washer change out would be approximately 10,007 gallons, using the following calculation with Vallejo persons per household value of 2.85 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 2.85 people/house x 0.37 loads/person/day x 365 days = 10,007 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-9
SFR HE Washer Rebate Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	146	730
Age of Housing	--	1905 - 2010	1880 - 2008
Average House Size	sq ft	1,727	1,673
Average Number of Bedrooms	--	3.5	3.4
Total Number of Rebates Issued	--	146	n/a
Total Dollar Value of Rebates Issued	$	10,950	n/a
Average Rebate Value	$	75	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	124	117
Average Annual Water Use 2014 - 2015	HCF	97	100
Estimated Water Savings			
Reduction in Water Use per Account	HCF	27	18
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	9	n/a
	gal	7,099	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.11	n/a



Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-9
SFR HE Washer Rebate Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

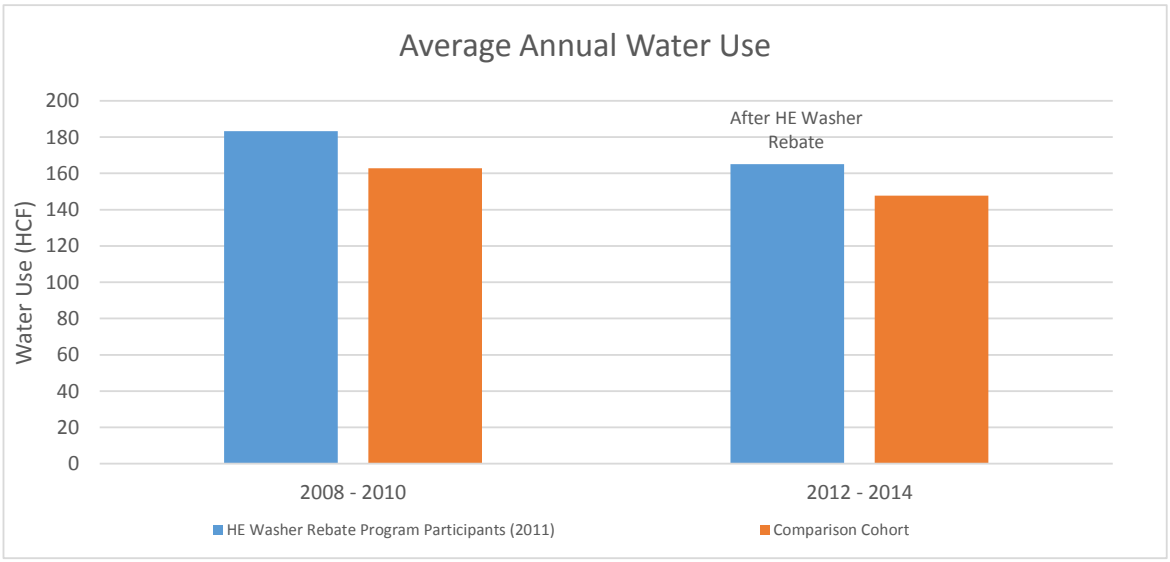
(d) Expected annual water savings per HE washer change out would be approximately 10,007 gallons, using the following calculation with Vallejo persons per household value of 2.85 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 2.85 people/house x 0.37 loads/person/day x 365 days = 10,007 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-10
SFR HE Washer Rebate Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	28	140
Age of Housing	--	1943 - 1999	1915 - 2008
Average House Size	sq ft	2,028	1,885
Average Number of Bedrooms	--	3.5	3.5
Total Number of Rebates Issued	--	28	n/a
Total Dollar Value of Rebates Issued	$	2,975	n/a
Average Rebate Value	$	106	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	183	163
Average Annual Water Use 2012 - 2014	HCF	165	148
Estimated Water Savings			
Reduction in Water Use per Account	HCF	18	15
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	3	n/a
	gal	2,244	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.47	n/a



Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-10
SFR HE Washer Rebate Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

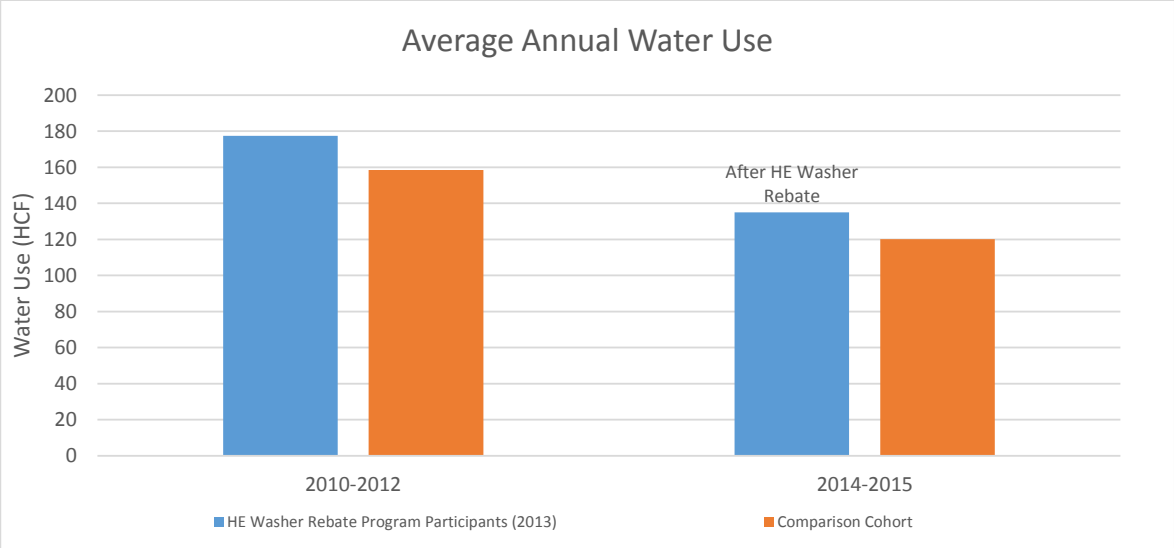
(d) Expected annual water savings per HE washer change out would be approximately 8,954 gallons, using the following calculation with Benicia persons per household value of 2.55 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 2.55 people/house x 0.37 loads/person/day x 365 days = 8,954 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-11
SFR HE Washer Rebate Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	42	210
Age of Housing	--	1930 - 2007	1900 - 2007
Average House Size	sq ft	2,238	1,959
Average Number of Bedrooms	--	3.8	3.5
Total Number of Rebates Issued	--	42	n/a
Total Dollar Value of Rebates Issued	$	3,150	n/a
Average Rebate Value	$	75	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	177	159
Average Annual Water Use 2014 - 2015	HCF	135	120
Estimated Water Savings			
Reduction in Water Use per Account	HCF	42	38
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	4	n/a
	gal	3,022	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.25	n/a



Abbreviations
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-11
SFR HE Washer Rebate Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

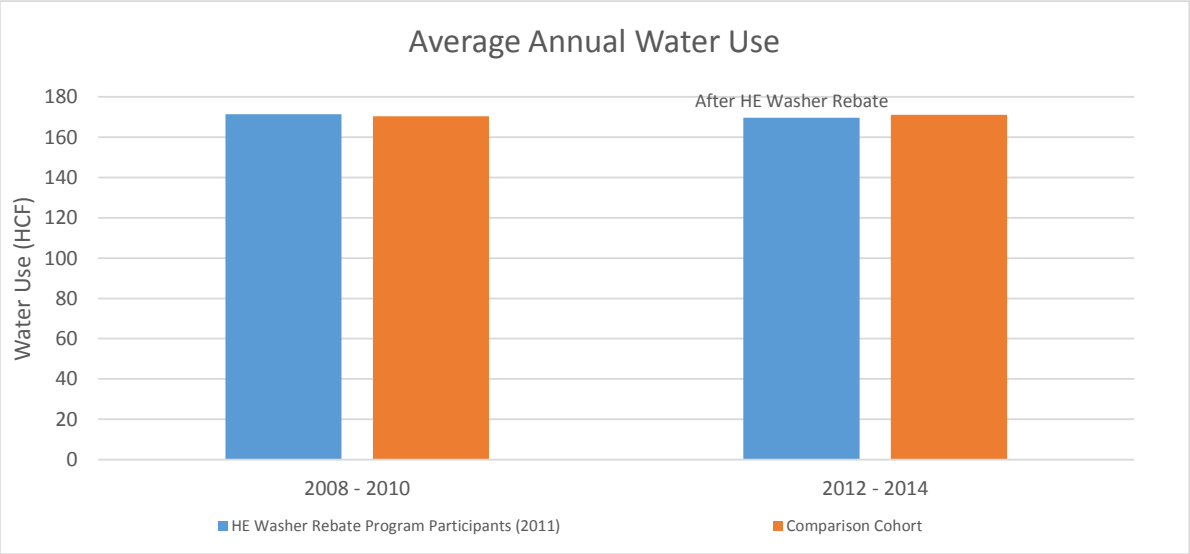
(d) Expected annual water savings per HE washer change out would be approximately 8,954 gallons, using the following calculation with Benicia persons per household value of 2.55 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 2.55 people/house x 0.37 loads/person/day x 365 days = 8,954 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-12
SFR HE Washer Rebate Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	165	825
Age of Housing	--	1950 - 2006	1937 - 2007
Average House Size	sq ft	1,960	1,864
Average Number of Bedrooms	--	3.6	3.6
Total Number of Rebates Issued	--	165	n/a
Total Dollar Value of Rebates Issued	$	17,125	n/a
Average Rebate Value	$	104	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	171	170
Average Annual Water Use 2012 - 2014	HCF	170	171
Estimated Water Savings			
Reduction in Water Use per Account	HCF	2	-1
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	3	n/a
	gal	1,907	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.54	n/a



Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-12
SFR HE Washer Rebate Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2011. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

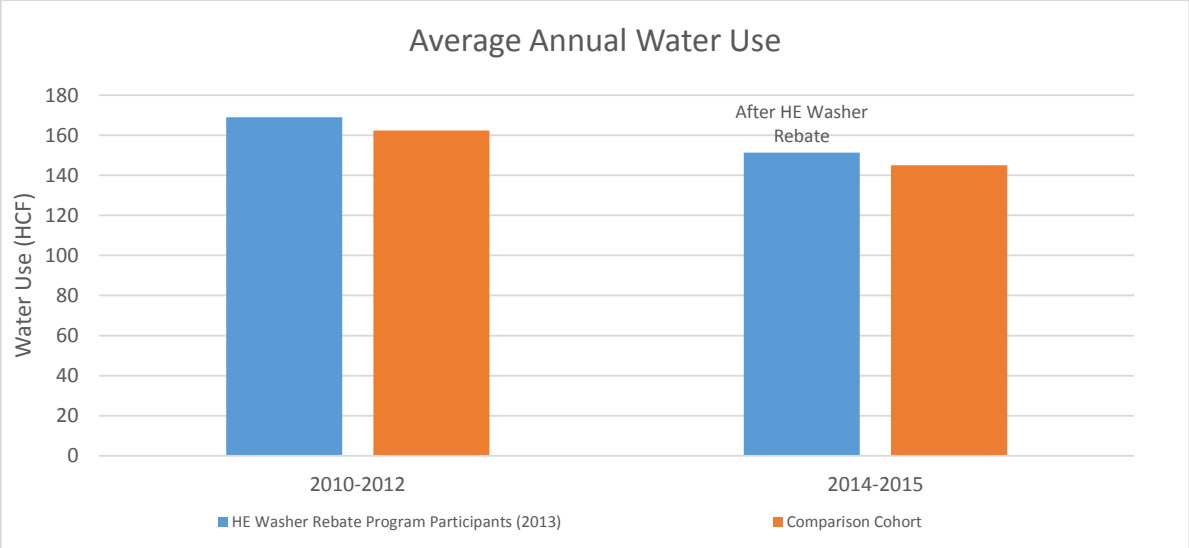
(d) Expected annual water savings per HE washer change out would be approximately 10,885 gallons, using the following calculation with Fairfield persons per household value of 3.1 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 3.1 people/house x 0.37 loads/person/day x 365 days = 10,885 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-13
SFR HE Washer Rebate Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	207	1,040
Age of Housing	--	1952 - 2008	1902 - 2009
Average House Size	sq ft	1,992	2,011
Average Number of Bedrooms	--	3.7	3.7
Total Number of Rebates Issued	--	207	n/a
Total Dollar Value of Rebates Issued	$	15,600	n/a
Average Rebate Value	$	75	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	169	162
Average Annual Water Use 2014 - 2015	HCF	151	145
Estimated Water Savings			
Reduction in Water Use per Account	HCF	18	17
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	0	n/a
	gal	254	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	2.96	n/a



Abbreviations
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-13
SFR HE Washer Rebate Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

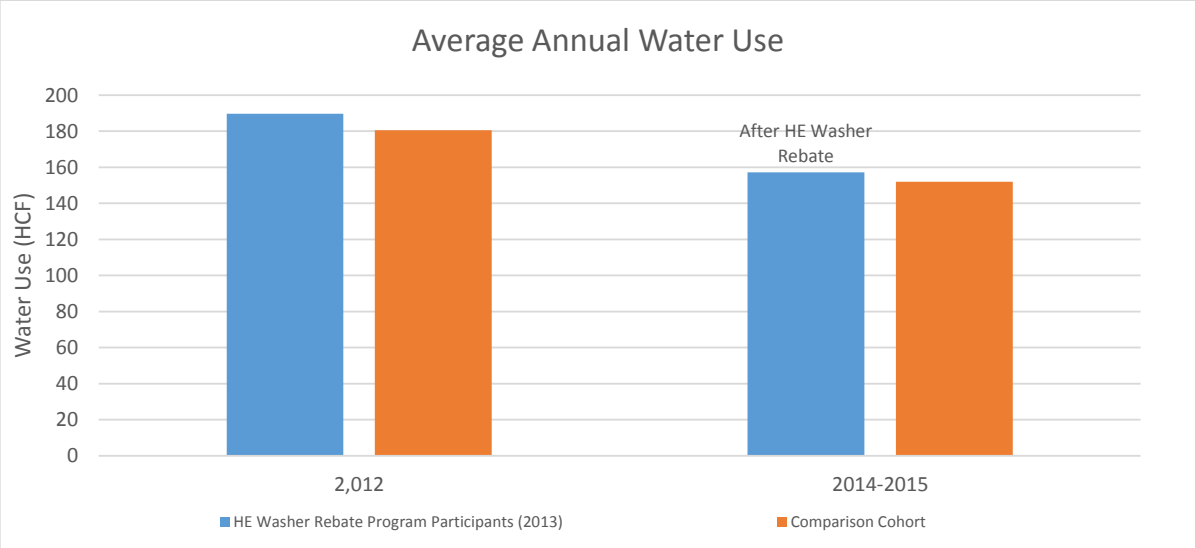
(d) Expected annual water savings per HE washer change out would be approximately 10,885 gallons, using the following calculation with Fairfield persons per household value of 3.1 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 3.1 people/house x 0.37 loads/person/day x 365 days = 10,885 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-14
SFR HE Washer Rebate Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

	Units	HE Washer Rebate Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	221	1,105
Age of Housing	--	1920 - 2012	1910 - 2013
Average House Size	sq ft	1,890	1,870
Average Number of Bedrooms	--	3.6	3.6
Total Number of Rebates Issued	--	221	n/a
Total Dollar Value of Rebates Issued	$	16,575	n/a
Average Rebate Value	$	75	n/a
Water Use			
Average Annual Water Use 2012	HCF	190	181
Average Annual Water Use 2014 - 2015	HCF	157	152
Estimated Water Savings			
Reduction in Water Use per Account	HCF	32	29
Annual Water Savings per HE Washer Rebate Issued (c) (d)	HCF	4	n/a
	gal	2,932	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (e)	$/100 gal	0.26	n/a



Abbreviations
FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Table 6-14
SFR HE Washer Rebate Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the HE washer rebate program based on available information. Additional HE washer rebates have been issued.

(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received HE washer rebates in 2013. Program participation records indicate that cohort accounts did not participate in the HE Washer Rebate Program.

(c) Estimated annual water savings associated with the HE Washer Rebate Program are calculated as the incremental amount of water saved by the HE Washer Rebate Program participants over that of the Comparison Cohort accounts.

(d) Expected annual water savings per HE washer change out would be approximately 9,481 gallons, using the following calculation with Benicia persons per household value of 2.76 (BAWSCA, 2013; Aquacraft, 2011; Census, 2017):
(39 gal/load - 13 gal/load) x 2.76 people/house x 0.37 loads/person/day x 365 days = 9,481 gal.

(e) Rebate cost per 100 gallons 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 HE washer rebate extended over a ten-year period. Rebate cost does not include the cost of program administration.

(f) Totals may not sum exactly due to rounding.

Table 6-15
SFR Turf Replacement Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

	Units	Turf Replacement Program (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	17	85
Home Construction Years	--	1918 - 1995	1929 - 2008
Average House Size	sq ft	1,798	1,789
Average Lot Size	sq ft	12,980	7,611
Total Area of Turf Replaced Under Rebate	sq ft	13,031	n/a
Total Area of Turf Replaced, Including Area in Excess of Rebate (c)	sq ft	14,873	n/a
Average Area of Turf Replaced per Account	sq ft	875	n/a
Total Dollar Value of Rebates Issued	$	12,657	n/a
Average Rebate	$	745	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	123	122
Average Annual Water Use 2014 - 2015	HCF	88	101
Estimated Water Savings			
Reduction in Water Use per Account	HCF	34	21
Annual Water Savings per Average Turf Replacement Project (875 sq ft) (d) (e)	HCF	13	n/a
	gal	9,806	n/a
Annual Water Savings per 1,000 sq ft turf replaced (d)	HCF	15	n/a
	gal	11,209	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (f)	$/gal	0.76	n/a

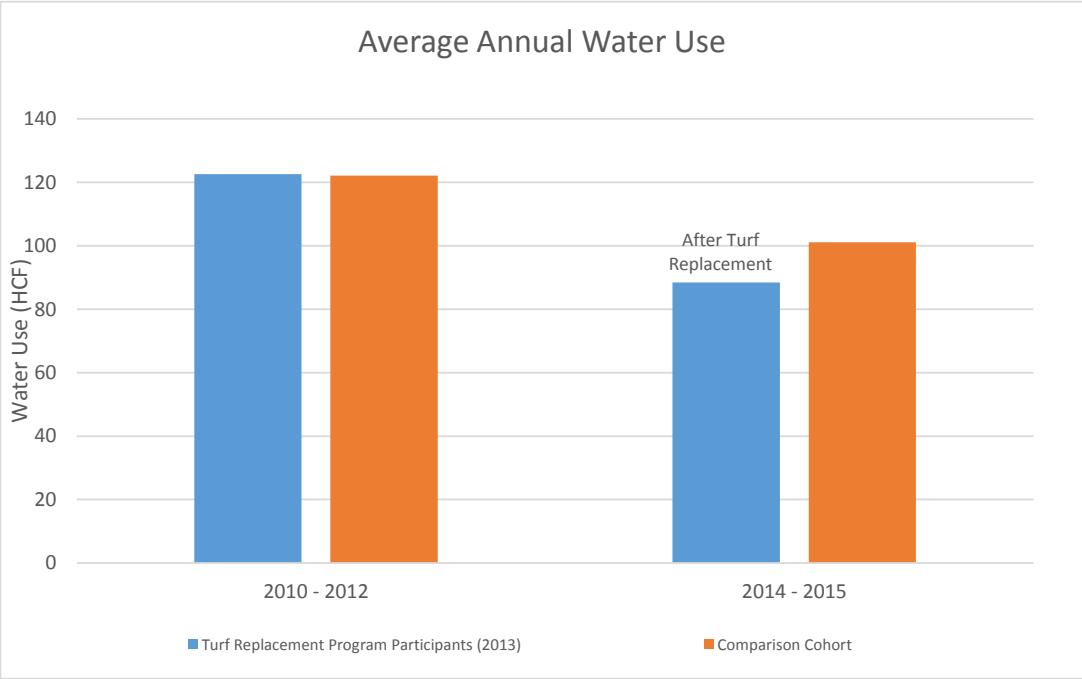


Table 6-15
SFR Turf Replacement Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available and (2) that are identified as single-family residences by the Solano County Assessor's Office. Additional turf replacement rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received turf replacement rebates in 2013. Program participation records indicate that cohort accounts did not participate in the Turf Replacement Program.
(c) In 2013, rebates were issued for a maximum of 1,000 sq ft of replaced turf for SFR accounts. The total amount of turf replaced exceeded 1,000 sq ft for 11 out of the 22 participating accounts.
(d) Estimated annual water savings due to the Turf Replacement Program are calculated as the incremental amount of water saved by the Turf Replacement Program Participants over that of the Comparison Cohort accounts.
(e) Expected annual water savings would be approximately 18,701 gallons per maximum turf replacement project (1,000 sq ft), using the following calculation (BAWSCA, 2013):
(3.5 acre-feet/acre - 1.0 acre-feet/acre) /43,560 sq ft/acre x 1,000 sq ft x 325,851 gal/acre-foot = 18,701 gal
(f) 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 replacement project (assumed to be 947 sq ft) extended over a ten-year period. Rebate cost does not include the cost of program administration.
(g) Totals may not sum exactly due to rounding.

Table 6-16
SFR Turf Replacement Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

	Units	Turf Replacement Program (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	13	65
Home Construction Years	--	1895 - 2005	1941 - 2007
Average House Size	sq ft	2,005	2,122
Average Lot Size	sq ft	9,166	8,782
Total Area of Turf Replaced Under Rebate	sq ft	9,934	n/a
Total Area of Turf Replaced, Including Area in Excess of Rebate (c)	sq ft	13,177	n/a
Average Area of Turf Replaced per Account	sq ft	1,014	n/a
Total Dollar Value of Rebates Issued	$	9,934	n/a
Average Rebate	$	764	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	135	159
Average Annual Water Use 2014 - 2015	HCF	88	128
Estimated Water Savings			
Reduction in Water Use per Account	HCF	47	31
Annual Water Savings per Average Turf Replacement Project (1,014 sq ft) (d) (e)	HCF	16	n/a
	gal	11,803	
Annual Water Savings per 1,000 sq ft turf replaced (d)	HCF	16	n/a
	gal	11,645	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (f)	$/gal	0.65	n/a

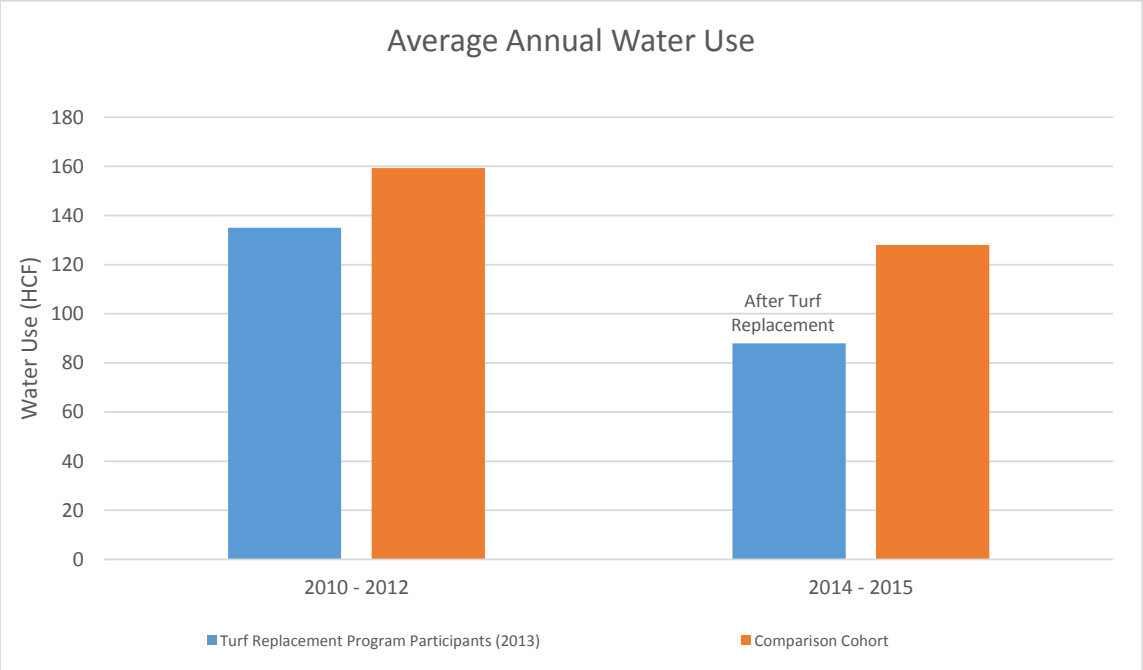


Table 6-16
SFR Turf Replacement Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available and (2) that are identified as single-family residences by the Solano County Assessor's Office. Additional turf replacement rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received turf replacement rebates in 2013. Program participation records indicate that cohort accounts did not participate in the Turf Replacement Program.
(c) In 2013, rebates were issued for a maximum of 1,000 sq ft of replaced turf for SFR accounts. The total amount of turf replaced exceeded 1,000 sq ft for 6 out of the 13 participating accounts.
(d) Estimated annual water savings due to the Turf Replacement Program are calculated as the incremental amount of water saved by the Turf Replacement Program Participants over that of the Comparison Cohort accounts.
(e) Expected annual water savings would be approximately 18,701 gallons per maximum turf replacement project (1,000 sq ft), using the following calculation (BAWSCA, 2013):
(3.5 acre-feet/acre - 1.0 acre-feet/acre) /43,560 sq ft/acre x 1,000 sq ft x 325,851 gal/acre-foot = 18,701 gal
(f) 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 replacement project (assumed to be 1,014 sq ft) extended over a ten-year period. Rebate cost does not include the cost of program administration.
(g) Totals may not sum exactly due to rounding.

Table 6-17
SFR Turf Replacement Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

	Units	Turf Replacement Program (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	17	85
Home Construction Years	--	1944 - 2005	1944 - 2008
Average House Size	sq ft	1,675	1,864
Average Lot Size	sq ft	7,184	8,743
Total Area of Turf Replaced Under Rebate	sq ft	13,265	n/a
Total Area of Turf Replaced, Including Area in Excess of Rebate (c)	sq ft	14,675	n/a
Average Area of Turf Replaced per Account	sq ft	863	n/a
Total Dollar Value of Rebates Issued	$	13,265	n/a
Average Rebate	$	780	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	140	168
Average Annual Water Use 2014 - 2015	HCF	106	155
Estimated Water Savings			
Reduction in Water Use per Account	HCF	34	13
Annual Water Savings per Average Turf Replacement Project (863 sq ft) (d) (e)	HCF	21	n/a
	gal	15,551	n/a
Annual Water Savings per 1,000 sq ft turf replaced (d)	HCF	24	n/a
	gal	18,015	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (f)	$/gal	0.50	n/a

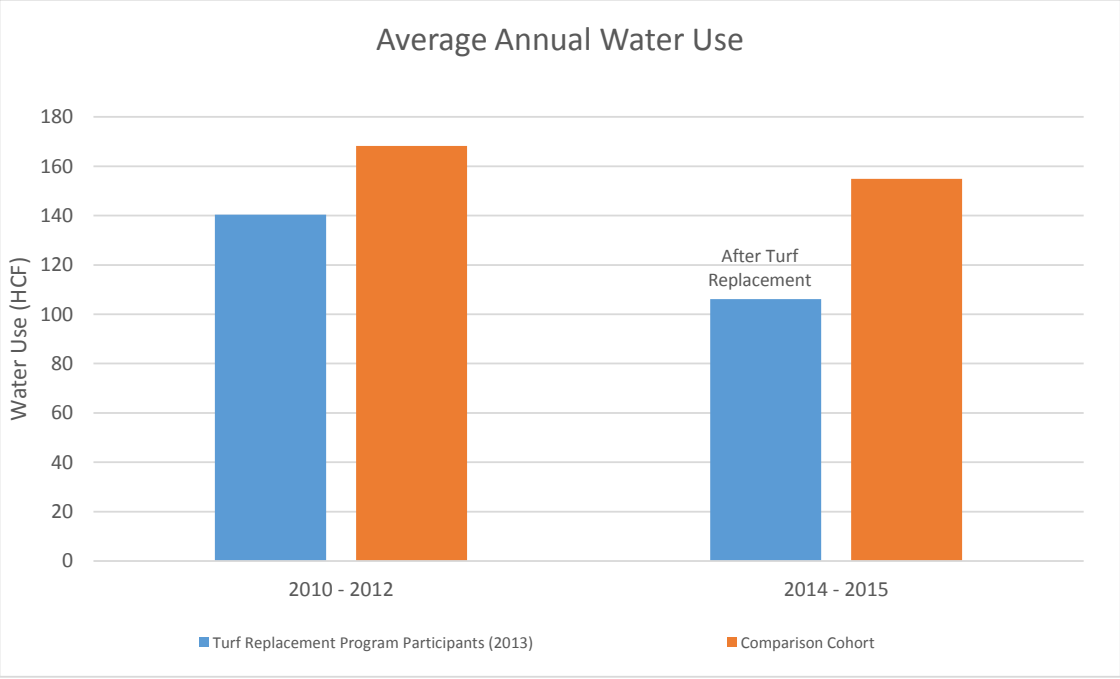


Table 6-17
SFR Turf Replacement Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available and (2) that are identified as single-family residences by the Solano County Assessor's Office. Additional turf replacement rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received turf replacement rebates in 2013. Program participation records indicate that cohort accounts did not participate in the Turf Replacement Program.
(c) In 2013, rebates were issued for a maximum of 1,000 sq ft of replaced turf for SFR accounts. The total amount of turf replaced exceeded 1,000 sq ft for 5 out of the 17 participating accounts.
(d) Estimated annual water savings due to the Turf Replacement Program are calculated as the incremental amount of water saved by the Turf Replacement Program Participants over that of the Comparison Cohort accounts.
(e) Expected annual water savings would be approximately 18,701 gallons per maximum turf replacement project (1,000 sq ft), using the following calculation (BAWSCA, 2013):
(3.5 acre-feet/acre - 1.0 acre-feet/acre) /43,560 sq ft/acre x 1,000 sq ft x 325,851 gal/acre-foot = 18,701 gal
(f) 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 replacement project (assumed to be 863 sq ft) extended over a ten-year period. Rebate cost does not include the cost of program administration.
(g) Totals may not sum exactly due to rounding.

Table 6-18
SFR Turf Replacement Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

	Units	Turf Replacement Program (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	10	50
Home Construction Years	--	1972 - 2003	1973 - 2012
Average House Size	sq ft	1,972	1,934
Average Lot Size	sq ft	8,055	6,979
Total Area of Turf Replaced Under Rebate	sq ft	8,544	n/a
Total Area of Turf Replaced, Including Area in Excess of Rebate (c)	sq ft	10,635	n/a
Average Area of Turf Replaced per Account	sq ft	1,063	n/a
Total Dollar Value of Rebates Issued	$	8,544	n/a
Average Rebate	$	854	n/a
Water Use			
Average Annual Water Use 2012	HCF	192	193
Average Annual Water Use 2014 - 2015	HCF	141	169
Estimated Water Savings			
Reduction in Water Use per Account	HCF	51	24
Annual Water Savings per Average Turf Replacement Project (1,053 sq ft) (d) (e)	HCF	28	n/a
	gal	20,675	
Annual Water Savings per 1,000 sq ft turf replaced (d)	HCF	26	n/a
	gal	19,441	n/a
Rebate Cost per 100 Gallons of Water Saved Over a 10-Year Period (f)	$/gal	0.41	n/a

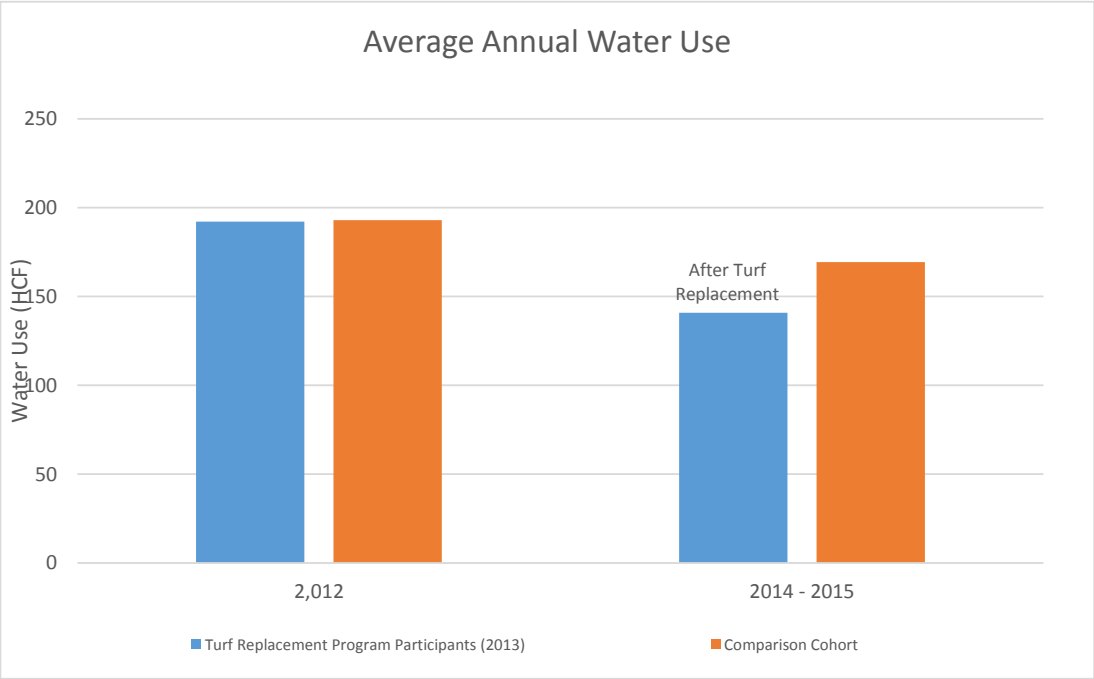


Table 6-18
SFR Turf Replacement Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

Abbreviations

FY = fiscal year
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available and (2) that are identified as single-family residences by the Solano County Assessor's Office. Additional turf replacement rebates have been issued.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received turf replacement rebates in 2013. Program participation records indicate that cohort accounts did not participate in the Turf Replacement Program.
(c) In 2013, rebates were issued for a maximum of 1,000 sq ft of replaced turf for SFR accounts. The total amount of turf replaced exceeded 1,000 sq ft for 6 out of the 10 participating accounts.
(d) Estimated annual water savings due to the Turf Replacement Program are calculated as the incremental amount of water saved by the Turf Replacement Program Participants over that of the Comparison Cohort accounts.
(e) Expected annual water savings would be approximately 18,701 gallons per maximum turf replacement project (1,000 sq ft), using the following calculation (BAWSCA, 2013):
(3.5 acre-feet/acre - 1.0 acre-feet/acre) /43,560 sq ft/acre x 1,000 sq ft x 325,851 gal/acre-foot = 18,701 gal
(f) 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 replacement project (assumed to be 1,063 sq ft) extended over a ten-year period. Rebate cost does not include the cost of program administration.
(g) Totals may not sum exactly due to rounding.

Table 6-19
SFR Water Use Survey Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	90	450
Home Construction Years	--	1912 - 2006	1890 - 2008
Average House Size	sq ft	2,068	1,913
Average Number of Bedrooms	--	3.7	2.4
Average Number of Bathrooms	--	2.4	2.3
Average Lot Size	sq ft	10,719	7,453
Median Lot Size	sq ft	7,405	6,534
Number of Surveys Performed	--	90	n/a
Number of Surveys - Leaks Identified	--	9	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	29	n/a
Number of Surveys - Hardware Distributed (c)	--	33	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	211	140
Average Annual Water Use 2012 - 2014	HCF	155	127
Estimated Water Savings			
Reduction in Water Use per Account	HCF	56	12
Annual Water Savings per Survey Performed (d)	HCF	44	n/a
	gal	32,912	n/a

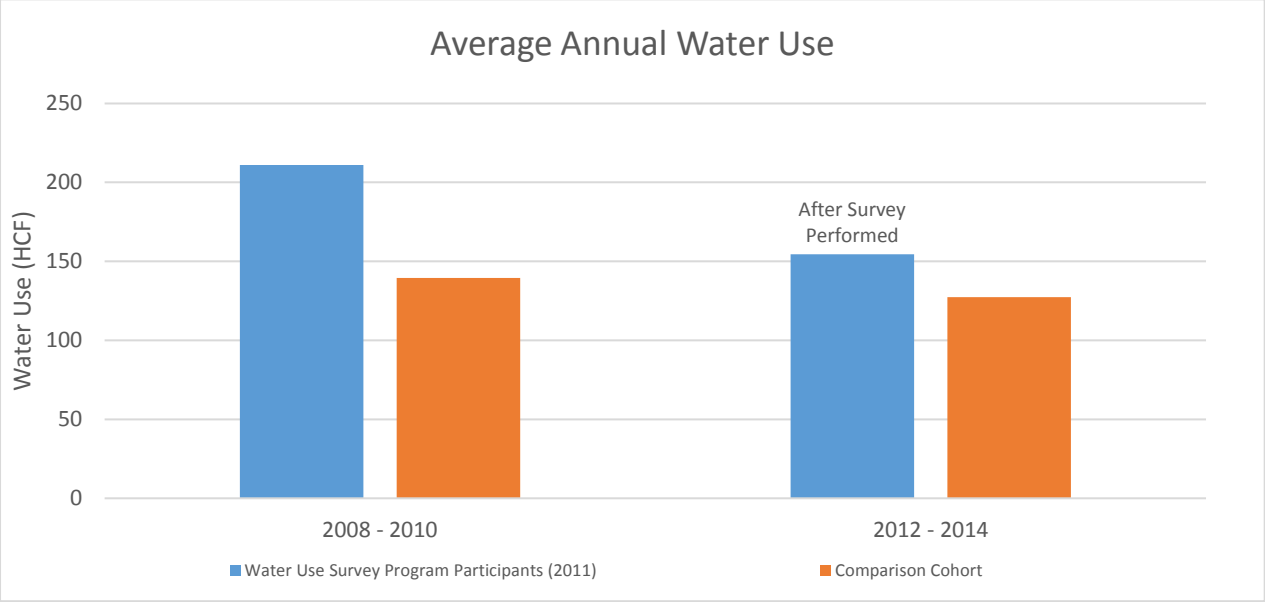


Table 6-19
SFR Water Use Survey Program Water Savings (2011) – City of Vallejo
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2011. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-20
SFR Water Use Survey Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	32	160
Home Construction Years	--	1933 - 2011	1915 - 2005
Average House Size	sq ft	2,250	1,847
Average Number of Bedrooms	--	3.5	3.3
Average Number of Bathrooms	--	2.6	2.2
Average Lot Size	sq ft	11,248	7,848
Median Lot Size	sq ft	8,058	6,948
Number of Surveys Performed	--	32	n/a
Number of Surveys - Leaks Identified	--	6	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	10	n/a
Number of Surveys - Hardware Distributed (c)	--	18	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	245	124
Average Annual Water Use 2014 - 2015	HCF	179	106
Estimated Water Savings			
Reduction in Water Use per Account	HCF	65	18
Annual Water Savings per Survey Performed (d)	HCF	48	n/a
	gal	35,605	n/a

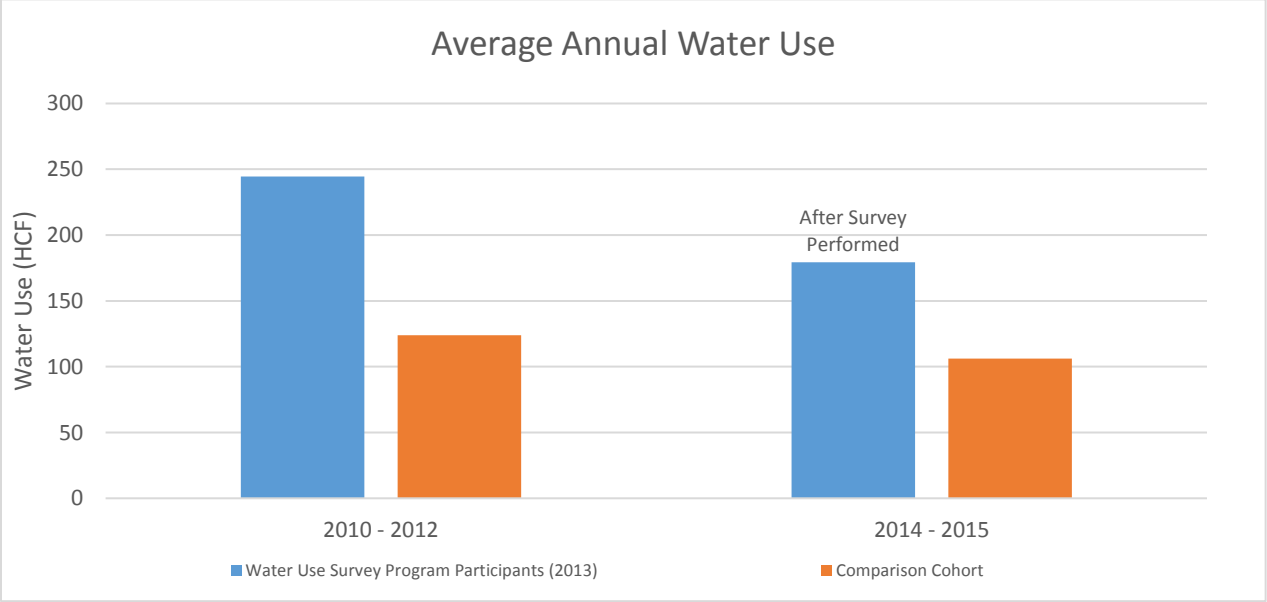


Table 6-20
SFR Water Use Survey Program Water Savings (2013) – City of Vallejo
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2013. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-21
SFR Water Use Survey Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	47	235
Home Construction Years	--	1943 - 2007	1888 - 2008
Average House Size	sq ft	2,334	2,220
Average Number of Bedrooms	--	3.8	3.6
Average Number of Bathrooms	--	2.6	2.5
Average Lot Size	sq ft	9,436	8,819
Median Lot Size	sq ft	8,712	8,444
Number of Surveys Performed	--	47	n/a
Number of Surveys - Leaks Identified	--	4	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	17	n/a
Number of Surveys - Hardware Distributed (c)	--	8	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	238	178
Average Annual Water Use 2012 - 2014	HCF	213	171
Estimated Water Savings			
Reduction in Water Use per Account	HCF	25	7
Annual Water Savings per Survey Performed (d)	HCF	18	n/a
	gal	13,509	n/a

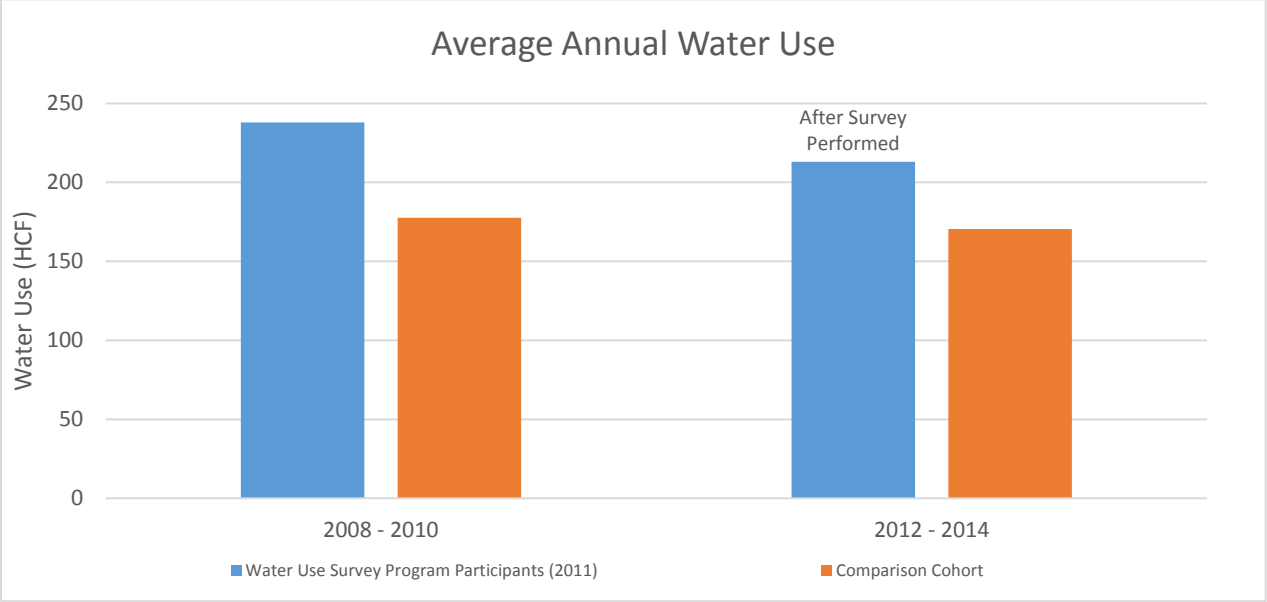


Table 6-21
SFR Water Use Survey Program Water Savings (2011) – City of Benicia
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2011. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-22
SFR Water Use Survey Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	51	255
Home Construction Years	--	1927 - 2009	1890 - 2010
Average House Size	sq ft	2,125	2,062
Average Number of Bedrooms	--	3.8	3.6
Average Number of Bathrooms	--	2.5	2.5
Average Lot Size	sq ft	8,671	8,645
Median Lot Size	sq ft	8,763	8,712
Number of Surveys Performed	--	51	n/a
Number of Surveys - Leaks Identified	--	5	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	22	n/a
Number of Surveys - Hardware Distributed (c)	--	33	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	195	170
Average Annual Water Use 2014 - 2015	HCF	138	126
Estimated Water Savings			
Reduction in Water Use per Account	HCF	57	43
Annual Water Savings per Survey Performed (d)	HCF	14	n/a
	gal	10,300	n/a

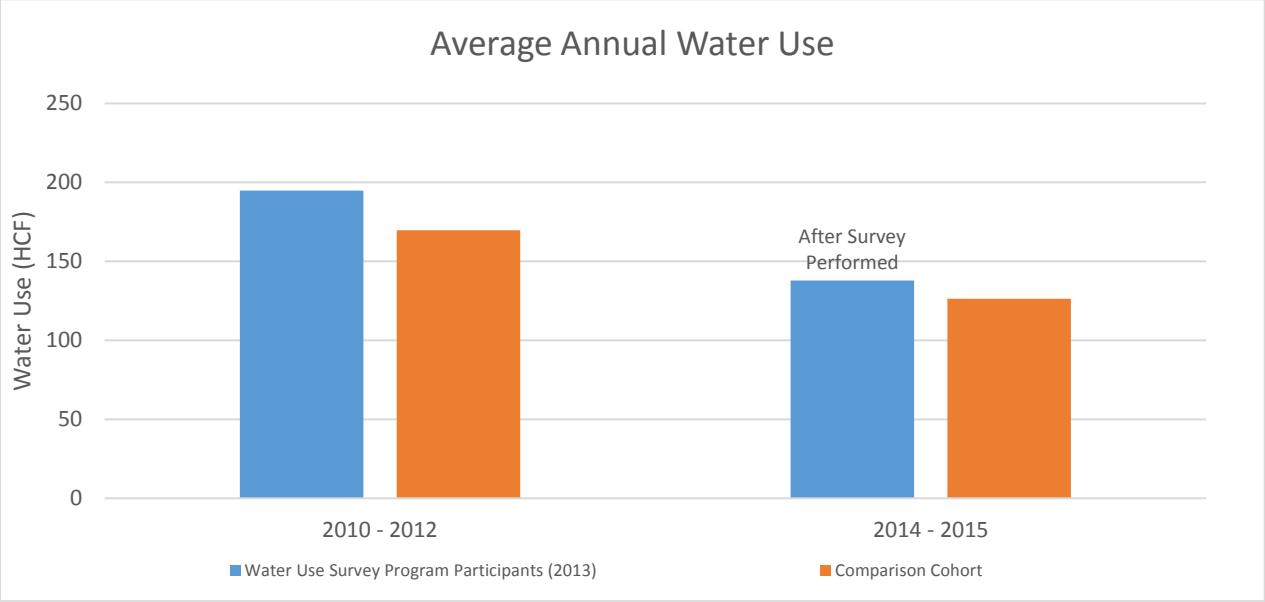


Table 6-22
SFR Water Use Survey Program Water Savings (2013) – City of Benicia
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2013. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-23
SFR Water Use Survey Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	175	880
Home Construction Years	--	1920 - 2008	1900 - 2008
Average House Size	sq ft	2,192	2,066
Average Number of Bedrooms	--	3.8	3.7
Average Number of Bathrooms	--	2.5	2.5
Average Lot Size	sq ft	8,680	8,103
Median Lot Size	sq ft	7,405	7,191
Number of Surveys Performed	--	177	n/a
Number of Surveys - Leaks Identified	--	38	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	52	n/a
Number of Surveys - Hardware Distributed (c)	--	38	n/a
Water Use			
Average Annual Water Use 2008 - 2010	HCF	241	190
Average Annual Water Use 2012 - 2014	HCF	241	194
Estimated Water Savings			
Reduction in Water Use per Account	HCF	0.4	-4
Annual Water Savings per Survey Performed (d)	HCF	4	n/a
	gal	3,261	n/a

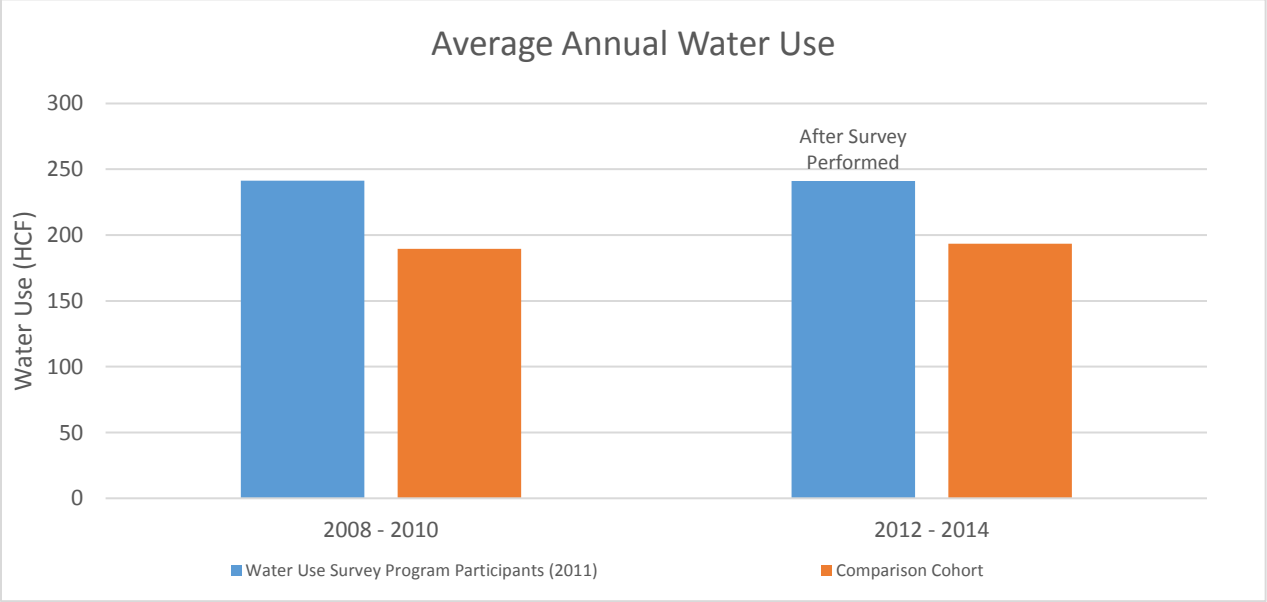


Table 6-23
SFR Water Use Survey Program Water Savings (2011) – City of Fairfield
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2011. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-24
SFR Water Use Survey Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	107	540
Home Construction Years	--	1938 - 2007	1902 - 2008
Average House Size	sq ft	2,226	2,101
Average Number of Bedrooms	--	3.8	3.7
Average Number of Bathrooms	--	2.6	2.4
Average Lot Size	sq ft	9,216	8,133
Median Lot Size	sq ft	8,276	7,777
Number of Surveys Performed	--	107	n/a
Number of Surveys - Leaks Identified	--	16	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	48	n/a
Number of Surveys - Hardware Distributed (c)	--	61	n/a
Water Use			
Average Annual Water Use 2010 - 2012	HCF	253	173
Average Annual Water Use 2014 - 2015	HCF	220	161
Estimated Water Savings			
Reduction in Water Use per Account	HCF	32	12
Annual Water Savings per Survey Performed (d)	HCF	20	n/a
	gal	15,087	n/a

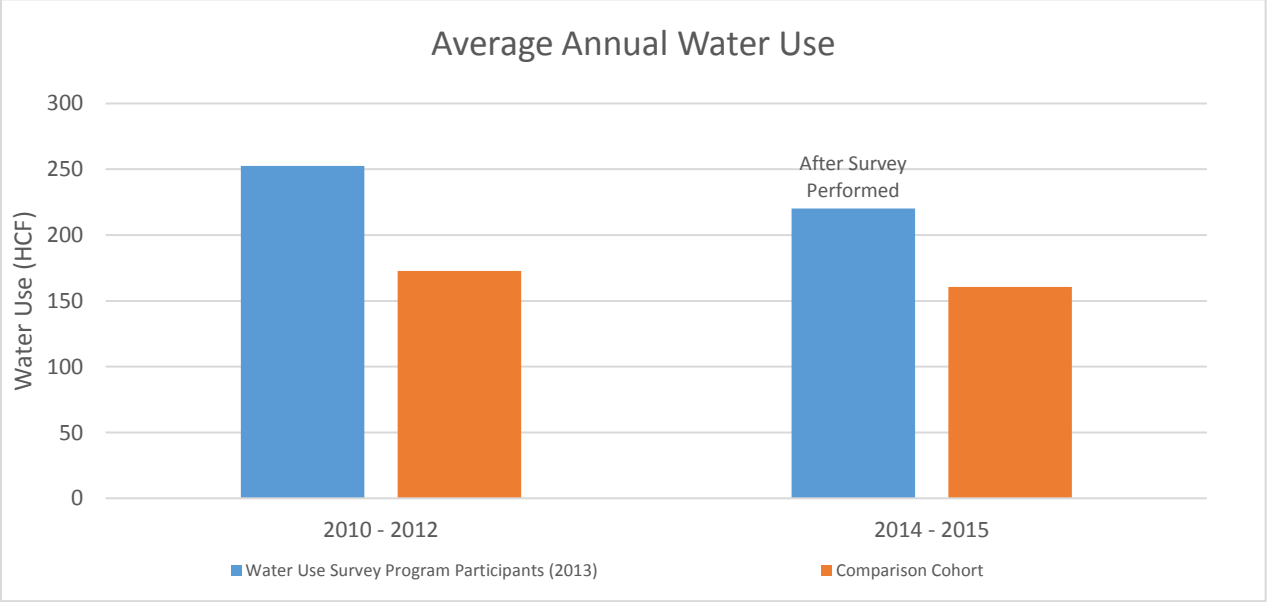


Table 6-24
SFR Water Use Survey Program Water Savings (2013) – City of Fairfield
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2013. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-25
SFR Water Use Survey Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

	Units	Water Use Survey Program Participants (a)	Comparison Cohort (b)
Account Characteristics			
Number of Accounts	--	141	705
Home Construction Years	--	1929 - 2010	1912 - 2012
Average House Size	sq ft	2,256	1,932
Average Number of Bedrooms	--	3.9	3.6
Average Number of Bathrooms	--	2.6	2.4
Average Lot Size	sq ft	9,160	7,952
Median Lot Size	sq ft	7,982	6,969
Number of Surveys Performed	--	141	n/a
Number of Surveys - Leaks Identified	--	34	n/a
Number of Surveys - Irrigation System Settings Adjusted	--	78	n/a
Number of Surveys - Hardware Distributed (c)	--	60	n/a
Water Use			
Average Annual Water Use 2012	HCF	226	190
Average Annual Water Use 2014 - 2015	HCF	173	160
Estimated Water Savings			
Reduction in Water Use per Account	HCF	53	30
Annual Water Savings per Survey Performed (d)	HCF	23	n/a
	gal	17,204	n/a

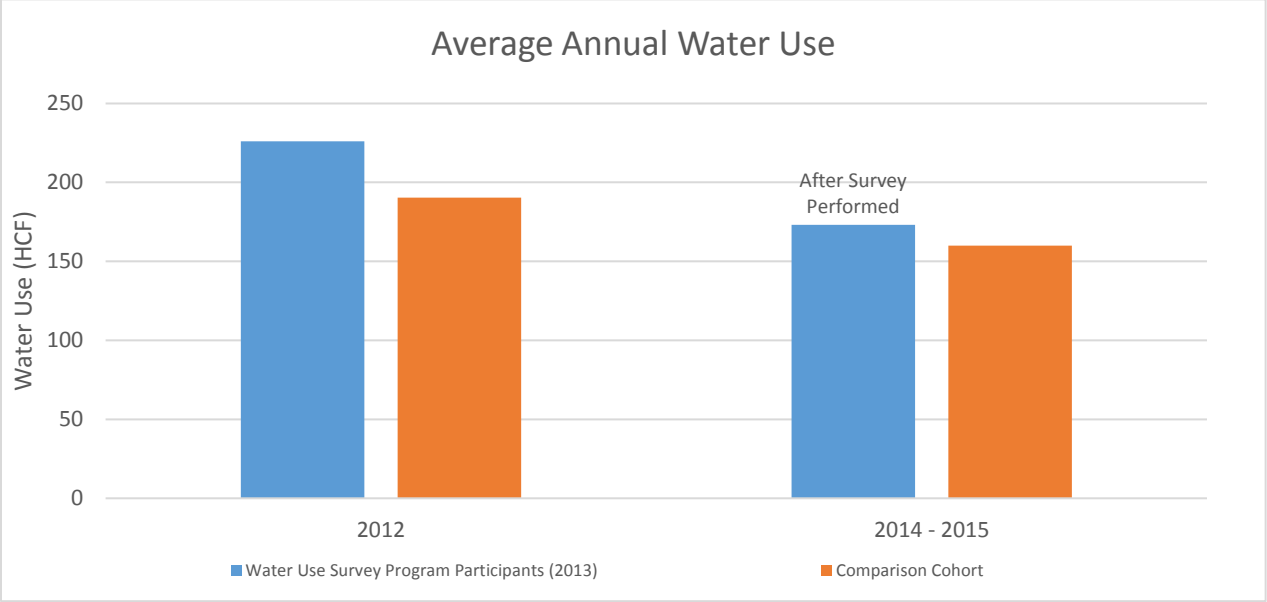


Table 6-25
SFR Water Use Survey Program Water Savings (2013) – City of Vacaville
Solano County Water Agency, California

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
n/a = not applicable
SFR = single-family residential
sq ft = square feet

Notes

(a) Accounts included for analysis are limited to those (1) for which water billing history data were available, (2) that are identified as single-family residences by the Solano County Assessor's Office, and (3) have only participated in the water use survey program based on available information.
(b) Accounts selected for the "Comparison Cohort" were randomly selected from the same neighborhoods (i.e., same census block group) as those that received a water use survey in 2011. Program participation records indicate that cohort accounts did not participate in a water use survey.
(c) Fixture hardware distributed includes kitchen and bathroom sink aerators, showerheads, and hose nozzles.
(d) Estimated annual water savings associated with the Water Use Survey Program are calculated as the incremental amount of water saved by the Water Use Survey Program participants over that of the Comparison Cohort accounts.

Table 6-26
Summary of Estimated SFR Rebate Program Savings and Costs - City of Vallejo
Solano County Water Agency, California

	Units	HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate (c)	Water Use Survey
Annual Water Savings due to program participation, per account (a)	HCF	17-18	9-18	15	44-48
	gal	12,600 - 13,200	7,100 - 13,300	11,000	33,200 - 35,600
Estimated Water Savings Over a 10-year Period, per account (b)	HCF	172	137	150	460
	gal	128,800	102,200	112,000	344,00
Estimated Range of Rebate Cost per 100 Gallons of Water Saved Over a 10-year Period (a)	$/100 gal	0.09	0.08 - 0.11	0.76	n/a

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
SFR = single-family residential

Notes

(a) Estimated water savings are summarized from Tables 6-1, 6-2, 6-8, 6-9, 6-15, 6-19, and 6-20.
(b) Estimated water savings over a 10-year period are calculated based on the average of the range of water savings per note (a).
(c) Average water savings is given per 1,000 square feet of turf replaced.

Table 6-27
Summary of Estimated SFR Rebate Program Savings and Costs - City of Benicia
Solano County Water Agency, California

	Units	HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate (c)	Water Use Survey
Annual Water Savings due to program participation, per account (a)	HCF	4-10	3-4	16	14-39
	gal	2,700 - 7,800	2,200 - 3,000	11,600	10,300 - 13,500
Estimated Water Savings Over a 10-year Period, per account (b)	HCF	70	35	160	159
	gal	52,500	26,300	116,000	119,000
Estimated Range of Rebate Cost per 100 Gallons of Water Saved Over a 10-year Period (a)	$/100 gal	0.15 - 0.47	0.25 - 0.47	0.65	n/a

Abbreviations
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
SFR = single-family residential

Notes
(a) Estimated water savings are summarized from Tables 6-3, 6-4, 6-10, 6-11, 6-16, 6-21, and 6-22.
(b) Estimated water savings over a 10-year period are calculated based on the average of the range of water savings per note (a).
(c) Average water savings is given per 1,000 square feet of turf replaced.

Table 6-28
Summary of Estimated SFR Rebate Program Savings and Costs - City of Fairfield
Solano County Water Agency, California

	Units	HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate (c)	Water Use Survey
Annual Water Savings due to program participation, per account (a)	HCF	7-9	0-3	24	4-20
	gal	5,100 - 7,100	300 - 1,900	18,000	3,200 - 15,100
Estimated Water Savings Over a 10-year Period, per account (b)	HCF	82	14	240	123
	gal	61,000	10,800	180,000	91,700
Estimated Range of Rebate Cost per 100 Gallons of Water Saved Over a 10-year Period (a)	$/100 gal	0.15 - 0.23	0.54 - 2.96	0.50	n/a

Abbreviations
gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
SFR = single-family residential

Notes
(a) Estimated water savings are summarized from Tables 6-5, 6-6, 6-12, 6-13, 6-17, 6-23, and 6-24.
(b) Estimated water savings over a 10-year period are calculated based on the average of the range of water savings per note (a).
(c) Average water savings is given per 1,000 square feet of turf replaced.

Table 6-29
Summary of Estimated SFR Rebate Program Savings and Costs - City of Vacaville
Solano County Water Agency, California

	Units	HE Toilet Rebate	HE Washer Rebate	Turf Replacement Rebate (c)	Water Use Survey
Annual Water Savings due to program participation, per account (a)	HCF	7	4	26	23
	gal	5,100	2,900	19,400	16,800
Estimated Water Savings Over a 10-year Period, per account (b)	HCF	68	39	260	225
	gal	51,000	29,000	194,000	168,000
Estimated Range of Rebate Cost per 100 Gallons of Water Saved Over a 10-year Period (a)	$/100 gal	0.22	0.26	0.41	n/a

Abbreviations

gal = gallons
HCF = one hundred cubic feet
HE = high efficiency
SFR = single-family residential

Notes

(a) Estimated water savings are summarized from Tables 6-7, 6-14, 6-18, and 6-25.
(b) Estimated water savings over a 10-year period are calculated based on the average of the range of water savings per note (a).
(c) Average water savings is given per 1,000 square feet of turf replaced.

7.0 REMAINING WATER CONSERVATION POTENTIAL

The SCWA's SFR water conservation programs have each reached thousands of customers across the service area and successfully reduced water use by those participating accounts. As discussed in previous sections, different factors contribute to the degree of water savings achieved through implementation of each program, resulting in varying amounts of water saved by customers within and between different cities. For example, the amount of water saved by implementation of a turf replacement project depends on the amount of turf replaced (partially a factor of yard size), the previous irrigation design (partially a factor of when the original landscaping was installed), and the amount of water previously used to irrigated it (partially a factor of ETo rate and location within the County), among other factors. In order to understand the potential for future water savings by SFR water conservation programs, SFR accounts were screened against key characteristics to identify accounts that had the highest potential for water savings and eligibility for program participation. The accounts screened through this process are identified as those to potentially target with education and outreach materials for SFR conservation programs in the future and can be used to estimate the amount of remaining potential water savings. This analysis was performed for each of the four member units that were able to provide account-level water use for this study: the Cities of Vallejo, Benicia, Fairfield, and Vacaville.

7.1 Methodology Used to Identify Target Program Opportunities

The strategic program opportunity analysis, presented in the following sections, suggests that the markets for the water conservation programs are not yet saturated within the SCWA service area. For each program, specific criteria were used to evaluate potential opportunities for future program participation within each city. Factors that were used to evaluate potential opportunities for each water conservation program were (1) prior participation in the water conservation program, and (2) water use. Additional program-specific criteria are described in each section below, including the general level of participation in the program in an area, age of housing stock, income in an area, and lot size.

Estimated potential water savings was calculated as the product of potential target accounts and the annual savings per account demonstrated by previous program participants and described in Section 6.0. Annual account savings was calculated as a weighted average of the water savings estimated for participating accounts in each city (see Tables 6-26 through 6-29), and weighting was based on the number of SFR parcels in each city.

7.2 HE Toilet Replacement Program Opportunities

The SFR accounts with the greatest potential for savings if they were to participate in an HE toilet replacement program[25] were identified based on the following criteria:

1) Have not previously received a rebate through SCWA's HE Toilet Rebate Program;
2) Are located in areas with average or low participation in the HE Toilet Rebate Program to date (see the "hot spot" analysis presented in Figures 4-5 through 4-8);
3) Have houses constructed prior to 1994 (i.e., were built prior to the effective date of the Energy Policy Act of 1992, which mandated that an efficiency standard of 1.6 gpf or less for toilets within the United States);
4) Are located in low income Census Block Groups; [26] and
5) Were among the top 20% of SFR water users in their respective city in 2013.

The results of this analysis are summarized on Figure 7-1 and in the table below. As of January 2016, all new toilets sold in California meet a minimum efficiency standard of 1.28 gpf, and as of January 2017 all toilets in SFR homes built prior to 1994 are required to be replaced with new HE toilets. However, as a practical matter, the requirement to replace older toilets is typically only enforceable when building permits are issued for a house and when houses are sold. Therefore, potential HE toilet replacement programs only serve to provide water savings if they 1) result in accounts changing-out an older toilet that would not have otherwise replaced the toilet and/or 2) incentivize an account to purchase a higher efficiency toilet than the new market standard (i.e., a 0.8 gpf toilet instead of a 1.28 gpf toilet). Of these, programs that incentivize toilet replacements that would not otherwise occur, such as those in lower-income households, would be expected to result in the greatest potential water savings.

Across all four cities, nearly 2,300 SFR accounts were identified as potential target opportunities for an HE toilet replacement program. If all of these accounts were to participate in such a program and replace an older inefficient toilet with an HE toilet and to the extent that these accounts would not otherwise be required to replace

HE Toilet Program Opportunities		
City	Potential Target SFR Accounts	Estimated Potential Water Savings (MG/year)
Vallejo	1,367	11
Benicia	50	0.4
Fairfield	745	6.0
Vacaville	137	1.1
Total	**2,299**	**19**

[25] The HE Toilet Rebate Program ended in 2015 and options for future programs are being considered, including potentially a direct-installation program for low-income and senior households.

[26] As discussed in Section 5.1, household income is based on 2014 Census estimated median household income and HCD income level groupings.

their toilets, based on the water savings estimated in Section 6.2 above, approximately 19 MG of water could be saved per year.

7.3 HE Washer Replacement Program Opportunities

The SFR accounts with the greatest potential for savings if they were to participate in an HE washer replacement program[27] were identified based on the following criteria:

1) Have not previously received a rebate through SCWA's HE Washer Rebate Program;
2) Are located in areas with average or low participation in the HE Washer Rebate Program to date (see the "hot spot" analysis presented in Figures 4-9 through 4-12);
3) Have houses constructed prior to 2007 (i.e., when the 2005 California Appliance Efficiency Regulations became effective and established minimum standards for the efficiency of residential clothes washers);
4) Are located in low income Census Block Groups; and
5) Were among the top 20% of SFR water users in their respective city in 2013.

The SFR accounts to potentially target for future participation in the HE Washer Program are shown on Figure 7-2 and summarized in the table to the right. In total, across the four cities, almost 2,400 SFR accounts were identified as potential target accounts. If these accounts were all to replace older inefficient washers with new HE washing machines, it could result in approximately 12 MG of water savings per year.

HE Washer Program Opportunities		
City	**Potential Target SFR Accounts**	**Estimated Potential Water Savings (MG/year)**
Vallejo	1,382	6.6
Benicia	75	0.4
Fairfield	779	3.7
Vacaville	157	0.8
Total	**2,393**	**12**

7.4 Turf Replacement Rebate Program Opportunities

The SFR accounts with the greatest potential for savings if they were to participate in SCWA's Turf Replacement Rebate program were identified based on the following criteria:

1) Have not previously received a rebate through SCWA's Turf Replacement Rebate Program;
2) Are located in areas with average or low participation in the Turf Replacement Rebate Program to date (see the "hot spot" analysis presented in Figures 4-12 through 4-15);

[27] The HE Washer Rebate Program was canceled by PG&E and will be continued by SCWA through 2017.

3) Have a lot size less than one acre and a greater than average potential landscape area, within their respective city [28];
4) Have houses constructed prior to 2010 (i.e., following the 2010 Water-Efficient Landscape Ordinance adoption, establishing minimum standards for the efficiency residential landscape irrigation in new homes);
5) Are located in low or moderate income Census Block Groups; and
6) Were among the top 20% of SFR water users in their respective city in 2013.

The SFR accounts to potentially target for future participation in the Turf Replacement Rebate Program are shown on Figure 7-3 and summarized in the table to the right. In total, across the four cities, approximately 3,200 SFR accounts were identified as potential target accounts. If these accounts were all to replace 1,000 sq ft of existing turf landscapes with water efficient landscaping and replace their irrigation systems with one appropriate for the new landscape, it could result in approximately 50 MG of water savings per year.

Turf Program Opportunities		
City	Potential Target SFR Accounts	Estimated Potential Water Savings (MG/year)
Vallejo	1,355	21
Benicia	211	3.3
Fairfield	873	14
Vacaville	767	12
Total	**3,206**	**50**

7.5 Residential Water Use Survey Program Opportunities

The SFR accounts with the greatest potential for savings if they were to participate in SCWA's Residential Water Use Survey program were identified based on the following criteria:

1) Have not previously participated in the SCWA Residential Water Use Survey Program;
2) Reduced their water use by less than 10% between 2013 and 2015 (potentially indicating the presence of a leak or change in behavior); and
3) Were among the top 20% of SFR water users in their respective city in 2013.

The SFR accounts to potentially target for future participation in Water Use Surveys are shown on Figure 7-4 and summarized in the table to the right. In total, across the four cities, nearly 1,800 SFR accounts

Residential Water Use Survey Program Opportunities		
City	Potential Target SFR Accounts	Estimated Potential Water Savings (MG/year)
Vallejo	901	18
Benicia	64	1.3
Fairfield	417	8.4
Vacaville	386	7.8
Total	**1,768**	**36**

[28] Potential landscape area is estimated as the difference between total lot size and square footage of a home's first floor, per parcel data provided by the Assessor's Office.

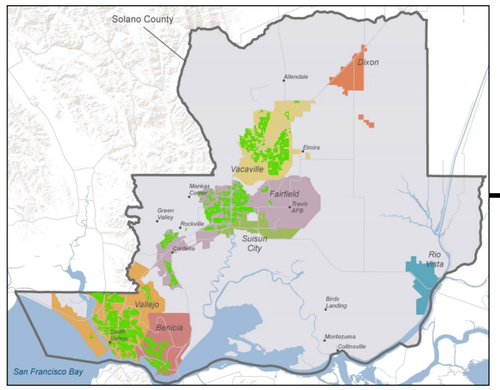
were identified as potential target accounts. If these accounts were all to receive a Residential Water Use Survey by SCWA staff, it could result in approximately 36 MG of water savings per year.

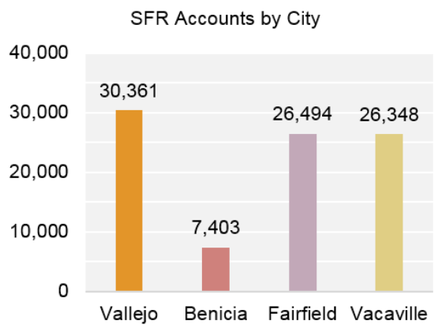
7.6 Program Opportunities Summary

Based on the analysis discussed above, significant water savings potential remains for each of the water conservation programs evaluated. The greatest potential water savings are available through the Turf Replacement Rebate and Residential Water Use Survey programs, with estimated potential savings of 50 MG/year and 36 MG/year, respectively.

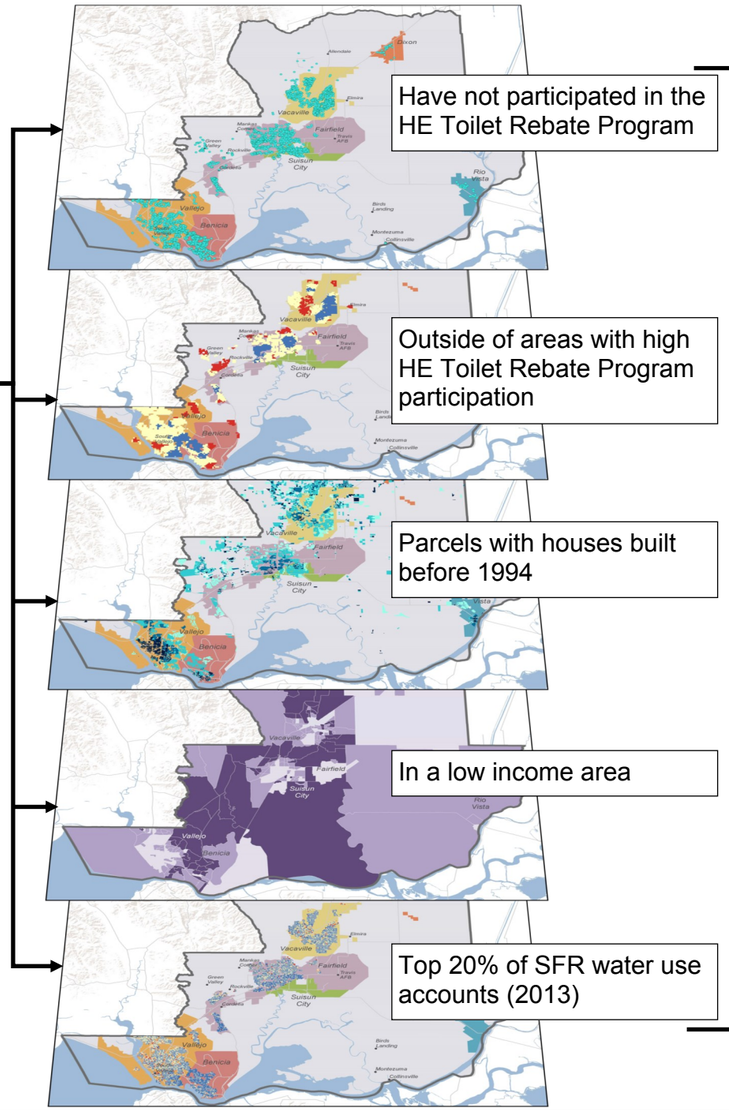
SFR Conservation Program	Estimated Annual Water Savings Per Account	Potential Target SFR Accounts	Remaining Conservation Potential
HE Toilet Replacement	8,000 gallons	2,299	18 MG/year
HE Washer Replacement	4,800 gallons	2,393	12 MG/year
Turf Replacement Rebate	16,000 gallons	3,206	50 MG/year
Residential Water Use Survey	20,000 gallons	1,768	36 MG/year

SFR Accounts



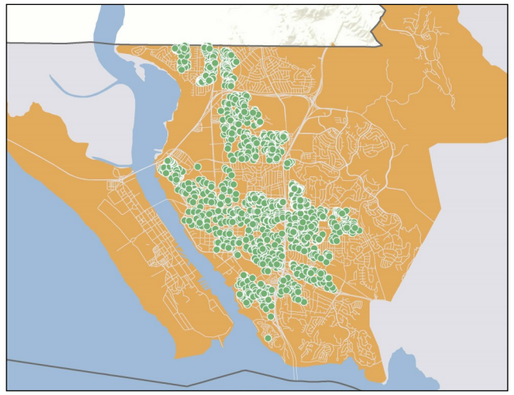


Program Targeting Criteria



Potential Target SFR Accounts

Vallejo

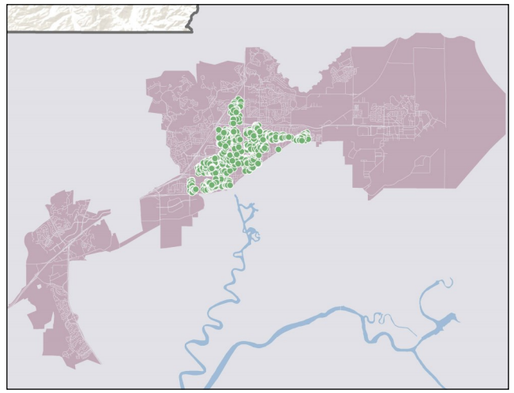


1,367 Accounts to Target
11.0 MG/year Estimated Potential Savings

Benicia

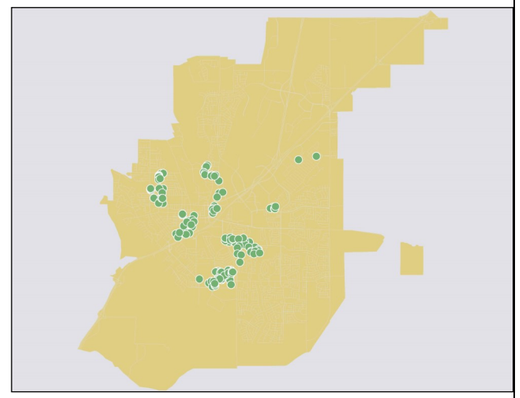
50 Accounts to Target
0.4 MG/year Estimated Potential Savings

Fairfield



745 Accounts to Target
6.0 MG/year Estimated Potential Savings

Vacaville



137 Accounts to Target
1.1 MG/year Estimated Potential Savings

Abbreviations

gpd = gallons per day
HE = high efficiency
MG = million gallons
SFR = single-family residential

Notes

1. All locations are approximate.
2. Accounts identified to potentially target for participation in an HE toilet program are those that 1) have not previously participated in the HE toilet rebate program (see Figures 4-5 through 4-8), 2) are from areas of their city that have had average or lower participation in the program (see Figures 4-5 through 4-8), 3) have houses built prior to the 1992 Federal Energy Policy Act (effective 1994) (see Figures 2-5 through 2-8), 4) are located within low income areas (based on Census data) (see Figures 5-2 through 5-5), and 5) are among the top 20% of SFR water use accounts in their city (see Figures 3-5 through 3-8).
3. Estimated potential water savings was calculated based on an annual savings of 8,000 gallons per account demonstrated by previous program participants. This annual account savings was calculated as a weighted average of the water savings estimated for participating accounts in each city (see Tables 6-26 through 6-29) and weighted based on the number of SFR accounts in each city.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Toilet
Program Opportunities

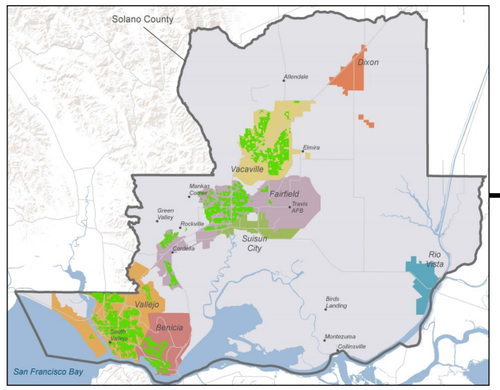
Study of Single-Family Residential Water
Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01

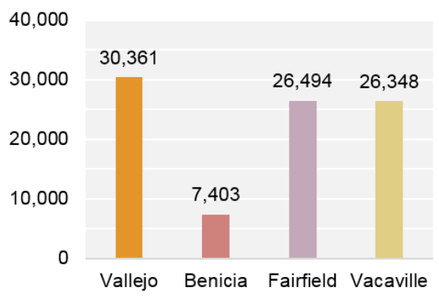
Figure 7-1

eki environment & water

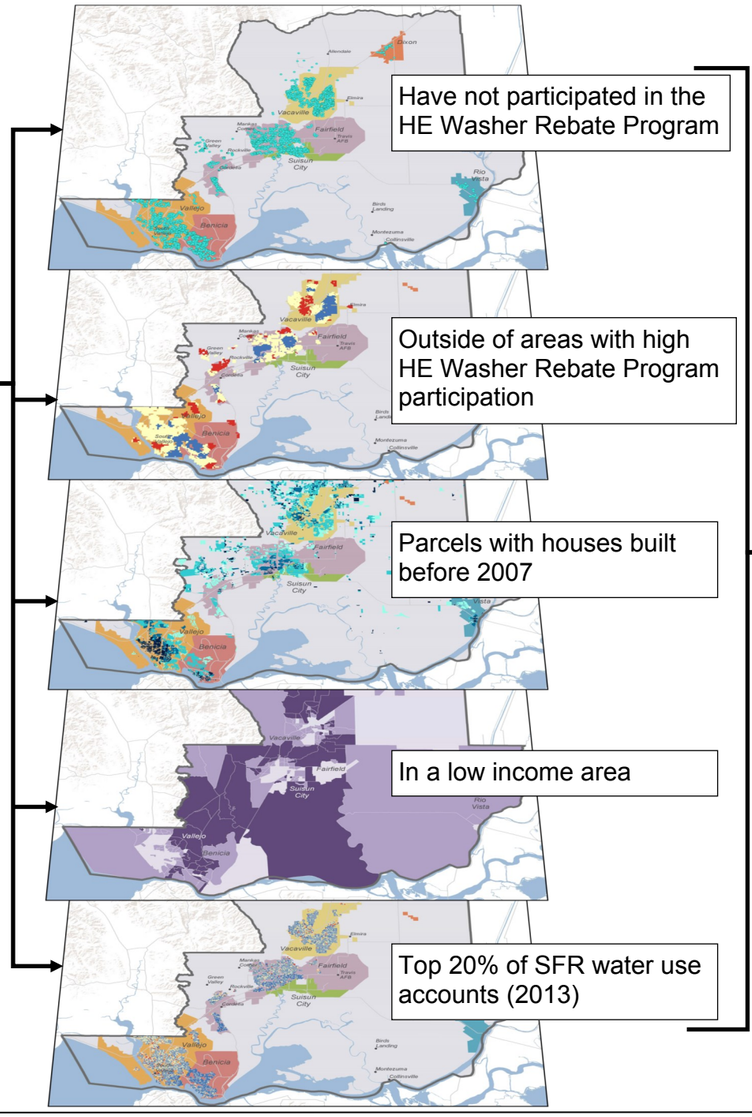
SFR Accounts



SFR Accounts by City

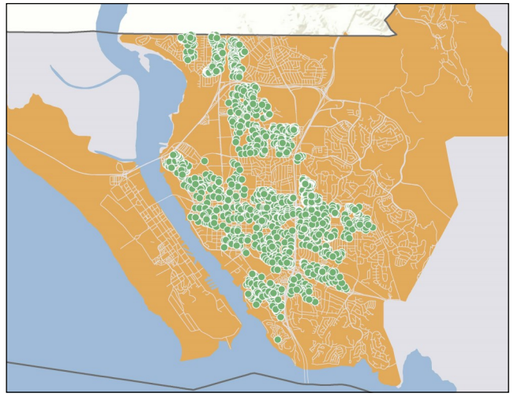


Program Targeting Criteria



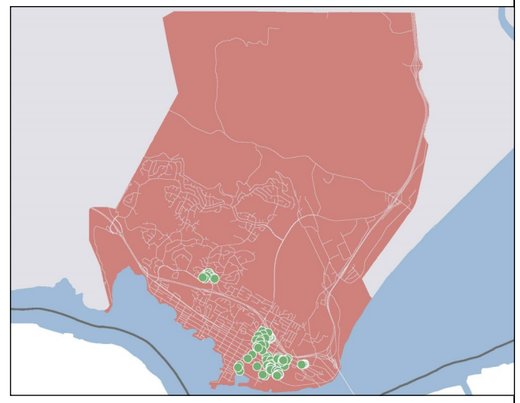
Potential Target SFR Accounts

Vallejo



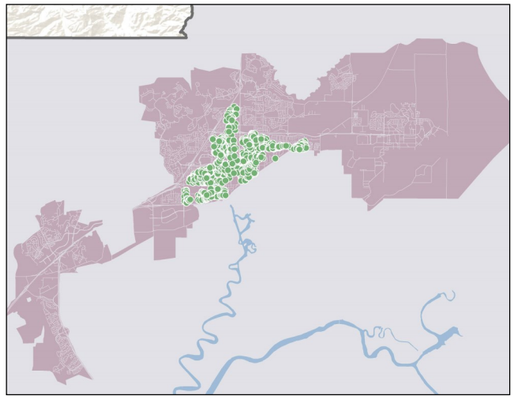
1,382 Accounts to Target
6.6 MG/year Estimated Potential Savings

Benicia



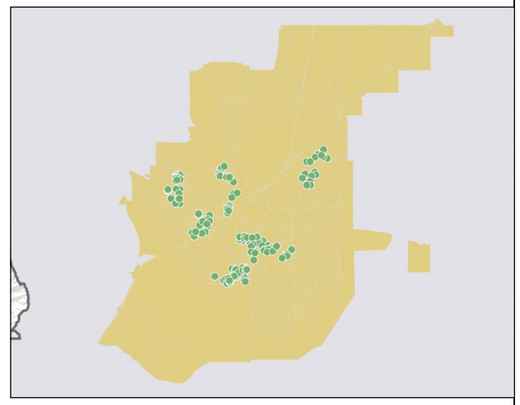
75 Accounts to Target
0.4 MG/year Estimated Potential Savings

Fairfield



779 Accounts to Target
3.7 MG/year Estimated Potential Savings

Vacaville



157 Accounts to Target
0.8 MG/year Estimated Potential Savings

Abbreviations

gpd = gallons per day
HE = high efficiency
MG = million gallons
SFR = single-family residential

Notes

1. All locations are approximate.
2. Accounts identified to potentially target for participation in an HE washer program are those that 1) have not previously participated in the HE washer rebate program (see Figures 4-9 through 4-12), 2) are from areas of their city that have had average or lower participation in the program (see Figures 4-9 through 4-12), 3) have houses built prior to the 2005 California Appliance Efficiency Regulations (standards effective 2007) (see Figures 2-5 through 2-8), 4) are located within low income areas (based on Census data) (see Figures 5-2 through 5-5), and 5) are among the top 20% of SFR water use accounts in their city (see Figures 3-5 through 3-8).
3. Estimated potential water savings was calculated based on an annual savings of 4,800 gallons per account demonstrated by previous program participants. This annual account savings was calculated as a weighted average of the water savings estimated for participating accounts in each city (see Tables 6-26 through 6-29) and weighted based on the number of SFR accounts in each city.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR HE Washer
Program Opportunities

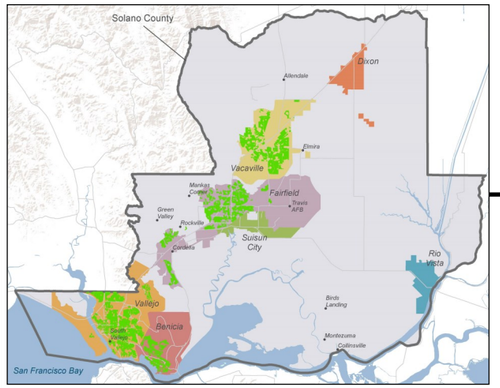
Study of Single-Family Residential Water
Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01

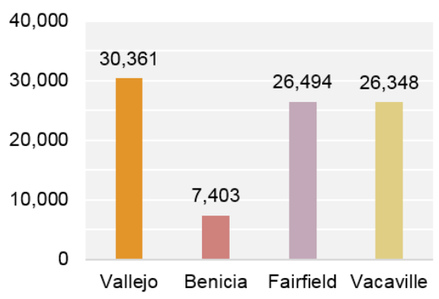
eki environment & water

Figure 7-2

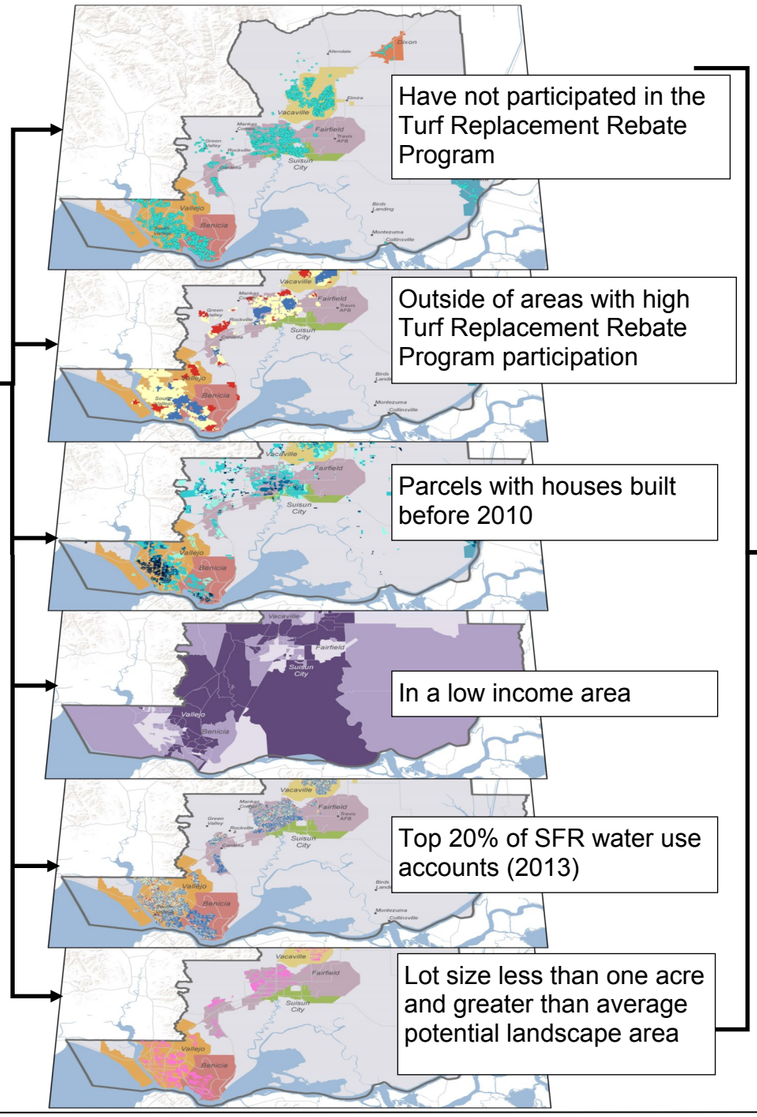
SFR Accounts



SFR Accounts by City

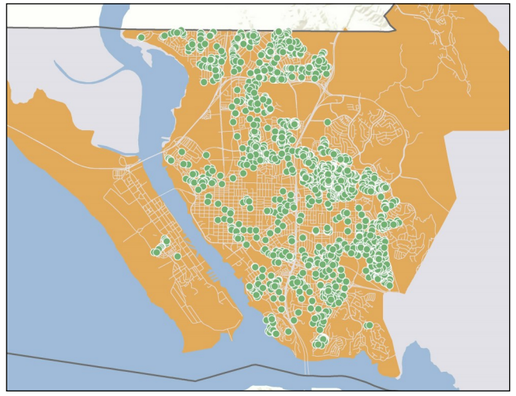


Program Targeting Criteria



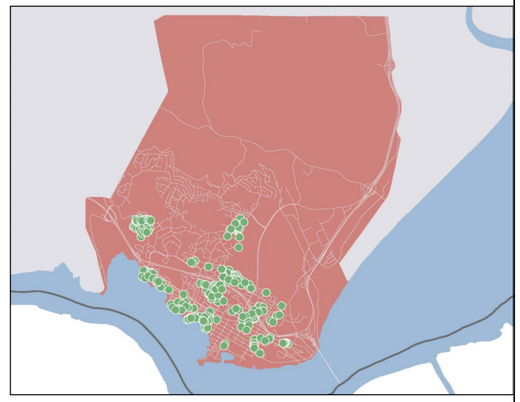
Potential Target SFR Accounts

Vallejo



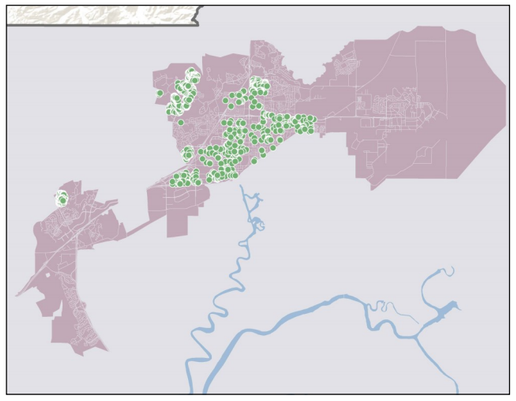
1,355 Accounts to Target
21.2 MG/year Estimated Potential Savings

Benicia



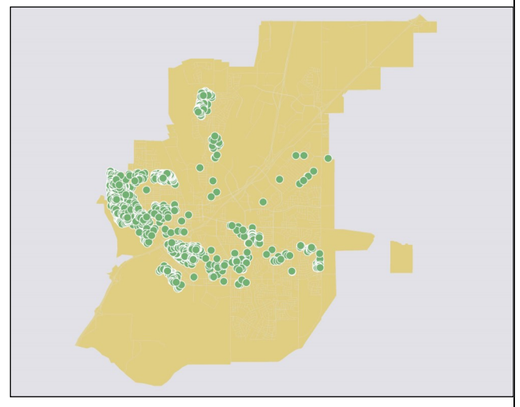
211 Accounts to Target
3.3 MG/year Estimated Potential Savings

Fairfield



873 Accounts to Target
13.6 MG/year Estimated Potential Savings

Vacaville



767 Accounts to Target
12.0 MG/year Estimated Potential Savings

Abbreviations

gpd = gallons per day
HE = high efficiency
MG = million gallons
SFR = single-family residential

Notes

1. All locations are approximate.
2. Accounts identified to potentially target for participation in a turf replacement program are those that 1) have not previously participated in the turf replacement program (see Figures 4-13 through 4-16), 2) are from areas of their city that have had average or lower participation in the program (see Figures 4-13 through 4-16), 3) have houses built prior to the Vallejo Water Efficient Landscaping Ordinance (effective January 2010) (see Figures 2-5 through 2-8), 4) are located within low income areas (based on Census data) (see Figures 5-2 through 5-5), 5) are among the top 20% of SFR water use accounts in their city (see Figures 3-5 through 3-8), and 6) have a lot size less than one acre and greater than average potential landscape area (estimated as the difference between total lot size and square footage of a home's first floor).
3. Estimated potential water savings was calculated based on an annual savings of 16,000 gallons per 1,000 square feet of turf replaced demonstrated by previous program participants and using the maximum turf rebate area of 1,000 square feet. This annual account savings was calculated as a weighted average of the water savings estimated for participating accounts in each city (see Tables 6-26 through 6-29) and weighted based on the number of SFR accounts in each city.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR Turf Replacement Program Opportunities

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

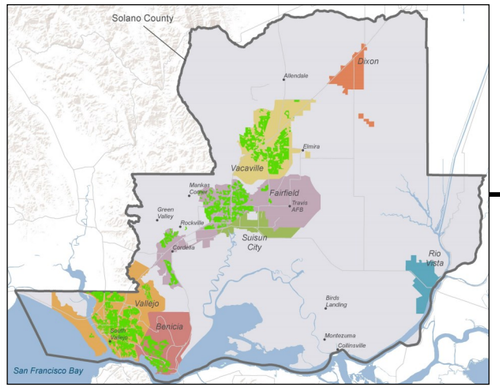
July 2017
EKI B50067.01

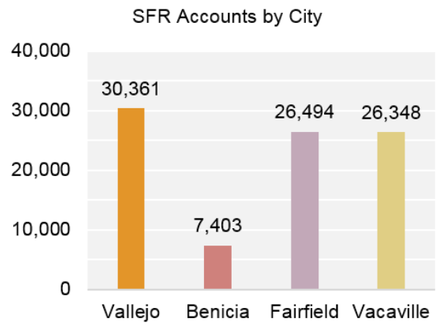
eki environment & water

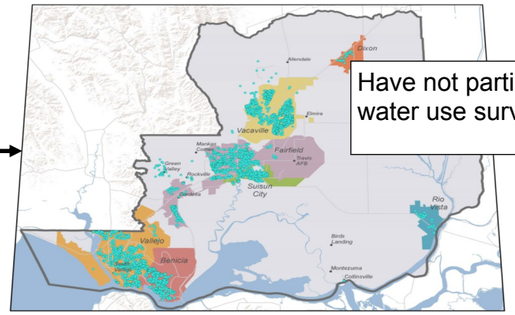
Figure 7-3

Program Targeting Criteria

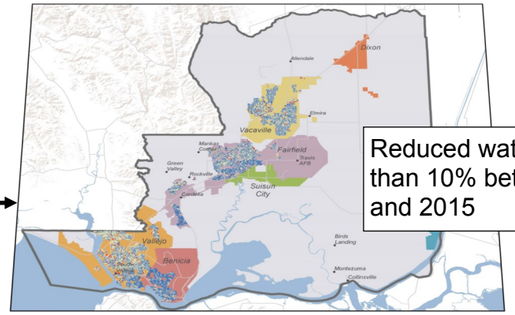
SFR Accounts



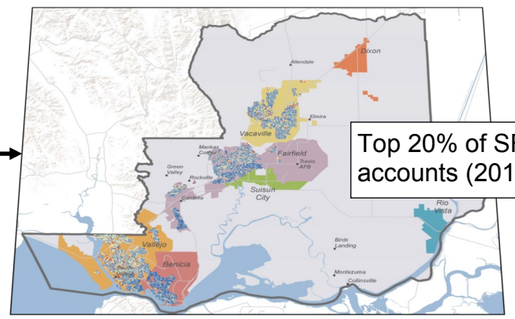




Have not participated in water use surveys



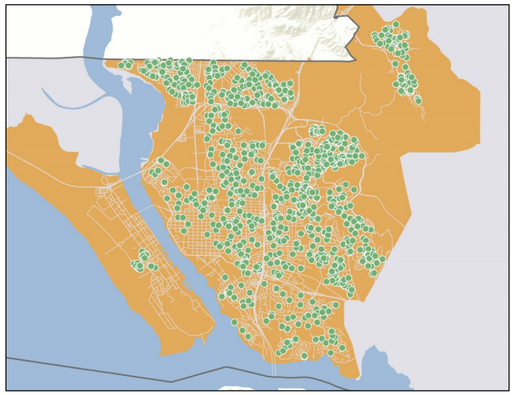
Reduced water use by less than 10% between 2013 and 2015



Top 20% of SFR water use accounts (2013)

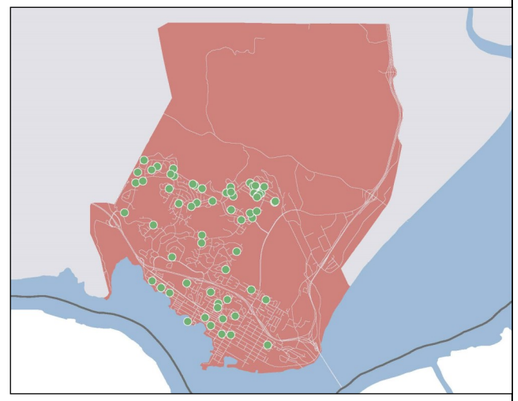
Potential Target SFR Accounts

Vallejo



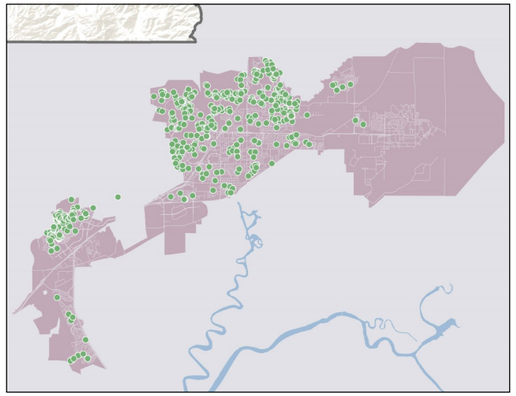
901 Accounts to Target
18.1 MG/year Estimated Potential Savings

Benicia



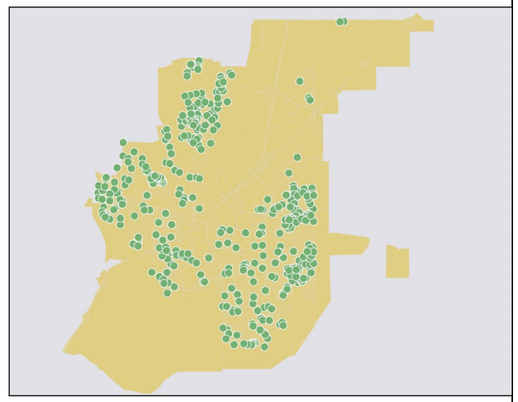
64 Accounts to Target
1.3 MG/year Estimated Potential Savings

Fairfield



417 Accounts to Target
8.4 MG/year Estimated Potential Savings

Vacaville



386 Accounts to Target
7.8 MG/year Estimated Potential Savings

Abbreviations

gpd = gallons per day
HE = high efficiency
MG = million gallons
SFR = single-family residential

Notes

1. All locations are approximate.
2. Accounts identified to potentially target for participation in water use surveys are those that 1) have not previously participated in water use surveys (see Figures 4-17 through 4-20), 2) are among the top 20% of SFR water use accounts in their city (see Figures 3-5 through 3-8), and 3) reduced their water use by less than 10% between 2013 and 2015 (see Figures 3-5 through 3-8).
3. Estimated potential water savings was calculated based on an annual savings of 20,000 gallons per account demonstrated by previous program participants. This annual account savings was calculated as a weighted average of the water savings estimated for participating accounts in each city (see Tables 6-26 through 6-29) and weighted based on the number of SFR accounts in each city.

Sources

1. Parcel locations and attributes provided by the Solano County Assessor's Office, August 2015.
2. Basemap layers obtained from the Solano Regional GIS Consortium website, 2015.

SFR Water Use Survey
Program Opportunities

Study of Single-Family Residential Water Use and Conservation Potential
Solano County Water Agency, CA

July 2017
EKI B50067.01

Figure 7-4

8.0 CONSERVATION PROGRAM CONSIDERATIONS AND POTENTIAL NEXT STEPS

Analysis presented in previous sections identified the relative water savings achieved by implementation of the current or recent SFR water conservation programs, the spatial and other trends in participation by each program, and the key characteristics that effected the observed water savings and participation levels. The SFR accounts were screened by these key characteristics to identify SFR accounts that could potentially be targeted with outreach and educational materials to increase participation in these or similar conservation programs. Based on the findings of these analyses, considerations for the strategic refinement of SCWA SFR water conservation programs, potential future conservation programs, and additional actions that will support SCWA and its member units with long-term water conservation and drought response planning are discussed below.

8.1 Refinement of Current and Recent SCWA SFR Water Conservation Programs

8.1.1 *Potential HE Toilet Programs*

The SCWA's HE Toilet Rebate Program was ended in January 2015, coincident with the state-wide change to toilet efficiency standards, requiring all toilets for sale after 2014 to be 1.28 gpf or more efficient. However, of the four SFR water conservation programs evaluated, the HE Toilet Rebate Program has had the highest number of participating accounts County-wide and, in terms of rebate dollars spent, has been the most cost-effective program. As such, it will be important for SCWA to evaluate potential options to continue and expand these water savings benefits.

- **Continue to Pilot a Direct Install HE Toilet Program for Low-Income and Seniors:** SCWA is currently performing a pilot of a new HE toilet-focused program that replaces rebates with the direct-installation of HE toilets for low income and senior households. Given the historically low participation levels in the HE Toilet Rebate Program by SFR accounts in low income neighborhoods, this focused direct-installation program is expected to reach SFR customers that would not have otherwise replaced their old, high-water-use toilet. Results of the pilot, including an analysis of participation, cost and perceived effectiveness will be conducted in 2018 and the decision will be made whether to expand this program beyond the pilot phase.

- **Offer Ultra HE Toilet Rebates:** Another toilet-focused option that SCWA could consider is providing a rebate incentive to replace 1.6 gpf or higher toilets with ultra HE toilets (i.e., toilets that use 0.8 to 1.0 gpf). Given the recent changes in minimum efficiency standards for toilets sold in California, toilet rebates could be used to incentivize the purchase of a 0.8 gpf toilet instead of a 1.28 gpf toilet, resulting in a

potential incremental savings of approximately 0.48 gpf, or nearly 900 gallons per person per toilet annual water savings.[29] While such a rebate program could be offered, the resultant water savings may not be as high as those that could be achieved by other programs.

8.1.2 *Modify HE Washer Program*

PG&E has cancelled its HE Washer Rebate Program, wherein it partnered with SCWA and other similar agencies to share rebate costs. As a result, the cost of any future HE washer-focused program would be borne solely by SCWA and its member units. Of the four SFR water conservation programs evaluated herein, the HE Washer Rebate program resulted in the lowest per account water savings at a County-wide level at the second highest cost. Given that the cost of such a program would no longer be shared with PG&E, HE washer rebate programs would not likely be very cost-effective, relative to other available options. If future HE washer programs are explored, refinements for the program could include targeting lower income and/or senior households with outreach and education materials and/or offering tiered rebate amounts relative to the level of efficiency. The SFR accounts identified under Section 7.3 could be specifically targeted with education and outreach materials to encourage participation by those accounts with the significant potential for water savings.

8.1.3 *Turf Replacement Rebate Program*

Of the four SFR water conservation programs evaluated, the Turf Replacement Rebate Program resulted in the second highest amount of water savings on a per account basis. Despite being the newest program evaluated, participation in the Turf Replacement Rebate Program has increased significantly over the last several years. Some of this increased level of participation is likely due to the public awareness of the historic 2012-2016 drought. Given the heavy winter rains of 2016-2017, SCWA may face a challenge maintaining the same momentum and level of participation in the program experienced during the drought.

- **Targeted Messaging for Turf Replacement Rebate Program:** A key strategy to maintain the success of the Turf Replacement Rebate Program is to implement targeted outreach to key SFR accounts, focusing on those with the highest potential for water savings. Options for targeted public outreach include, among other things: (1) distributing door hangers in neighborhoods with large numbers of target accounts, (2) hosting turf replacement educational workshops in neighborhoods with large numbers of target accounts, or (3) advertising the program through bill inserts to neighborhoods with a large number of target accounts. Given that the program has the largest effect in the hotter, drier parts of the service area, SCWA could also consider promoting the program most aggressively in the easternmost cities via social

[29] This calculation assumes 5 flushes per person per toilet per day (BAWSCA, 2013).

media programs that allow for limited localized messaging such as Facebook and Nextdoor.

- **Identify Barriers to Participation in Turf Replacement Program:** Another strategy to encourage participation in the Turf Replacement Rebate Program is to identify and reduce customer barriers to participation. A turf replacement project is a significant undertaking for most SFR customers and many possible real and perceived hurdles can stop a customer from moving forward with a new project. Such hurdles include the perception that drought-tolerate plants will result in an unattractive yard, lack of knowledge of appropriate water-efficient plants, tradeoff between a daunting do-it-yourself ("DIY") design and selecting a professional landscape designer, and the process of selecting a landscape contractor, in addition to the project cost. With a better understanding of the biggest barriers to implementation, SCWA could then tailor the program and/or outreach to specifically address these hurdles. For example, if one of the most significant barriers is found to be a lack of knowledge of drought tolerant plants, SCWA could specifically focus its outreach materials to plant education resources such as the ReScape California website (http://rescapeca.org/).

8.1.4 *Residential Water Use Survey Program*

Of the four SFR water conservation programs evaluated, the Residential Water Use Survey Program resulted in the highest amount of water savings on a per account basis. The surveys are conducted by SCWA staff and often include the identification of water leaks that are subsequently repaired and/or the adjustment of landscape irrigation settings to those more appropriate for the specific landscape - activities that can result in substantial water savings. The program currently targets the top 10% of water users in each member units service area and is therefore already very focused on accounts with very high water savings potential. In order to increase participation, SCWA could consider reaching out to HOAs, neighborhood watch groups, and other organized community groups, to the degree they are active in neighborhoods with many high-water-using accounts. The program can be promoted through social media services that allow for localized messaging such as Facebook and Nextdoor. The SCWA could also consider expanding the program, offering Residential Water Use Surveys to customers located in low income areas, who have high levels of water use, but may not fall within the top 10% tier of water users. Section 7.5 identified potential SFR accounts to target, using an alternative set of screening criteria, including accounts that did not demonstrate the typical reduction in water use during the drought.

8.1.5 *Smart Irrigation Controller Rebate*

To date, there has been minimal participation in the Smart Irrigation Controller Rebate Program compared to the other SFR water conservation programs offered by SCWA. Smart Irrigation Controllers automatically adjust the amount of water applied to a landscape based on changes in weather over the course of the year. Such controllers have the potential to

provide the most water savings when used by households that do not vary their landscape irrigation rates over the course of the year to reduce watering in wetter months. SCWA could therefore conduct additional analysis of water use histories to identify high-water using SFR accounts where the water use remains relatively constant over the course of the year, i.e., accounts that do not currently adjust their landscape irrigation based on the season. Such accounts could then be targeted with education and outreach materials.

8.2 Additional Water Conservation Program Options

8.2.1 *Build Database of Customer Emails*

Building up a database of customer email addresses would facilitate SCWA and its member units to conduct cost-effective and targeted customer outreach and messaging. Such outreach would also serve to build a direct relationship between SCWA and the retail customers and elevate the agency's visibility to the community. One method to increase and build customer email lists is to host raffles at community outreach events, where customers are encouraged to submit their physical mailing and email addresses to enter a raffle for a relatively inexpensive prize such as gift cards donated by local businesses. Linking physical mailing addresses to email addresses would allow for SCWA and its member units to target outreach to specific target areas.

8.2.2 *Conduct Analysis of Home Water Report Software Benefits*

Since 2015, the City of Benicia has been implementing WaterSmart Software, a service that provides individualized home water use reports that compare a customer's water use to that of other similar customers as part of customers' water bills. Given that this program has been implemented by Benicia, for nearly two years, SCWA could work with the city to evaluate the sustained effectiveness and customer-approval of the program. Such an evaluation could be conducted via a web-based survey of City of Benicia customers coupled with the evaluation of water use data. If an evaluation suggests that WaterSmart Software program is beneficial in reducing customer water use in Benicia and that the effect is sustained, SCWA could evaluate the feasibility of implementing WaterSmart or other similar customer feedback software systems (e.g., DropCountr and Smart Utility Systems) on a regional basis.

8.2.3 *Evaluation of Water Use and Drought Response by Other Customer Sectors*

This study and the Pilot Study focused on water use by SFR accounts. However, the analysis of water use and drought response presented in Section 3.0 could be applied to other water use sectors, particularly CII and MFR. To the extent that CII accounts could be identified by their specific business type (e.g., restaurants, gas stations, manufacturing facilities), such an analysis could provide an understanding of what business types have the potential to save water when motivated, and which are more restricted in their water use. The results of such

a study could facilitate (1) development projections of future water demands, (2) planning for and response to future drought events, and (3) development of more accurate California Environmental Quality Act- ("CEQA-") required Water Supply Assessments, among other things.

8.2.4 *Drought Response and Water Shortage Contingency Planning*

The recent Executive Order B-37-16 *Making Water Conservation a California Way of Life* ("Order") outlines future water conservation planning requirements for urban water suppliers (DWR, 2016). One of the goals of the Order is to strengthen local drought resistance, and as such, requires DWR to strengthen requirements for Water Shortage Contingency Plans ("WSCPs") by urban water suppliers. Going forward, WSCPs will need to include additional elements such as annual water budget forecast procedures, defined lists of shortage response actions to be taken in the event of water shortages at a minimum of six stages of water supply shortage, and a communication plan for disseminating information to customers and other parties. The SFR drought response analysis presented in Section 3.0 and, if performed, a similar study of the other water sectors (Section 8.2.3), can inform WSCP development by identifying the amount of water saved and the varying levels of responsiveness by customers to the drought response actions implemented in 2012-2016. By taking a closer look at the specific actions implemented by the member units, SCWA, and the State as well as associated media attention during this last drought and the corresponding customer responses, the member units can use this information to develop more robust and effective WSCPs under the new requirements. In particular, looking at significant water savings achieved by Benicia SFR customers as a result of Benicia's comprehensive customer outreach campaign can help guide effective WSCP development. Likewise, building customer email databases and other direct customer outreach methods (Section 8.2.1) would facilitate the development and implementation of the communication plan element of WSCPs.

8.2.5 *Water Conservation Targets Beyond 2020*

The Order and subsequent report outlining its implementation (DWR, 2016) describes a new framework for determining conservation targets as part of urban water suppliers' UWMP development process. These new standards will be determined by 2020 and must be reported in 2020 UWMPs, and water use by suppliers will be required to comply with the new standards by 2025. Although compliance will be required on a system-wide basis, the conservation standards (targets) will be developed and reported-on using a water budget approach, with separate methodologies to determine budgets for 1) indoor residential water use, 2) outdoor water use, 3) indoor CII water use, and 4) water lost through leaks. The estimated breakdown of indoor and outdoor water by SFR accounts presented in Section 3.0 provides a foundation for analysis of past SFR water use relative to the future targets. The scope of this analysis has been limited to SFR water use, but a similar analysis could be conducted for water use by MFR and CII accounts.

9.0 CONCLUSIONS

This study built on the findings and methodology developed in the Pilot Study, and presented updated analyses for the City of Vallejo and new analyses for three additional SCWA member units: City of Benicia, City of Fairfield, and City of Vacaville. Together, these four cities include over 80% of the SFR accounts in Solano County. The results of the conservation program evaluations (Sections 4.0 through 6.0) provide insights on variables that affect both participation rates and overall water savings. These findings can be used to support future conservation efforts by SCWA and its member units, through strategic targeting of conservation programs (Section 7.0), refinements to the current SFR water conservation programs offered by SCWA, and potential addition of new conservation programs (Section 8.0). In addition to supporting long-term conservation efforts and compliance with new UIWMP water conservation standards, the findings of the SFR water use and drought response analysis (Section 3.0) will support SCWA and its member units responding to new requirements for WSCP development and water conservation targets.

10.0 REFERENCES

ABAG, 2013. The Association of Bay Area Governments and the Metropolitan Transportation Commission, 2013, *Plan Bay Area County*, adopted July 2013.

Aquacraft, 2011. Aquacraft Water Engineering & Management, *Analysis of Water Use in New Single Family Homes*, prepared for the Salt Lake City Corporation and the US Environmental Protection Agency, dated 28 July 2011.

BAWSCA, 2013. Bay Area Water Supply and Conservation Agency (BAWSCA), *Fiscal Year 2012-13 BAWSCA Annual Water Conservation Report*, dated 2013.

Census, 2016. 2010-2014 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, accessed 8 September 2016.

Census, 2017. Solano County Quick Facts, http://www.census.gov/quickfacts/table/PST045215/06095, United States Census Bureau, accessed 10 January 2017.

City of Benicia, 2011. City of Benicia, *Final 2010 Urban Water Management Plan*, dated June 2011.

City of Benicia, 2016. City of Benicia, *2015 Urban Water Management Plan*, dated 21 June 2016.

City of Fairfield, 2011. City of Fairfield, *2010 Urban Water Management Plan*, dated 21 June 2011.

City of Fairfield, 2015. City of Fairfield, *Low-Flow Toilet Saturation Study*, dated Fall 2015.

City of Fairfield, 2016. City of Fairfield, *2015 Urban Water Management Plan*, dated 7 June 2016.

City of Vacaville, 2016. City of Vacaville, *2015 Urban Water Management Plan Update*, dated July 2016.

City of Benicia, 2011. City of Benicia, *2010 Urban Water Management Plan Update*, dated July 2011.

City of Vallejo, 2013. *Administrative Draft 2010 Urban Water Management Plan*, dated 23 September 2013.

City of Vallejo, 2016. City of Vallejo, *2015 Urban Water Management Plan*, dated November 2016.

DWR, 1999. California Irrigation Management System (CIMIS) Reference Evapotranspiration Map, Department of Water Resources, map prepared 1999.

DWR, 2016. California Department of Water Resources, *Draft 2015 Urban Water Management Plans Guidebook for Urban Water Suppliers, Appendix K – Estimating Future Water Savings from Adopted Codes, Standards, Ordinances, or Transportation and Land Use Plans*, dated November 2016.

DWR, 2016. California Department of Water Resources, State Water Resources Control Board, California Public Utilities Commission, California Department of Food and Agriculture, and California Energy Commission, *Making Water Conservation a California Way of Life: Implementing Executive Order B-37-16 Public Review Draft*, dated November 2016.

EKI, 2016. *Single-Family Residential Water Use and Conservation Potential Pilot Study, Solano County Water Agency,* prepared by Erler & Kalinowski, Inc., dated February 2016.

ENERGY STAR, 2017. ENERGY STAR Most Efficient 2017 – Large Clothes Washers, accessed 1 February 2017 https://www.energystar.gov/most-efficient/me-certified-clothes-washers/.

Pacific Institute, 2012. Pacific Institute, *Urban Water Demand in California to 2100: Incorporating Climate Change*, dated August 2012.

SCWA, 2010. Solano County Water Agency, *2010 Urban Water Management Plan*, dated 2010.

SCWA, 2013. Solano County Water Agency, *Solano County Water Agency's Experience in Doing More with Less*, dated 2013, accessed 13 January 2016, http://38.106.5.134/home/showdocument?id=28.

SCWA, 2016. *2015 Solano County Water Agency Urban Water Management Plan*, dated August 2016.

SMWD, 2016. *SustainaBlue Landscape Design Studio,* Santa Margarita Water District, Presentation by Nathan Adams, , 2016 Water Smart Innovations Conference, 6 October 2016 https://watersmartinnovations.com/documents/sessions/2016/T-1612.pdf.

SWRCB, 2016. California State Water Resources Control Board, June 2015 - December 2015 Cumulative Savings and Urban Water Supplier Conservation Compliance Dataset, dated 2 February 2016, http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/docs/2016feb/suppliercompliance_020216.pdf.

SWRCB, 2017. California State Water Resources Control Board, June 2015 – December 2016 Cumulative Savings and Compliance Dataset, dated 8 February 2017, http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/docs/2017feb/suppliercompliance_020817.pdf.

WDOH, 2009. *Water System Design Manual,* Washington State Department of Health (WDOH), dated December 2009.