LANDSCAPE TRANSFORMATION STUDY: 2018 ANALYTICS REPORT

*AWE Non-Member Edition**

Alliance for Water Efficiency

A & N Technical Services, Inc.
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Sligo Creek Resources

Acknowledgements

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*This is the AWE Non-Member Edition of the *Landscape Transformation Study: 2018 Analytics Report* and does not include the fourteen utility program descriptions found in Chapter 4. Pages 33 through 62 are intentionally missing. For information on AWE membership and to gain access to the program descriptions in Chapter 4, please visit the Alliance for Water Efficiency website www.allianceforwaterefficiency.org. If you are an AWE Member in good standing and would like access to the full member edition please contact AWE at info@a4we.org.

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Abbreviations

ACM - Association for Computing Machinery
Aust - City of Austin, Texas
AWE - Alliance for Water Efficiency
BMP - Best Management Practice
CALAM - California American Water
DSM - Demand Side Management
ET_o - Evapotranspiration
FCGO - City of Fort Collins, Colorado
gl - Gallon
gpd - Gallons per Day
Guel - City of Guelph, Ontario, Canada
IRP - Integrated Resources Planning
LT - Landscape Transformation
MT - Market Transformation
MWDS - Metropolitan Water District of Southern California
MWELO - Model Water Efficient Landscape Ordinance
NMWD - North Marin Water District
PAC - Project Advisory Committee
Peel - Region of Peel (Ontario, Canada)
Peta - City of Petaluma, California
Sact - City of Sacramento, California
SCWA - Sonoma County Water Agency
SDCI - City of San Diego, California
SDCWA - San Diego County Water Authority
Seat - City of Seattle, Washington
SLP - Sustainable Landscape Program (San Diego County Water Authority)
SNWA - Southern Nevada Water Authority
SPU - Seattle Public Utilities
SRos - City of Santa Rosa, California
SUTVA - Stable Unit Treatment Value Assumption
SWP - Saving Water Partnership
WSLM - WaterSmart Landscape Makeover (San Diego County Water Authority)
XIP - Xeriscape Incentive Program (City of Fort Collins, CO)

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Executive Summary

This Alliance for Water Efficiency (AWE) research project conducted new empirical research on Landscape Transformation (LT) projects, such as turf removal and replacement, "cash for grass," Xeriscape and water wise re-landscaping, and utility sponsored efforts to promote and incentivize reductions in the landscape water requirement. The research focused on what motivates landscape and irrigation changes and what changes in water use occurred and therefore can be expected. The research sought to answer the following questions:

1. What motivates people to change their landscape and irrigation practices to reduce the overall water requirement and usage?
2. What are the reasons and rationale for their landscape choices?
3. What barriers exist to landscape transformation and to utility-sponsored programs?
4. What range of water savings (gallons reduced annually per impacted customer and per square footage of landscape) can be expected from reducing landscape water requirements?
5. What factors influence the volume of water savings achieved by reducing irrigation requirements?
6. How can water savings be maximized?

This *2018 Analytics Report* provides detailed research documentation on the analytics used in the Landscape Transformation project. There is a companion *2018 Market Analysis and Recommendations* report that provides a higher-level communication of the market analysis and recommendations of this research.

Findings:

Impact Evaluation—Landscape Water Savings

1. Detectable water savings were observed, both for the turf conversion programs and for the landscape transformation programs that did not have incentives for turf conversion.
2. The magnitude of water savings for turf conversion was related to pre-participation mean water use.
3. Water savings were observed to slowly increase over time: water savings were lower in the first year of establishing new plantings and grew over time.

Process Evaluation—Customer Motivations and Reasons for Landscape Transformation

1. Customer surveys reveal great diversity in customer reasons, rationales, and motivations for landscape transformation.
2. Market segmentation analysis can reveal location-specific differences in customer motivations.
3. Customer messaging and engagement also varied greatly across participants. Customer engagement and messaging that targets customers differently can reach different customer types.

Organization of the 2018 Analytics Report

Before beginning this report, readers may want to start first with the companion *2018 Market Analysis and Recommendations* report that provides a higher-level communication of the market analysis and recommendations of the AWE Landscape Transformation project. The *2018 Analytics Report* is organized as follows.

Chapter 1 Introduction – This chapter provides an overview of the project, the research questions, and unpacks the concepts behind Landscape Transformation—landscapes, transformation, and the combination of the two. It examines the related concepts of Market Acceleration and Market Transformation. Combining the concepts of landscapes and market transformation, this project adopts a working definition of "Landscape Transformation."

> *Landscape Transformation: Customers changing landscapes to reduce the irrigation water requirement, and, ultimately, outdoor water end uses.*

The chapter concludes by developing four measures of success for Landscape Transformation Programs:

- Water/Energy Savings Evident – Water and energy savings are observable and significant.
- Customer Acceptance – Customers accept and prefer water/energy efficient services and products.
- Supply Chain Satisfaction – Manufacturers, Suppliers, Distributors, and Vendors are satisfied with Landscape Transformation (LT) outcomes and are open to further innovation.
- Incentives Are Not Required – At some point, economic incentives are not required, water efficient choices are the market outcome.

Chapter 2 Research Plan – A Landscape Transformation Research plan was developed early in this project, reviewed by the Project Advisory Committee (PAC), and guided the research project throughout. This chapter reviews the Research Plan:

- Task 1 – Project Initiation, Research Plan
- Task 2 – Process Evaluation
- Task 3 – Impact Evaluation
- Task 4 – Scaling Results, Recommendations, and Replication

Chapter 3 Data and Methods Review – This chapter reviews the data and methods of this research project. It notes the structured interview protocols found in Appendix B (Data Assessment Interview Protocol [Task 1] and the Process Evaluation Interview Protocol [Task2]). It presents the sampling plan for consumption data and a summary of data collection [Task 3]. Last, this chapter provides a review of methods used to estimate water savings [Task 3] and for customer market segmentation [Task 2].

Chapter 4 Program Descriptions – Based on the process evaluation interviews and review of program documentation, a detailed program description was developed for each participating utility's LT program. Also known as a program "cut-sheet," they provide a quick understanding of the utility, the program design, goals of the program, how the program adapted over time, and some insight into its components. Briefer versions can be found in the *2018 Market Analysis and Recommendations*.

Chapter 5 Impact Evaluation: Water Savings – This chapter provides the statistical specification and estimation results for the impact evaluation of LT Participant water savings. Specification of the statistical model defines the analytic model form—an algebraic description of what causes water use. Estimation of the statistical model imposes the model specification on the available data to find out which model parameters maximize the likelihood of observing the data at hand. The estimated models are summarized for the average effect of participation, the change to the seasonal shape of water demand, and evidence on the persistence of water savings.

Chapter 6 Process Evaluation – This chapter provides the results of the online customer surveys of participants and non-participants. Descriptive statistics of survey results across participating water utilities are provided as well as in-depth market segmentation analyses that delve into different customer motivations within each water utility.

Chapter 7 Landscape Transformation Programs Future – This last chapter looks to the future and addresses how lessons from this research project can be extrapolated into the future. This chapter also provides recommendations for program design, for the landscape supply chain, and for the green industry.

Appendix A - Priorities for Future Research – This appendix provides recommendations for future research and includes the following:

- Market Segmentation Analysis for Improved Customer Engagement
- Impact Evaluation in Real Time
- Supply Chain Research
- Landscape Design Standards
- Program Design for Outdoor Water Use in Disadvantaged Communities
- Drought Management and Outdoor Water Use

Appendix B - Interview Questionnaires – This appendix provides the interview protocols used in the research.

Appendix C - Participant and Non-Participant Surveys – This appendix provides the original surveys sent to each utility and includes:

- Landscape Transformation - Program Participant Customer Survey (Non-Turf)
- Landscape Transformation - Program Participant Customer Survey (Turf)
- Landscape Transformation - Customer Survey (Non-Participant)

Appendix D - Detailed Estimation Results of Single-Family Landscape Transformation Participation – This appendix provides the estimated single-family water use models that measure the change in water use resulting from participation in Landscape Transformation programs: on average in a year, changes in the shape of water demand in a year, and the persistence of water savings over time.

Chapter 1: Introduction

Overview

An effective way of reducing outdoor water use is to change the landscape itself, removing plants and grasses that have a high-water requirement and replacing them with plants, grasses, and ground covers that require less water. What motivates people to make these landscape and irrigation system changes? Landscapes are complex systems. Removing turf alone is often not enough to achieve sustained reduction in water use. Irrigation systems and schedules, as well as behavior must be changed to achieve water use reductions.

Before beginning this report, readers may want to start first with the companion *2018 Market Analysis and Recommendations* report that provides a higher-level communication of the market analysis and recommendations of the AWE Landscape Transformation project.

Research Questions

The goal of this project is to conduct new empirical research on landscape transformation projects such as turf removal and replacement, "cash for grass", Xeriscape and water wise re-landscaping, and utility sponsored efforts to promote and incentivize reductions in the landscape water requirement. The research focuses on what motivates landscape and irrigation changes and what changes in water use occurred and therefore can be expected.

The research team seeks to answer the following questions:

1) What motivates people to change their landscape and irrigation practices to reduce the overall water requirement and usage?
2) What are the reasons and rationale for their landscape choices?
3) What barriers exist to landscape transformation and to utility sponsored programs?
4) What range of water savings (gallons reduced annually per impacted customer and per SF of landscape) can be expected from reducing landscape water requirements?
5) What factors influence the volume of water savings achieved from reducing irrigation requirements?
6) How can water savings be maximized?

This introductory chapter examines the concepts behind "Landscape Transformation" to better inform the design and implementation of water utility programs that aim to bring about Landscape transformation. This chapter examines "Market Acceleration" and "Market Transformation" and concludes by defining four performance measures for Landscape Transformation success.

Landscape Transformation--Concepts

Landscape Transformation encompasses two concepts, landscapes and transformation.

The Concept of Landscape

The term 'landscape'[1] has been used with different interpretations and connotations. Different disciplines—geography, ecology, archeology, spatial planning and design—have used 'landscape' as a unifying concept for otherwise diffuse meanings. Tress and Tress[2] trace the history of the term back to 13th century Netherlands where 'lantschap' was both an administrative area and an identifying reference for an individual's native country. Combining administrative function with personal identity in the single term 'landscape' can begin to create the understanding of why changing landscape can be controversial. Toward the late 16th century, 'lantschap' came to take on a more perceptual meaning, due in no small part to Dutch landscape painters. The use of the term 'landscape' in England appears closer to "a piece of art, a painted scene." Thus, landscape can be "the portion of land or scenery which the eye can view at one" which, in turn, can incorporate the picture or image of land as well as the land of itself[3]. "Landscape" lives on, as a page format distinguished from "Portrait", as an alternative mode of projecting a visual information.

Landscapes as a Public Good

Landscapes qualify for an economic classification as a "Public Good" because they are non-excludable (it is difficult to prevent anyone from appreciating landscape) and non-rival (my appreciation of landscape does not preclude yours). When landscape is publicly-owned the government can, in principle, design the landscape that is best for society. The circumstance where use of publicly-owned landscape is difficult or costly to control is the case of a 'common-pool resource' and the source of the classic article "The Tragedy of the Commons." Resolving common-pool resource problems requires an external government regulation or privatization of the resource.

Privately-owned landscape presents a different set of problems. Farmers or landowners can be regarded as stewards or managers of landscapes. The incentives for private-owners of landscapes may only incorporate a subset of the values produced by landscapes; thus, the use and preservation of landscapes may not align over long term with public interests. Yes, this is the classic case of externalities, where the actions of one actor impose costs/benefits on others.

The Concept of Transformation

Transformation- "The operation of changing one configuration into another."

[1] Price, C. 1978. *Landscape Economics*, London, McMillian.
[2] Tress B. and Tress G. 2001. "Capitalizing on multiplicity: A transdisciplinary systems approach to Landscape research," *Landscape and Urban Planning*, vol 57, no. 3-4: pp. 143-157.
[3] Wylie, J., 2007. *Landscape*, Abingdon, Oxon: Routledge. P. 6.

Transformation as a Utility-directed Influence on Market Innovation

A market transformation (MT) occurs when a new technology or method emerges, is found to be superior, and results in the product and/or service, which pre-dated it, to become obsolete. A prime example of MT in the world marketplace (or a series of market transformation initiatives) are well known to all consumers starting with the shift from vinyl records to the more portable eight track tapes…then eight track tapes to the more compact cassette tapes...cassette tapes to higher sound quality CDs and forward to today's iPods or similar electronic devices. Clearly the market for audio devices has transformed over time and consumers have no desire to purchase the earlier technologies.

The energy industry, facing resource challenges, offers applicable experiences that can benefit of the water resource industry. ACEEE, the American Council for an Energy-Efficient Economy, defines market transformation for their resource sector as the following:

> The term market transformation is the strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.

"Market transformation," as a concept, originated in response to changes in regulated energy markets in the late 1990's. Broader in scope, energy efficiency advocates pushed for programs that went beyond individual utility service areas to encompass regional and national markets. By collaborations and partnerships with multiple parties contributing funds and expertise, groups attempted to make long-term changes in customer preferences and the markets for target technologies and services.

Market Transformation differs from traditional water conservation programs that offer customer incentives or direct provision of water efficient devices or services. The term was developed among regulated energy utilities to describe approaches that differed from utility demand-side management (DSM) programs. DSM programs were typically narrow in scope, focusing on reducing energy demand as a means of the least cost expansion path within an Integrated Resources Planning (IRP) framework. Traditional DSM programs were implemented by individual utilities for their own customers, as ordered by utility commissions, with direct cost recovery from customer retail rates.

The process of MT includes such common elements as:

- Targeted, focused, strategic market intervention
- Development, introduction and increased availability of efficient products and services

- Lasting changes in consumer behavior and preferences (increased consideration of efficiency as a purchase criterion)
- Increased market share of efficient products and services through reduction of market barriers
- Broad (regional or national) scope for the targeted market
- Permanence of impact

Experts have delineated five types of consumer purchase patterns that influence MT initiatives. The market transformation bell curve in Figure 1.1 shows the cross section of market respondents and the timeline for adoption of an innovation:

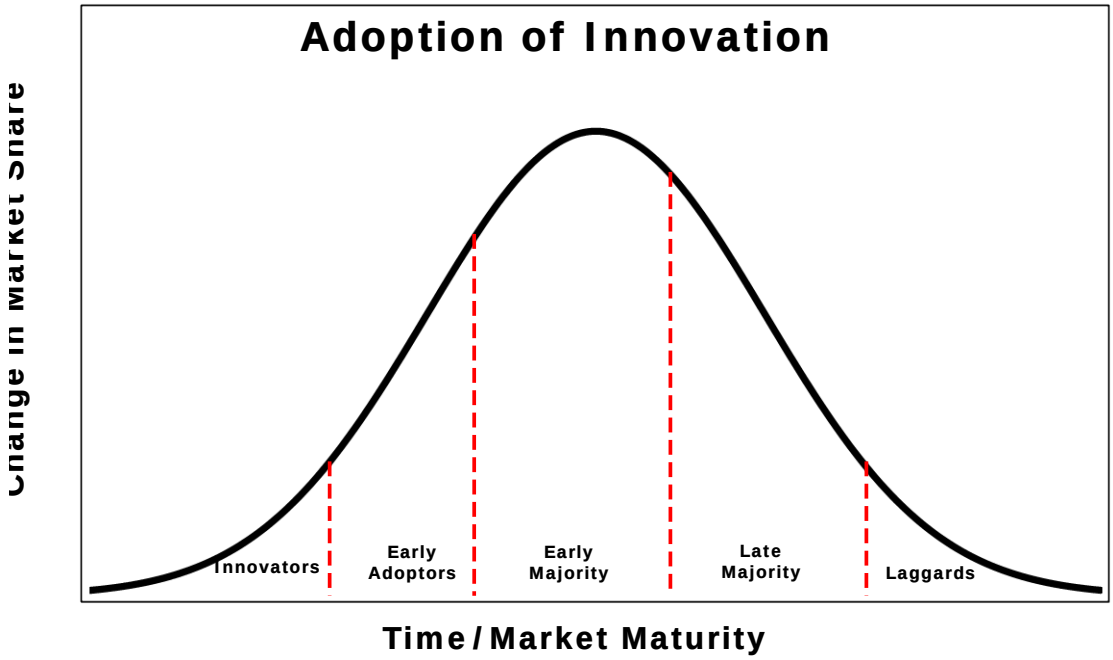

Figure 1.1: Adoption of Innovation

Market respondents are described as follows:

- **Innovators:** adventurous persons
- **Early adopters:** educated leaders
- **Early majority:** deliberate decision makers
- **Late majority:** cautious and skeptical individuals
- **Laggards:** risk averse persons

Market Transformation does not simply happen. It requires disciplined planning and sustained implementation in order to deliver innovative change. Targeted outreach directed at key leverage points in the supply chain dramatically accelerate acceptance of an innovation. These are strategic situations where new actions will have greatest impact.

Key leverage points consider who can have significant impact:

- end users, such as water utility customers or retailers,
- landscape municipal planners,
- engineers, builders, and
- manufacturers, architects, contractors, professional trades, and suppliers

The Concept of Landscape Transformation

Combining the concepts of landscapes and market transformation, this project adopts a working definition of "Landscape Transformation."

> *Landscape Transformation: Customers changing landscapes to reduce the irrigation water requirement, and ultimately, outdoor water end uses.*

This definition does not exclude other desired aims of landscape change but retains a focus on outdoor water end use requirements.

Practically speaking, an understanding of the water requirements of landscape plantings through the year (see WaterRF 3094 *Water Budgets and Rate Structures, 2008)* can drive a meaningful understanding of what constitutes efficient landscape water use. The Figure 1.2 depicts the landscape planting requirements, the subset of precipitation that satisfies some of this requirement (effective precipitation), the remaining plant needs for water, and compared to the total amount of water used.

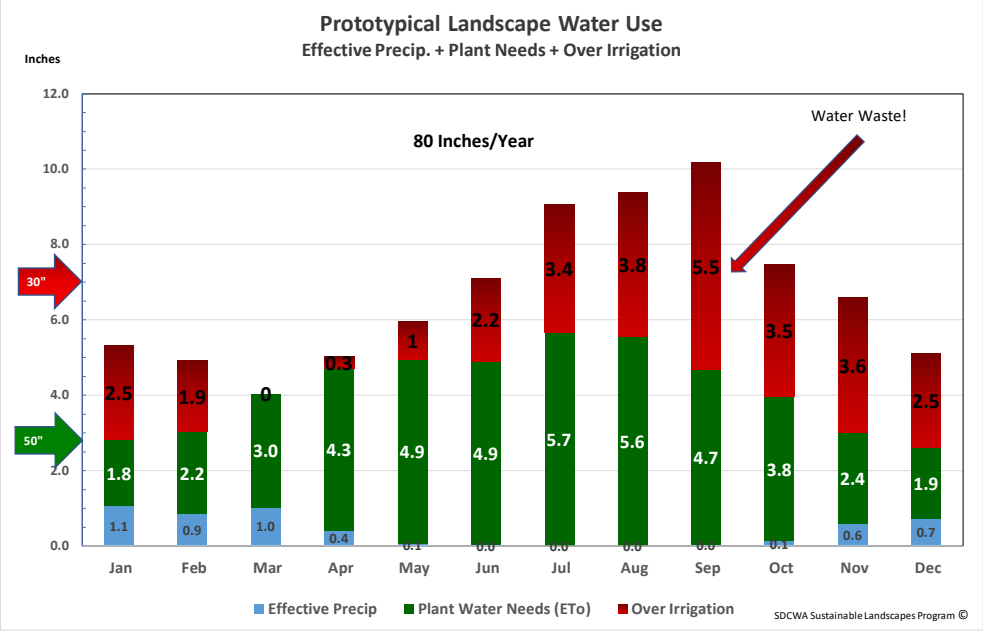

Figure 1.2: Components of Landscape Water Use

The combination of the concepts of Landscape and Transformation bring into view the key leverage point(s) that necessarily depend upon the intended goal—customer change of landscape—being driven into the market. This is illustrated in the Landscape Transformation "S" curve shown in Figure 1.3.

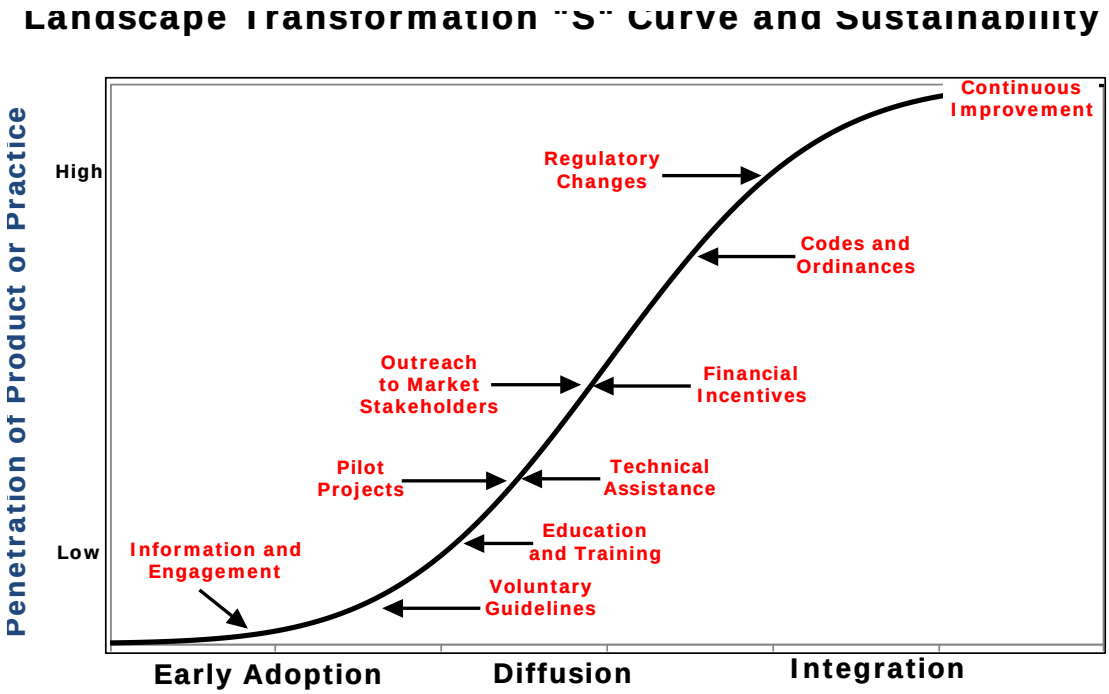

Figure 1.3: Landscape Transformation and Sustainability

As shown in the S Curve above, there are a number of strategies targeted to effect change (although not necessarily in this order):

- **Information and Engagement** - Build knowledge, skills, interest and awareness for targeted stakeholders and public constituencies. Establish partnerships and networks to help with planning, implementation and knowledge transfer. Publicly recognize leadership.
- **Voluntary Guidelines** - Stakeholder driven projects that define guidelines for Landscape Transformation have set standards and provided guidance for emerging landscape transformation.
- **Education and Training** - Classes in landscaping and training for green industry professionals have conveyed best practices and professionalized working knowledge of good landscaping practices.
- **Pilot Projects** - Early projects are incubators for strengthening policy, skills, knowledge and awareness in government, the private sector and the community at large. These projects can be in the public or private sectors and should be

monitored to maximize learning. Ideally, they inform decisions on future actions and catalyze a series of changes.

- **Technical Assistance** - Water utilities have provided direct technical assistance as a form of customer service and knowledge extension.
- **Programs and Outreach to Market Stakeholders** - Water utility programs are one element in the transformation of a market, often educating key points along the sales chain via outreach to market stakeholders.
- **Financial Incentives** - To reduce risk and overcome market barriers associated with new practices, design incentives to encourage early adopters. The timing of financial incentives is critical. Offered too early on pre-piloted products risks providing incentives to products with other qualitative flaws. Offering financial incentives after market acceptance is the classic case of free-ridership: paying customers to do what they would have done anyway.
- **Requests for Voluntary Changes** - Incentives aren't always money. Local governments can also agree to fast-track projects that meet green criteria, or they can defer fees and allow them to be paid based on water savings.
- **Regulatory or Ordinance Changes** - When the new practices are sufficiently well established, they consolidate the change by adjusting regulations and standards to require this new efficiency level. This is a way of embedding a new norm for efficiency in a legal standard. The U.S. EPA WaterSense program is one such attempt to improve national standards and labeling for water efficient products and practices.

The question facing water utilities—and government entities with water responsibilities, and the collections of collaborating stakeholders—is… *how to best direct their collective influence toward shaping market choices.* This is the essence of Landscape Transformation.

Market Transformation versus Market Acceleration

Two labels used by utilities that describe how they try to shape market choices are "*Market Acceleration*" and "*Market Transformation.*" Market Transformation applied to markets for landscape products and practices will be referred to as Landscape Transformation.

Water and energy utilities are continually taking action to eradicate resource inefficiency at their customers' sites. Technologies are selected; incentive programs are designed; and budgets are driven through the maze of approvals. Thousands of products are installed at customer sites as a direct result of these programs. When the incentive program ends, product saturation can lag as customers and contractors revert to old ways.

Some market advancement has been made as a result of the utilities' programs but not a fully executed market transformation. The water utility initiated activities that created *market acceleration (Figure 1.4).* This is the typical strategy taken by energy and water utilities across the nation, leading to a long and extracted attempt for market change.

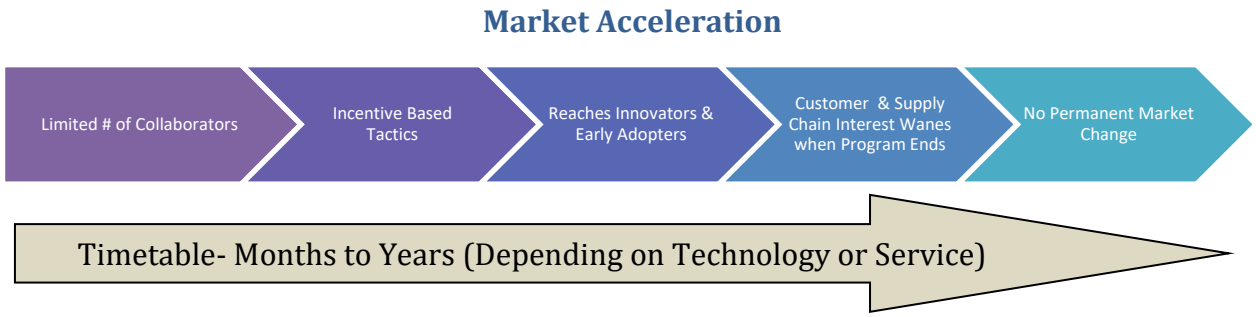

Figure 1.4: Market Acceleration

- ***Market Acceleration*** initiatives tend to be local with few partnerships
- Utilize incentive-based program tactics
- Typically reaches only "Innovators", "Early Adopters" and some "Early Majority" consumers
- Fails to reach "Late Majority" and "Laggards"
- Program does not eliminate market barriers
- Customer interest wanes when incentive program ends
- Supply chain and contractors fail to provide or endorse new technology or service beyond program
- Regulations that require new service or technology are not adopted due to continued market issues

Landscape Transformation is a more strategic and far-reaching process. It encompasses a broad array of innovative strategies in order to create permanent change in the marketplace. A wide range of tactics are implemented, including incentives that are used to stimulate adoption of a new technology. Landscape Transformation requires a long-term sustained effort and investment in order to be successful as shown in Figure 1.5.

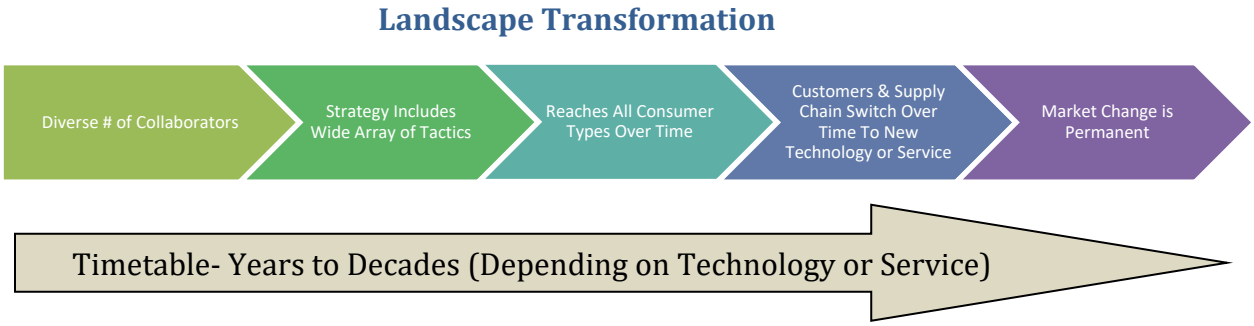

Figure 1.5: Landscape Transformation

- ***Landscape Transformation*** initiatives leverage local, regional & national entities, working in strong collaboration to drive change
- Collaborative team creates strategy that requires diverse array of tactics
- Many tactics are initiated, including incentive programs in early stages of MT process
- Reaches all consumer types
- Supply chain and contractors gradually shift to new technology or service
- Consumers prefer new product or service over the former
- Product or service readily available to consumers
- Old technology no longer obtainable
- Regulations enacted stating that new technology or service be the required standard

Defining Success in Landscape Transformation Programs

This project puts forward four performance measures of LT success:

1. Water/Energy Savings Evident – Water and energy savings are observable and significant.
2. Customer Acceptance – Customers accept and prefer water/energy efficient services and products.
3. Supply Chain Satisfaction – Manufacturers, Suppliers, Distributors, and Vendors are satisfied with LT outcomes and are open to further innovation.
4. Incentives Are Not Required – At some point, economic incentives are not required, water efficient choices are the market outcome.

Chapter 2: Research Plan

A Research Plan was developed for this project and was approved by the Project Advisory Committee (PAC) in February 2017.

Landscape Transformation Programs

The research plan was broken into four tasks.

Task 1 – Project Initiation, Research Plan: Process and Impact Evaluations

A & N Technical Services project team provided an in-depth process and impact evaluation of Landscape Transformation programs at participating water utilities. Process evaluations assess "how" the program was implemented and impact evaluations address "what" was accomplished. By building comprehensive and reliable data sets, the evaluation sought to build value by providing an empirical basis for subsequent evaluation and prospective planning tasks.

An early issue dealt with by the research team was a working definition of "Landscape Transformation."

> *Landscape Transformation: Customers changing landscapes to reduce the irrigation water requirement, and ultimately, outdoor water end uses.*

This definition does not exclude other desired aims of landscape change but retains a focus on outdoor water end use requirements.

As part of Task 1 we performed a data assessment by interviewing each participating water utilities (participants). The attached a "*Data Assessment Interview Protocol"* (see Appendix B) that contains the questions addressed to participant. The objective of the data assessment was to identify the Landscape Transformation program to be studied, identify participant research priorities (Process, Impact, or both), discover what compiled information had been retained about program participants, identify possibilities for enacting a customer survey (existence of email, mode of dissemination, and customer questions), conveying requirements for the consumption data histories needed for the Impact Evaluation, and privacy protection protocols. Reponses were compiled and shared with team members using a collaboration tool. As follow-up, each participant was emailed a customized link to a secure FTP site on December 22nd 2016 to facilitate uploading and downloading of any data/reports.

Separately, the research team compiled descriptive statistics to describe the different participating service areas. Table 2.1 provides the annual precipitation, service area in square miles, the population served, and information sources.

Table 2.1: Landscape Transformation Participants & Service Area Characteristics

Location	Annual Precip.	Population served	Population Year	Population Source
Austin, Texas	32.1	928,026	2013	City of Austin Water Conservation Plan
Fort Collins, Colorado	16.7	130,200	2014	2015 Water Efficiency Plan
Guelph, (Canada)	33.0	130,670	2013	Water Supply Master Plan Update
Metropolitan Water District	12.1	18,700,000	2015	MWDSC 2015 UWMP
Sonoma County Water Agency	32.5	614,196	2015	Sonoma CWA 2015 UWMP
North Marin WD	29.6	61,381	2015	Final North Marin UWMP Master 2015
Petaluma, City of	25	60,214	2010	UWMP Public Review Draft (Petaluma)
Santa Rosa, City of	30.1	173,071	2015	Santa Rosa 2015 UWMP
Peel Region, (Canada)	31.3	1,400,000	2015	peelregion.ca
Sacramento, California	17	480,105	2015	City of Sacramento Final 2015 UWMP
San Diego, California	10.0	1,377,884	2015	City San Diego 2015 UWMP Report
Seattle, Washington	36.1	1,400,000	2018	Seattle Public Utilities
Southern Nevada Water Authority	4.2	2,100,000	2012	SNWA Conservation Plan 2014-2018
San Diego County water Authority*	10.0	3,200,000	2015	2015 Urban Water Management Plan
California American Water*	3 sites: 10”-17”	463,094	2015	2015 Urban Water Management Plans

We also assessed each participant’s interest in the process evaluation (a customer survey requiring email addresses) and impact evaluation (a statistical analysis requiring consumption data and a control group). The two largest participants had already completed impact evaluations or had them underway. The remaining participants expressed different levels of interest and we reviewed the consumption data requirements (two years post-intervention consumption histories and a minimum of three years pre-intervention and a control group.) See Table 2.2 for the Landscape Transformation Participants Evaluation options.

Table 2.2: Landscape Transformation Participants Evaluation options

Location	Type of Program	Process Evaluation Customer Survey?	Impact Evaluation
Austin, Texas (Aust)	Cash for Grass	Yes	Review Only
Fort Collins, Colorado (FCGO)	Cash for Grass	Yes	Review Only
Guelph, (Canada) (Guel)	Outreach and Support	Yes	Yes
Metropolitan Water District (MWDS)	Cash for Grass	Performing own surveys	Review Only
Sonoma County Water Agency (SCWA)	Cash for Grass	Yes	Review Only
North Marin WD (NMWD)	Cash for Grass	Yes	Yes
Petaluma, City of (Peta)	Mulch Madness	Yes	Yes
Santa Rosa, City of (SRos)	Cash for Grass	Yes	Yes
Peel Region, (Canada) (Peel)	Outreach and Support	Yes	TBD
Sacramento, California (Sact)	Cash for Grass	Yes	Yes
San Diego, California (SDCI)	Cash for Grass	Yes	Yes
Seattle, Washington (Seat)	Device Incentives	Yes	Review Only
Southern Nevada Water Authority (SNWA)	Cash for Grass	Yes	Yes
San Diego County water Authority (SDCWA)*	Sustainable Landscapes Programs	No	Yes (Landscape Makeover Classes)
California American Water (CAL AM)*	Cash for Grass	Yes	No

*Participating utilities added after February 2017

Task 2 – Process Evaluation

The process evaluation was set forth to provide answers to the first three research questions posed in the RFP:

1. What motivates people to change their landscape and irrigation practices to reduce the overall water requirement and usage?
2. What are the reasons and rationale for their landscape choices?
3. What barriers exist to landscape transformation and to utility-sponsored programs?

Thus, the process evaluation of Landscape Transformation programs began by documenting how these programs were implemented. It identified the procedures undertaken and the decisions made in developing the programs. It addressed whether the programs provided the services as intended. It also assessed the delivery experience from all stakeholder's perspectives. The information was used to ascertain the reasons for successful or unsuccessful performance and provided information for potential replication.

The process evaluation combined data generated by program implementers (process flows and procedures, progress reports and customer application data) with structured interviews of implementers, landscape industry stakeholders, other water utility staff, grantor staff (if grant funded), participants and other stakeholders.

Data Collection and Validation

Data generated by Landscape Transformation programs included:

- Database of customer information with incentive amounts.
- Hardcopy records of applications and receipts with hardware and devices documented.
- Documentation of the original program theory.
- Detailed program description including: target market, marketing and outreach methods, geographical coverage, implementing organization, market stakeholders, water use efficiency measures addressed, delivery mechanisms, tracking system, grant and other incentive funding requirements.
- Program budget broken down by administration, marketing, product costs, installation costs, incentive costs, and verification if available.
- Flow charts of program processes from customer outreach through reporting and grant invoicing.
- Detailed procedures of program processes including administrative requirements.
- Sample applications.
- Sample outreach materials.

Process Evaluation Interviews

The research team conducted structured in-person and phone interviews with Landscape Transformation implementers to document program functioning: original design, evolution over time, and current status. The focused interviews targeted key groups:

1. Water utility staff and vendors responsible for program implementation to document the original program theory, program processes and procedures, program outcome, and to identify factors impacting the outcome, barriers to success, strengths, and areas for improvement.

2. Water utility management staff to determine views of the program outcome, factors impacting the outcome, barriers to success, strengths, and areas for improvement as well as how the program fits into the utility's program portfolio as well as into the utility's overall goals and objectives.

A structured interview protocol was also drafted and submitted to the project manager for approval. Interviews began as soon as possible thereafter.

Customer Survey—Participants and Non-participants

Implementation of the customer survey was flexible, depending on conditions at each participating utility. As envisioned, we drafted a survey instrument (attached) that was implemented online (SurveyMonkey) with notification by email or postcard. If a participating utility preferred implementation by hardcopy, this was accomplished if the utility covers postage and keypunch costs. The data assessment in Task 1 helped define the realm of the possible for each participating utility. The customer survey targeted both participants and non-participants.

1. Participants to ascertain their views of the delivery experience, how they heard about the program, why they chose to participate, their views on whether the water use efficiency measures delivered the water savings as expected, and areas for improvement. This would be incorporated with the results of the existing customer satisfaction surveys.
2. Non-participants to find out if they had heard of the program, why they chose not to participate, and what could be changed to obtain their participation.

A small number of questions, two to three, customized to specific service areas were also allowed for each individual utility's Customer Survey.

Task 3 – Impact Evaluation

The impact evaluation sought to develop sound empirical answers to the following research questions posed by the RFP:

1. What range of water savings (gallons reduced annually per impacted customer and per Sq. Ft. of landscape) could be expected from reducing landscape water requirements?
2. What factors influence the volume of water savings achieved from reducing irrigation requirements?
3. How could water savings be maximized?

The answer to the first question was simpler and required less data (consumption records, the time and nature of intervention). The answers to the second and third questions were more complex and required more data.

Consumption Data Collection and Validation

The Landscape Transformation programs have been implemented in different parts of North America and were done at different time periods. We proposed to create a combined database of consumption records inclusive of eligible customers-- participating and nonparticipating customers. This data collection effort targeted participants and potential participants in the landscape water conservation programs.

The wide definition of both participants and potential participants was important for two reasons: 1) a control group would be selected from the sample of nonparticipating customers, and 2) nonparticipating customers formed the basis for estimates of future conservation potential.

Each implementation phase used different methods and procedures for recording program implementation data. The data assessment subtask sought to; first create a sketch of available program databases, their fields, and some indication of the likely internal validity of these records. Sampling strata (categories) were needed to be developed to control for the areas of interest, namely:

1. Calendar time period—this is important for two reasons, first, implementation methods have varied over time, and second, the threats to validity also vary over time (due, for example, to weather and ongoing conservation).
2. Different retail utilities—some participants are likely to have better follow-through than others. This variation in savings will not be the primary focus of any program-specific evaluation. This variation in savings can be critical, however, for addressing how future programs can be improved.

Statistical Impact Analysis

We analyzed the available consumption data—at least three years of pre-intervention consumption and two years of post-intervention data. This then formed the basis for defensible and credible estimates of the net water savings attributable to the Landscape Transformation programs.

The quantity of data required was driven by a key finding of earlier research. Prior impact evaluations found that water savings varies through the year. The impact evaluation enabled the measurement of seasonally varying water savings—controlling for weather--through sophisticated modeling to control for potential biases. Using historical account level water use records and multiple climatic measures, the water use analysis developed climate-adjusted estimates of water savings using panel data (time series cross section) regression methods. A comparable “control group” of non-participants was developed to permit an assessment of net conservation. The amount of additional effort allocated to this question was determined after issues of data availability were resolved. Appropriate panel data estimators ensure that unbiased estimates of water savings can be made

without cross-sectional data on customer characteristics. Variation in water savings was not the first research objective and was only addressed as time and budget allowed. The analysis itself was broken up into phases with a descriptive analysis occurring first that described collected data followed by the statistical impact analysis that connected consumption data to explanatory data (individual customer characteristics, season of year, weather, and participation in conservation programs).

Task 4 – Scaling Results, Recommendations, and Replication

Based on the data collected in Task 2 and the water savings estimates created in Task 3, we then developed a forward-looking assessment of the landscape transformation programs. The results of this assessment answered the following questions:

- Scaling Results – Based on the data and estimates generated in Tasks 2 and 3, how many additional program interventions could be achieved, and at what cost? What are the ongoing costs of running the program, including water utility staff costs? What other utility costs are avoided through effective program interventions? What are the sunk program costs that would not need to be incurred again?
- Recommendations – What changes would increase awareness and participation, minimize administrative burden, streamline operations, meet the needs of market stakeholders to improve product availability and pricing, and achieve higher water savings? What solutions would improve the cost-effectiveness of the program? How could the program better meet the needs of water utilities, grantors, market stakeholders, and potential participants? What measures offer the highest cost/effectiveness and market potential? What customer markets are the best targets?
- Replication – How easy or difficult would this program, or variants of it, be to implement by other retail utilities? Which program components would be available to other utilities at low or no cost? Based on the implementing experience, what are the organizational requirements for replication? In short, how can the lessons learned from participating water provider experience be applied elsewhere to improve program scalability?

The standard Evaluation Report Outline follows. We believe that the discussion of research priorities may require a more in-depth treatment for larger programs or ones that may be under consideration for up scaling in the near future (Figure 2.1).

Evaluation Report Outline

- Executive Summary
- Introduction
- Research Plan
- Data and Methods Review

- Program Descriptions
- Impact Evaluation: Water Savings
- Process Evaluation
- Results and Recommendations
- Appendix: Priorities for Future Research

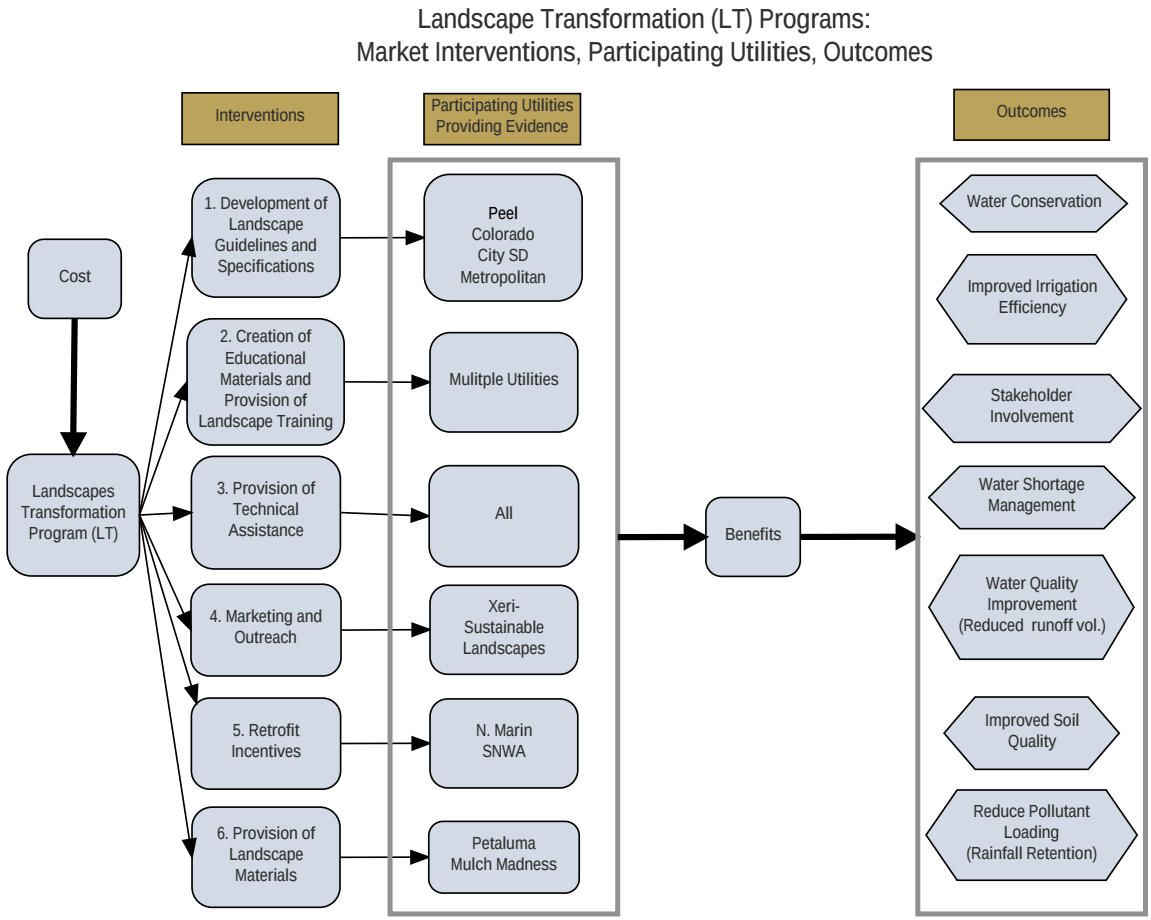

Figure 2.1: Landscape Transformation Programs: Market Interventions, Participating Utilities, Outcomes

Chapter 3: Data and Methods Review

Data and Methods

From the Research Plan, the following interview protocols were created and used to guide the initial steps of this research:

1. AWE Landscape Transformation Data Assessment Interview Protocol
    a. Purpose: Assess core facts, available data, and research focus
2. AWE Landscape Transformation Process Evaluation Interview Protocol
    a. Purpose: Assess core facts, available data, and research focus

These interview protocols can be found in Appendix B.

Sampling Plan

A data assessment was conducted in the process of completing this research plan. Based on the program databases, LT program participation by year was compiled. The research plan proposed collecting water consumption data from as many participating water utilities as were able to provide it. The intent was to collect as diverse a sample of utilities that would represent a range of climate zones and landscape transformation programs. A "control" group of non-participants was requested and where provided was used. Participating utilities that did not provide a sample of non-participants used pre-participation consumption data as the statistically-adjusted control. Table 3.1 lists what data was to be collected.

Table 3.1: Utility Consumption Data Structure

Field Name	Description
Study ID	Unique Study ID Number
customer_type	Customer Type
readdate	Bill period end read date
readdate2	Bill period begin read date (can be inferred)
day_no	Number of days in meter reading period
perioduse	Consumption volume
BU	Type of Billing Units (HCF, Thou. Gal., Cubic Meters)
use	Use, gl. per day
YYMMDD	Year, Month, Date
part	Participant Indicator
sequential_id	Unique ID Tracking Number
program	Landscape Incentive Program
participation_date	Date of customer participation

Data Collection

We requested a minimum of three years of pre-participation consumption data and available post-participation customer consumption data from all the participating utilities. The utilities we received participant consumption data include:

1. Austin (Aust)
2. Guelph (Guel)
3. North Marin Water District (NMWD)
4. City of Petaluma (Peta)
5. Sacramento (Sact)
6. San Diego, City of (SDCI)
7. Southern Nevada Water Authority (SNWA)
8. Santa Rosa, City of (SRos)
9. San Diego County Water Authority (SDCWA)

The match of consumption data to the participants list had the usual list of expected hiccups. Some account number encoding had changed, some participants had to be address-matched to consumption records, and some participants had moved. We compiled household metered consumption records across available consumption history. We converted metered consumption to average daily use by dividing by the length of the billing period measured in days. Participants with less than three years of pre-intervention data or two years of post-intervention data were excluded from the sample. Consumption data were also analyzed using robust regression methods for corrupt or missing data.

Table 3.2 presents the counts and descriptive statistics on the final sample used to estimate the water use model.

Table 3.2: Sample Statistics - Estimated Water Use Models of Single Family Customers

Utility	Participant pre-intervention use (gpd/meter)	Nonparticipant use (gpd/meter)	Number of Participants in Sample	Total Number of Observations	Begin Period	End Period
Aust	252.4	N/A	65	4,543	1/1/2011	9/1/2017
Guel	149.1	162.0	2,526	1,531,000	1/1/2006	12/1/2015
NMWD	400.6	322.9	602	151,268	12/1/2003	12/1/2015
Petaluma	207.0	224.1	36	5,250	1/1/2010	5/1/2017
Sact	377.0	372.1	240	17,641	1/1/2009	5/1/2017
SDCI	330.4	263.4	384	199,460	1/1/2007	7/1/2017
SNWA	724.2	679.4	28,632	5,943,413	1/1/1997	12/1/2016
SRos	240.4	211.7	1,805	411,726	1/1/2010	12/1/2016
SDCWA	329.6	N/A	282	12,757	5/1/2008	2/1/2017

Each participating utility has different weather characteristics. Evapotranspiration (ET) is the term used to describe the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). Reference evapotranspiration (ET_o) is the loss of water from a reference plant (4-7" tall cool season grass growing in an open-field). Precipitation is also important because it can offset plant evapotranspiration requirements (Table 3.3).

Table 3.3: Weather Differences across Participating Utilities—Precipitation and Reference Evapotranspiration

Participating Utility	State/ Province	Precipitation (in./yr)	Evapotranspiration Ref. (in./yr)
Austin, Texas (Aust)	TX	25.4	63.2
Fort Collins, Colorado (FCGO)	CO	14.1	48.9
Guelph, (Canada) (Guel)	ON, Canada	33.0	30.1
North Marin WD (NMWD)	CA	29.3	41.8
Petaluma, City of (Peta)	CA	29.4	42.7
Santa Rosa, City of (SRos)	CA	26.3	45.6
Peel Region, (Canada) (Peel)	ON, Canada	31.3	29.9
Sacramento, California (Sact)	CA	13.4	57
San Diego, California (SDCI)	CA	10	47.9
Seattle, Washington (Seat)	WA	37.2	32.9
Southern Nevada Water Authority (SNWA)	NV	4.2	89.5
San Diego County Water Authority (SDCWA)*	CA	10	47.9

Source: Data from IWMI Water& Climate Atlas (www.iwmi.org) except for San Diego where CIMIS values were used.
*Participating utilities added after February 2017

Methods

Defining Methods to Estimate Water Savings

1) Engineering Estimates – estimate the water saved of each conservation intervention (device—irrigation controller, efficient urinal, toilet, etc.—or a practice that affects device use) by multiplying the physical change in device flow by an estimated device utilization. The total volume of water saved is then estimated by multiplying the number of devices by the amount saved per device.
2) Univariate: Difference of Means – this method, derived from laboratory statistical methods where all exogenous influences are controlled for through laboratory methods – defines the "treatment" effect as the difference between the group receiving the treatment (treatment group) and those that don't. When the difference being compared is the change in water use, this is sometimes referred to as a "difference in differences" method: one compares the difference in water use among the treatment group to the difference in water use among the control group.
3) Multivariate Statistical Models—this method is more data intensive, requiring data on water use and on factors that cause differences in water use, in addition to the timing and nature of the water conservation intervention. In so doing, however, it does not require assumptions of similitude between potentially dissimilar groups. It allows for definition and testing of differences and analysis of implications.

Assessment of Methods for Estimating Water Savings

1) Engineering Estimates–Better understood as a calculation of prospective technical conservation potential, engineering estimates can be illustrated by the classic case of efficient toilet replacement calculation:

$$Volume\ of\ Water\ Savings \equiv \left(\frac{Volume_{old}}{Utilization} * Utilization\right) - \left(\frac{Volume_{new}}{Utilization} * Utilization\right)$$
$$= \frac{Volume_{old}}{Flush} * Number\ of\ Flushes - \frac{Volume_{new}}{Flush} * Number\ of\ Flushes$$

Though certainly simple to explain, this method has several problems.

First, this engineering estimate requires knowledge of the installation and removal of conservation devices. Though this problem is often assumed away, not all conservation devices will be installed and some of the installed devices may later be removed.

Second, a stipulated engineering estimate ignores human behavioral changes in response to technical change. In the above example, the number of flushes per day could change with different technology—double flushing or higher utilization of the newest toilet in the house. In another real example, low-flow showerheads may use 50 percent less water per

minute but people may take longer showers. Additionally, the act of receiving a retrofit kit may increase an individual's sensitivity to conservation in general and may then affect outdoor water using habits. This is sometimes called a spillover effect.

Third, in the need to arrive at a tractable equation the engineering method can exclude potential drivers of water savings. Devices savings derived directly from device change out difference in flow rate will exclude potential savings from leak reduction. There is evidence that some of the greater water savings observed from efficient toilet replacement in the multiple family sector is due to higher per toilet utilization as a substitute for garbage disposals (Veritec, 2002).

2) Univariate: Difference of Mean Water Use (or "Difference in Differences"). This method compares water use of a group of households assigned to receive efficient devices to a matching control group of households that does not. Also known as the "difference of differences" method, it comes from the statistical theory of randomized controlled laboratory experiments. Individuals are randomly assigned to one of two groups: an experimental group that receives the treatment and a control group that does not. Since the two groups are otherwise identical, any difference in water use between them can be attributed to the laboratory experiment (efficient devices).

Though simple, this method also suffers from a set of often fatal flaws. Below is a summary of these problems:

The most serious problem lies in the inattention of this method to the principles of good sample design. Conservation programs are rarely randomized or controlled. As a consequence, the experimental and control groups often are systematically different. Differential water use resulting from these household differences will be incorrectly attributed to the experiment. Without the difficult methodological work of randomizing and controlling ("designing") the experiment, this simple method yields biased estimates.

Second, the difference of differences method requires that a strict set of assumptions be true in order for the results to be valid. Some of these assumptions are:

- Customers are randomly assigned to the control and experimental groups.
- Observable customer characteristics are the same in the control and experimental groups.
- Non-observed characteristics (attitudes and predispositions) are the same
- External confounding factors are controlled for in a laboratory setting

In many real-world programs, most of these assumptions will not hold up. Testing the validity of these assumptions requires collecting data on customer characteristics and water use throughout the year. Testing with multivariate data naturally leads to the next

method that addresses what can be done when simple assumptions are empirically wrong.

3) Estimates from Multivariate Statistical Models. Multivariate Statistical Models—this method requiring data on water use as measured at the customer meter and on factors that cause differences in measured water use. Specifying these relationships in a multivariate equation, allows statistical testing of potential simplifying assumptions. Defining participation in a conservation program as an intervention occurring at a single point in time—even if the intervention is composed of multiple devices, education, and follow-up—allow use of intervention analysis methods well developed in the statistical literature (Box and Tsai, 1975). Inclusion and testing of informed engineering physical parameters is one area where two of the above methods can both be used. An example of this would be development of an index of intensity of participation in conservation programs (number of devices, level of follow up, etc.)

The magic of multivariate methods, in terms of statistical power to detect water savings, comes from inclusion of additional variables that predict variation in measured water use: weather, time of year, or customer characteristics. By explaining much of the variation in measured water use, multivariate models can better detect changes in mean water use and changes in the shape of water use through the year that are attributable to conservation interventions.

Methodological Complications of Landscape Transformation

We note that measuring the quantitative effect of landscape transformation programs is complicated by the programs intent: shaping the desirability of efficient landscaping for all customers, participants and non-participants alike. Thus, the water utility offers programs eliciting participants with the intent of bringing about the same changes in other non-participants down the line. This intended effect of landscape transformation has been referred to as a "spillover," "neighborhood," or "network" effect.

Consider simplistic attempts to compare water use of participants against a "control" group of non-participants. Each control household who was inspired by a participating neighbor to enact landscape transformation will reduce the net difference between participants and non-participants. Causally, the water saved by inspired and nonparticipating customers would reduce the estimated average effect of the LT program! This confounds an intended positive water savings (via spillover) among non-participants into a reduction in the estimated net water savings among participants.
The "Difference-in-differences" method comes from the statistical theory of randomized controlled experiments. Individuals are randomly assigned to one of two groups: a "treatment" group that receives a treatment and a control group that does not. Since the two groups are otherwise identical, any difference in water use between them would be attributed to the experiment (in this case the treatment would be the conservation program).

So, what happens when the assignment to "treatment" is not randomized and the "treatment" requires voluntary agreement, and possibly even effort by the water customer? Lacking randomized assignment, the "Difference-in-differences" method is prone to inferential error when the "control" group does not match the treatment group of participants. This "exchangeability" between "control" and "treatment" is required for the "difference in differences" method to estimate the causal effect. Sadly, voluntary conservation programs will empirically violate this needed assumption.

Happily, the statistics community has provided the label to place on this confounding--"stable unit treatment value assumption" (SUTVA), which implies that the treatment only affects the response of treated users and does not affect the response of their neighbors. When the SUTVA assumption fails, then the estimate of causal effect will be biased (off-target).[4]

Questions to ask of a "Difference in Difference" Method

WATER SAVINGS FROM "DIFFERENCE IN DIFFERENCES" METHODS GIVE CAUSALLY BIASED ESTIMATES WITHOUT:

- RANDOMIZATION: DO YOU HAVE A RANDOMLY ASSIGNED TREATMENT GROUP OR DO YOU HAVE VOLUNTARY PARTICIPANTS?
- CONTROL OF CONFOUNDING FACTORS: HAVE CONFOUNDING FACTORS BEEN CONTROLLED FOR IN THE LABORATORY?
- STABLE UNIT TREATMENT VALUE ASSUMPTION (SUTVA) – ARE THERE SPILLOVER OR NETWORK EFFECTS OF PARTICIPATION?

Landscape transformation programs require voluntary participation and, often, at a very high level of customer intention and effort. Clearly, voluntary participants in LT programs cannot be presumed to be identical, much less exchangeable, with non-participants. For each participating utility that provided a sample of non-participants, the impact evaluation tested the water use between the groups of participants and non-participants. In all cases, statistically distinguishable differences were found. (The direction of the difference depended on the design of the LT program.) In the process evaluation web surveys, attitudinal differences between LT participants and non-participants were easy to distinguish, if not rampant. Neither of these facts appear to surprise water utility decision makers and managers. Thus, the intervention analysis methods of this report,

[4] See Guido W Imbens and Donald B Rubin. 2015. Causal Inference in Statistics, Social, and Biomedical Sciences. Cambridge University Press and Donald B Rubin. 1990. Formal mode of statistical inference for causal effects. Journal of Statistical Planning and Inference (1990)

described in Chapter 5, should be understood as comparing participant consumption to their own pre-participation consumption (adjusting for weather).

Defining Methods to Segment Customers into Market Segments

How can water utilities effectively communicate with diverse customers to motivate adoption of efficient outdoor landscapes? Many water and energy utilities have adopted customer outreach strategies that hinge on targeting actionable messages to homogeneous customer groups. Identifying these "market segments" focuses on categorizing populations along demographic characteristics and psychological orientation. Moss (2008) suggested that energy utilities historically focused on customer class-based sectors—industrial, commercial, retail and agriculture—with little tailored segmentation reflected in program design for efficiency programs.[5] Clearly, not all single family customers are created alike: some would like to save water, some want to save money, some want to save money and water, some want to reduce landscape maintenance requirements, some want the same landscape as their neighbor, and some want the next level of aesthetic accomplishment. Even though customers are known to differ, targeted customer outreach remain the exception rather than the rule for water utilities. This can be attributed, in part, to a lack of customer-specific information on characteristics and attitudes and, in part, to an engineering economic focus on specific devices (efficient showerheads, toilets, etc.) Additionally, public water utilities may want to avoid the perception of providing assistance only to a subset of their customers.

One research objective of this project was to dig deeper into customer characteristics and attitudes to examine what motivates customer choices for landscape transformation. Based on the web surveys conducted as part of the process evaluation (Chapter 6), a set of customer segmentation analyses were conducted. Given a vast array of customer responses to survey questions, how can customers be grouped into homogeneous customer segments? The analytic methods used to accomplish "market segmentation" include cluster analysis, discriminate analysis, principle component analysis, or factor analysis that have methodological linkages but seek the same end—grouping customers into coherent segments.

The analytic method used in this report—principle components—can be intuitively understood as a dimension-reduction technique. Given survey responses by a large number of customers (hundreds), which responses can be used to identify a small number of homogeneous customer segments (say 3-5 segments)? This lower dimension of components/factors can reveal the structure that is not obvious from the mass of data. Principle components (a subset of factor analysis) approaches this task by seeking a weight for each question that explains variation in the responses. The first principle

[5] Moss, R. 2008. *Market Segmentation and Energy Efficiency Program Design.* California Institute for Energy and Environment, Oakland, CA.

component (factor) selects weights to maximize the explanation of variation. A second factor then seeks to explain the remaining variation selecting a new set of weights with the constraint that the second factor be uncorrelated with the first, though this constraint can be later relaxed. Additional factors are added to reach the number of desired customer segments (this is constrained by the sufficiency of sampled responses, of course.) This report does not provide a rigorous textbook development of this method as those already exist.[6]

[6] For an intuitive tutorial using only concepts from linear algebra, that is avoiding statistical optimization, we recommend Shlens (2014) *Tutorial on Principal Components Analysis.* https://arxiv.org/pdf/1404.1100.pdf

Chapter 4: Program Descriptions

Overview

Fourteen water utility programs were submitted for review; with water utilities looking for suggestions and feedback on design effectiveness. The programs fall into four categories:

1. Per Square Foot Incentives for Lawn Removal
2. Irrigation Equipment Incentives
3. Site Consultations (Audits)
4. Free Sheet Mulching Materials

The fourteen water utilities span from the low rainfall and drought areas of California, Nevada and Texas, to the moderately high rainfall regions of City of Guelph and the region of Peel, to the temperate marine weather of Seattle. The program designs range as well, with varying levels of incentives, customer support and rules/ requirements. Due to these factors the programs are not statistically comparable. For the purposes of this study, we have identified general barriers and opportunities that crossed the boundaries of most programs. Table 4.1 provides an overview of the program names, and types of program by utility. The following pages are basic overviews of the fourteen programs to provide the reader with key program elements.[7]

[7] This is the AWE Non-Member Edition of *the Landscape Transformation Study: 2018 Analytics Report* and does not include the fourteen utility program descriptions found in Chapter 4. Pages 33-62 are intentionally missing.

Table 4.1: Programs by Utility

Utility	Program Name	Type of Program
Austin Water	WaterWise Landscape Rebate Program	Per Sq. Ft. incentive for landscape transformation
California American Water	Turf Replacement Program	Per Sq. Ft. incentive for landscape transformation
Fort Collins Utilities	Xeriscape Incentive Program	Per Sq. Ft. incentive for landscape transformation
City of Guelph	Healthy Landscape Assessment Program	Site consultation and support
Metropolitan Water District of Southern California	SoCal WaterSmart	Per Sq. Ft. incentive for landscape transformation
North Marin Water District	Cash for Grass	Per Sq. Ft. incentive for landscape transformation
Region of Peel	Fusion Landscaping	Site consultation and support
City of Petaluma	Mulch Madness	Free mulch, compost, cardboard
City of Sacramento	River Friendly Landscape Program	Per Sq. Ft. incentive for landscape transformation
San Diego County Water Authority	Sustainable Landscapes Program	Per Sq. Ft. incentive for landscape transformation
City of San Diego	Grass Replacement Rebate	Per Sq. Ft. incentive for landscape transformation
City of Santa Rosa	Green Exchange Program Cash for Grass Rebate	Per Sq. Ft. incentive for landscape transformation
Seattle Public Utilities	Irrigation Equipment Rebate Program	Per Sq. Ft. incentive for landscape transformation
Southern Nevada Water Authority	Water Smart Landscapes Rebate	Per Sq. Ft. incentive for landscape transformation

Chapter 5: Impact Evaluation: Water Savings

This impact evaluation seeks to develop sound empirical answers to the following questions:

1. What change in water use was found in landscape transformation customers among the various water utility programs?
2. How do the water use reductions vary seasonally through the year?
3. How do the water use reductions vary over multiple years (do water savings persist?)

To answer these questions consumption data were compiled from utilities' customer billing systems for customers in the study areas.

Specification of Statistical Model

The model for customer water use seeks to separate several important driving forces. In the short run, changes in weather can make demand increase or decrease in a given year. These models are estimated at a household level and, as such, should be interpreted as a condensation of many types of relationships—meteorological, physical, behavioral, managerial, legal, and chronological. Nonetheless, these models depict key short-run and long-run relationships and should serve as a solid point of departure for improved quantification of these linkages.

Systematic Effects

This section specifies a water demand function that has several unique features. First, it models seasonal and climatic effects as continuous (as opposed to discrete monthly, semi-annual, or annual) function of time. Thus, the seasonal component in the water demand model can be specified on a continuous basis, then aggregated to a level comparable to measured water use (e.g. monthly). Second, the climatic component is specified in different form as a similar continuous function of time. The weather measures are thereby made independent of the seasonal component. Third, the model permits interactions of the seasonal component and the climatic component. Thus, the season-specific response of water demand can be specific to the season of the year.
The general form of the model is:

Equation 1 General Model Form

$$Use_{i,t} = \mu_i + S_t + W_t + I_{i,t}$$

where ***Use*** is the quantity of water consumption within time *t* measured at meter *i*, the parameter $\boldsymbol{\mu_i}$ represents mean water consumption per meter *i*, $\boldsymbol{S_t}$ is a seasonal

component, W_t is the weather component, $I_{i,t}$ is the effect of landscape transformation for customer meter *i* at time period *t*. Each of these components is described below.

Seasonal Component: A monthly seasonal component can be formed using monthly dummy variables to represent a seasonal step function. Equivalently, one may form a combination of sine and cosine terms in a Fourier series to define the seasonal component as a continuous function of time.[8] The following harmonics are defined for a given day *T*, ignoring the slight complication of leap years:

Equation 2 Seasonal Component

$$S_t \equiv \sum_{1}^{6}\left[\beta_{i,j}\cdot\sin\left(\frac{2\pi\cdot jT}{365}\right)+\beta_{i,j}\cdot\cos\left(\frac{2\pi\cdot jT}{365}\right)\right]=Z\cdot\beta_S$$

where ß is the coefficient to be estimated, *T* = (1,..., 365) and *j* represents the frequency of each harmonic, and *Z* is the matrix of harmonic effects.[9] Because the lower frequencies tend to explain most of the seasonal fluctuation, the higher frequencies can often be omitted with little predictive loss.

To compute the seasonal component one simply sums the multiplication of the seasonal coefficient with its respective value. This number will explain how demand changes due to seasonal fluctuation.

Weather Component: The model incorporates two types of weather measures into the weather component–maximum air temperature and rainfall. The measures of temperature and rainfall are then logarithmically transformed to yield:

Equation 3 Weather variables created from transformations of rainfall and temperature

$$R_t \equiv ln\left[1+\sum_{t=T}^{T_d} Rain_t\right], T_t \equiv ln\left[\sum_{t=T}^{T_d}\frac{Temp_t}{d}\right]$$

where *d* is the number of days in the time period. For monthly aggregations, *d* takes on the values 31, 30, or 28, ignoring leap years. R_t is the vector of logarithmically transformed and scaled rainfall and T_t is the vector of logarithmically transformed daily maximum air temperature. Because weather exhibits strong seasonal patterns, climatic measures are strongly correlated with the seasonal measures. To obtain valid estimates of a constant

[8] The use of a harmonic representation for a seasonal component in a regression context dates back to Hannan [1960]. Jorgenson [1964] extended these results to include least squares estimation of both trend and seasonal components.

[9] A quick note for those awaiting the arrival of daily consumption measures from automated metering: If measures of water demand are available on a daily basis, the harmonics defined by Equation 2 can be directly applied. When measures of water demand are only observed on a monthly basis, two steps must be taken to ensure comparability. First, water demand should be divided by the number of days in the month to give a measure of average daily use. Otherwise, the estimated seasonal component will be distorted by the differing number of days in a month. The comparable measures of the seasonal component are given by averaging each harmonic measure for the number of days in a given time period.

seasonal effect, the seasonal component is removed from the weather measures by construction.

Specifically, the weather measures will be constructed as a departure from their "normal" or expected value at a given time of the year. The expected value for rainfall during the year, for example, is derived from regression against the seasonal harmonics. The predicted value from this auxiliary regression is the expected value of the weather measures ($\widehat{\mathrm{R}} = \boldsymbol{Z}\boldsymbol{\beta}_{\boldsymbol{R}}$) and is then subtracted from the original weather measures:

Equation 4 Weather Component

$$W_t \equiv \left(R_t - \widehat{R_t}\right) \cdot \beta_R + \left(T_t - \widehat{T_t}\right) \cdot \beta_T$$

The weather measures in this deviation-from-mean form are thereby separated from the constant seasonal effect. Thus, the seasonal component of the model captures all constant seasonal effects, as it should, even if these constant effects are due to normal weather conditions. The remaining weather measures capture the effect of weather departing from its normal pattern.

The model can also specify a richer texture in the temporal effect of weather than the usual fixed contemporaneous effect. Seasonally-varying weather effects can be created by interacting the weather measures with the harmonic terms. In addition, the measures can be constructed to detect lagged effects of weather, such as the effect of rainfall one month ago on this month's water demand. Table 5.1 lists the Participating Utilities and their assigned Weather Stations, daily precipitation and maximum air temperature.

Table 5.1: Participating Utilities and assigned Weather Stations

Participating Utility	NOAA Weather Station	WBAN Number	Daily Precip.	Maxi Air Temp.
Austin, Texas	AUSTIN CAMP MABRY	13958	0.091	79.5
Fort Collins, Colorado	FORT COLLINS	53005	0.042	63.4
Guelph, Ontario, Canada	GEORGETOWN WWTP	52695	0.026	70.6
North Marin WD, California	PETALUMA AIRPORT	46826	0.069	70.5
Petaluma, California	PETALUMA AIRPORT	46826	0.069	70.5
Santa Rosa, California	SANTA ROSA	47965	0.087	71.3
Sacramento, California	SACRAMENTO EXECUTIVE AIRPORT	23232	0.049	73.9
San Diego, California	SAN DIEGO INTERNATIONAL AIRPORT	23188	0.090	55.8

Southern Nevada Water Authority, Las Vegas NV	LAS VEGAS MCCARRAN INTERNATIONAL AIRPORT	23169	0.011	80.2
San Diego County Water Authority, California*	3 CIMIS STATIONS IN SAN DIEGO COUNTY			
Source: NOAA weather from National Climate Data Center, beginning Jan. 1, 1950 for most stations. *Participating utilities added after February 2017				

Effect of Landscape Transformation Interventions: Information was compiled on the timing and customer meter of each landscape transformation participant. The unique identifier from these data were matched to meter consumption histories going back to the beginning of available consumption history. All raw meter reads were converted to average daily consumption by dividing by the number of days in the read cycle. Using these data, "intervention analysis" models were statistically estimated where, in this case, the intervention is participation in a Landscape Transformation Program. The form of the intervention variables will be:

Equation 5 Intervention Variables

$$I_{i,t} \equiv I_{LT} \cdot \beta_{LT} + I_{LT} \cdot sin1 \cdot \beta_{LT\_sin1} + I_{LT} \cdot cos1 \cdot \beta_{LT\_cos1}$$

The indicator variable I_{LT} takes on the value one to indicate the participation in a Landscape Transformation program and is zero otherwise.[10] The parameter $\hat{\beta}_{LT}$ represents the mean effect of landscape transformation participation and is expected to be negative (participating reduces water use.) This formulation also permits formal testing of the hypothesis that landscape interventions can affect the seasonal shape of water consumption within the year. Since numerous studies have identified a tendency of customers to irrigate more than ET requirements in the fall and somewhat less in the spring,[11] it will be informative to examine the effect of Landscape Transformation programs to reduce landscape water requirements. The formal test is enacted by interacting the participation indicators with the sine and cosine harmonics. The model will also include parameters to formally test for preexisting differences between participating customers and nonparticipating customers, where available.

For two of the participating utilities with more data, we also experimented with a different specification of the intervention variable. By multiplying the indicator variable

[10] To remove the effect of additional water applied during the establishment period, and any anticipation of landscape conversion (letting a lawn go brown prior to date of approved application), we replace the intervention variables with a missing value for six months after and six months before the date of participation.

[11] *The Residential Runoff Reduction Study*, Municipal Water District of Orange County, Irvine Ranch Water District, July 2004. *Smart Landscape Programs Comprehensive Evaluation*, San Diego County Water Authority, 2011. MWDOC Smart Timer Rebate Program Evaluation, Municipal Water District of Orange County, 2011.

I_{LT} by the number of square feet of turf converted, one can obtain an estimated effect per square foot replaced:

Equation 6 Intervention Variable with a linear effect per Square Foot of Turf Converted

$$I_{i,t} \equiv [\, I_{LT} \cdot TurfSqFt] \cdot \beta_{LTSqFt}$$

Note that this specification asserts that the water reduction is exactly proportional to the number of square feet of turf converted. This is a testable hypothesis. Adding an additional term that squares the turf-converted-area can test for curvature (a second derivative) of the per square foot effect:

Equation 7 Intervention Variables with a nonlinear effect per Square Foot of Turf Converted

$$I_{i,t} \equiv [\, I_{LT} \cdot TurfSqFt] \cdot \beta_{LTSqFt} + [\, I_{LT} \cdot TurfSqFt^2] \cdot \beta_{LTSqFtSq}$$

One can also test for persistence of the water savings effect. Constructing indicators for the number of years since turf conversion, one can test for variation in the water savings effect over time:

Equation 8 Intervention Variables per Square Foot of Turf Converted

$$\begin{gathered} I_{i,t} \equiv [\, I_{LT} \cdot TurfSqFt \cdot 1\, Year\ After\,] \cdot \beta_{LTSqFt_{Year1}} + \\ [\, I_{LT} \cdot TurfSqFt \cdot 2\, Years\ After\,] \cdot \beta_{LTSqFt_{Year2}} + \\ \dots \\ [\, I_{LT} \cdot TurfSqFt \cdot 10 YearsorMoreAfter\,] \cdot \beta_{LTSqFt_{Year10Plus}} \end{gathered}$$

If the water savings effect is constant, all estimated coefficients will be exactly equal.

Stochastic Effects

To complete the model, we must account for the fact that not every data point will lie on the plane defined by **Equation 9** below. This fundamental characteristic of all systematic models can impose large inferential costs if ignored. Misspecification of this "error component" can lead to inefficient estimation of the coefficients defining the systematic forces, incorrect estimates of coefficient standard errors, and an invalid basis for inference about forecast uncertainty. The specification of the error component involves defining what departures from pure randomness are allowed. What is the functional form of model error? Just as the model of systematic forces can be thought of as an estimate of a function for the "mean" or expected value, so too can a model be developed to explain departures from the mean—i.e., a "variance function" If the vertical distance from any observation to the plane defined by **Equation 9** is the quantity **ε**, then the error component is added to **Equation 9**:

Equation 9 Systematic and Non-systematic (Error) Components

$$Use_{i,t} = \boldsymbol{f}(S_t, W_t, I_t) + \boldsymbol{\varepsilon_{i,t}}$$

Two different types of error structures were tested and used in the analysis. The first type is the "fixed effects" model estimates a specific "fixed" effect $\widehat{\mu_i}$ for each customer *i*. No distributional assumption is required for the distribution of customer-specific intercepts, $\widehat{\mu_i}$. The fixed effects model can be simply implemented by adding a customer-specific dummy variable for each customer.

The second error structure is termed a "random effects" model because it assumes that the customer-specific are modeled as coming from a random population distribution. T random effects error structure is specified as:

Equation 10 Random Effects Error Structure

$$\varepsilon_{it} = \mu_i + \xi_{it}$$
$$where$$
$$\mu_i \sim N(0, \sigma_\mu^2)$$
$$\xi_{it} \sim N(0, \sigma_\xi^2)$$

The explanatory variables and ξ are assumed to be independent of each other and of μ. The individual component μ represents the effects of unmeasured household characteristics on household water use. An example of such an unmeasured characteristic might be the water use behavior of household members. This effect is assumed to persist over the estimation period. The second component ξ represents random error. Because μ and ξ are independent, the error variance can be decomposed into two components:

Equation 11 Error Components

$$\sigma_\varepsilon^2 = T \cdot \sigma_\mu^2 + \sigma_\xi^2$$

This model specification is accordingly called an error components or variance components model. The model will be estimated using maximum likelihood methods using the STATA statistical software package. The reader should note that other statistical software can enact this panel data estimator; an open source choice is *R* statistical software using the "plm" package.[12]

There is an additional refinement, in that the estimation method provides estimated standard errors around the coefficients that are adjusted for "clustering" within the panel (defined by a customer meter). The effect of this adjustment results in larger estimated standard errors due to within-cluster correlation.

[12] See Croissant Y, Millo G (2008). "Panel Data Econometrics in R: The plm Package."Journal of Statistical Software, 27 (2). http://cran.r-project.org/web/packages/plm/vignettes/plm.pdf

Data Quality Testing and Diagnostics: Robust regression techniques were used to detect which observations are potentially data quality errors. This methodology determines the relative level of inconsistency of each observation with a given model form. A measure is constructed to depict the level of inconsistency between zero and one; this measure is then used as a weight in subsequent regressions. Less consistent observations are down-weighted. Meter-specific means of this robust weight can help flag customers that have questionable meter reads or questionable customer type classification. Other model-based outlier diagnostics were also employed to screen the data for any egregious data quality issues.

Model Estimation: Average Participant Water Savings Effect

Table 5.2 summarizes the sample statistics from the estimated water use models of single family residential landscape transformation program customers in the participating water utilities. The reader should note that the incentive base programs attracted participants having higher mean water use than non-participants. The reverse was the case for the Guelph and Petaluma programs that did not have cash incentives. Readers should also note the wide differences in sample sizes, both in the number of participants and in the length of available consumption history.

Table 5.2: Sample Statistics - Estimated Water Use Models of Single Family Customers

Utility	Participant pre-intervention use (gpd/meter)	Nonparticipant use (gpd/meter)	Number of Participants in Sample	Number of Observations	Begin Period	End Period	Type of Program
Austin	252.4	N/A	65	4,543	1/1/2011	9/1/2017	Cash for Grass
Guelph	149.1	162.0	2,526	1,531,000	1/1/2006	12/1/2015	Outreach and Support
North Marin	400.6	322.9	602	151,268	12/1/2003	12/1/2015	Cash for Grass
Petaluma	207.0	224.1	36	5,250	1/1/2010	5/1/2017	Mulch Madness
Sacramento	377.0	372.1	240	17,641	1/1/2009	5/1/2017	Cash for Grass
San Diego, City	330.4	263.4	384	199,460	1/1/2007	7/1/2017	Cash for Grass
SNWA	724.2	679.4	28,632	5,943,413	1/1/1997	12/1/2016	Cash for Grass
Santa Rosa	240.4	211.7	1,805	411,726	1/1/2010	12/1/2016	Cash for Grass
San Diego CWA	329.6	N/A	282	12,757	5/1/2008	2/1/2017	Incentives and Classes

Table 5.3 summarizes the average participant effect from the estimated water use models of single family residential landscape transformation program customers in the participating water utilities. Detailed statistical estimation results are found in Appendix D for each participating utility.

Table 5.3: Average Participation Effect from Estimated Water Use Models of Single Family Customers

Utility	Average Participant Savings, β_{LT} (gpd/meter)	lower bound (gpd/m)	upper bound (gpd/m)	Participant pre-intervention use (gpd/meter)	Average Participant Savings (%)	Lower Bound (%)	Upper Bound (%)	Mean Turf Sq. Ft. replaced	Mean Savings per Sq. Ft per year (gl/yr)	Type of Program
Austin	47.7	23.7	71.7	252.4	18.9%	9.4%	28.4%	1549.3	11.2	Cash for Grass
Guelph	10.3	5.7	14.8	149.1	6.9%	3.8%	9.9%	N/A	N/A	Outreach and Support
North Marin	100.0	83.1	117.0	400.6	25.0%	20.7%	29.2%	599.9	60.9	Cash for Grass
Petaluma	27.6	9.5	45.7	207.0	13.3%	4.6%	22.1%	N/A	N/A	Mulch Madness
Sacramento	111.7	61.0	162.4	377.0	29.6%	16.2%	43.1%	919.3	44.3	Cash for Grass
San Diego, City	109.8	95.6	124.1	330.4	33.2%	26.7%	37.6%	959.2	41.8	Cash for Grass
SNWA	280.6	277.3	284.0	724.2	38.8%	38.3%	39.2%	1348.0	76.0	Cash for Grass
Santa Rosa	54.9	50.4	59.4	240.4	22.8%	21.0%	24.7%	852.1	23.5	Cash for Grass
San Diego CWA	114.8	98.5	131.2	329.6	34.8%	29.9%	39.8%	1046.0	40.1	Incentives and Classes

In Table 5.3, the average participant effect comes from the estimated coefficient on the landscape intervention, β_{LT}, for each utility. We also provide the lower and upper bound (a 95% confidence interval) of the estimated average effect of LT Participation.

The average participant savings, expressed across water utilities varies. It likely varies by more dimensions than the number of participating utilities. Setting aside this "degrees-of-freedom" issue for the moment, several one-way relationships can be observed in Table 5.3. As suggested by Figure 5.1, higher LT participant water savings are associated with higher levels of pre-participation mean use. Thus water utilities in areas with causal forces that drive single family customer water use up--high evapotranspiriation and/or large landscape areas—experienced higher water savings for each single family residence. The relationship is not strictly linear but appears relatively coherent.

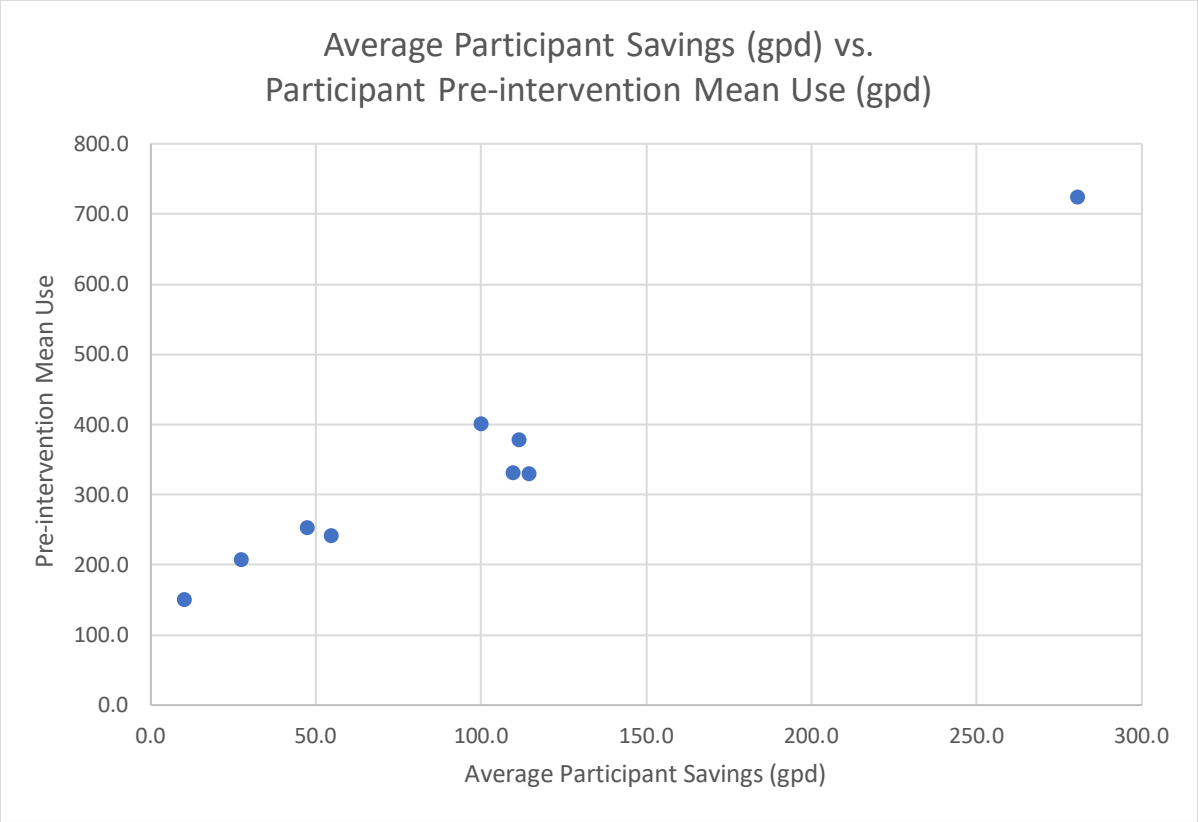

Figure 5.1: Average Participant Water Savings vs. Pre-Intervention Mean Use

Another one-way association exists between the average participant water savings and the amount of turf area replaced. Figure 5.2 plots the average participant water savings and the amount of turf area replaced and shows a positive relationship. More variation can be observed around this one-way relationship than would be explained by causal forces not included: the pre-participation mean use, the characteristics of the LT program, and the intensity of implementation, to name a subset of omitted variables from this

scatterplot.

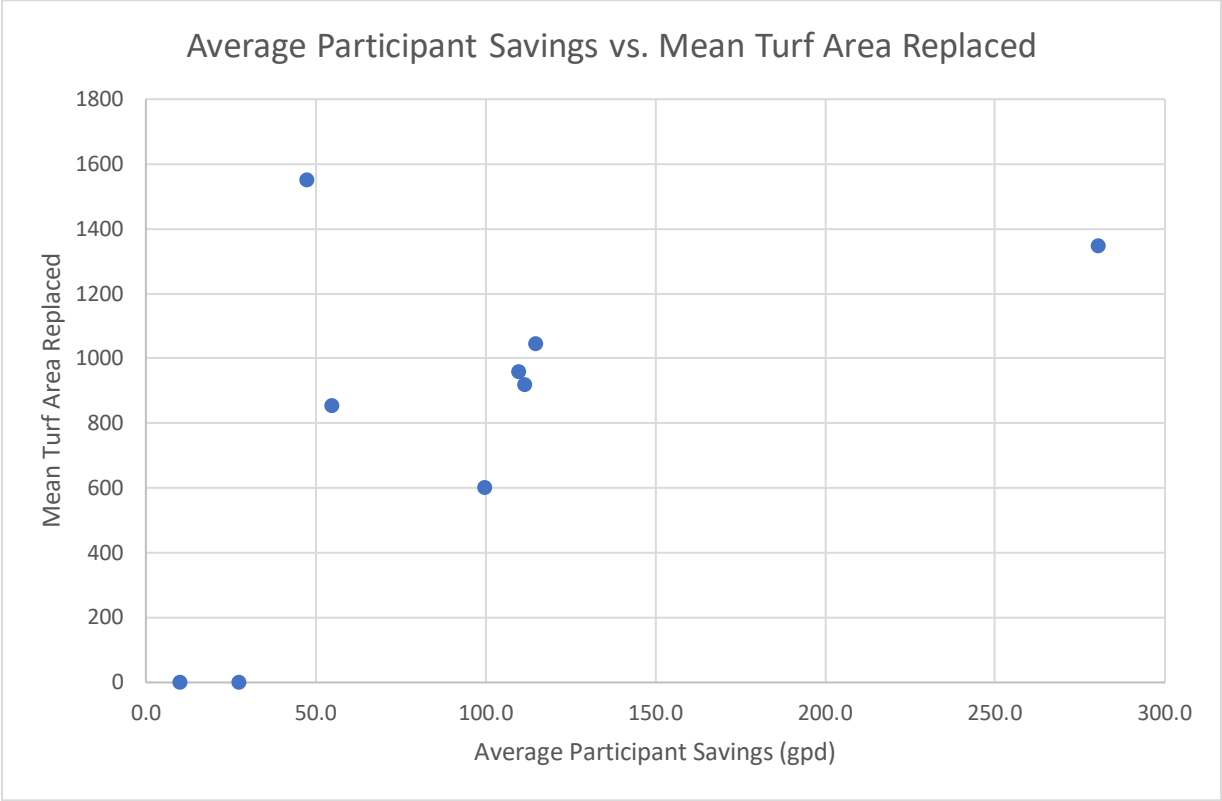

Figure 5.2: Average Participant Savings vs. Mean Turf Area Replaced

Model Estimation: Shaping Seasonal Participant Water Use

As a performance metric, the average annual participant water savings does not completely capture the impact of these landscape transformation programs. Water utilities initiate LT programs for more than average annual water savings—shaping customer water demand through the year can help reduce peak demand, reduce design requirements for integrated water infrastructure, and avoid additional costs that can reduce customer bills over time.

The independent variables made up of the sines and cosines of the Fourier series described in Equation 2—are used to depict the seasonal shape of water demand. The predicted seasonal effect (that is, $Z \cdot \widehat{\beta_S}$) is the shape of demand in a normal weather year. This evaluation tested for changes to the shape of LT participant season demand--that is, testing if $\beta_{LT\_sin1}, \beta_{LT\_cos1}$ were distinguishable from zero. Detectable changes—at high levels of statistical confidence—were observed at each participating water utility. Figures 5.3 through 5.11 shows participating utilities' seasonal pattern of water use, both before and after participation

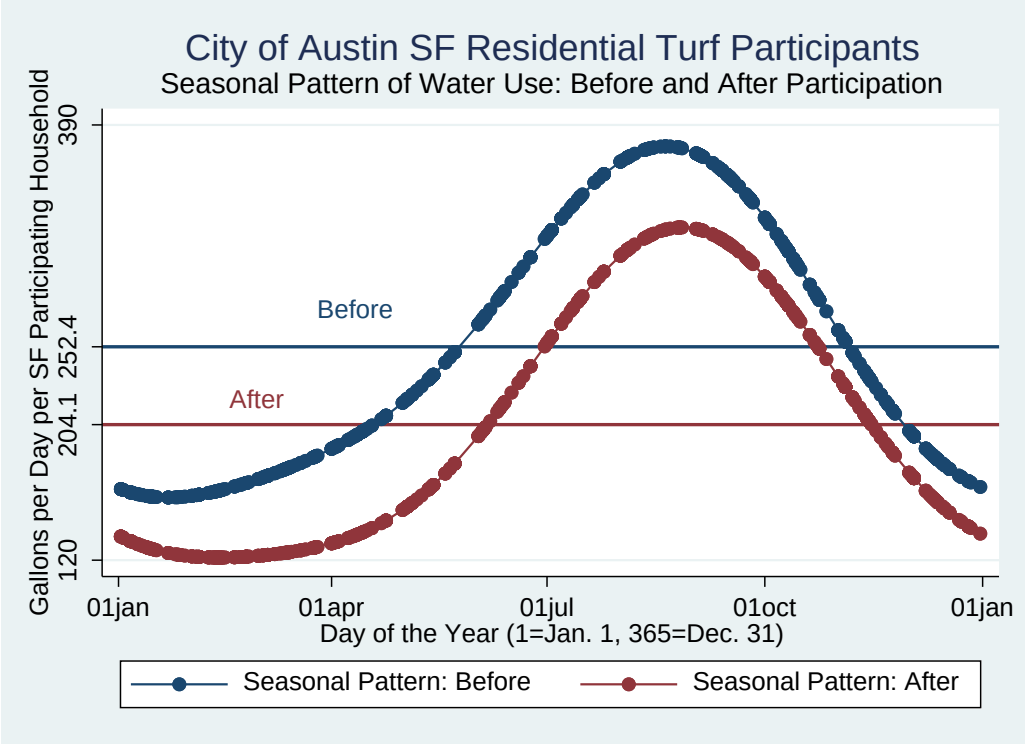

Figure 5.3: City of Austin Participants' Seasonal Pattern of Water Use-Before and After Participation

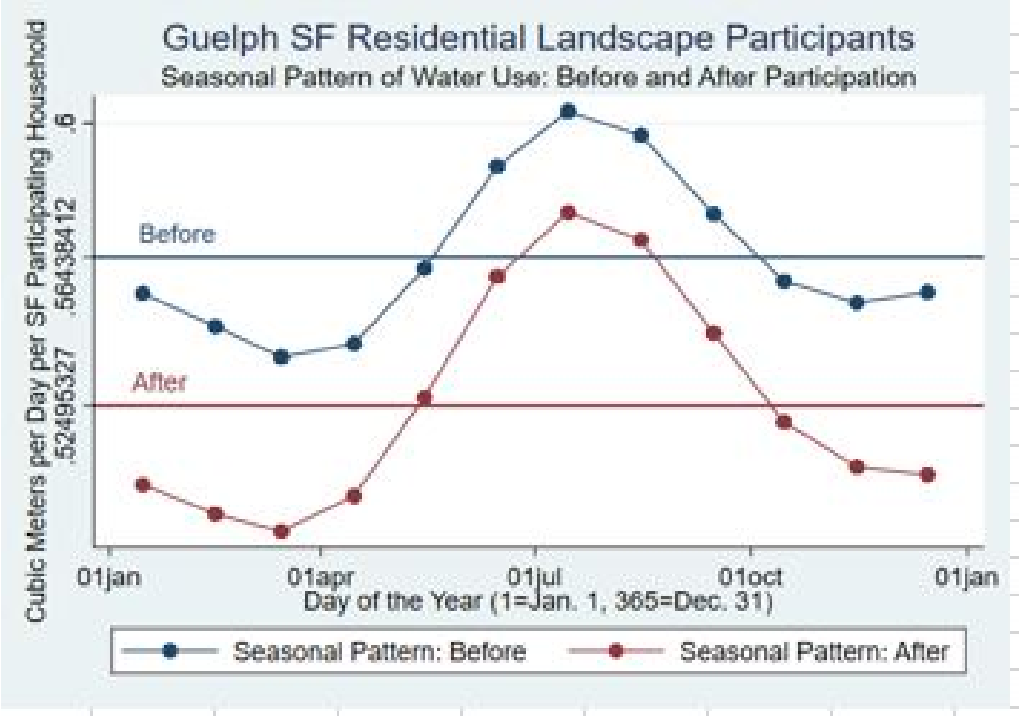

Figure 5.4: Guelph Participants' Seasonal Pattern of Water Use-Before and After Participation

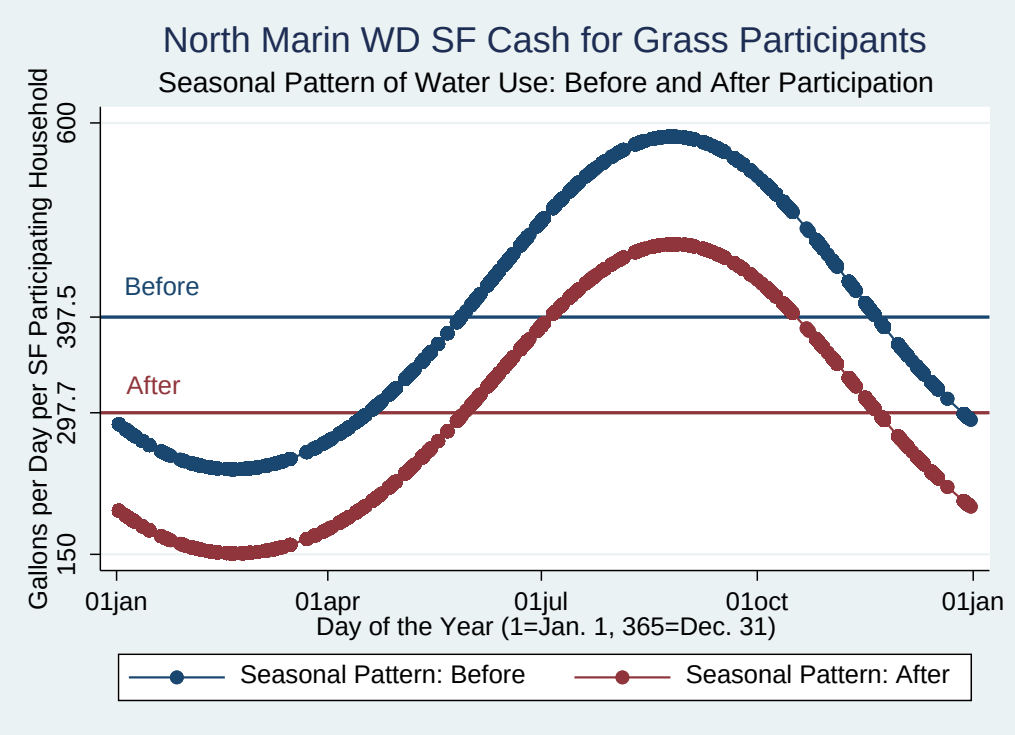

Figure 5.5: North Marin Participants' Seasonal Pattern of Water Use-Before and After Participation

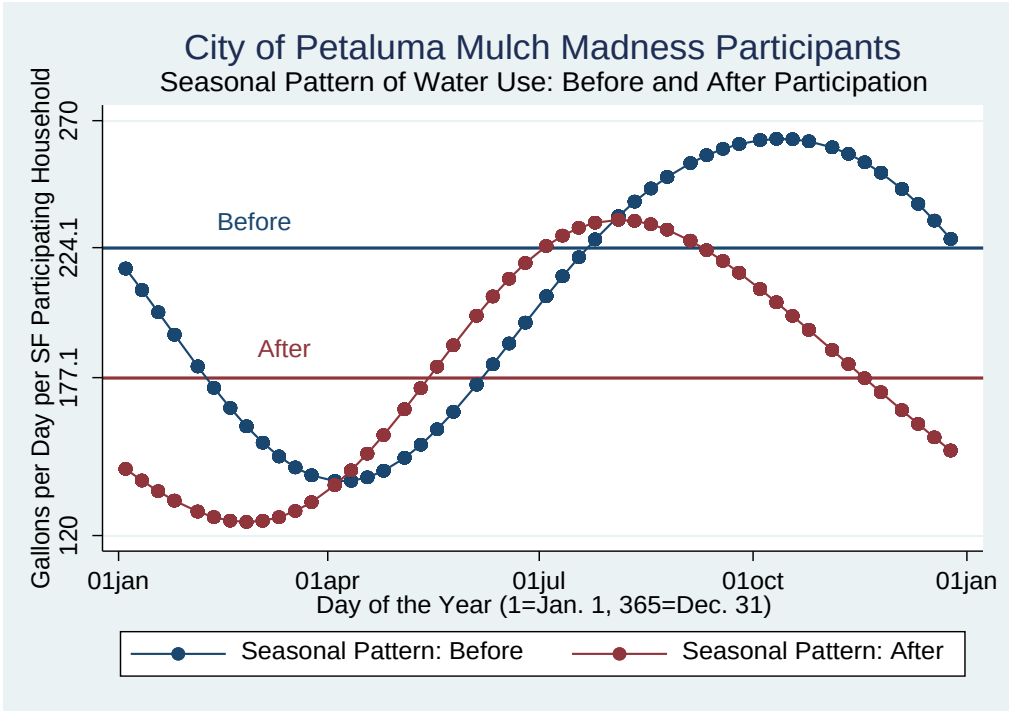

Figure 5.6: City of Petaluma Participants' Seasonal Pattern of Water Use-Before and After Participation

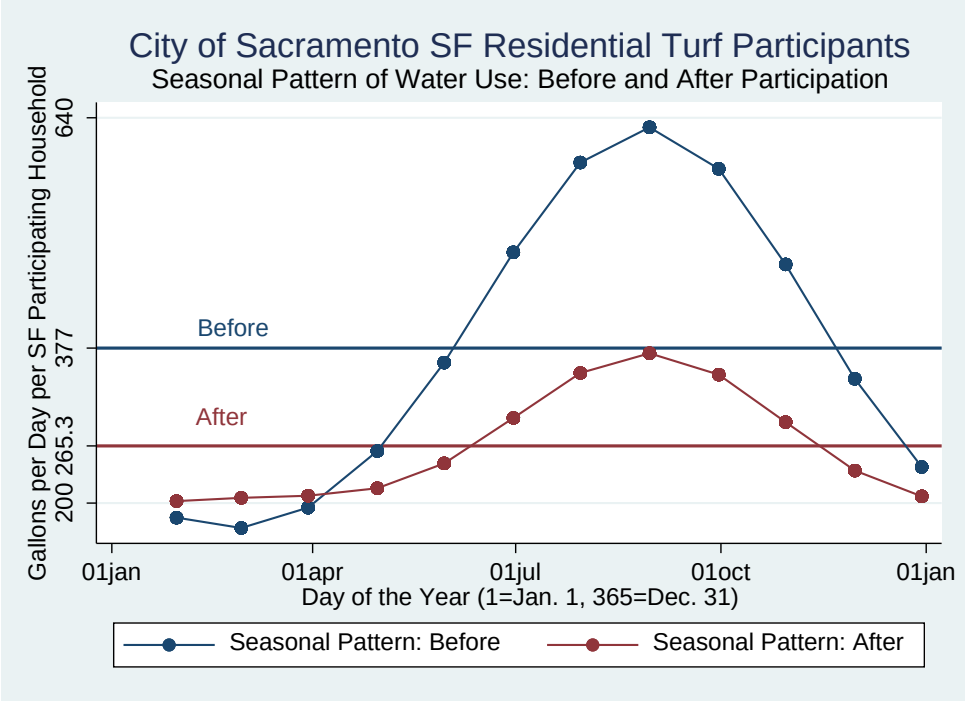

Figure 5.7: City of Sacramento Participants' Seasonal Pattern of Water Use-Before and After Participation

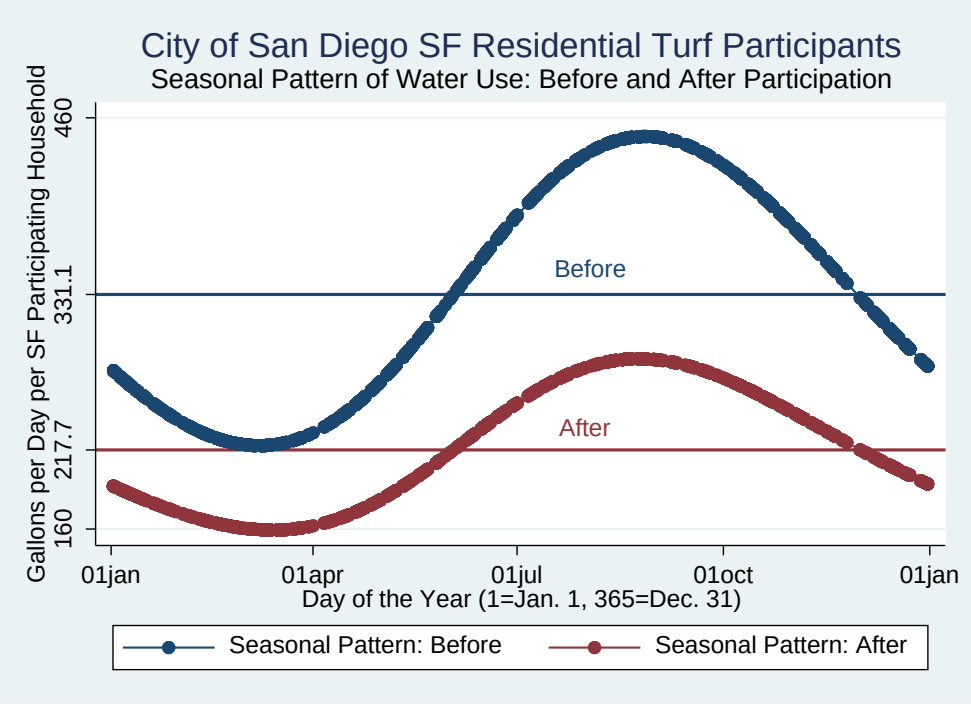

Figure 5.8: City of San Diego Participants' Seasonal Pattern of Water Use-Before and After Participation

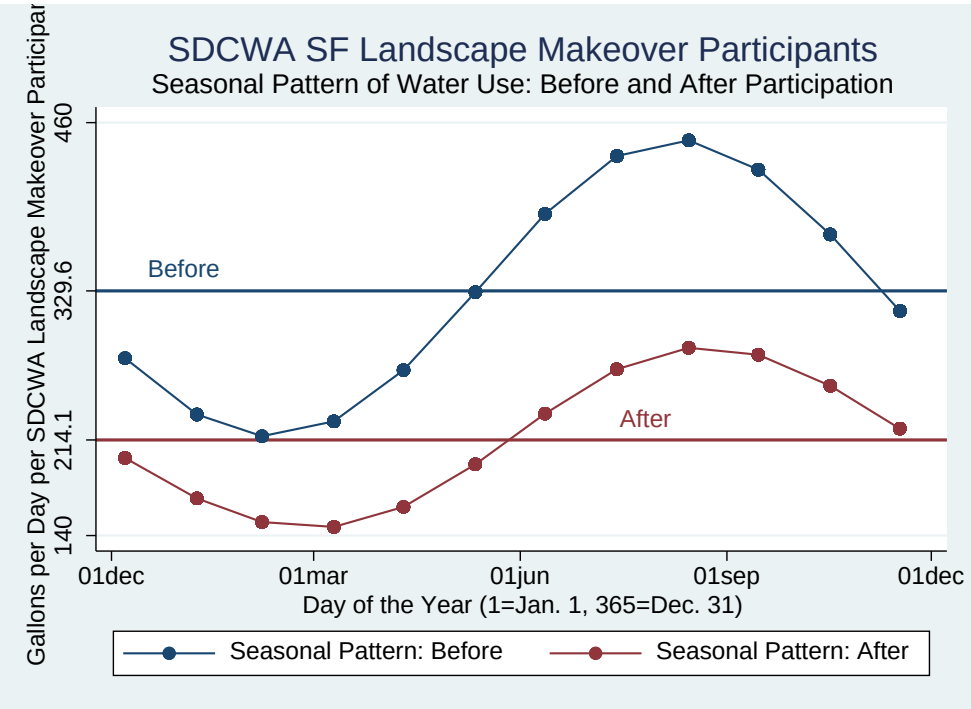

Figure 5.9: SDCWA Participants' Seasonal Pattern of Water Use-Before and After Participation

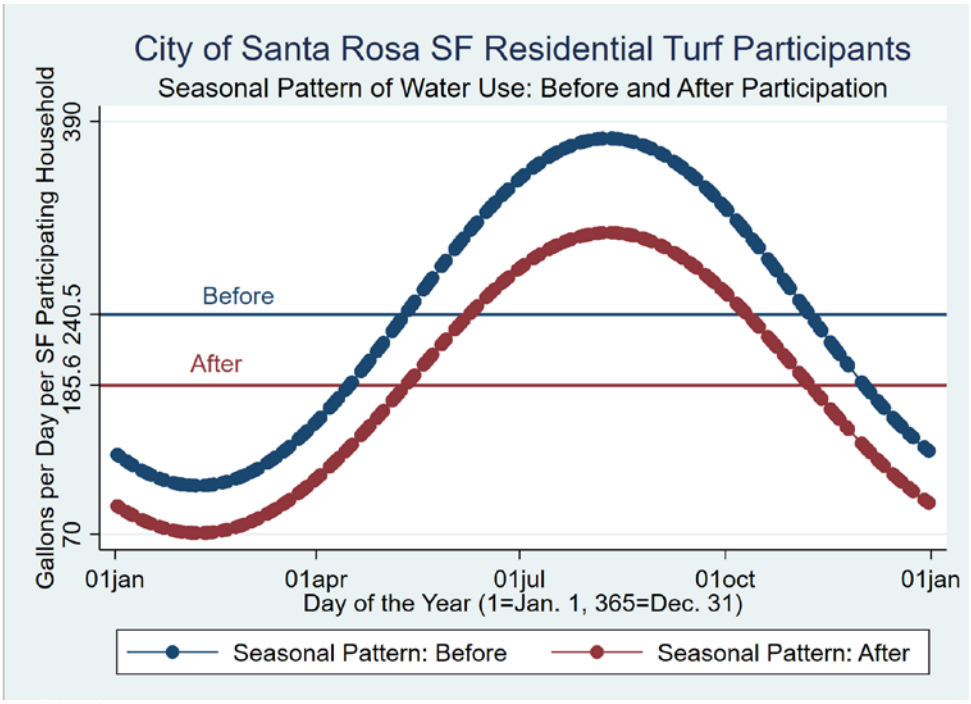

Figure 5.10: City of Santa Rosa Participants' Seasonal Pattern of Water Use-Before and After Participation

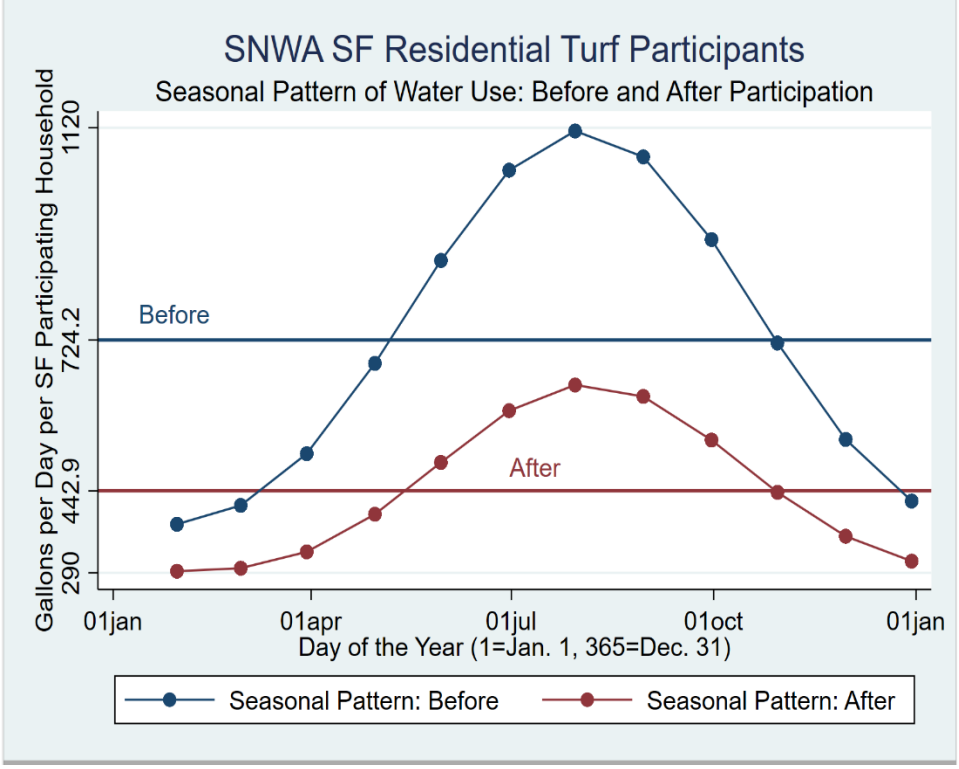

Figure 5.11: SNWA Participants' Seasonal Pattern of Water Use-Before and After Participation

Model Estimation: Persistence of Water Savings

Two additional statistical models—for the City of San Diego and Southern Nevada Water Authority--explored additional questions of how water savings vary:

- By square foot (across customers) and
- Over time (years since turf conversion)

The detailed model results can be found at the end of Appendix D. We interpret the results from SNWA due to the long empirical history with which to assess persistence. First, the hypothesis that water savings per square foot were exactly proportional to the number of square feet of turf replaced could be rejected: there were decreasing (per square foot) returns to the size of turf area converted (as can be judged by the coefficient on turf area squared, $\beta_{i\_convert\_sqftsqd}$, which is twelve times larger than its' standard error.)

The persistence of water savings per square foot was tested by adding indicators for a change to the mean savings based on the number of years since the turf conversion. Converting from volumetric daily savings per square foot to annual savings per square foot, the Figure 5.12 can be composed. There is weak evidence for lower water savings in the early years. Water savings can be seen to climb over time, rising from 71.1 gallons per

square foot in the first year following conversion to 81.4 gallons per square foot after 10 or more years. Both the 5 to 9 year coefficient and the 10 plus year coefficient are statistically significant at classical levels and materially significant.

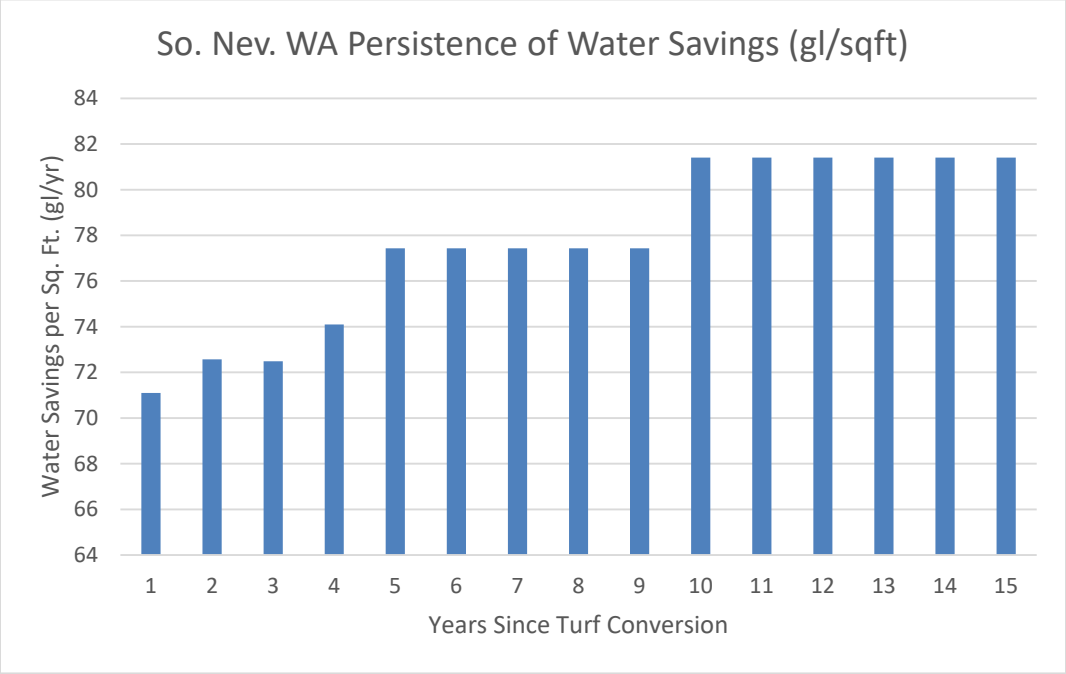

Figure 5.12: SNWA Persistence of Water Savings

This evidence strongly supports the long-term persistence of water savings from turf conversion in Southern Nevada. The model of persistence for the City of San Diego has a much shorter history but displays a similar pattern in the first four years.

Chapter 6: Process Evaluation

Participant On-line Survey Overview

Participant and Non-participant surveys were developed with the involvement of each of the utilities. A draft survey questionnaire was sent to each utility to allow for question input. Once this process was completed individual surveys were generated for each Utility. Most of the participating utilities had one survey for Landscape transformation program participants and one for non-participants. Once the surveys were finalized each utility determined how they would operationalize customer contact. This was done by:

- Utility managed email blasts
- Consultant managed email blasts
- Website links
- Postcard mailers
- Utility newsletters
- Utility partnership websites
- Utility partnership newsletters
- Social Media

The program participants were asked to rank the most important elements of their landscape. As with non-participants, the responses were similar with aesthetics ranking number 1. The only variation was that participants ranked low water use higher and usable space lower as desirable elements. This makes sense because these were the people that actually took action as a response to drought conditions and a "saving water" marketing message. Interestingly, although participants stated aesthetics as their number one desirable design element, only 10% stated "the new look" was the reason that they converted their landscape. This somewhat makes sense these early adaptors historically are people that are environmentally focused and "doing the right thing" drove their participation. [13]

Survey Findings Summary

Table 6.1 provides the descriptive statistics for each of the Utilities surveys for participant and non-participant. The three utilities that chose to offer a prize for completing the online survey were the City of Fort Collins, Region of Peel and the City of Sacramento. Survey participants were required to complete the survey and provide their Name and other pertinent information to be entered in a drawing for a gift card.

[13] A more in-depth interpretation of the on-line survey can be found in the companion report "AWE Landscape Transformation Study What are Customer Landscape Preferences and What Drives Customers to Change Their Landscape?"

Table 6.1: Survey Descriptive Statistics by Utility

Utility	Survey Name	Method for survey	Count sent	Count taken	Survey Incentive offered
Austin Water	Austin Water -- WaterWise Landscape Rebate Program (Participants)	email	126	35	No
Austin Water	Austin Water-- WaterWise Landscape Survey (Non-Participants)	email	15991	238	No
California American Water	California American Water -- Landscape Transformation Survey 1 - Knowledge About Water Use and Program Awareness	email	1110	25	Yes
California American Water	California American Water -- Landscape Transformation Survey 2 - Attitudes and Opinions of Home Landscapes	email	1160	18	Yes
California American Water	California American Water -- Landscape Transformation Survey 3 - Customer Motivations and Barriers About Replacing Lawns	email	1110	14	Yes
California American Water	California American Water -- Landscape Transformation Survey 4 - Irrigation Equipment and Level of Interest in Efficiency Products	email	1060	20	Yes
California American Water	California American Water -- Landscape Transformation Survey 5 - Landscape and Irrigation Purchasing Habits and Influences	email	1105	20	Yes
California American Water	California American Water -- Turf Rebate Program Survey (Participants)	email	2196	95	Yes
City of Fort Collins	City of Fort Collins -- Landscape Survey (Non-Participants)	email	2508	590	Yes
City of Fort Collins	City of Fort Collins -- Landscape Transformation Program (Participants)	email	88	43	Yes
City of Guelph	City of Guelph -- Landscape Survey (Non-Participants)	Social Media	Unknown	205	No
City of Guelph	City of Guelph -- Landscape Transformation Program (Participants)	email	1000	382	No
City of Petaluma	City of Petaluma -- Landscape Transformation Program (Participants)	webpage	Unknown	4	No
City of Sacramento Water	City of Sacramento Water -- Landscape Survey (Non-Participants)	email	5927	552	Yes
City of Sacramento Water	City of Sacramento Water -- Turf Rebate Program Survey (Participants)	email	89	24	Yes

Utility	Survey Name	Method for survey	Count sent	Count taken	Survey Incentive offered
City of San Diego Public Utilities	City of San Diego Public Utilities -- Landscape Survey (Non-Participants)	webpage	Unknown	29	No
City of San Diego Public Utilities	City of San Diego Public Utilities -- Turf Rebate Program Survey (Participants)	email	400	120	No
City of Seattle	Saving Water Partnership -- Landscape Survey (Non-Participants)	webpage, social media	Unknown	21	No
City of Seattle	Saving Water Partnership -- Landscape Transformation Program (Participants)	email	1686	169	No
North Marin Water District	North Marin Water District -- Landscape Transformation Survey (Participants)	email	500	104	No
Region of Peel	Region of Peel -- Landscape Transformation Survey	online article, webpage	Unknown	1724	Yes
Region of Peel	Region of Peel -- Landscape Transformation Survey Fusion Design	email	4030	898	Yes
Sonoma County Water Agency	Sonoma County Water Agency -- Landscape Survey	Newsletter	Unknown	30	No
Southern Nevada Water Authority	Southern Nevada Water Authority -- Conversion to Water Efficient Landscape (WSL Participants)	email	4158	438	No
Southern Nevada Water Authority	Southern Nevada Water Authority -- Landscape Survey (C)	email	6976	544	No
Southern Nevada Water Authority	Southern Nevada Water Authority -- Landscape Survey (D)	email	1460	109	No

Participant Survey Findings

There is great diversity among and within participating utilities (Figure 6.1):

- City of Austin participants heard of the program through the water bill and social media
- Fort Collins participants heard of the program through the water bill.
- Guelph participants heard through the local newspaper and social media
- North Marin WD participants heard of the program through the water bill and the NMWD website.

- The City of San Diego participants heard through the word of mouth and the City website.
- The Cities of Sacramento and Seattle had very diverse modes of informing participants.
- SNWD participants heard through the water bill, word of mouth, and the utility website.

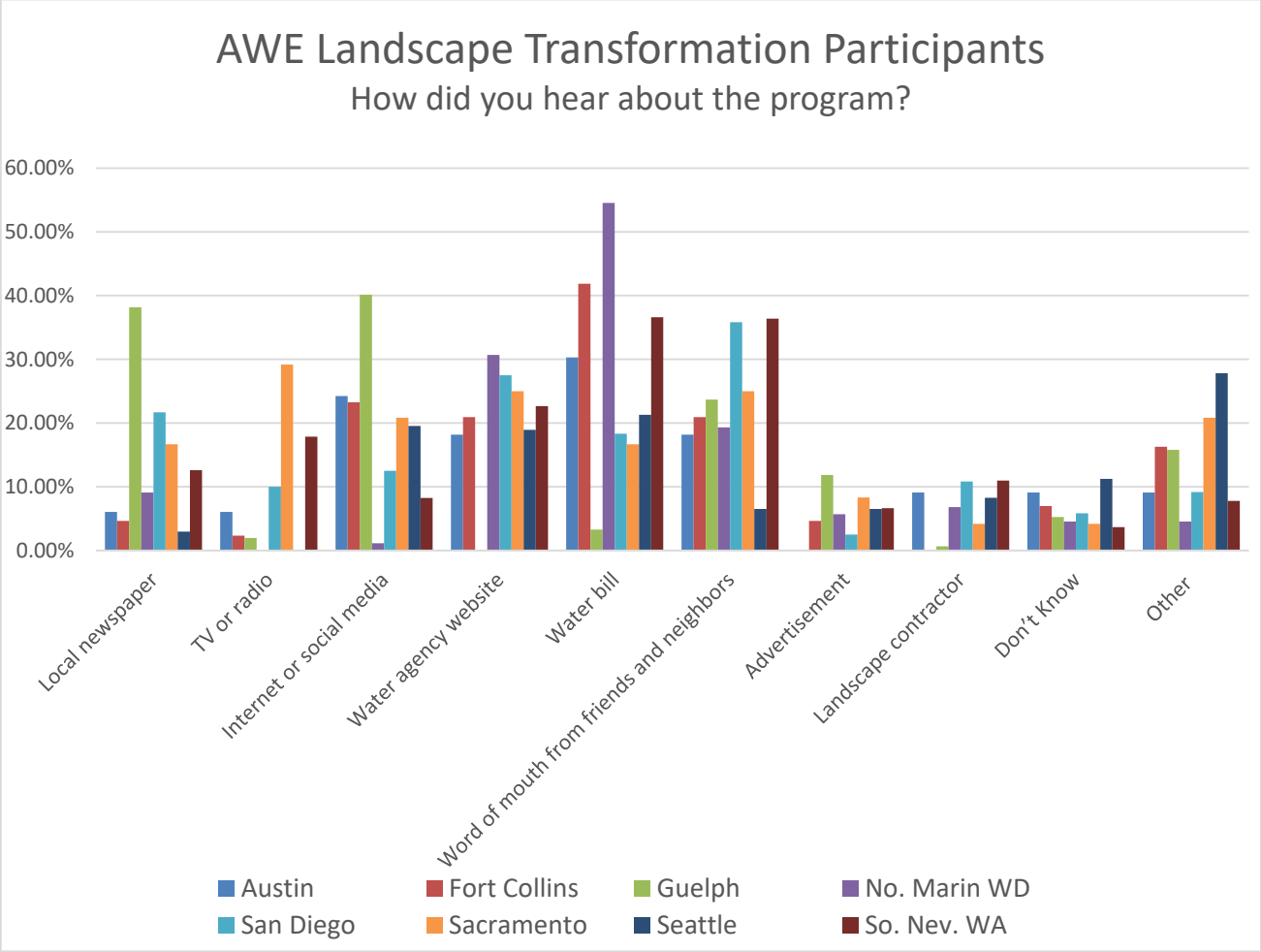

Figure 6.1: Survey Question - How did you hear about the program?

More than a third of Austin, Fort Collins, San Diego, No. Marin, and Sacramento participants had participated in other programs. Figure 6.2 displays responses to this by utility.

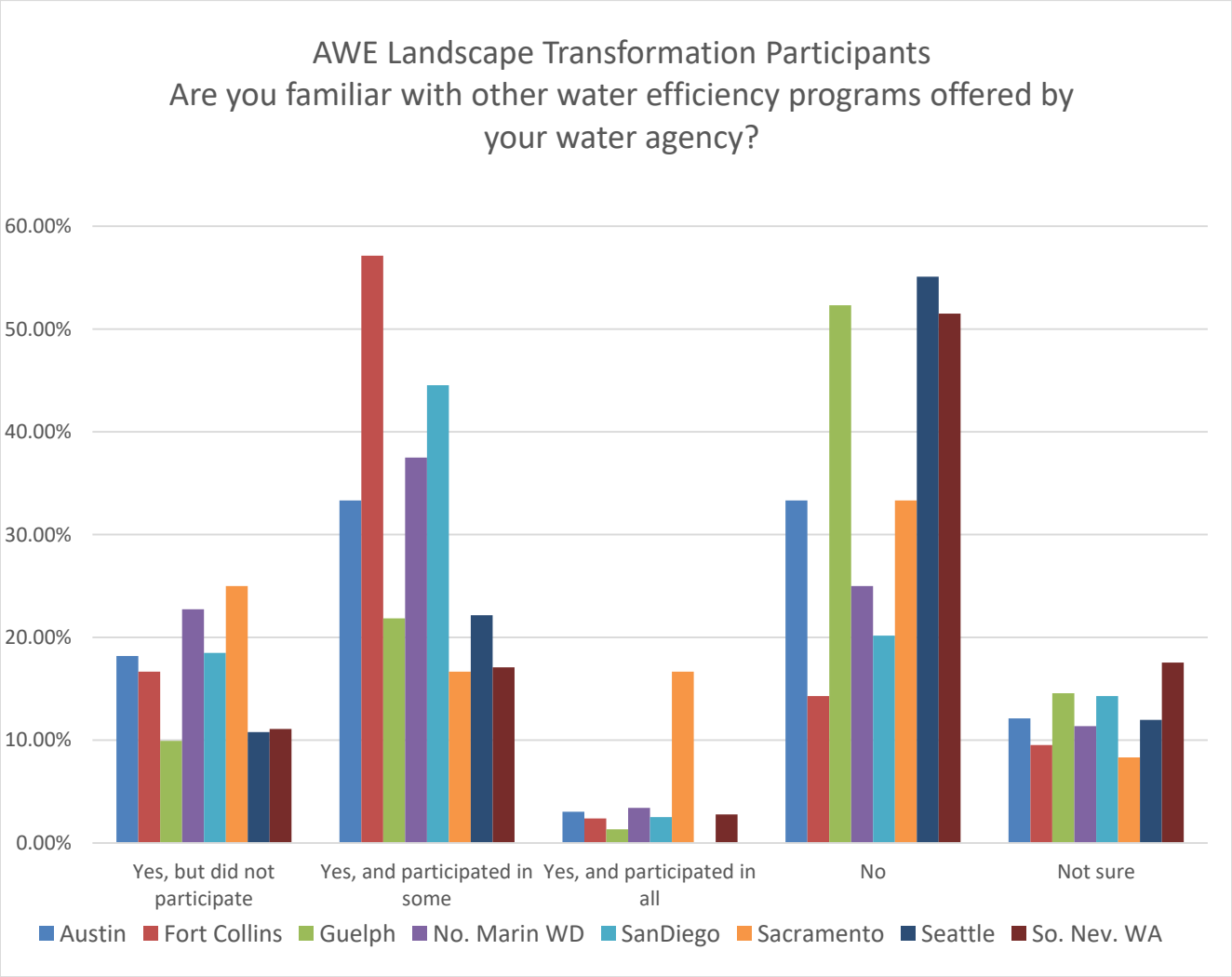

Figure 6.2: Survey Question - Are you familiar with other water efficiency programs offered by your water utility?

In overall rank order, Landscape Transformation participants gave the reasons for changing landscape as: 1) saving water, 2) reducing maintenance, 3) drought, 4) saving money, 5) liked the look, and 6) due to incentive.

Participants from utilities offering cash-incentives noted the importance of saving money/water (Figure 6.3).

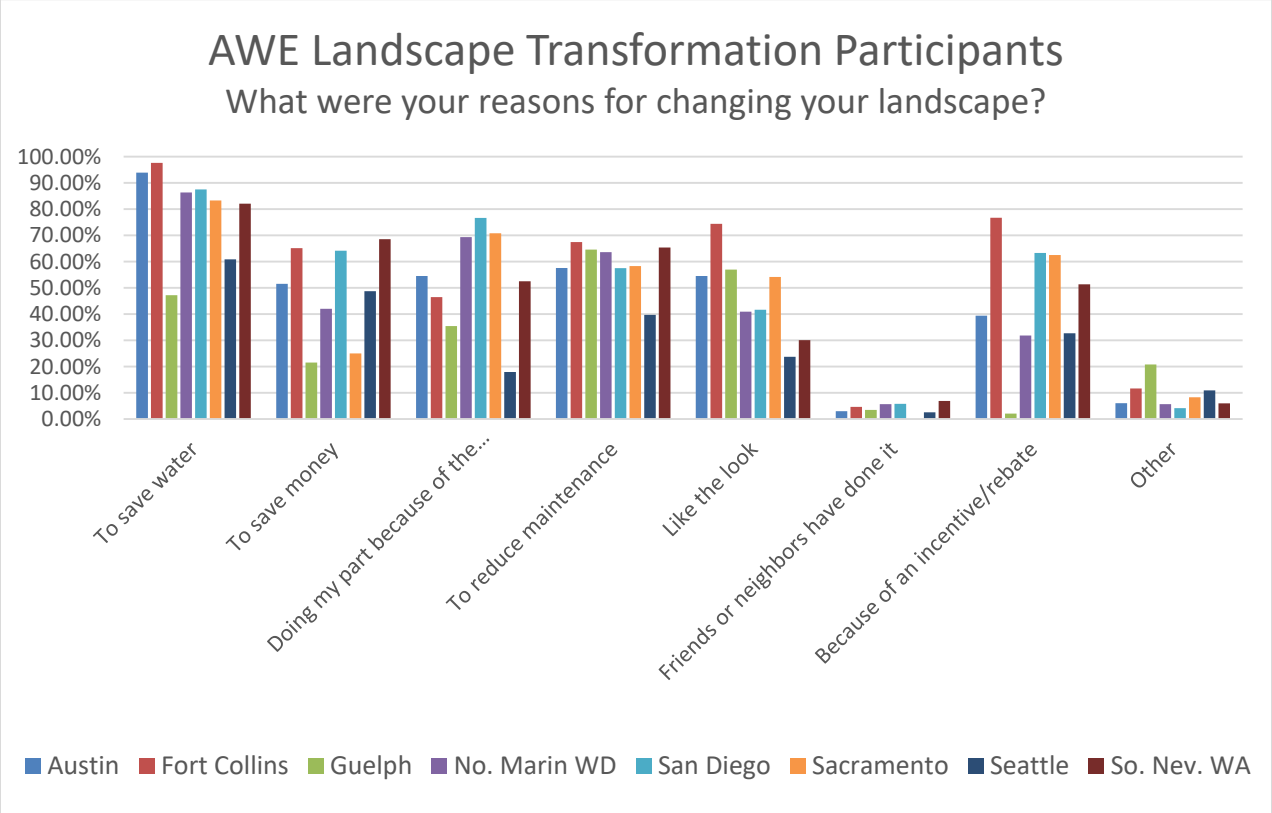

Figure 6.3: Survey Question - What were your reasons for changing your landscape?

To drill further into the idea of decision for change the graph in figure 6.4 shows the great diversity in participant identification of the most important reason.

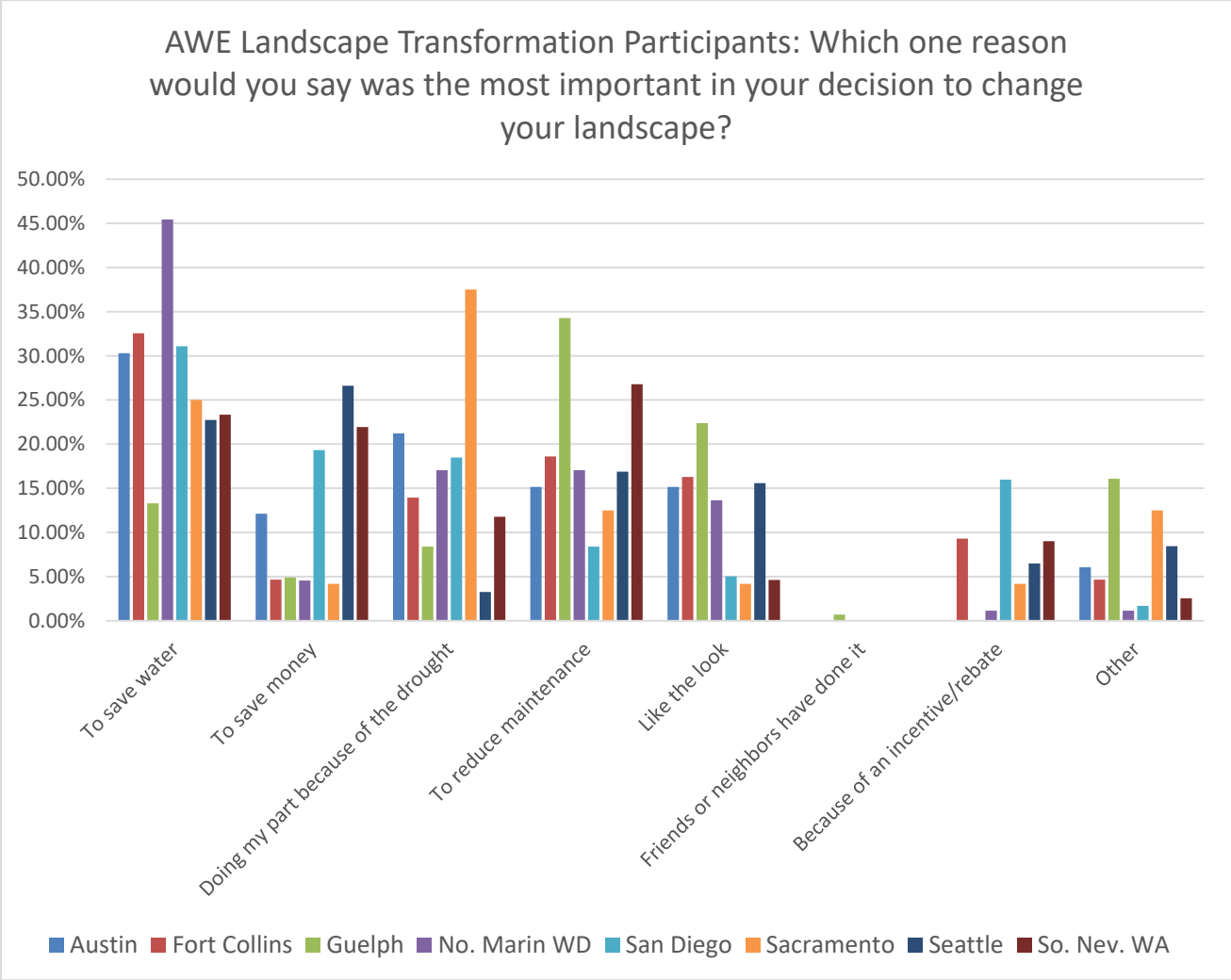

Figure 6.4: Survey Question - Which one reason would you say was the most important in your decision to change your landscape?

When asking the customers about who designed their landscape the largest majority across utility's said themselves or a family member, with those using a landscape designer following second. (Figure 6.5)

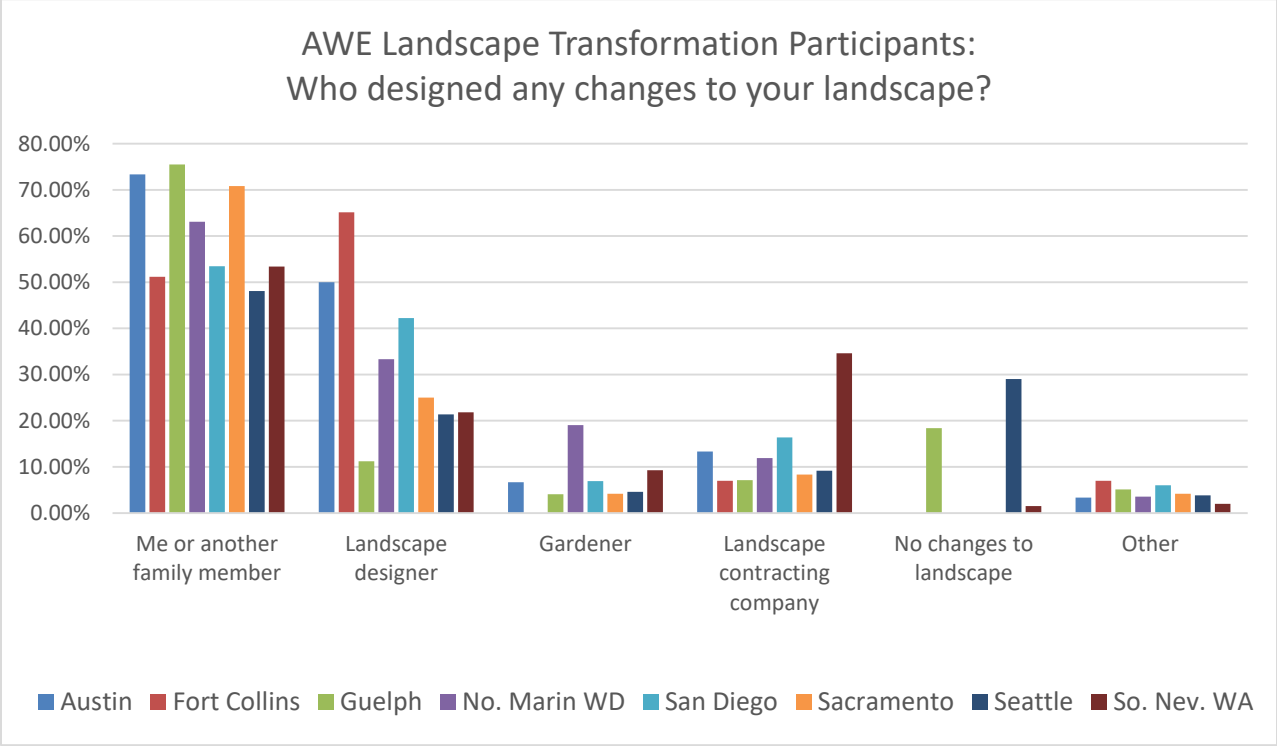

Figure 6.5: Survey Question - Who designed any changes to your landscape?

When asking the customers about who installed their landscape the following should be noted (Figure 6.6):

- Programs with a longer history of program evolution tend to have higher levels of professional installation, perhaps indicating better integration into the existing green industry supply chain.
- Some programs are designed for homeowner implementation.
- Different proclivities for self-installation versus professional installation, depending on the program and service area.

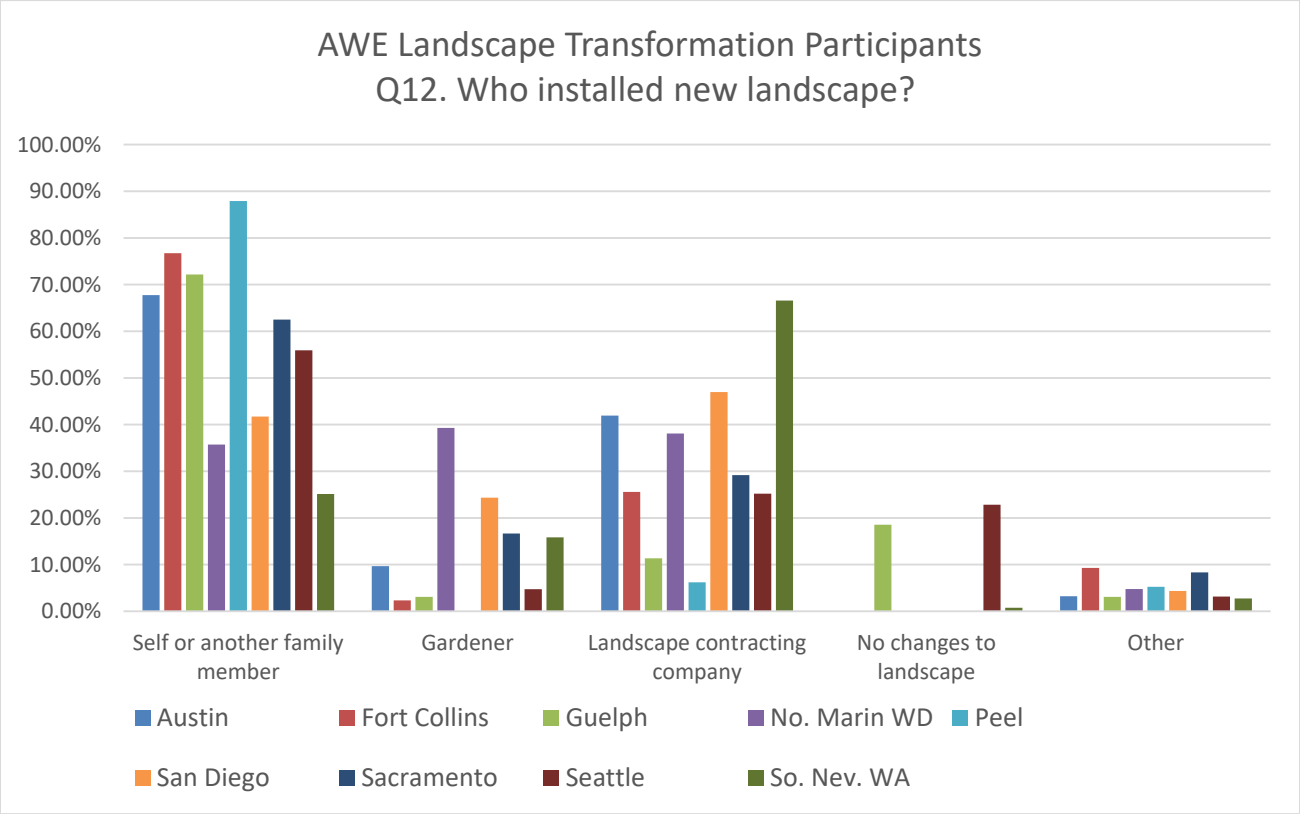

Figure 6.6: Survey Question – Who installed new landscape?

It should be noted that when surveyed, there were very few dissatisfied customers and the Cash for Grass programs had higher levels of customer satisfaction. (Figure 6.7)

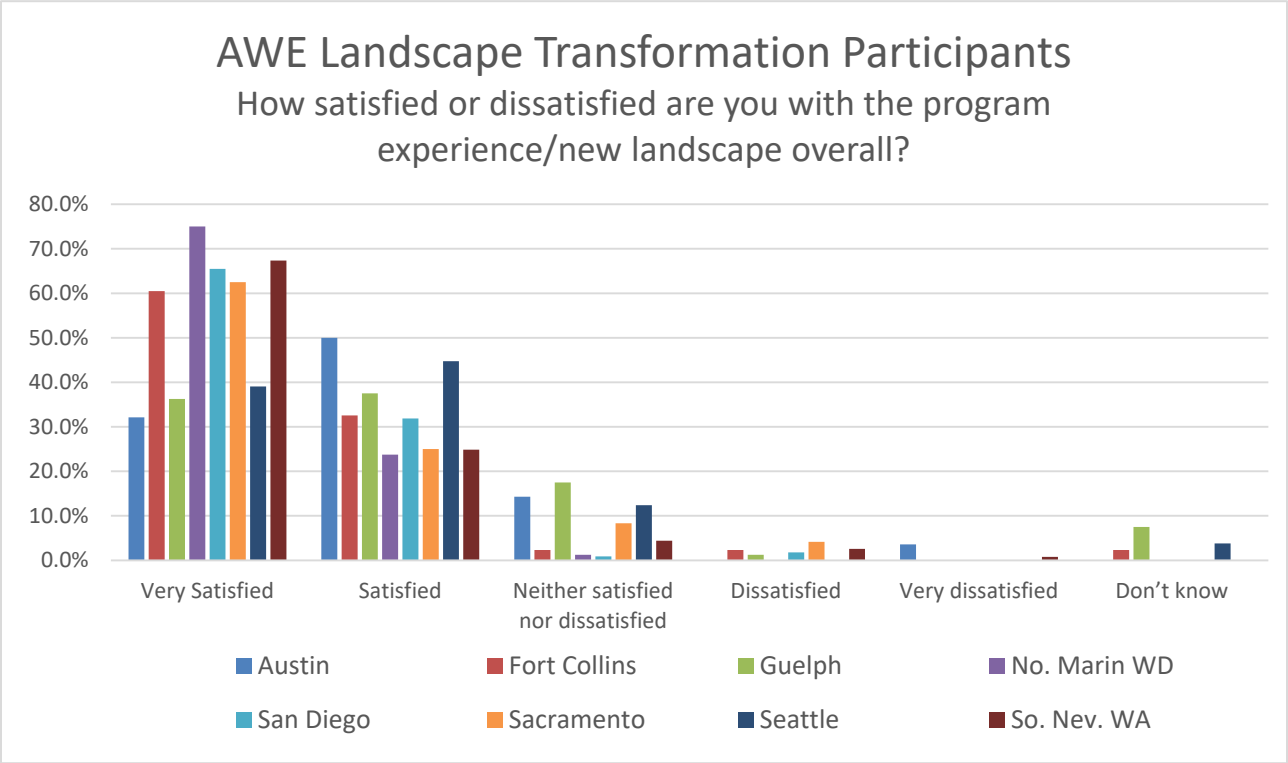

Figure 6.7: Survey Question - How satisfied or dissatisfied are you with the program experience/new landscape overall?

The oldest and most established programs (No. Marin WD, Seattle, So. Nev. WA) had the fewest participants reporting that they would have done anything differently. (Figure 6.8)

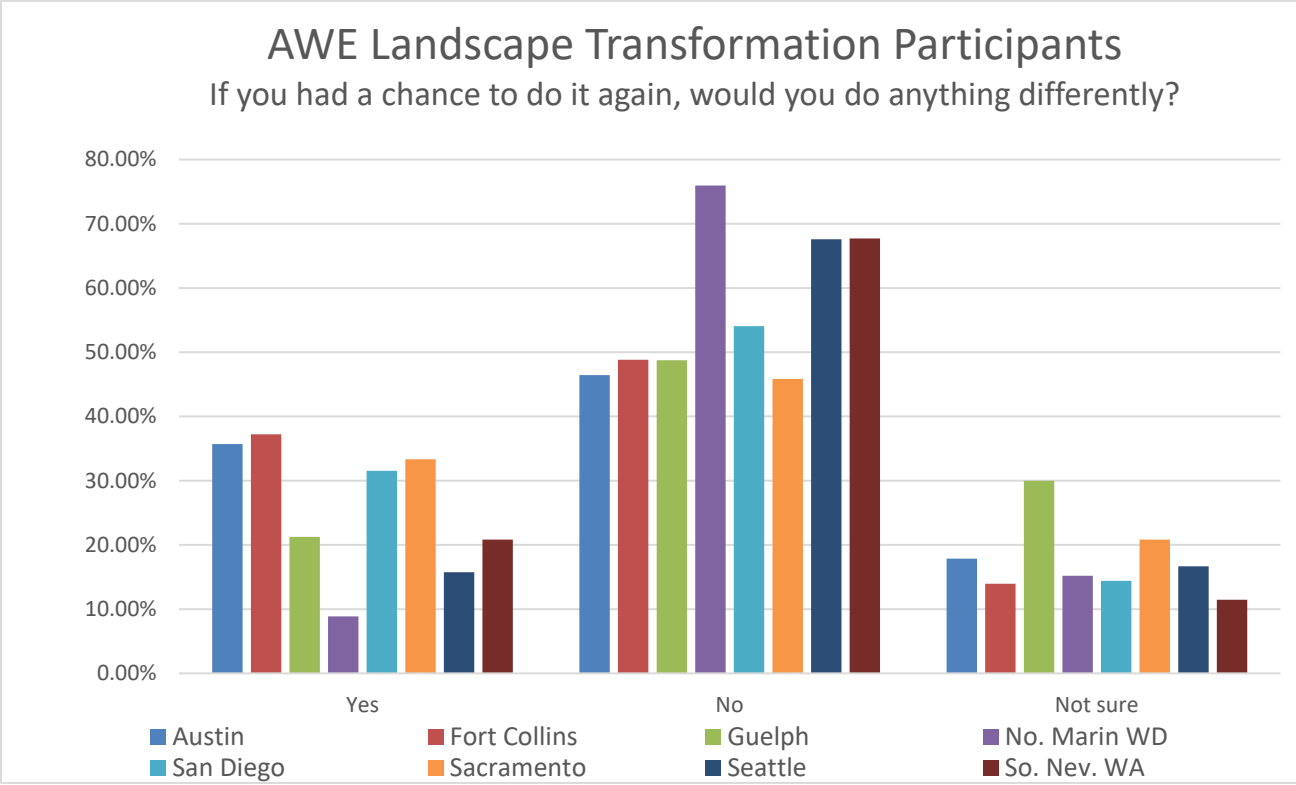

Figure 6.8: Survey Question - If you had a chance to do it again, would you do anything differently?

Non-Participant Survey Findings

The responses to the web survey of non-participants reveal wide differences in the installation of in ground systems. (Figure 6.9) Also, interestingly, Non-participants in Seattle, Guelph and San Diego, seemed to not be well informed in regards to landscape programs available. All three of these utilities has responses of NO at over 50%. (Figure 6.10)

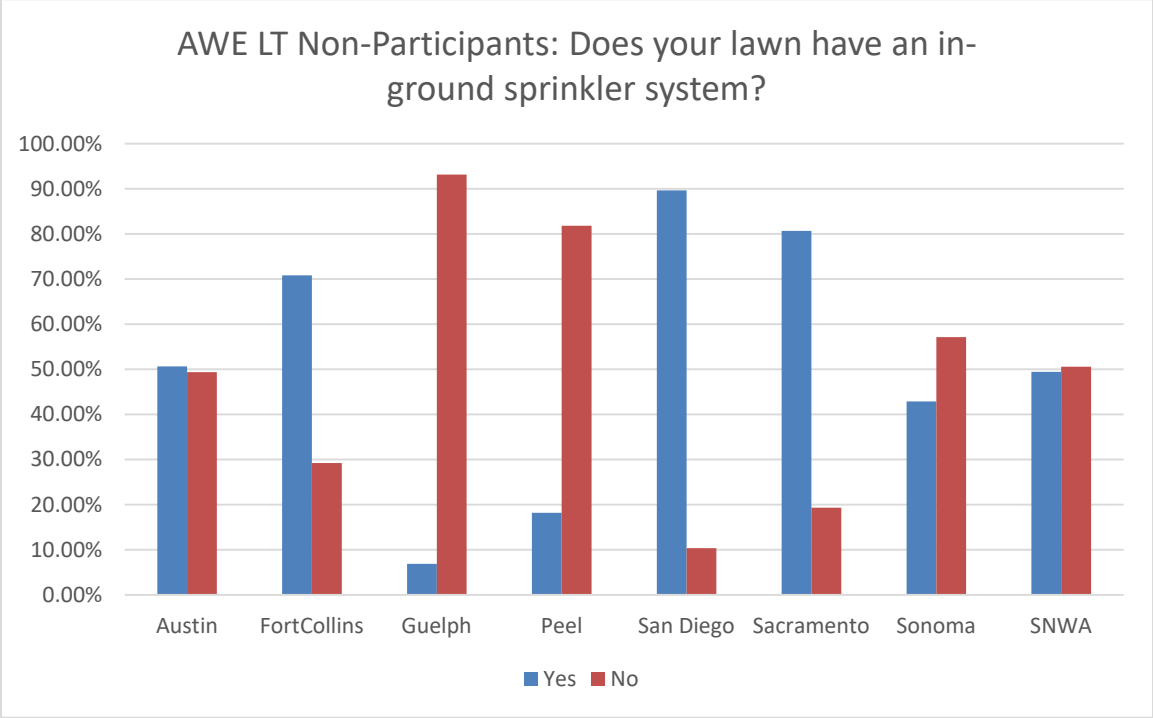

Figure 6.9: Does your lawn have an in-ground sprinkler system?

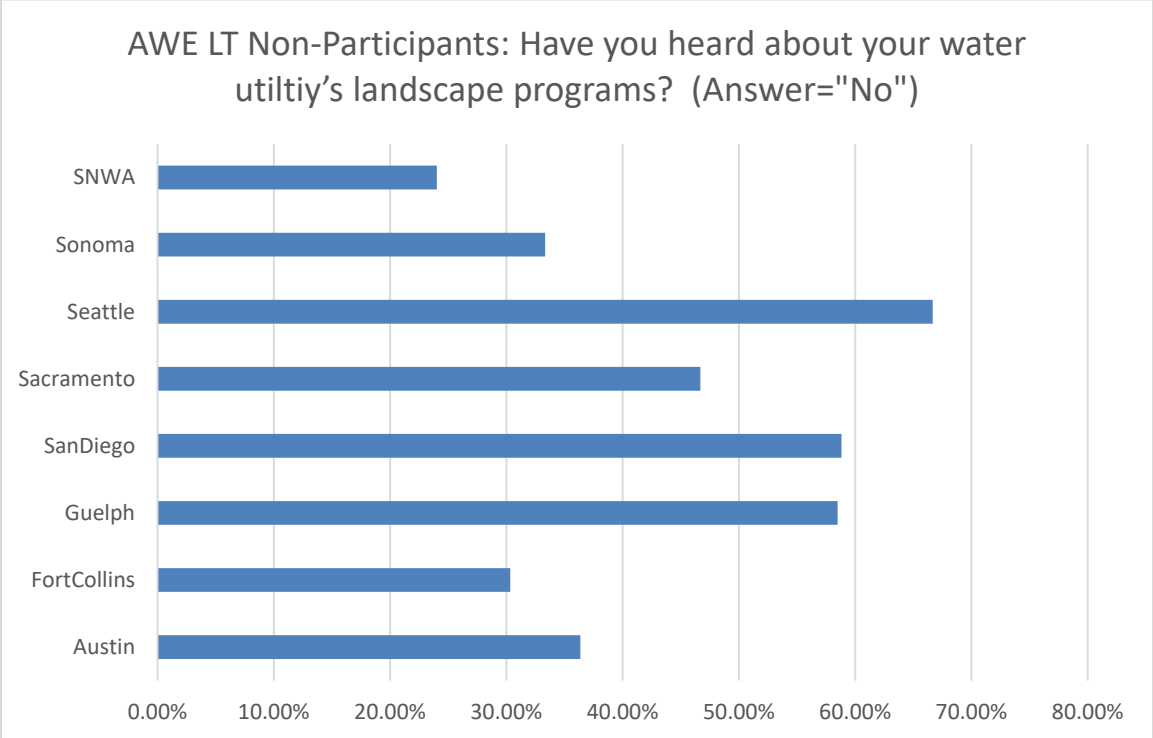

Figure 6.10: Have you heard about your water utility's landscape programs? (Answer="No")

Figures 6.11 and 6.12 asked non-participants about getting information on landscape maintenance and watering, and what the most important aspects of their yard/landscape was. Both question gave the non-participant the option to pick three, thus giving a broad range of responses for each utility.

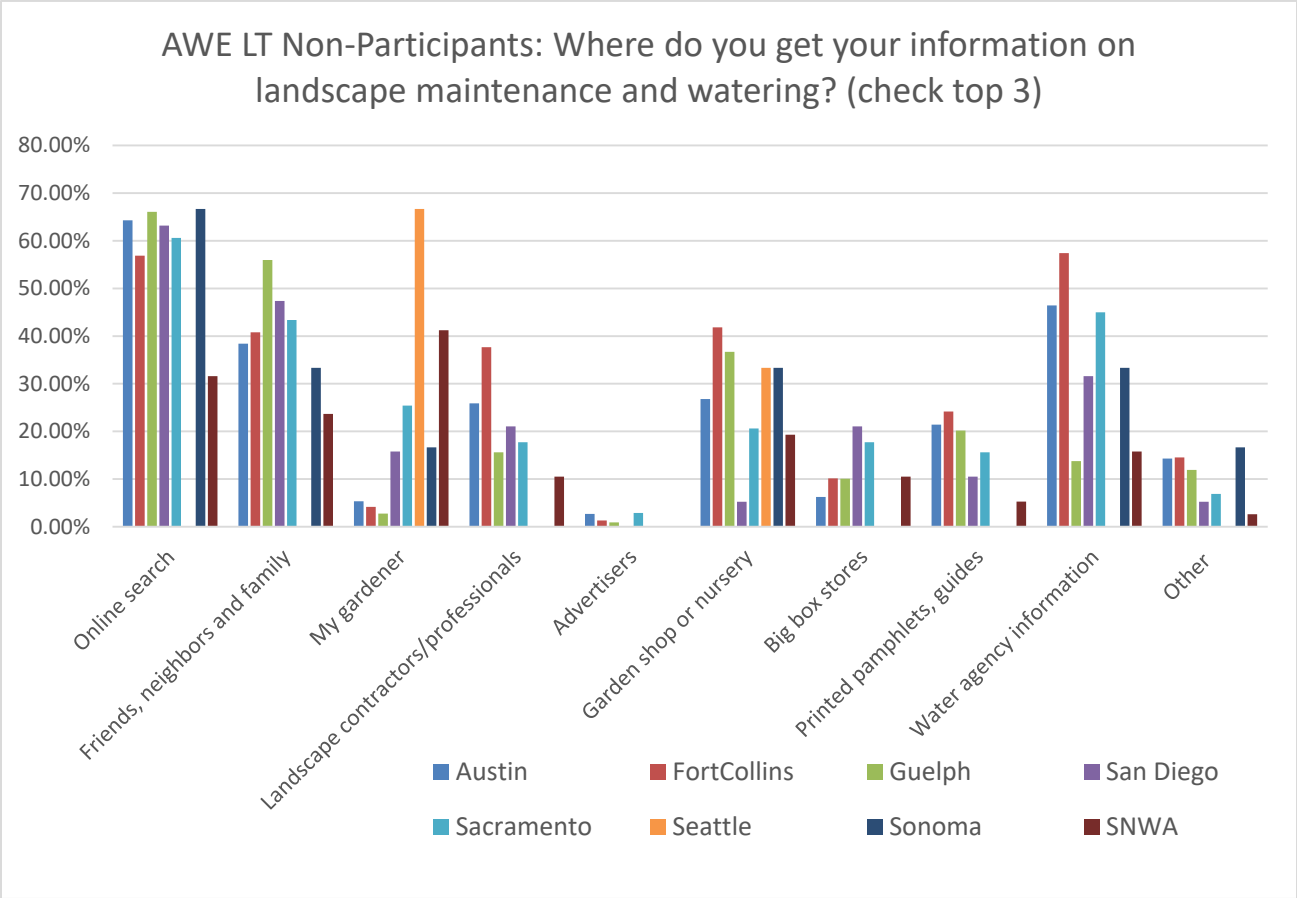

Figure 6.11: Where do you get your information on landscape maintenance and watering? (check top 3)

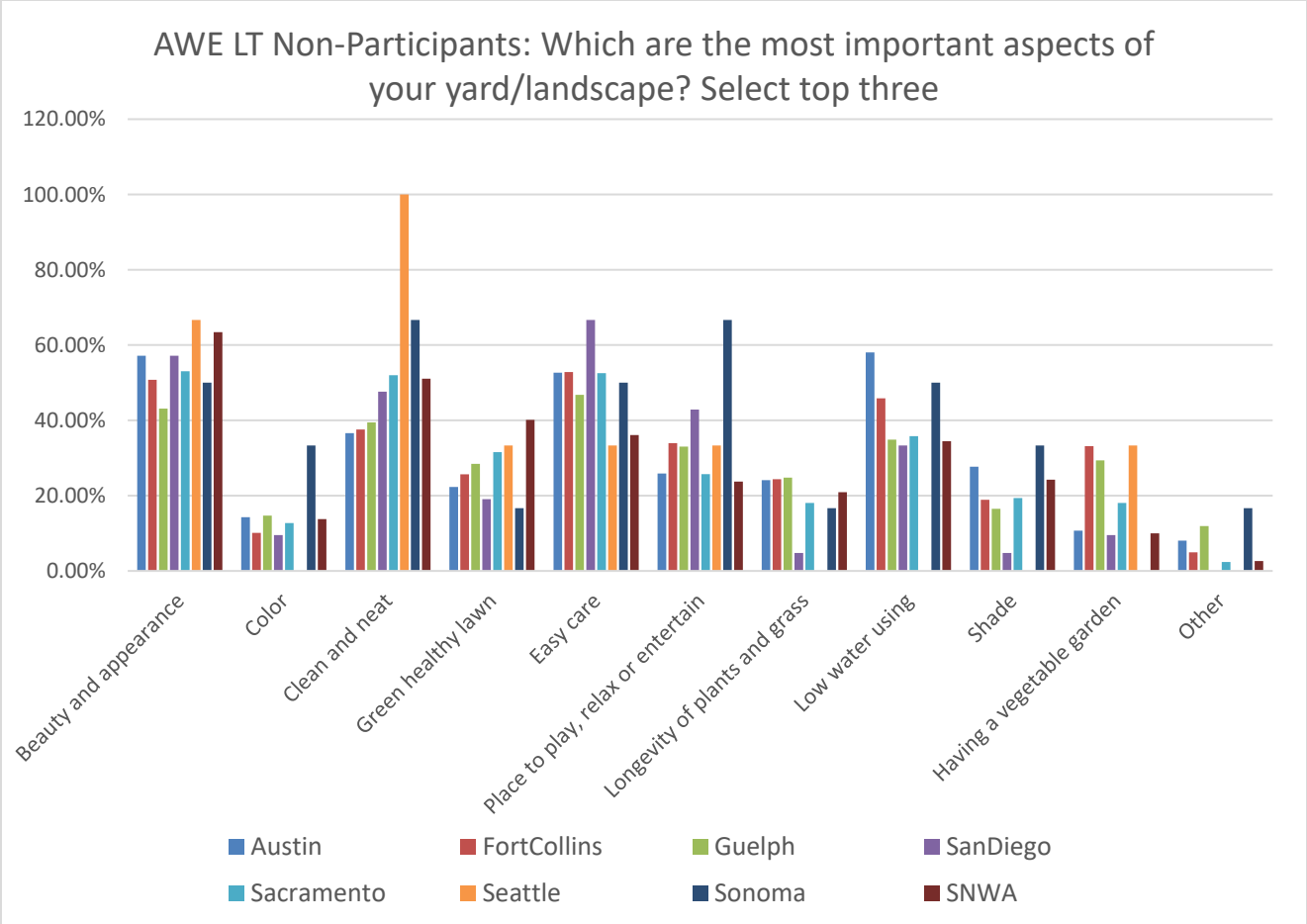

Figure 6.12: Which are the most important aspects of your yard/landscape? Select top three

Market Segmentation Analyses

Interpreting a market segmentation analysis is akin to reading tea leaves after the tea is gone. While one interpretation for each analysis will be attempted, we note that alternative readings are possible. A core objective is to identify potential market segments so that programs can be better targeted.

Interpretation-California-American Participants

The first market segment (Factor 1) were those who used a landscape company to design/install (q11d, q12c) and were newer residents (Q4). This first market segment spent the most on their new landscaping. The second market segment (Factor 2) were the participants who designed (q11a) and installed themselves (q12a), who had the longest residence in the home (Q4), and were intent on saving water (q7a). The third market segment were also longer term participants (Q4) and used a gardener to install new landscape (q12b), and did not overspend (q21_). (Table 6.2)

Table 6.2: California American Participants – Cluster Analysis using Principal Components

California American Participants – Cluster Analysis using Principal Components (N=85, not rotated)					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q12c	0.8769	0.1778	-0.1444	0.1786	Who installed? Landscape contracting company
q11a	-0.3618	0.6609	-0.1393	0.4129	Who designed? Me or another family member
q12b	-0.4205	-0.0482	0.5919	0.4705	Who installed? Gardener
q12a	-0.5782	0.2498	-0.2708	0.5299	Who installed? Me or another family member
q11d	0.5636	0.1809	-0.041	0.648	Who designed? Landscape contracting company
q7b	0.0429	0.4937	0.2871	0.672	Reason for changing landscape? Save money
q21_	0.5108	0.1717	0.0663	0.7052	How much did you spend on the new landscape?
q11b	0.4325	-0.2132	0.2317	0.7138	Who designed? Landscape designer
q7a	0.1419	0.481	0.1599	0.7229	Reason for changing landscape? Save water
Q4	0.0211	0.245	0.1676	0.9114	How long have you lived in this residence?
q26_	-0.0891	-0.1559	-0.1838	0.934	Is your new landscape less (1) or more (3) difficult to maintain than what
q5_	-0.0153	-0.1912	0.0998	0.9533	How has your household's OUTDOOR use of water changed
q6_	0.0252	-0.0596	0.1656	0.9684	There is more my household could do to reduce OUTDOOR water use

Interpretation—Fort Collins Participants

The first market segment (Factor 1) of Fort Collins participants are not afraid to spend money (Q17) and call in landscape contractors to design (Q11d) and install (Q12c). These customers do not believe that they could do more to reduce outdoor use (Q6). The second market segment (Factor 2) brought in separate landscape design expertise (Q11b). They were not DIY designers (Q11a) and felt their new landscape was easier to maintain (Q22). The third market segment is easy to identify—they have been in their home a very long time (Q4) and were more likely to have self designed (Q11a) and installed (Q12a). (Table 6.3)

Table 6.3: Fort Collins Participants – Cluster Analysis using Principal Components

Fort Collins Participants – Cluster Analysis using Principal Components (N=40, not rotated) Three factors explain 93% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q17	0.8767	0.2016	-0.2003	0.1506	How much did you spend on the new landscape?
q11b	0.1875	0.8267	0.07	0.2764	Who designed? Landscape designer
q12c	0.7327	-0.0135	0.3718	0.3247	Who installed? Landscape contracting company
q12a	-0.7575	-0.0404	0.2497	0.3622	Who installed? Me or another family member
q11a	-0.2616	-0.6527	0.1332	0.4878	Who designed? Me or another family member
Q4	0.1627	0.1938	0.6334	0.5347	How long have you lived in this residence?
q11d	0.5323	-0.3873	0.1173	0.5529	Who designed? Landscape contracting company
q6_	-0.5736	0.14	-0.1297	0.6345	Q6 (There is more my household could do to reduce our OUTDOOR water use)
q12b	0.1938	0.1422	-0.4405	0.7482	Who installed? Gardener
q22_	0.0131	0.4122	0.0126	0.8297	Q22 (Is your new landscape more or less difficult to maintain)
q7a	0.1812	0.2377	0.0388	0.9091	Reason for changing landscape? Save water
q7b	0.2229	0.0589	-0.1804	0.9143	Reason for changing landscape? Save money
q5_	-0.0933	0.0426	0.0802	0.983	Q5 (How has your household' OUTDOOR use of water changed in the last)
Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).					

Interpretation-Region of Peel Participants

The first market segment (Factor 1) were participants who found the Build your Garden information to be useful (Q15) and were highly satisfied with the landscape consultation (Q12). The second market segment were those who did find the information useful (Q15) and/or were not highly satisfied (Q12). Lack of variation in the data prevented the identification of additional market segments. It should be noted that about 7 percent of participants scored the information as unhelpful (less than 5 on a 10 point scale) and about 8 percent of participants rated their satisfaction as less than 5 on a 10 point scale. It the Region

of Peel were to generate more dissatisfied customers, additional factors could be identified. (Table 6.4)

Table 6.4: Region of Peel Participants – Cluster Analysis using Principal Components

Region of Peel Participants – Cluster Analysis using Principal Components (N=312, not rotated)				
Variable	**Factor1**	**Factor2**	**Uniqueness**	**Variable Name**
Q15	0.7547	-0.168	0.4022	Q15 On a scale of 1 to 10, please rate how useful you found the How-to-Build Your Garden information (where 1 is not at all useful and 10 is very useful)?
Q12	0.7477	-0.1602	0.4153	Q12 On a scale of 1 to 10, rate your satisfaction with the landscape consultation (where 1 is very unsatisfied and 10 is very satisfied
Q6	0.3746	0.3853	0.7112	Q6 On a scale of 1 to 10, rate the importance of your home landscape (where 1 is low and 10 is high)
Q4	0.2391	0.4277	0.7599	Q4 On a scale of 1 to 10, rate the importance of your home (where 1 is low and 10 is high)

Interpretation-City of San Diego Participants

The first market segment (Factor 1) of participants those who used a landscape designer (Q11b), spent well on installation (Q21) and did not do so for the reason of saving money (Q7b). The second market sector (Factor 2) used a landscape contractor to install (Q12c), did spend money (Q21), and did so for the reason of saving money. The third market segment (Factor 3) had reduced outdoor water use (Q5), did want to save money and water (Q7b, Q7a), and were more likely to be long-term residents. (Table 6.5)

Table 6.5: City of San Diego Participants – Cluster Analysis using Principal Components

City of San Diego Participants – Cluster Analysis using Principal Components (N=120, not rotated) Three factors explain 93% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q11a	-0.8637	-0.1939	-0.007	0.1709	Who designed? Me or another family member
q11b	0.8269	-0.1158	0.0706	0.3236	Who designed? Landscape designer
q5_	0.2494	-0.2803	0.6446	0.4692	Q5 (How has your household's OUTDOOR use of water changed since you installed)
q12c	0.2672	0.6393	0.0335	0.4715	Who installed? Landscape contracting company
q7b	-0.3243	0.3449	0.5538	0.4926	Reason for changing landscape? Save money
q21	0.4033	0.4558	0.0634	0.5744	How much did you spend on the new landscape?
q12b	0.1441	-0.5878	0.1626	0.6341	Who installed? Gardener
q12a	-0.5838	-0.0139	0.0438	0.6551	Who installed? Me or another family member
q11d	0.4352	0.3293	-0.067	0.6602	Who designed? Landscape contracting company
q7a	0.1394	0.3154	0.4146	0.691	Reason for changing landscape? Save water
q26_	-0.0481	0.1011	-0.5255	0.7147	Q26 (Is your new landscape more or less difficult to maintain)
Q4	-0.1971	0.0585	0.3686	0.8247	How long have you lived in this residence?
q6_	-0.0105	-0.3913	0.1344	0.8299	There is more my household could do to reduce OUTDOOR water use
Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).					

Interpretation-Seattle Saving Water Partnership Participants

The first market segment (Factor 1) of Seattle participants are the "do it right" crowd. These are customers who used a landscape contractor or gardener to design and install landscape (Q11d, Q12c). They were not afraid to spend what it took to do things right on the landscape project (Q17). These customers were not likely to be directly motivated by the desire to save water or to save money (Q7), and they are not likely to work themselves (Q11a, Q12a). The second market segment (Factor 2) were the DIY crowd—self-design

(Q11a) and self-installation (Q12a).The third market segment (Factor 3) is concerned with saving water (Q7a) and saving money (Q7b). (Table 6.6).

Table 6.6: Seattle Participants – Cluster Analysis using Principal Components

Seattle Participants – Cluster Analysis using Principal Components (N=169, not rotated) Three factors explain 93% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q11d	0.4998	0.514	0.3288	0.3779	Who designed? Landscape contracting company
q12c	0.6917	-0.1202	0.2686	0.4349	Who installed? Landscape contracting company
q7a	-0.405	-0.3308	0.5043	0.4722	Reason for changing landscape? Save water
q7b	-0.4506	-0.1923	0.5117	0.4981	Reason for changing landscape? Save money
q11a	-0.5994	0.3425	0.1456	0.5023	Who designed? Me or another family member
q12a	-0.5971	0.3453	-0.1326	0.5066	Who installed? Me or another family member
q17	0.6581	-0.0921	0.0194	0.5581	How much did you spend on the new landscape?
q11b	0.5895	-0.2252	0.0147	0.6015	Who designed? Landscape designer
q12b	0.3847	0.3213	0.1384	0.7296	Who installed?
q22_	0.277	0.3629	0.1828	0.7582	Q22 Is your new landscape more or less difficult to maintain)
Q4	0.2515	-0.0557	-0.0721	0.9284	How long have you lived in this residence?
q6_	-0.139	0.1795	0.0947	0.9395	There is more my household could do to reduce our OUTDOOR water use.
q5_	0.1178	0.2143	-0.0102	0.9401	How has your household's OUTDOOR use of water changed in the last 5 years?
Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).					

Interpretation SNWA Cash for Grass Participants

The first market segment (Factor 1) of SNWA participants hired a landscape contractor or designer to design and install (Q12c, Q11b, Q11d) and were more likely to spend more on

the conversion (Q21). The second market segment (Factor 2) were the DIY crowd—self-design (Q11a) and self-installation (Q12a). These customers were motivated by saving water (Q7a) and saving money (Q7b). The third market segment (Factor 3) were installed by the gardener and were more concerned with saving money (Q7b). (Table 6.7)

Table 6.7: SNWA Participants – Cluster Analysis using Principal Components

SNWA Participants – Cluster Analysis using Principal Components (N=372, not rotated) Three factors explain 90% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q12c	0.8253	0.2064	-0.1543	0.2524	Who installed? Landscape contracting company
q12a	-0.6416	0.2978	-0.2074	0.4566	Who installed? Me or another family member
q12b	-0.3616	-0.5222	0.2987	0.5073	Who installed? Gardener
q11d	0.5549	0.2824	0.3126	0.5145	Who designed? Landscape contracting company
q11a	-0.6092	0.2648	-0.177	0.5275	Who designed? Me or another family member
q11b	0.3835	-0.3446	-0.3153	0.6348	Who designed? Landscape designer
q21_	0.416	-0.0411	-0.1185	0.8112	How much did you spend on the new landscape?
q7b	0.0113	0.1184	0.283	0.9058	Reason for changing landscape? Save money
q7a	0.0004	0.19	0.1935	0.9264	Reason for changing landscape? Save water
q5_	0.079	-0.16	-0.1284	0.9517	How has your household's OUTDOOR use of water changed since you installed
q26_	-0.0398	0.0774	0.0489	0.9900	Q26 Is your new landscape more or less difficult to maintain than before?
Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).					

Interpretation-City of Sacramento Non-Participants

The first market segment (Factor 1) of Sacramento non-participants are as the "aware." These customers are aware 1) that they could do more to reduce outdoor use (Q10), and 2) of Sacramento's landscape conservation program offerings (Q12), and 3) that their outdoor water use has changed in the last 5 years (Q9). The second market segment

(Factor 2) has lower awareness (Q8, Q12, Q9) but do have concerns with their lawn (Q16g) and appreciate easy maintenance (Q6e).The third market segment (Factor 3) is not concerned with lawn water use (Q16b). They don't like the time/work required by a lawn (Q16d), care for lawn beauty (Q6a), and have no other conservation products installed. (Table 6.8)

Table 6.8: Sacramento Non-Participants–Cluster Analysis Using Principal Components

Sacramento Non-Participants – Cluster Analysis using Principal Components (N=552, not rotated) Three factors explain 74.5% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q10_	**0.8378**	**0.0227**	**-0.0365**	0.3144	Q10 More could do to reduce outdoor use?
q12_	0.8183	0.0743	-0.0251	0.3308	Q12 Have you heard about agency landscape programs?
q9_	0.6329	-0.0127	0.0387	0.5826	Q9 How has outdoor use changed past 5 years?
q16g	0.0487	0.5392	0.0059	0.7025	Q16g What causes you concern with lawn?: Other
q16b	0.5589	-0.014	-0.3028	0.7080	Q16b What causes you concern with lawn?: Requires too much water
q20i	0.0779	0.5084	0.0108	0.7283	Q6e Most important aspects of yard/landscape: Easy care
q6e	0.5209	-0.0524	-0.0407	0.7411	Q20i What would ideal landscape have?: Other
q16d	0.4054	-0.184	0.1664	0.7475	Q16d What causes you concern with lawn?: Requires lots of time/work
q6a	0.3616	0.1179	0.1781	0.7694	Q6a Most important aspects of yard/landscape: Beauty and appearance
q11f	0.0534	0.0253	0.2883	0.9009	Q11f Which conservation products installed: None
Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).					

Interpretation - SNWA Non-Participants

The first market segment (Factor 1) of non-participants might be known as the "aware." These customers are aware 1) of how much money that they spend on water to irrigate

(Q8); 2) that they could do more to reduce outdoor use (Q10); and 3) of SNWA conservation program offerings (Q12). The second market segment has lower awareness (Q6, Q8, Q12) and are less likely to have installed high efficiency plumbing fixtures(Q11*); they are concerned with the cost of their yard (Q16c) and ease of maintenance (Q6e). The third market segment is easy to identify—they have no conservation products installed (Q11f). They still like their outdoor deck (Q20a) and their vegetable garden (Q6j). (Table 6.9)

Table 6.9: SNWA Non-Participants

SNWA Non-Participants - Cluster Analysis using Principal Components (N=552, rotated) Three factors explain 82% of the variation					
Variable	**Factor1**	**Factor2**	**Factor3**	**Uniqueness**	**Variable Name**
q8	**0.8560**	0.1134	0.0078	0.1940	Q8 Do you know how much money spend on water to irrigate
q10_	**0.7515**	**0.2936**	0.107	0.1957	Q10 More could do to reduce outdoor use?
q12_	**0.8172**	0.1894	-0.0371	0.2035	Q12 Have you heard about agency landscape programs?
q20e	0.839	0.0578	0.1302	0.2318	Q20e What would ideal landscape have?: Trees and shrubs
q11c	0.8072	0.0384	-0.0505	0.3309	Q11c Which conservation products installed: High efficiency clothes washer
q20a	0.7657	-0.1139	**0.2788**	0.3422	Q20a What would ideal landscape have?: Decks/patio/sitting area
q9_	0.7252	0.1851	-0.0132	0.3584	Q9 How has outdoor use changed past 5 years?
q20g	0.7874	-0.1955	0.2128	0.3615	Q20g What would ideal landscape have?: Water/pool/fountain
q20c	0.8143	-0.1761	0.0157	0.3912	Q20c What would ideal landscape have?: Lawn
q11a	0.6789	0.0519	**-0.3551**	0.4200	Q11a Which conservation products installed: Low water use showerhead
q20b	0.7206	0.0135	0.1516	0.4366	Q20b What would ideal landscape have?: Flowers
q20f	0.726	-0.1427	0.1722	0.4654	Q20f What would ideal landscape have?: Walkway
q11b	0.7069	-0.0366	-0.2302	0.4857	Q11b Which conservation products installed: Low water use toilet
q6a	0.7093	0.0084	-0.1103	0.4918	Q6a Most important aspects of yard/landscape: Beauty and appearance
q20h	0.5083	-0.0559	**0.4687**	0.4992	Q20h What would ideal landscape have?: Vegetable garden

q16b	0.4249	**0.4390**	0.0955	0.5035	Q16b What causes you concern with lawn?: Requires too much water
q11d	0.7148	-0.0851	-0.0953	0.5206	Q11d Which conservation products installed: More efficient sprinkler system (eg)
q5i	0.5637	0.1603	**-0.2118**	0.5684	Q5i Sources of Information: Water agency information
q5a	0.5613	0.135	0.1667	0.5826	Q5a Sources of Information: Online Search
q20d	0.5936	0.0933	0.0633	0.5966	Q20d What would ideal landscape have?: Rocks
q6c	0.4876	0.2534	-0.1143	0.6131	Q6c Most important aspects of yard/landscape: Clean and neat
q16d	0.46	0.2606	0.1082	0.6323	Q16d What causes you concern with lawn?: Requires lots of time/work
q6d	0.6321	-0.126	-0.064	0.636	Q6d Most important aspects of yard/landscape: Green healthy lawn
q6h	0.3064	**0.3857**	**-0.2009**	0.6427	Q6h Most important aspects of yard/landscape: Low water using
q6e	0.3409	**0.3875**	-0.0291	0.6518	Q6e Most important aspects of yard/landscape: Easy care
q16a	0.5363	0.128	-0.0406	0.6547	Q16a What causes you concern with lawn?: Weeds
q16e	0.4073	0.2974	0.111	0.6575	Q16e What causes you concern with lawn?: Hard to make look attractive
q11e	0.5726	-0.0487	-0.1186	0.6831	Q11e Which conservation products installed: Irrigation/sprinkler smart timer
q6j	0.2709	0.0237	**0.4506**	0.7034	Q6j Most important aspects of yard/landscape: Vegetable garden
q16c	0.2535	**0.4057**	0.0545	0.7063	Q16c What causes you concern with lawn?: Costs too much to maintain
q11f	-0.0808	0.334	**0.4224**	0.7441	Q11f Which conservation products installed: None

Sorted on Uniqueness. Uniqueness is the variance that is 'unique' to the variable and not shared with other variables. It is equal to 1 – communality (variance that is shared with other variables).

Next Steps for Market Segmentation Analysis

The identification and definition of Customer Market Segments is the first step in a Segmentation Analysis. Next steps could include assigning each customer to a segment, creating and testing of segment-specific messaging, and development of targeted customer outreach. The project team also strongly recommend that analysts developing analytic algorithms read and contemplate the Assoc. for Computing Machinery (ACM) U.S. Public Policy Council's *Statement on Algorithmic Transparency and Accountability*.

Chapter 7: Landscape Transformation Programs Future

Recommendations

The landscape market transformation process has challenged the water industry far beyond that of indoor residential efficiency. Landscape programs are typically costly, complicated, and labor-intensive. Site completion comes about by way of a long, drawn out process for both the customer and the water utility personnel. That said, the water industry has seen a modest level of success over the years with outdoor efficiency programs. The industry's market penetration is the direct outcome of remarkable efforts and toil by water utility staff, ignited by years of drought conditions.

Any recommendation for Landscape Transformation must be reality-based on local conditions. There are wide geographical differences in landscaping and in customers' motivations about their landscaping, as is revealed in Figure 7.1. The presence of in-ground sprinkler systems varied from 7 percent to 90 percent in this research project's web survey. (Areas with higher evapotranspiration and more outdoor water use are more likely to have in-ground systems.) A national survey by WaterSmart Software found a wide range in customer willingness to remove turf grass. Planning for landscape market transformation must conform to these wide differences.

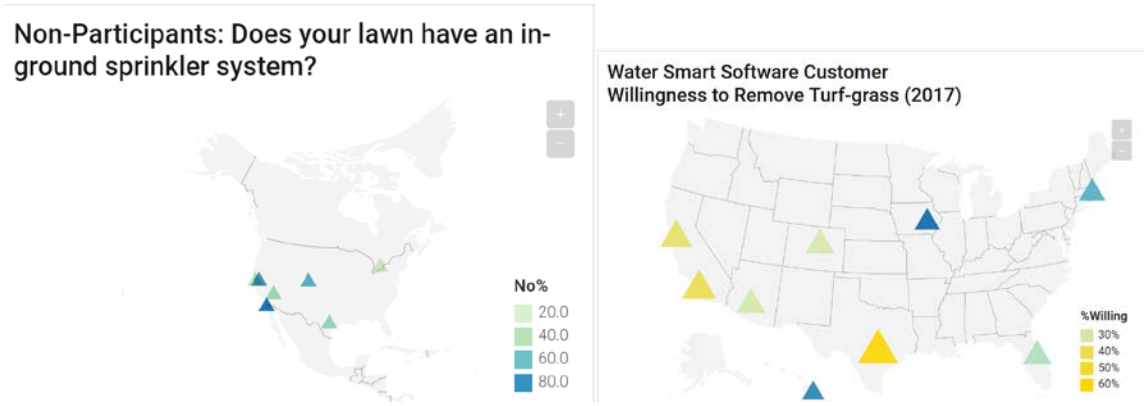

Figure 7.1: Geographical Differences—In-Ground Sprinklers and Customer Willingness to Remove Turf-grass

Program Recommendations

Readers are referred to the companion *2018 Market Analysis and Recommendations* for more details. Looking forward, what should water utilities consider when designing a landscape transformation program:

1. Correct customer misperceptions about water usage
2. Educate the customer, right from the start
3. Find the optimal design balance
4. Balance program requirements

5. Expand program messaging and tailor to each customer

Supply Chain Recommendations

The supply chain needs to be invigorated and better connected with the water efficiency industry that it serves. While most water utilities stay focused on program design and customer needs, the importance of the supply chain is often overlooked.

Industry Recommendations

1. It's time to lead with technology.
2. Consider industry initiative to produce on-line landscape design software.
3. Make the shift to big data and predictive analytics.

For more on each of these recommendations refer to the companion *2018 Market Analysis and Recommendations*.

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Appendix A: Priorities for Future Research

Market Segmentation Analysis for Improved Customer Engagement

Retail water customers are not all alike; different types of customers respond to different types of information. Understanding the different market segments in landscape transformation is not easy: what customers say and what customer do are often two different things. Conversely, customers who say different things may end up doing the same thing. The emergence of a market segment for native and water-wise plantings can be driven by very different customer motivations: saving water, aesthetic differentiation, or armoring against another drought emergency.

Location-specific research is needed to help water utilities better understand market segments of their customers, what information is lacking for each segment, and how customer engagement can be sculpted for different types of customer motivations. Market segmentation analysis can help water utilities understand how people manage natural landscapes, what additional information is needed to help customers choose and manage these landscapes (plants selection, design layout vs one-on-one support, irrigation design), and the role of the green industry supply chain in realizing water savings over the life of the landscape.

Customer Outreach and Messaging: A/B Testing of Differing Modes and Messages

Improving analytics capabilities at water utilities will allow side-by-side (A/B) testing of alternative modes of customer outreach (Facebook, Direct mail, Bill inserts, etc.) as well as alternative messaging for different customer segments. Customer message types might include:

- Aesthetic and Beauty messages about different types of landscapes
- Investment messages
- Community Involvement (Do the Right Thing) messages

Evidence-based feedback on customer outreach and messaging is sorely lacking at many water utilities.

Impact Evaluation in Real Time

As data infrastructure improves among water utilities, the possibility of real-time water consumption monitoring offers the prospect of more immediate feedback on the water saving success of outdoor WUE programs.

Supply Chain Research

How can the green industry be better integrated into landscape transformation? Successful change in landscape often requires expertise and knowledge of what has worked. Being able to integrate professional training and utilizing landscape vendor customer outreach can facilitate change in outdoor water use. The supply chain research focuses on interviewing retailers, suppliers, manufacturers on how to improve products, plant availability, contractor and customer promotions, and contractor training and certification. This type of research can constitute the first steps toward creating a more formal dialog. In this way, the on-the-ground knowledge of the supply chain can be leveraged by the water utility or regional partnership.

Landscape Design Standards

Developing locally-specific actionable guidance on best practices in Landscape Transformation often requires a rethink for both existing landscapes and future yet-to-be designed landscapes.

Locally-specific plant palate research and development remains needed in many areas. This type of research can help identify drought tolerant xeric and turf landscape materials; Understanding the drought tolerance on a broad range of low water using plants in different climates is critical for landscape sustainability in drought-prone areas.

Program Design for Outdoor Water Use of Disadvantaged Communities

Many of water utility outdoor WUE offerings focus on irrigation systems and large water users. Customers who hand water or use water on small to medium-sized landscaped areas are often under-addressed by existing conservation programs.

Drought Management and Outdoor Water Use

Research on institutional responses to recent drought points to the need to reconsider the role of outdoor water use as primary mode of drought response. This “hump of the camel” may not contain discretionary water if states and locales use mandatory water supply curtailment as the first choice of drought response.

Appendix B: Interview Questionnaires

Data Assessment Interview Protocol

Confidentiality Statement

YOUR RESPONSES TO THE FOLLOWING QUESTIONS WILL BE TREATED IN COMPLETE CONFIDENCE AND USED ONLY TO EVALUATE A LANDSCAPE TRANSFORMATION PROGRAM IN YOUR SERVICE AREA. RESULTS OF THIS INTERVIEW WILL ONLY BE PRESENTED IN A SUMMARY FORM, TO PROTECT THE IDENTITY OF RESPONDENTS.

Interview Identification

Date of Interview:

Name of Organization:

Name of Respondent: Job Title:

Your Interest in this Research?

Are you more interested in the process evaluation or the impact evaluation?

Within the process evaluation, are you more interested in program implementation processes or customer motivations and rationales for landscape choices?

Service Area and Program Description

What would be a good source for service area descriptive statistics (planning documents, master plan, urban water management plan, etc.)? We are looking to compile information such as:

State, region
Annual precipitation
Service area (square miles)
Population served, (year of estimate and source)
Number of single family residential customers
Total system billed consumption for 2016
Total system water production for 2016
Consumption per capita
Description of utilities current rate structure (rate schedule and/or code)
Other demographics (income, age, race distributions)
Overview of water demand
Overview of water supply

Landscape Transformation Program

For the selected Landscape Transformation program, elicit the following information:
Program identifier and timing
Formal name of program
Approximate date of the program's formal inception
Duration
Supporting Programs (Promotion, training, education, etc.)

Process Evaluation—Customer Survey Data Assessment
Customer Survey Sampling Frame—
Can you give me a rough guestimate of the number of SF participants over time?
Do you have (or can you create) a count of customer participation by year?

Can you describe your customer participation database?
Does it include installation date? (Date of application and date of rebate can provide a bracket.)
Does it include indication of contractor/professional or DIY installation?
Does it include landscape area? Pre-Turf area? Post-Turf?

Control Group of Non-participants
Do you have (or can you create) contact information for a sample of non-participants in the select LT program?
- Random sample of all SF customers
- Email contacts for participants in other conservation programs

Customer Survey Instrument
Existing Surveys and Survey Instruments? Please provide examples of customer survey instruments that have been used before in your service area and mark specific questions that you would love to see asked again. (The proposed customer survey is envisioned to have a common core of questions and a few [2 to 3] service-area specific questions.)

Custom Questions? Are there questions that you would like asked in a customer survey that are specific to your service area? (Up to 3 custom questions are allowed.)

Impact Evaluation—Consumption Data for Water Use Analysis
Are your single-family consumption meters read monthly, bi-monthly, or quarterly?

Customer-specific meter-read consumption data is needed for both participants and non-participants.

- A minimum of two years post-intervention data is required for each program participant to be analyzed.
- We aspire to get at least five years of consumption history in machine-readable form.
- We are not picky about the format of the data; we can work with Excel, Access, and most database or statistical dataset formats.
- Typically, consumption data from a billing system include a customer identifier, the volume of water consumption, meter read date, and number of days in the billing cycle. (Additional information on whether a meter read is estimated or adjusted is icing on the cake.)

For the control group of non-participants, there are alternatives

Proximity matched control group – select 2 nearby nonparticipating SF homes

Stratified Random sample—we can work with your designated analysis to define and select a stratified random sample.

Is there a parcel specific unique identifier? If yes, what is the field name?

Is there an identifier for a change in home ownership? (An "odometer digit" in the account number does qualify.

Is there additional data that could be used to help explain mean customer water use and changes in mean customer water use? (Parcel-specific characteristics, tax assessor data, census data, etc.) that have been (or can be) matched to your customer consumption data?

Do you have matchable records of participation in other conservation programs (with date of participation)?

A & N Technical Services is looking for water consumption data for participants and a control group in the following electronic form:

Field Name	**Description**
Study ID	Unique Study ID Number (A sequential number that you assign to each customer)
Account No.	Account No. within the agency billing system and the program participant database
Meter size	Size of meter serving account
Customer Type	Single or Multi Family, Commercial, Irrigation, etc.
Read Date	End of read period

Read Date 2	Beginning of Read period (optional)
Days in Read	Total number of days in read period
Period Use	Volume of consumption in read period (typically 1,000gal. or HCF)
Billing Unit	Type of billing unit – HCF, 1,000 gal, etc.
Use	Use, gallons per day in billing period – optional, as this can be calculated from the above
Customer Characteristics	Any additional cross-sectional data on customer characteristics (APN, Parcel Size, Etc.) from billing system can go into a separate flat file keyed in unique account numbers

For customer privacy protection, we have options to maintain confidentiality. One way would be to limit the information exchange to account number, street address and consumption data; and exclude customer name. Another way is to sign a confidentiality or nondisclosure agreement between your agency/utility and A & N Technical Services.

Please identify the name of an appropriate data contact person and their contact information. Dr. Chesnutt or Dana Hold will handle follow-up once an agency data contact has been identified.

Snowball Sampling Questions:

Who else in your utility should I speak with on these questions? (Names and numbers.)

Do you have any suggestions for individuals outside the utility that we should speak with? (Names and numbers.)

Are there any additional questions that you wish I would have asked you?

Interview Questions for Process Evaluation

Your responses to these questions will be treated in complete confidence, and used only to evaluate a landscape transformation program in your service area. Results of this interview will be presented in summary form only, to protect your identity.

Program Identification

Name of Organization: Date of Interview:
Name of Respondent: Job Title:
Formal name of program
Date of the program's start
Duration
Supporting Programs (Promotion, training, education, etc.)
Were you personally involved in the creation of the program? In the implementation?

Program Design

Describe the program as originally designed.

- What are the goals of the program?
- How was the program staffed and organized?
- Did you outsource the administration? If so, company name.
- Were educational workshops or other support programs available? Were they required?

Program Features

- How did you determine the incentive amount? Did it change over the program duration?
- Who set the program requirements?
- What are the specific program requirements? Such as pre-approval, pre-and post-inspections, photos, design approval, plant/coverage requirement, irrigation requirement, mulch requirement, timeframes to complete, caps.
- Was the program or the application automated?
- Was the contractor able to receive the incentive directly?
- Can we get access to the program website and/or customer screen shots?

Motivation and Background for Program

Describe the circumstances that led up to the creation of the program.

Modifications Over Time

What changes were made to the program over time?

- What motivated the changes?
- Did the changes serve their intended purpose? Is the program better as a result?
- Are there additional program modifications that are being considered?

What is the next phase of the program, if there is one?
Is there a need to continue the program over time?

Financing the Program

How was the program funded?
Was cost sharing involved with other agencies/sources (e.g., state or federal grants, energy, waste water, or welfare agencies)?
What has been the annual program budget since its inception?

Marketing the Program

Did you market the program, if so through what methods?
What marketing methods to you think worked best?
What do you think was the customer's biggest driver to participate?

Program Response

What was program response? More or less than expected? Any documentation?
What are a customer's biggest issues in conducting the replacement?
What do you think holds customers back from replacing their turf?
How could this be improved?

Installation Issues

Do you think customers were able to easily find resources, plants, contractors to replace their turf?
Are there issues with customer installations?
Are contractors to conduct the replacements easily available in your service area?
Do these contractors conduct the replacements for the cost of the incentive?
Are there issues with contractor installations?

Program Effectiveness (strengths and weaknesses)

On a 1 to 10 scale, how successful do you think the program was?
What is your impression of the program's effectiveness in achieving water savings?
What percentage level of water use reduction would you expect among participating customers?
How confident are you in this estimate? Could you give a range of expected savings?
Besides water savings, what additional benefits would you attribute to the program?
Has the program been formally or informally evaluated?
What specific strengths and weaknesses would you identify?

Public Relations

What is your impression of your customers' response to this program? (1=v. negative, 10 = v. positive)

How would you describe the public relations benefits from the program (if any)?
Any public relations nightmares?
What has been the response in the press?
Other customer responses?

Lessons Learned

What advice would you give to other agencies contemplating similar programs?
What would limit the applicability of your program to other areas?
What are the important lessons that you learned in the development and implementation of the programs?
What special features or design elements of the program are important for its operation and success?

Closing

Who else in your utility should I speak with on these questions? (names and numbers)
Do you have any suggestions for individuals outside the utility that we should speak with? (names and numbers)
Are there any additional questions that you wish I would have asked you?

Appendix C: Participant and Non-Participant Surveys

Landscape Transformation - Program Participant Customer Survey (Non-Turf)

What do we want to learn from participant surveys?

1. *How well did the different program delivery mechanisms and landscape products/services work in getting customers to reduce outdoor water use?*
2. *How did participants hear about the program?*
3. *What motivated their participation?*
4. *What are customers' views on achieved water savings, improved landscapes, and areas for program improvement?*

Who is the target audience for program participant survey?

Participants (single family homeowners) in water agency landscape transformation programs. Customers that completed the project/program and customers that enrolled but dropped out of the program as some point will be surveyed separately.

How will surveys be implemented?

Each program type will have its own set of program questions, as well as several common questions. The program and costs sections will vary; the other sections will remain the same. Each survey is intentionally kept brief, and designed to hone in on a specific topic. This will result in a higher number of accurate, completed surveys.

Program types:

- Turf replacement incentives/rebates
- Landscape transformation outreach and support
- Efficient irrigation equipment (drip, nozzles, timer) incentives
- Soil amendments, mulch and other non-rebate assistance

Survey topic areas:

The survey questions are divided into several categories.

- Introductory
- Motivation to change landscape
- Program process and support (will differ somewhat by program type and allow for a couple of agency-specific questions)
- Costs and economics
- Program impact and effectiveness

The survey below is for Landscape Program Participants (not Turf Replacement).

Introductory Questions

You are receiving this survey because you have participated in your water utilities' landscape program. Thank you for agreeing to take part in this important survey so we can better understand ways to help our customers. The survey should only take 5 – 10 minutes to complete. Be assured that your answers will be kept in strictest confidence.

1. How did you hear about the program, please check all that apply?

O Local newspaper
O TV or radio
O Internet or social media
O Water agency website
O Water bill
O Word of mouth from friends and neighbors
O Advertisement
O Landscape contractor
O Don't Know
O Other, Please Specify
_____

2. Which method of learning about the program influenced you the most when making your decision to participate in the program? (select one)

O Local newspaper
O TV or radio
O Internet or social media
O Water agency website
O Water bill
O Word of mouth from friends and neighbors
O Advertisement
O Landscape contractor/professional
O Don't Know
O Other

3. Are you familiar with other water efficiency programs offered by your water agency?

O Yes, but did not participate
O Yes, and participated in some
O Yes, and participated in all
O No
O Not sure

4. How long have you lived in this residence? _____ years

5. How has your household's OUTDOOR use of water changed in the last 5 years?

O Decreased significantly

O Decreased somewhat
O About the same
O Increased somewhat
O Increased significantly
O Not sure

6. There is more my household could do to reduce our OUTDOOR water use.
O Strongly disagree
O Somewhat disagree
O Neither agree or disagree
O Somewhat agree
O Strongly agree

Reasons for Changing Landscape

7. What were your reasons for changing your landscape? (check all that apply)
O To save water
O To save money
O Doing my part because of the drought
O To reduce maintenance
O Like the look
O Friends or neighbors have done it
O Because of an incentive/rebate
O Other, Please specify_____

8. Which one reason would you say was the most important in your decision to change your landscape?
O To save water
O To save money
O Doing my part because of the drought
O To reduce maintenance
O Like the look
O Friends or neighbors have done it
O Because of an incentive/rebate
O Other, Please specify_____

9. Which are the most important aspects of your yard/landscape? Select top three.
O Beauty and appearance
O Color
O Clean and neat
O Green healthy lawn
O Easy care
O Place to play, relax or entertain

O Longevity of plants and grass
O Low water using
O Shade
O Other, Please specify_____

Landscape (Not Turf Replacement) Program (will vary by program type)

10. Did you **apply** online or by mail for the landscape program? Do we need this question?

O Online
O Mail
O Don't know

11. Who **designed** any changes to your landscape?
O Me or another family member
O Landscape designer
O Gardener
O Landscape contracting company
O Other, Please Specify _____
O No changes to landscape

12. Who **installed** any new landscape?
O Me or another family member
O Gardener
O Landscape contracting company
O Other, Please Specify _____
O No changes to landscape

13. Who **maintains** your landscapes?
O Me or another family member
O Gardener
O Landscape contracting company
O Other, Please Specify _____

14. How easy were each of the steps of the program (1 to 5,1-difficult, 5-easy, use 0 if it does not apply)

Applying	
Determining eligibility	
Getting initial landscape information	
Technical assistance	
Understanding and complying with program requirements	
Plant, design and layout choices	
Sprinkler, timer or other watering choices	

Choosing a contractor	
Landscape installation	
Landscape maintenance	

15. How helpful were the program resources in helping you through each step of changing your landscape and participating in the program? (1 to 5,1-not at all helpful, 5-very helpful, use 0 if does not apply)

Applying	
Determining eligibility	
Getting initial landscape information	
Technical assistance	
Understanding and complying with program requirements	
Plant, design and layout choices	
Sprinkler, timer or other watering choices	
Choosing a contractor	
Landscape installation	
Landscape maintenance	

16. For any replaced landscape, what did you replace the lawn area with? (check all that apply)

O Flowers or ornamental plants
O Shrubs and trees
O Low water use or water-wise plants
O Vegetable garden
O Gravel, pavers or other surface treatments
O Pond or other water features

Landscape Costs

17. How much did you spend on the new landscape?

O $2,000 or less
O $2,001 - $4,000
O $4,001 - $6,000
O $6,001 - $10,000
O Over $10,000
O Not sure/decline to answer

18. In your view, was the new landscape worth the investment?

O No
O Yes
O Maybe
O Not sure

19. Did the new landscape cost more, less, or about what you expected?

O Less
O About the same
O More
O Don't know

Program Impact and Effectiveness

20. Before you started in this program, how would you rate your familiarity with the ways to reduce outdoor water use?

O Very familiar
O Somewhat familiar
O A little familiar
O Not at all familiar
O Don't know

21. As a result of this program, how would you now rate your familiarity with ways to reduce outdoor water use?

O Very familiar
O Somewhat familiar
O A little familiar
O Not at all familiar
O Don't know

22. Is your new landscape more or less difficult to maintain than what you had before?

O Less difficult
O About the same
O More difficult
O Don't know

23. Have you followed, or altered, any maintenance or watering practices recommended by the program?

O Followed all recommendations
O Followed most recommendations
O Followed about half of recommendation
O Followed some recommendations
O Have not followed recommendations
O Don't Know

24. Overall, how satisfied are you with the new landscape?

O Very satisfied
O Satisfied
O Neither satisfied nor dissatisfied
O Dissatisfied

O Very dissatisfied
O Don't know

24a. If dissatisfied, why?

25. How long do you think you will keep the new landscape? (in years)
O Less than 3 years
O 3 year, but less than 5 years
O 5 years, but less than 10 years
O 10 years, but less than 20 years
O 20 years or more

26. How satisfied or dissatisfied are you with the program experience overall?
O Very Satisfied
O Satisfied
O Neither satisfied nor dissatisfied
O Dissatisfied
O Very dissatisfied
O Don't know

27. If you had a chance to do it again, would you do anything differently?
O Yes
O No
O Not sure

27a. If so, what would you do?

28. What suggestions do you have for improving the program?

29. What additional actions have you taken since program participation? (check all that apply)
O Changed outdoor watering practices
O Installed smart timer (weather-based)
O Took actions to reduce indoor water use
O Suggested to someone else that they change their landscape
O Other, Please Specify _____

Landscape Transformation - Program Participant Customer Survey (Turf)

What do we want to learn from participant surveys?

1. *How well did the different program delivery mechanisms and landscape products/services work in getting customers to reduce outdoor water use?*
2. *How did participants hear about the program?*
3. *What motivated their participation?*
4. *What are customers' views on achieved water savings, improved landscapes, and areas for program improvement?*

Who is the target audience for program participant survey?

Participants (single family homeowners) in water agency landscape transformation programs. Customers that completed the project/program and customers that enrolled but dropped out of the program as some point will be surveyed separately.

How will surveys be implemented?

Each program type will have its own set of program questions, as well as several common questions. The program and costs sections will vary; the other sections will remain the same. Each survey is intentionally kept brief, and designed to hone in on a specific topic. This will result in a higher number of accurate, completed surveys.

Program types:

- Turf replacement incentives/rebates
- Landscape transformation outreach and support
- Efficient irrigation equipment (drip, nozzles, timer) incentives
- Soil amendments, mulch and other non-rebate assistance

Survey topic areas:

The survey questions are divided into several categories.

- Introductory
- Motivation to change landscape
- Program process and support (will differ somewhat by program type and allow for a couple of agency-specific questions)
- Costs and economics
- Program impact and effectiveness

The survey below is for Turf Replacement Program Participants.

Introductory Questions

You are receiving this survey because you have participated in your water agency's turf replacement program. Thank you for agreeing to take part in this important survey so we can better understand ways to help our customers. The survey should only take 5 – 10 minutes to complete. Be assured that your answers will be kept in strictest confidence.

30. How did you hear about the program?

O Local newspaper
O TV or radio
O Internet or social media
O Water agency website
O Water bill
O Word of mouth from friends and neighbors
O Advertisement
O Landscape contractor
O Other

31. Which method of learning about the program influenced you the most when making your decision to participate in the program? (select one)

O Local newspaper
O TV or radio
O Internet or social media
O Water agency website
O Water bill
O Word of mouth from friends and neighbors
O Advertisement
O Landscape contractor/professional
O Other

32. Are you familiar with other water efficiency programs offered by your water agency?

O Yes, but did not participate
O Yes, and participated in some
O Yes, and participated in all
O No
O Not sure

33. How long have you lived in this residence? _____ years

34. How has your household's OUTDOOR use of water changed in the last 5 years?

O Decreased significantly
O Decreased somewhat
O About the same

O Increased somewhat
O Increased significantly
O Not sure

35. There is more my household could do to reduce our OUTDOOR water use.
O Strongly disagree
O Somewhat disagree
O Neither agree or disagree
O Somewhat agree
O Strongly agree

Reasons for Changing Landscape

36. What were your reasons for changing your landscape? (check all that apply)
O To save water
O To save money
O Doing my part because of the drought
O To reduce maintenance
O Like the look
O Friends or neighbors have done it
O Because of an incentive/rebate

37. Which one reason would you say was the most important in your decision to change your landscape?
O To save water
O To save money
O Doing my part because of the drought
O To reduce maintenance
O Like the look
O Friends or neighbors have done it
O Because of an incentive/rebate

38. Which are the most important aspects of your yard/landscape? Select top three.
O Beauty and appearance
O Color
O Clean and neat
O Green healthy lawn
O Easy care
O Place to play, relax or entertain
O Longevity of plants and grass
O Low water using
O Shade

Turf Replacement Program (will vary by program type)

39. Did you **apply** online or by mail for the landscape program?

O Online
O Mail
O Don't know

40. Who **designed** the new landscape?
O Me or another family member
O Landscape designer
O Gardener
O Landscape contracting company
O Other

41. Who **installed** the new landscape?
O Me or another family member
O Gardener
O Landscape contracting company
O Other

42. Who **maintains** the new landscapes?
O Me or another family member
O Gardener
O Landscape contracting company
O Other

43. How easy were each of these steps of the program (1-5, 5 easy, does not apply)

Applying	
Determining eligibility	
Getting initial landscape information	
Technical assistance	
Understanding and complying with program requirements	
Plant, design and layout choices	
Sprinkler, timer or other watering choices	
Choosing a contractor	
Landscape installation	
Landscape maintenance	

44. How helpful were the program resources in helping you through each step of changing your landscape and participating in the program? (1-5, 5 very helpful, does not apply)

Applying	
Determining eligibility	
Getting initial landscape information	

Technical assistance	
Understanding and complying with program requirements	
Plant, design and layout choices	
Sprinkler, timer or other watering choices	
Choosing a contractor	
Landscape installation	
Landscape maintenance	

45. How much of your lawn did you remove?
O Less than 1/3
O About half
O About 2/3
O All
O Not sure

46. If you did not remove all of your lawn, why did you keep some of the lawn?
O I like the look of a lawn
O To see how I like it
O To keep some open space to play, relax or entertain
O How property looks from curb
O For my pets
O I could not afford to remove all the lawn
O Other

47. What did you replace the lawn area with? (check all that apply)
O Flowers or ornamental plants
O Shrubs and trees
O Low water use or water-wise plants
O Vegetable garden
O Gravel, pavers or other surface treatments
O Pond or other water features

Landscape Costs
48. What rebate level for turf replacement did you receive?
O Under $1.00 per square foot
O $1.00 - $1.50 per square foot
O $1.51 - $2.00 per square foot
O $2.01 - $3.00 per square foot
O Above $3.00 per square foot

49. Would you have participated in the rebate was lower?
10% lower Yes No
25% lower Yes No

50% lower Yes No
O Would have done it without a rebate

50. How much did you spend on the new landscape?
O Less than $2,000
O $2,001 - $4,000
O $4,001 - $6,000
O $6,001 - $10,000
O Over $10,000
O Not sure/decline to answer

51. In your view, was the new landscape worth the investment?
O No
O Yes
O Maybe
O Not sure

52. Did the new landscape cost more, less, or about what you expected?
O Less
O About the same
O More
O Don't know

Program Impact and Effectiveness

53. Before you started in this program, how would you rate your familiarity with the ways to reduce outdoor water use?
O Very familiar
O Somewhat familiar
O A little familiar
O Not at all familiar
O Don't know

54. As a result of this program, how would you now rate your familiarity with ways to reduce outdoor water use?
O Very familiar
O Somewhat familiar
O A little familiar
O Not at all familiar
O Don't know

55. Is your new landscape more or less difficult to maintain than what you had before?
O Less difficult
O About the same

O More difficult
O Don't know

56. Have you followed, or altered, any maintenance or watering practices recommended by the program?
O Followed all recommendations
O Followed most recommendations
O Followed about half of recommendation
O Followed some recommendations
O Have not followed recommendations

57. Overall, how satisfied are you with the new landscape?
O Very satisfied
O Satisfied
O Neither satisfied nor dissatisfied
O Dissatisfied
O Very dissatisfied
O Don't know

------- If dissatisfied, why?

58. How long do you think you will keep the new landscape? (in years)
O 0 – 3 years
O 3 – 5 years
O 5 – 10 years
O 10 – 20 years
O Over 20

59. How satisfied or dissatisfied are you with the program experience overall?
O Very Satisfied
O Satisfied
O Neither satisfied nor dissatisfied
O Dissatisfied
O Very dissatisfied
O Don't know

60. If you had a chance to do it again, would you do anything differently?
O Yes
O No
O Not sure

-------- If so, what would you do?

61. What suggestions do you have for improving the program?

62. What additional actions have you taken since program participation? (check all that apply)
    O Changed outdoor watering practices
    O Installed smart timer (weather-based)
    O Took actions to reduce indoor water use
    O Suggested to someone else that they change their landscape
    O Other

Landscape Transformation - Customer Survey (Non-Participant)

Landscape Transformation Definition
The intentional effort to alter an existing landscape with a goal of reducing the irrigation water requirement.

What do we want to learn?

1. *What motivates people to change their landscape and irrigation practices to reduce the overall water requirement and usage?*
2. *What are the reasons and rationale for their landscape choices?*
3. *What barriers exist to landscape transformation and to utility sponsored programs?*

Who is the target audience for non-participant survey?
Single family homeowners with existing lawns within participating water agency territories.

- Austin Texas
- Fort Collins Colorado
- Peel Region Canada
- Sacramento
- Seattle Washington
- Southern California
- Sonoma County
- Southern Nevada

How will surveys be implemented?
Survey takers abandon long surveys or lose interest in answering questions accurately for the sake of completing the survey. It is important to design the survey in a manner that avoids "survey fatigue". Instead, we will initiate six separate short surveys, randomly divided among the pool of target customers.

Each survey is intentionally kept brief, with xx-xx questions, and designed to hone in on a specific topic. This will result in a higher number of accurate, completed surveys. Below are the six survey topic categories:

1. Knowledge of outdoor water use and awareness of landscape efficiency programs
2. Attitudes and opinions of home landscapes
3. Level of interest/feelings about water efficient landscapes
4. Motivations and barriers to replacing lawns
5. Irrigation equipment and level of interest in efficiency products
6. Landscape and irrigation purchasing habits and influencers

Introductory Questions

Welcome to the Landscape Watering survey!

Thank you for agreeing to take part in this important survey so we can better understand ways to help our customers. The survey should only take 4 – 5 minutes to complete. Be assured that your answers will be kept in strictest confidence.

1. Do you live in a single family detached home? End survey if no.
2. Do you rent or own your home? End survey if rent.
3. Do you have a lawn? End survey if customer does not have lawn.
4. Does your lawn have an in-ground sprinkler system? End survey if no.

1. From what sources do you get your information on landscape maintenance and watering? (check top 3)

O Online search
O Friends, neighbors and family
O My gardener
O Landscape contractors/professionals
O Advertisers
O Garden shop or nursery
O Big box stores (Home Depot, Lowe's, etc.)
O Printed pamphlets, guides
O Water agency information (bills, website, mailers)
O Other, Please specify _____

2. Which are the most important aspects of your yard/landscape? Select top three.

O Beauty and appearance
O Color
O Clean and neat
O Green healthy lawn
O Easy care
O Place to play, relax or entertain
O Longevity of plants and grass
O Low water using
O Shade
O Having a vegetable garden
O Other, Please specify _____

Knowledge About Water Use and Program Awareness

1. On average, what percentage of your household water use do you think is indoor vs outdoor?

	Indoors	Outdoors
O	90%	10%
O	70%	30%
O	50%	50%
O	30%	70%
O	10%	90%

2. Do you know how much money your household spends on water to irrigate your landscape?

O Not at all familiar
O Somewhat familiar
O Very familiar

3. How has your household's OUTDOOR use of water changed in the last 5 years?

O Decreased significantly
O Decreased somewhat
O About the same
O Increased somewhat
O Increased significantly
O Not sure

4. There is more my household could do to reduce our OUTDOOR water use.

O Strongly disagree with the statement
O Somewhat disagree with the statement
O Neither agree or disagree with the statement
O Somewhat agree with the statement
O Strongly agree with the statement

5. Which water conservation products have you installed? (check all that apply)

O Low water use showerhead
O Low water use toilet
O High efficiency clothes washer
O More efficient sprinkler system (such as drip)
O Smart timer (weather-based)
O Other, Please specify _____
O None

6. Have you heard about your water agency's landscape programs?

O Yes, I participated in one/multiple program(s)

O Yes, but I didn't participate any program
O No, I haven't heard about any program
O Not sure/don't know

7. When you think of landscapes that use water efficiently what best represents your thoughts? (check all that apply).

O Means cactus, gravel and/or fake lawns
O Makes a yard unusable for gatherings or activities
O Can contain colorful plants
O Can be beautiful
O Can still be usable for gathering and activities
O Other
O None

8. Do you think your yard could look attractive with lower water use landscaping?

O Yes
O No
O Not sure

Consider additional question with pictures of traditional landscapes compared to water efficient? Request ranking or possible check list of like and dislikes.

Attitudes and Opinions of Home Landscapes

1. What do you like most about your lawn? Select top three.

O Appearance and beauty (aesthetics)
O Free of weeds
O Green
O Healthy lush
O Neat and clean
O Provides a place to play
O Enhances look of home
O Other, Please specify _____

2. What causes you concerns with your lawn? Select top three.

O Weeds
O Requires too much water
O Costs too much to maintain
O Requires lots of time/work
O Hard to make look attractive/keep green
O Not colorful/limited variety
O Other, Please specify _____

3. What type of landscape do you use for your lawn?

a. Mostly green grass with some flowers/trees
b. Mostly a water saving landscape (I'm not sure what the best terminology is here)
c. Other, please explain

4. Is your lawn healthy?

O Yes
O No
O Partially

5. How satisfied are you with your landscape?

O Very satisfied
O Somewhat satisfied
O Somewhat dis-satisfied
O Very Dis-satisfied

6. What would your ideal landscape have, check all that apply?

O Decks/patio/sitting area
O Flowers
O Lawn
O Rocks
O Trees and shrubs
O Walkway
O Water/pool/fountain
O Vegetable garden
O Other, Please specify _____

7. What is keeping you from having your ideal landscape?

O Knowledge
O Labor
O Money
O Space available
O Time for upkeep
O Nothing
O Other, Please specify _____

Consider additional question with pictures of traditional landscapes compared to water efficient? Request ranking or possible check list of like and dislikes.

Customer Motivations and Barriers About Replacing Their Lawns

1. Many people are saving water by replacing all or some of their lawn. What are your concerns about replacing your lawn?

O I have already replaced my lawn to save water (stop here and return survey so we know you have already replaced your lawn)

O The look
O Want an open space to play, relax, entertain
O Neighbor's opinion
O It's complicated – don't know where to start
O Need a professional and don't know one
O Don't have the time required
O Will cost too much
O Other, Please specify _____

2. Do you know neighbors and friends that have replaced some or all of their lawn with alternative landscaping that uses less water?

O Yes
O No, skip Question 3
O Not sure, skip Question 3

3. What do you think of their new landscape?

O Like a lot
O Like a little
O Neither like nor dislike
O Dislike a little
O Dislike a lot

4. Have you considered replacing all or part of your lawn with lower water using landscape?

O Yes
O No, skip Question 5

5. Why might you consider replacing all of some of your lawn? (check top 3)

O To save water
O To save money
O Doing my part because of severe water shortage
O To reduce maintenance
O If friends or neighbors have done it
O Like the look of water efficient landscapes
O Because of an incentive/rebate
O Not interested in replacing lawn

6. If you were to consider taking out your lawn, how would you rate your (or your household's) ability and skills to get it done?

O I feel confident on my (or my household's) ability to change out my landscape.
O If I had help designing the project then I/we could get it done.
O I/we would need help designing and implementing the project.
O I haven't thought about it.

O I don't think that I/we can do this successfully even with help.

7. If you had a choice of the following which would you prefer?
O Make no landscape changes
O Install more water efficient sprinkler system
O Replace part of my lawn
O Replace all of my lawn
O Not sure/don't know

8. If you decided to change out your landscape what level of assistance would you need?
O None, skip Question 9
O Moderate
O Substantial
O Full Assistance
O Not sure/don't know

9. What area could you use the most assistance? (check one)
O Landscape design
O Finding a contractor
O Replacing the lawn
O Finding irrigation products and plants
O Installing irrigation
O Installing plants
O Other, Please specify _____

10. What can your water agency do to persuade you to replace your lawn?
O Provide plant selection and layout support
O Provide Contractor references
O Offer discounted plants
O Provide monetary incentive
O Nothing could make me take my lawn out
O Other, Please specify _____

11. How much of a financial incentive would motivate you to replace your lawn?
O 1/4 of project costs
O 1/2 of project costs
O 3/4 of project costs
O 100% of project costs
O Wouldn't replace lawn even with incentive
O Other, Please specify _____

Irrigation Equipment and Level of Interest in Efficiency Products

1. Does your sprinkler system have a timer?
O Yes

O No
O Don't know

2. How do you change your watering schedule throughout the year? (check all that apply)

O Turn off during winter
O Decrease in the fall
O Increase or decrease based upon the month
O Turn off during rain
O No changes made
O Don't know

3. How often do you check the sprinkler system for breaks and leaks?

O Every season
O Once a year
O Randomly
O Never
O Rely upon my landscape contractor
O Other, Please specify _____

4. How important is each of the following factors to you when making decisions about lawn watering? (check appropriate boxes)

HOW IMPORTANT IS IT TO:	NOT AT ALL IMPORTANT	SOMEWHAT IMPORTANT	VERY IMPORTANT
Minimize time I spend watering/maintaining?			
Conserve water?			
Prevent brown spots on lawn?			
Have a green lawn?			
Maintain my property value?			
Keep my neighbors happy?			

5. If you don't have water efficient sprinklers, are you interested in installing them?

O Yes
O No
O Already have them

6. If you don't have a timer already, are you interested in installing a timer that adjusts the schedule based upon the plant needs and local weather?

O Yes
O No

O Already have one

7. If you had a choice of the following which would you prefer?
O Make no landscape changes
O Install more water efficient sprinkler system
O Replace part of my lawn
O Replace all of my lawn

Landscape and Irrigation Purchasing Habits and Influencers

1. Who takes care of your lawn?
O Me or another family member
O Gardener
O Landscape contracting company
O Homeowners Association
O Other, Please specify _____
O Not Sure

2. If you have a gardener or landscape contractor, what services do ~~you~~ they provide?
O Mow lawn, weed and/or leaf blow
O Fertilize lawn
O Plant seasonally or as necessary
O Make sprinkler system repairs
O Other
O Do not have a gardener, skip to Question 6

Has your gardener or landscape contractor talked to you (or someone in your household?) about installing water efficient sprinklers or timer?
O Yes
O No
O Not sure

Has your gardener or landscape contractor talked to you about replacing your lawn?
O Yes
O No
O Not sure

Would you trust your gardener or contractor to replace your lawn?
O Yes
O No
O Not sure

Where do you buy sprinkler equipment products?

O Big box store
O Local hardware store
O Whole irrigation equipment supplier
O Don't buy, rely upon landscape contractor or gardener
O Don't buy at all
O Other

Where do you buy your plants?
O Big box store
O Local nursery or garden shop
O Don't buy, rely upon landscape contractor or gardener
O Don't buy any plants
O Other

Appendix D: Detailed Estimation Results of Single Family Landscape Transformation Participation

In the Tables below, the constant term describes the mean intercept for this equation. (A separate intercept is estimated for each customers but these are not displayed for reasons of brevity.) The independent variables 1 to 4—made up of the sines and cosines of the Fourier series described in Equation 2 of Chapter 5—are used to depict the seasonal shape of water demand. The predicted seasonal effect (that is, $Z \cdot \widehat{\beta}_S$) is the shape of demand in a normal weather year. This seasonal shape is important in that it represents the point of departure for the estimated weather effects (expressed as departure from normal). We also test to see if the landscape interventions have any effect on this seasonal shape in Equation 5 of Chapter 5.

The estimated weather effect is specified in "departure-from-normal" form. Variable 5 is the departure of monthly rainfall from its seasonal average. (Average seasonal rainfall is derived from a regression of the rolling average of daily rainfall on the seasonal harmonics.) The one month lagged rainfall deviation is also included in the model (Variable 6). Variable 9 is the departure of monthly temperature from the average temperature for that month in the season. The reader should also note that the contemporaneous weather effect is interacted with the harmonics to capture any seasonal shape to both the rainfall (Variables 5 and 6) and the temperature (Variable 9) elasticities. Thus, departures of temperature from normal produce the largest percentage effect in the spring growing season. Similarly, an inch of rainfall produces a larger effect upon demand in the summer than in the winter.

City of Austin Interpretation: The effect of the Landscape Transformation program interventions is captured in the following rows. The parameter on the indicator for the average effect of participation in the Landscape Transformation program (Variable 12), suggests that the mean change in Austin Participant's water consumption is 47.78 gallons per day (an approximate 19% reduction from the weather normalized mean pre-intervention consumption of 252 gpd). The 95 percent confidence interval is between 23.7gpd and 71.7 gpd. The estimated mean net water savings of 47.8 gpd is more than 2 standard errors from zero implying that the null hypotheses (β_{LT}==0) can be rejected at high levels of statistical confidence.

Water Savings

Austin Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-50.60	(16.27)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-94.81	(12.68)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	20.61	(4.958)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	0.990	(6.527)
5. Deviation from logarithm of 30 moving sum of rainfall	dlr_mean	-33.20	(7.510)
6. Monthly lag from rain deviation	dlr_1	-23.23	(4.462)
7. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	22.11	(6.629)
8. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	11.42	(7.210)
9. Deviation from logarithm of 30 day moving average of maximum daily air temperature	dlt_mean	817.1	(252.8)
10. Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	111.8	(198.0)
11. Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	-906.8	(242.1)
12. Average Participation Effect (APE) by customers (65 metered sites in sample)	i_part	-47.68	(12.24)
13. Interaction of APE with annual sine harmonic	i_part_sin1	-15.51	(11.62)
14. Interaction of APE with annual cosine harmonic	i_part_cos1	15.53	(11.23)
15. Intercept (approximates mean pre-participation use)	_cons	252.4	(20.03)
Number of observations		4,543	
Number of Households		65	
Standard Error of Individual Constant Terms (sigma_u)		121.98	
Standard Error of White Noise Error (sigma_e)		240.16	
Rho – Intra-cluster correlation	rho	0.205	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.317	
Time period of Consumption - – January 2011 – September 2017			

Guelph Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-0.00148	(0.000594)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-0.0267	(0.00103)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	-0.00941	(0.000577)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	0.0150	(0.000631)
5. Monthly lag from rain deviation	dlr_1	-0.0121	(0.00169)
6. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-0.0512	(0.00270)
7. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	0.0413	(0.00324)
8. Participants difference in pre-participation mean use	part	-0.0487	(0.0113)
9. Average Participation Effect (APE) by customers (36,426 metered sites in sample)	i_part	-0.0389	(0.00875)
10. Interaction of APE with annual sine harmonic	i_part_sin1	0.00192	(0.00182)
11. Interaction of APE with annual cosine harmonic	i_part_cos1	-0.0125	(0.00301)
12. Intercept (approximates mean nonparticipant water use)	_cons	0.613	(0.00405)
Number of observations		1,531,000	
Number of Households		36,284	
Standard Error of Individual Constant Terms (sigma_u)		.7469	
Standard Error of White Noise Error (sigma_e)		.4199	
Rho – Intra-cluster correlation	rho	0.760	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.717	
Time period of Consumption – January 2006 – December 2015			

North Marin W.D. Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-72.25	(1.655)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-166.5	(3.201)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	12.81	(0.751)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	7.051	(0.713)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-34.25	(1.117)
6. Monthly lag from rain deviation	dlr_1	-9.006	(0.932)
7. Participants difference in pre-participation mean use	part	77.69	(11.36)
8. Average Participation Effect (APE) by customers (5,152 metered sites in sample)	i_part	-100.0	(8.647)
9. Interaction of APE with annual sine harmonic	i_part_sin1	2.424	(4.294)
10. Interaction of APE with annual cosine harmonic	i_part_cos1	12.83	(7.916)
11. Intercept (approximates mean nonparticipant water use)	_cons	322.9	(3.258)
Number of observations		151,268	
Number of Households		4,099	
Standard Error of Individual Constant Terms (sigma_u)		178.60	
Standard Error of White Noise Error (sigma_e)		204.62	
Rho – Intra-cluster correlation	rho	0.432	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.539	
Time period of Consumption – December 2003 – December 2015			

Petaluma Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-62.13	(6.815)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-7.083	(6.079)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	-2.717	(2.441)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	5.146	(2.159)
5. Monthly lag from rain deviation	dlr_1	-12.56	(2.525)
6. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	0.385	(4.156)
7. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	-3.441	(3.518)
8. Deviation from logarithm of 30 or 61 day moving average of maximum daily air temperature	dlt_mean	3.442	(47.07)
9. Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	-0.404	(81.47)
10. Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	144.3	(57.98)
11. Participants difference in pre-participation mean use	part	-17.11	(14.15)
12. Average Participation Effect (APE) by customers (68 metered sites in sample)	i_part	-27.60	(9.239)
13. Interaction of APE with annual sine harmonic	i_part_sin1	35.06	(6.242)
14. Interaction of APE with annual cosine harmonic	i_part_cos1	-39.76	(6.688)
15. Intercept (approximates mean nonparticipant water use)	_cons	224.1	(11.33)

Number of observations		5,250
Number of Households		68
Standard Error of Individual Constant Terms (sigma_u)		56.61
Standard Error of White Noise Error (sigma_e)		113.76
Rho – Intra-cluster correlation	rho	0.199
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.277
Time period of Consumption – January 2010 – May 2017		

Sacramento Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-106.5	(5.607)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-205.7	(10.08)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	21.48	(2.927)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	11.16	(2.966)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-35.12	(4.279)
6. Monthly lag from rain deviation	dlr_1	-19.57	(3.497)
7. Participants difference in pre-participation mean use	part	4.942	(24.36)
8. Average Participation Effect (APE) by customers (240 metered sites in sample)	i_part	-111.7	(25.88)
9. Interaction of APE with annual sine harmonic	i_part_sin1	68.73	(11.28)
10. Interaction of APE with annual cosine harmonic	i_part_cos1	131.1	(22.78)
11. Intercept (approximates mean nonparticipant water use)	_cons	372.1	(13.41)

Number of observations		17,641
Number of Households		233
Standard Error of Individual Constant Terms (sigma_u)		153.93
Standard Error of White Noise Error (sigma_e)		289.34
Rho – Intra-cluster correlation	rho	0.221
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.379
Time period of Consumption – January 2009 – May 2017		

San Diego City Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-60.41	(2.676)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-100.9	(6.225)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	-0.248	(1.916)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	6.963	(1.430)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-59.55	(3.206)
6. Monthly lag from rain deviation	dlr_1	-35.63	(2.440)
7. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-19.93	(3.240)
8. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	5.538	(3.259)
9. Average Participation Effect (APE) by customers (385 metered sites in sample)	i_part	-111.6	(7.068)
10. Interaction of APE with annual sine harmonic	i_part_sin1	26.56	(2.294)
11. Interaction of APE with annual cosine harmonic	i_part_cos1	46.01	(5.572)
12. Intercept (approximates mean nonparticipant water use)	_cons	331.1	(2.502)
Number of observations		21,697	
Number of Households		384	
Standard Error of Individual Constant Terms (sigma_u)		162.67	
Standard Error of White Noise Error (sigma_e)		176.93	
Rho – Intra-cluster correlation	rho	0.458	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.467	
	F	62.78	
	p	9.94e-79	
Time period of Consumption – January 2007 – July 2017			

SNWA Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-16.83	(0.412)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-371.0	(1.742)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	3.332	(0.179)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	24.51	(0.230)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-53.18	(0.593)
6. Monthly lag from rain deviation	dlr_1	-19.82	(0.428)
7. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-12.27	(0.689)
8. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	-4.105	(0.854)
9. Deviation from logarithm of 30 or 61 day moving average of maximum daily air temperature	dlt_mean	200.6	(4.818)
10. Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	68.68	(4.579)
11. Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	-211.0	(6.575)
12. Average Participation Effect (APE) by customers (28,632 metered sites in sample)	i_part	-280.6	(1.700)
13. Interaction of APE with annual sine harmonic	i_part_sin1	-2.755	(0.513)
14. Interaction of APE with annual cosine harmonic	i_part_cos1	195.3	(1.556)
15. Intercept (approximates mean nonparticipant water use)	_cons	724.2	(0.737)
Number of observations		5,943,413	
Number of Households		28,396	
Standard Error of Individual Constant Terms (sigma_u)		329.25	
Standard Error of White Noise Error (sigma_e)		365.36	
Rho – Intra-cluster correlation	rho	0.448	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.562	
Time period of Consumption – January 1997 – December 2016			

City of Santa Rosa Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-54.65	(0.852)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-124.6	(1.576)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	1.731	(0.312)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	1.010	(0.327)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-34.86	(0.772)
6. Monthly lag from rain deviation	dlr_1	-10.49	(0.393)
7. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	12.09	(0.724)
8. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	23.26	(1.019)
9. Deviation from logarithm of 30 or 61 day moving average of maximum daily air temperature	dlt_mean	5.813	(7.718)
10. Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	202.1	(9.988)
11. Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	362.4	(10.24)
12. Participants difference in pre-participation mean use	part	28.67	(3.292)
13. Average Participation Effect (APE) by customers (5,413 metered sites in sample)	i_part	-54.86	(2.290)
14. Interaction of APE with annual sine harmonic	i_part_sin1	6.927	(1.528)
15. Interaction of APE with annual cosine harmonic	i_part_cos1	17.05	(3.026)
16. Intercept (approximates mean nonparticipant water use)	_cons	211.7	(1.869)

Number of observations		411726
Number of Households		5347
Standard Error of Individual Constant Terms (sigma_u)		104.1
Standard Error of White Noise Error (sigma_e)		135.4
Rho – Intra-cluster correlation	rho	0.372
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.494
Time period of Consumption – January 2010 – December 2016		

San Diego County Water Authority Statistical Model of Landscape Transformation

Dependent Variable: Water Consumption in Gallons per Day

Model Variable	Name	Coeff.	St. Err.
1. First Sine harmonic, 12 month (annual) frequency	sin1	-36.74	(0.870)
2. First Cosine harmonic, 12 month (annual) frequency	cos1	-52.22	(1.302)
3. Second Sine harmonic, 6 month (semi-annual) frequency	sin2	1.387	(0.600)
4. Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	4.353	(0.489)
5. Deviation from logarithm of 30 or 61 day moving sum of rainfall	dlr_mean	-56.41	(1.418)
6. Monthly lag from rain deviation	dlr_1	-30.47	(1.141)
7. Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-10.51	(1.318)
8. Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	27.49	(1.615)
9. Deviation from logarithm of 30 or 61 day moving average of maximum daily air temperature	dlt_mean	66.96	(10.79)
10. Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	-109.8	(7.284)
11. Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	4.727	(1.636)
12. Average Participation Effect (APE) by customers (385 metered sites in sample)	i_part	-5.833	(2.975)
13. Interaction of APE with annual sine harmonic	i_part_sin1	263.4	(3.055)
14. Interaction of APE with annual cosine harmonic	i_part_cos1	-36.74	(0.870)
15. Intercept (approximates mean nonparticipant water use)	_cons	-52.22	(1.302)
Number of observations		199,460	
Number of Households		3216	
Standard Error of Individual Constant Terms (sigma_u)		157.8	
Standard Error of White Noise Error (sigma_e)		178.4	
Rho – Intra-cluster correlation	rho	0.439	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.579	
Time period of Consumption – May 2008 – February 2017			

Persistence of Water Savings

City of San Diego: Persistence of Participant Savings

Dependent Variable: Water Consumption in gallons per day

Model Variable	Name	Coeff.	St. Err.
First Sine harmonic, 12 month (annual) frequency	sin1	-36.34	(0.847)
First Cosine harmonic, 12 month (annual) frequency	cos1	-50.93	(1.197)
Second Sine harmonic, 6 month (semi-annual) frequency	sin2	1.758	(0.568)
Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	4.449	(0.472)
Third Sine harmonic, 4 month frequency	sin3	1.526	(0.631)
Third Cosine harmonic, 4 month frequency	cos3	3.778	(0.622)
Fourth Sine harmonic 3 month (quarterly) frequency	sin4	-0.204	(0.908)
Fourth Cosine harmonic, 3 month (quarterly) frequency	cos4	-6.694	(1.057)
Deviation from logarithm of 30 moving sum of rainfall	dlr_mean	-56.37	(1.372)
Monthly lag from rain deviation	dlr_1	-30.46	(1.136)
Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-11.76	(1.352)
Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	27.87	(1.618)
Participation indicator*Turf Area Converted in Sq. Ft. (385 metered sites in sample)	i_convert_sqft	-0.110	(0.0162)
Participation indicator*Turf AreaConvertedinSq.Ft.^2	i_convert_sqftsq	0.0000130	(0.0000125)
Interaction of i_convert_sqft with annual sine harmonic	i_convert_sin1	0.00150	(0.00198)
Interaction of i_convert_sqft with annual cosine harmonic	i_convert_cos1	-0.00922	(0.00350)
Interaction of i_convert_sqft with 1rst Yr post-convert	i_convert_sqft_1stYear	-0.0108	(0.00433)
Interaction of i_convert_sqft with 2nd Yr post-convert	i_convert_sqft_2ndYear	-0.00930	(0.00462)
Interaction of i_convert_sqft with 3rd Yr post-convert	i_convert_sqft_3rdYear	-0.0212	(0.00637)
Interaction of i_convert_sqft with 4th Yr post-convert	i_convert_sqft_4thYear	-0.0291	(0.00925)
Participants difference in pre-participation mean use	part	57.88	(9.068)
Intercept (approximates mean nonparticipant water use)	_cons	262.3	(2.984)
Number of observations	*N*	199380	
Number of Households	N_clust	3,212	

Standard Error of Individual Constant Terms	sigma_u	150.4
Standard Error of White Noise Error	sigma_e	172.7
Rho – Intra-cluster correlation	rho	0.431
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.4579
Wald chi2(21) =		3046.7
Prob > chi2 =		0.0000

SNWA Persistence of Participant Savings/SqFt

Dependent Variable: Water Consumption in gallons per day

Model Variable	Name	Coeff.	St. Err.
First Sine harmonic, 12 month (annual) frequency	sin1	-16.78	(0.380)
First Cosine harmonic, 12 month (annual) frequency	cos1	-312.4	(1.806)
Second Sine harmonic, 6 month (semi-annual) frequency	sin2	1.361	(0.193)
Second Cosine harmonic, 6 month (semi-annual) frequency	cos2	24.07	(0.255)
Third Sine harmonic, 4 month frequency	sin3	-3.595	(0.144)
Third Cosine harmonic, 4 month frequency	cos3	-1.708	(0.153)
Fourth Sine harmonic 3 month (quarterly) frequency	sin4	0.999	(0.128)
Fourth Cosine harmonic, 3 month (quarterly) frequency	cos4	5.285	(0.126)
Deviation from logarithm of 30 moving sum of rainfall	dlr_mean	-59.91	(0.668)
Monthly lag from rain deviation	dlr_1	-19.38	(0.454)
Interaction of contemporaneous rain with annual sine harmonic	dlr_sin1	-25.84	(0.798)
Interaction of contemporaneous rain with annual cosine harmonic	dlr_cos1	7.592	(0.919)
Deviation from logarithm of 30 day moving average of maximum daily air temperature	dlt_mean	204.6	(5.868)
Interaction of contemporaneous temp with annual sine harmonic	dlt_sin1	117.5	(5.038)
Interaction of contemporaneous temp with annual cosine harmonic	dlt_cos1	-30.09	(7.631)
Participation indicator*Turf Area Converted in Sq. Ft. (385 metered sites in sample)	i_convert_sqft	-0.197	(0.00274)
Participation indicator*Turf AreaConvertedinSq.Ft.^2	i_convert_sqftsq	0.00000950	(0.000000784)
Interaction of i_convert_sqft with annual sine harmonic	i_convert_sin1	-0.00450	(0.000416)
Interaction of i_convert_sqft with annual cosine harmonic	i_convert_cos1	0.0212	(0.00232)
Interaction of i_convert_sqft with 1rst Yr post-convert	i_convert_sqft_1stYear	0.00191	(0.00159)
Interaction of i_convert_sqft with 2nd Yr post-convert	i_convert_sqft_2	-0.00213	(0.00183)

Interaction of i_convert_sqft with 3rd Yr post-convert	ndYear i_convert_sqft_3rdYear	-0.00191	(0.00190)
Interaction of i_convert_sqft with 4th Yr post-convert	i_convert_sqft_4thYear	-0.00632	(0.00192)
Interaction of i_convert_sqft with 5th-9th Yr post-convert	i_convert_sqft_5th_9th	-0.0155	(0.00208)
Interaction of i_convert_sqft with 10th Yr + post-convert	i_convert_sqft_10thPlus	-0.0263	(0.00272)
Intercept (mean pre-participant water use)	_cons	719.4	(2.698)
Number of observations	*N*	5,994,387	
Number of Households	N_clust	28,632	
Standard Error of Individual Constant Terms (sigma_u)	sigma_u	345.1	
Standard Error of White Noise Error (sigma_e)	sigma_e	392.6	
Rho – Intra-cluster correlation	rho	0.436	
Adj. R-Squared (Inclusive of customer intercepts)	adj_r2	0.590	
Wald chi2(25)		55,510	
Prob > chi2 =		0.0000	