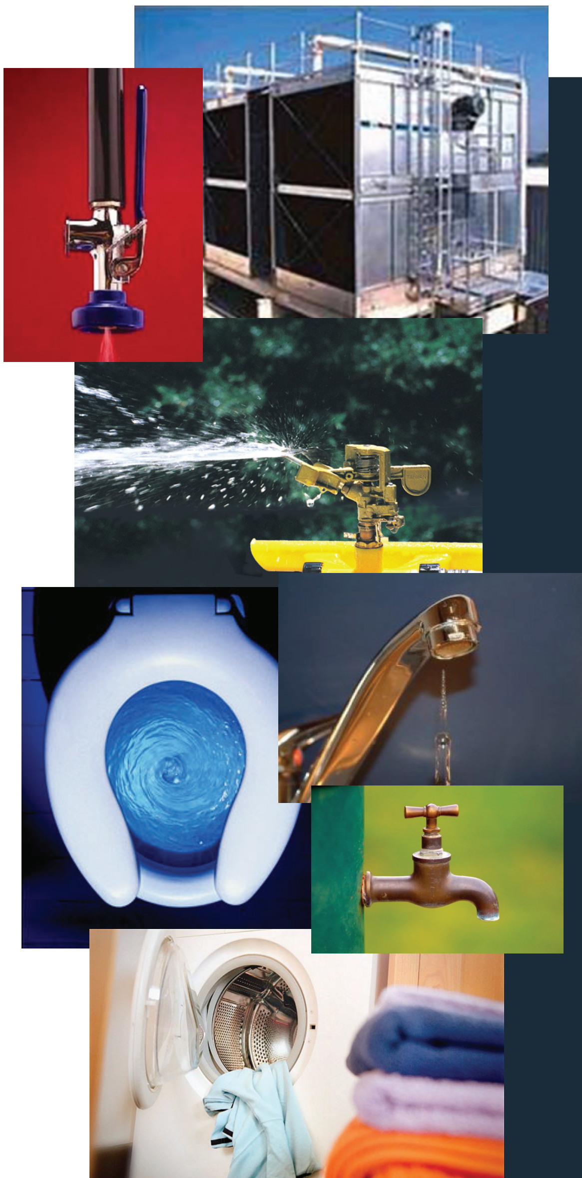
TAMPA BAY WATER
Supplying Water To The Region



Tampa Bay Water
Water Demand Management Plan
Final Report

December 2013

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HAZEN AND SAWYER
Environmental Engineers & Scientists

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TAMPA BAY WATER
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Executive Summary

ES.1 Background

Tampa Bay Water currently helps meet the water demands of more than 2.3 million people in the tri-county region. Residential demands accounted for nearly 75 percent of billed water consumption, with the remainder associated with the needs of commercial businesses and industry. The agency has been actively involved in quantifying water demand and potential changes in demand through water use efficiency efforts, mainly through member government implementation, since adoption of its original demand management plan the mid 1990's. Additionally, the agency developed tools to quantify ongoing member water use efficiency programs that helped to meet original Board of Directors adopted planning goals.

In 2013, approximately one-half of the water supplies for Tampa Bay Water member governments were dependent on the timing and quantity of local and regional rainfall. In order to meet reliability goals, it is important to understand how variability and uncertainties affect the planning and development of water supplies. As Tampa Bay Water's reliance on surface water and other alternative water sources continues to increase, the value of increased water use efficiency in managing future long-term supply needs has become evident. As new supply development costs continue to increase, avoided cost of water supply becomes a more critical element of the water supply planning process.

The Demand Management Plan (DMP) is an element of the Agency's Long-term Water Supply Plan and investigates the benefits and costs of water demand management as a quantifiable, alternative water supply source. The DMP is considered one component of the agency's strategic goals to achieve reliability of its water supply and delivery system to its member governments.

Demand side management efforts are intended to serve as a complementary component to traditional water supply planning processes in meeting current and future water demands. Demand-side management encompasses a set of activities designed to:

- Provide a better understanding of how and why water is used;
- Forecast human demands for water supplies;
- Develop prospective water-using efficiency (demand reduction) measures;
- Identify programmatic and project goals, evaluation criteria, performance measures, and monitoring mechanisms;

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- Define and evaluate program effectiveness and goal achievement; and
- Evaluate the benefits and costs of efficiency measures as an alternative or complement to supply development.

Through efficient use of available supplies and use of targeted implementation strategies, water use efficiency can help manage peak and average day water demand in conjunction with reducing long-term future water supply requirements. Cost-effective alternatives to new supply development and other valuable benefits can be realized through demand side management including: optimization of existing facilities, deferred capital investment costs, improved public perception, support of future supply projects, and environmental stewardship and protection.

ES.2 Components of Tampa Bay Water's DMP

This DMP consists of a comprehensive investigation of benefits and costs of integrated water demand management as a quantifiable, alternative to conventional water supply sources, reflecting improvements in the state of water use efficiency occurring since 1995 when the first DMP was adopted. The update includes an evaluation of potential demand management projects as a beneficial tool for long-term water supply planning. Results define how water efficiency activities may fit into Tampa Bay Water's long-term water supply planning process, which includes supply reliability and member government long range demand projections. The DMP report is organized into seven sections:

- Section 1: Introduction
- Section 2: Data Collection and Database Integration
- Section 3: Regional Baseline Water Demand Profile
- Section 4: Analysis of Water Technologies and Baseline Water Use Efficiency
- Section 5: Passive Water Efficiency Evaluation
- Section 6: Active Water Efficiency Alternatives Evaluation
- Section 7: Summary and Recommended Strategies

The demand management evaluation effort includes an analysis of water savings (past and future) and an analysis of avoided supply costs related to improved water use efficiency. The "avoided supply cost" analysis considers increments of conserved water versus (a) cost to operate existing water supply sources and (b) total cost (capital and operating costs) to develop new water supply. Consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water supply alternatives.

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ES.3 Regional Baseline Water Demand Profile

Demand profiling provides a greater understanding of demand trends and how these trends relate to or can be affected by water use efficiency improvements. The Regional Baseline Water Demand Profile quantifies and describes the water using and economic characteristics of Tampa Bay Water's member government customers. This includes an assessment of water savings estimates achieved from previously implemented conservation programs and the market for water efficiency technologies. The regional profile includes analyses of water use patterns among the major water using sectors in the Tampa Bay region.

ES.3.1 Distribution of Water Use

Characterization of water use relies on identification and assessment of water use trends over time, across sectors and geographies. Regionally, there are three major common sectoral uses of water, single-family residential (SF), multifamily residential (MF), and nonresidential (NR), which includes water used by businesses and institutions. The distribution of regional sectoral demands is illustrated in Figure ES.1. Regionally, single-family demand is greater than multifamily and nonresidential demands combined.

Weather-sensitive and weather-insensitive components of single-family demand were estimated regionally and for each member government over WY 2002 - 2008. Weather insensitive demand - predominantly indoor use - is generally influenced by the number of people residing in a household along with the presence and efficiency levels of various indoor domestic end uses (e.g., toilets, washing machines, etc.). Outdoor end uses are weather sensitive and tend to be a highly variable component of total water use. Outdoor uses are influenced both by weather and socioeconomic factors. Figure ES.2 illustrates the estimated proportion of weather-sensitive demands in the single-family sector by month through time. Annual average single-family household demand over the period 2002-2008 is 229 gpd, and is estimated to include 52 gpd of weather-sensitive and 177 gpd of weather-insensitive demand.

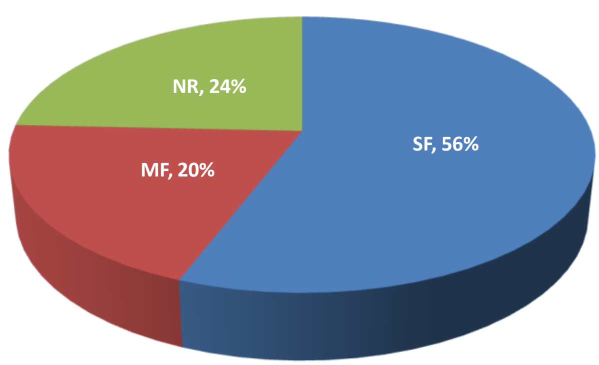

Figure ES.1: Distribution of Regional Sectoral Water Demands

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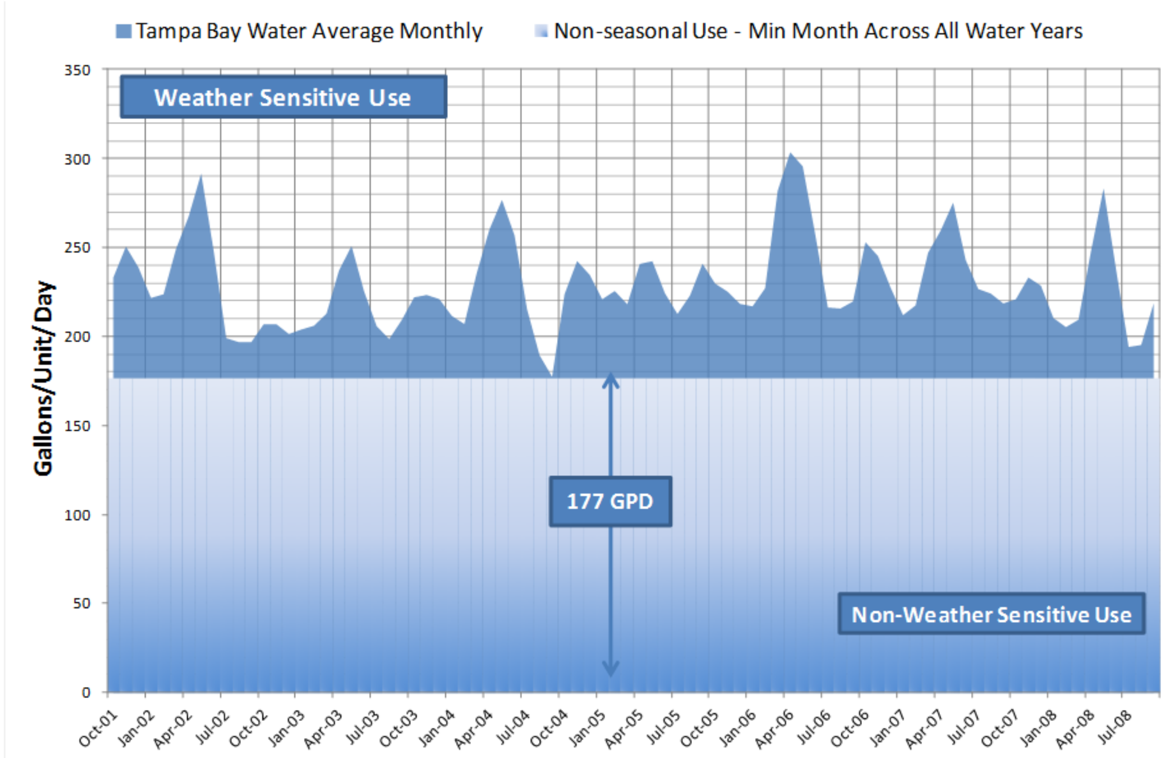

Figure ES.2: Regional Single-Family Weather-Sensitive and Weather-Insensitive Demands

ES.3.2 Evaluation of Achieved Water Savings from Existing Programs

Statistical evaluations were undertaken to measure and verify impacts of existing conservation programs implemented by member governments. The results of these evaluations can be summarized as follows:

- Member government ultra-low flow toilet rebate programs - The data indicates households having received one or more rebates, used nearly 12 percent less water on average after the change out of the toilet. Further analyses indicate homes with only one rebate averaged a 10.8 percent reduction.
- Florida-Friendly landscapes - Homes recognized by the County Extension offices as having both water wise landscape design and efficient irrigation technology and practices, used about 3-5 percent less after one year of participation and from 5-9 percent after two years.
- Member government irrigation evaluation programs - Although significant potential may exist, results suggest a diminution of savings over time, with an estimated reduction in water use by about 7 percent after one year of participating and only 3 percent after two years.

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ES.4 Analysis of Water Technologies and Baseline Water Use Efficiency

Through a literature review of available and emerging technologies/programs, a water efficiency program library (WEPL) of technically-applicable demand management technologies, programs and best management practices was developed for potential application in the Tampa Bay region. The library includes technologies and programs identified for preliminary assessment and information relating to cost, end use reduction, and durability, providing a menu of water conservation options expected to result in measurable water savings. Examples of residential end use technologies include toilets, showerheads, faucets, clothes washers, dishwashers and irrigation. Nonresidential end uses generally include those found in the residential sector, but also consist of technologies that can use substantial quantities of water used for cooling, heating and process water including product development (e.g. food service).

Estimates of water savings potential was based on a changing mix of water using technology, as well as the rate (or intensity) at which water using technology was used. Assessment of technology and program based savings potential required base-year (2008) estimates of distribution of fixture age and efficiency in region by sector of water use and market penetration of water efficient technologies. These estimates provide a baseline for examining remaining water efficiency potential over the agency's long-term water demand horizon (2035).

Parcel data provided current estimates of the distribution of fixture age and efficiency in region by sector of water use. In addition, a regional single-family survey was conducted to assist in quantifying prevailing water end uses and behaviors and the remaining potential for efficient technology. Market penetration by passive measures were assumed to be associated with plumbing standards and increased efficiency due to an evolving market (supply and demand) for water efficient products recognized or certified through the U.S. Environmental Protection Agency (EPA) WaterSense label and/or Energy Star programs.

Figure ES.3 illustrates estimated distribution of regional single-family water demands by end use in gallons per capita day for the Tampa Bay region. Table 1 provides estimated average end use flow rates. Based on this assessment, the greatest efficiency potential appears to exist in toilet, clothes washer and dishwasher use, with potential reductions in the 27-33 percent range under current federal standards and in the 33-55 percent range under high efficiency product benchmarks.

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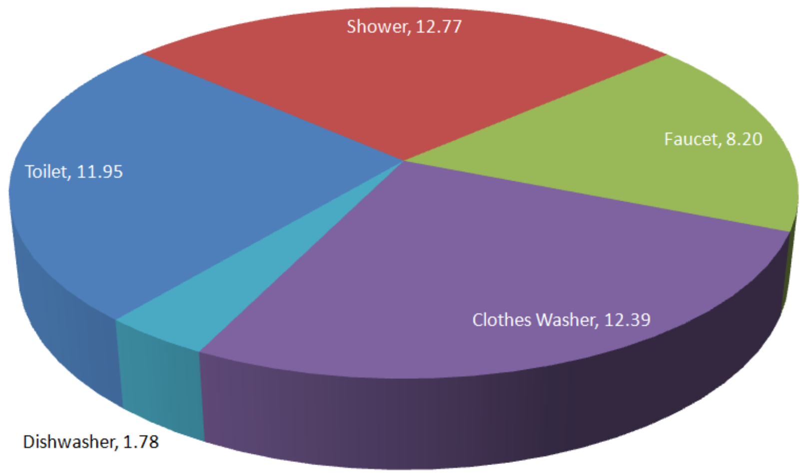

Figure ES.3: Estimated Distribution of Regional Single-Family End Uses of Water in Gallons/Capita/Day

Table ES-1
Estimated Baseline Single-Family Flow Rates, Gallons per Event (2008)

End Use	Tampa Bay Water	Current Standard	High Efficiency	Estimated % Reduction w/Standard Benchmark	Estimated % Reduction w/High Efficiency Benchmark
Toilet	2.39	1.60	1.28	-33%	-46%
Shower	2.10	2.50	2.00	19%	-5%
Faucet	1.01	2.20	1.50	117%	48%
Clothes Washer[1]	33.49	24.62	15.00	-26%	-55%
Dishwasher[2]	8.90	6.50	6.00	-27%	-33%

[1] Current standard based on 9.5 Water Factor, 2.7 cubic feet per load and .96 loads per day
[2] Current standard based on federal dishwasher standard effective January 2010.

ES.5 Evaluation of Water Efficiency Alternatives

Water savings can be realized from either passive or active water use efficiency measures.

- *Passive* water efficiency is achieved through a natural process of replacing old fixtures with new, more efficient fixtures as they wear out or become effectively obsolete or installing efficient water-using fixtures in new construction due to either codes or driven by market changes. Passive water efficiency typically occurs indoors with the replacement of toilets, clothes washers, dishwashers, and urinals.

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- *Active* water efficiency measures include programs designed to expedite the replacement process described above. Such programs are often sponsored by water utilities to ensure a target installation rate and associated water savings and can include outdoor efficiency technologies.

Estimating passive water savings is essential in determining efficacy of active water efficiency programs and for projecting long term water demands. Before the potential benefits of active water efficiency alternatives can be assessed, passive savings must be estimated.

An assessment of remaining passive efficiency potential was used to identify, develop, screen and select technically applicable active alternatives. The WEPL contains the complete listing of available indoor and outdoor measures for new homes, existing homes, and non-residential uses.

ES.5.1 Passive Water Efficiency Evaluation

The U.S. Energy Policy Act (EPAct), effective in 1994, mandated flow standards for many fixtures (e.g., toilets, faucets and showerheads, among others). Since then, manufacturers have introduced and marketed fixtures and appliances, which far exceed EPAct standards, leading to EPA WaterSense and Energy Star programming, which certify and label products meeting consumer expectations while performing at rates lower than current national efficiency standards. These programs influence the market by encouraging consumers to purchase high-efficiency (HE) water products. WaterSense labeled products require independent third-party certification of performance and product durability, insuring product use is consistent with labeling over a defined life. As consumers decide to purchase and install HE water products, water consumption efficiency increases.

The current (2011) Tampa Bay Water baseline demand forecast reflects water use of existing HE products within sectoral per account water use calculations, but does not integrate changes predicted in future product penetration. Accounting for prospective changes in market penetration allows adjustment to the baseline demand forecast reflecting market-based passive demand reductions.

Assumptions about efficiency standards, fixture life, and market penetration of high efficiency products, were used to estimate fixture distributions and water use for each year in the long-term demand forecast. Passive savings were estimated for residential toilets, washing machines and dishwashers as well as non-residential toilets and urinals. Figure ES.4 illustrates the estimated reduction in water demands from passive demand management programs relative to the baseline water demand forecast over the planning horizon. By 2035, approximately 26 MGD of water savings potential is estimated and attributable to passive efficiency.

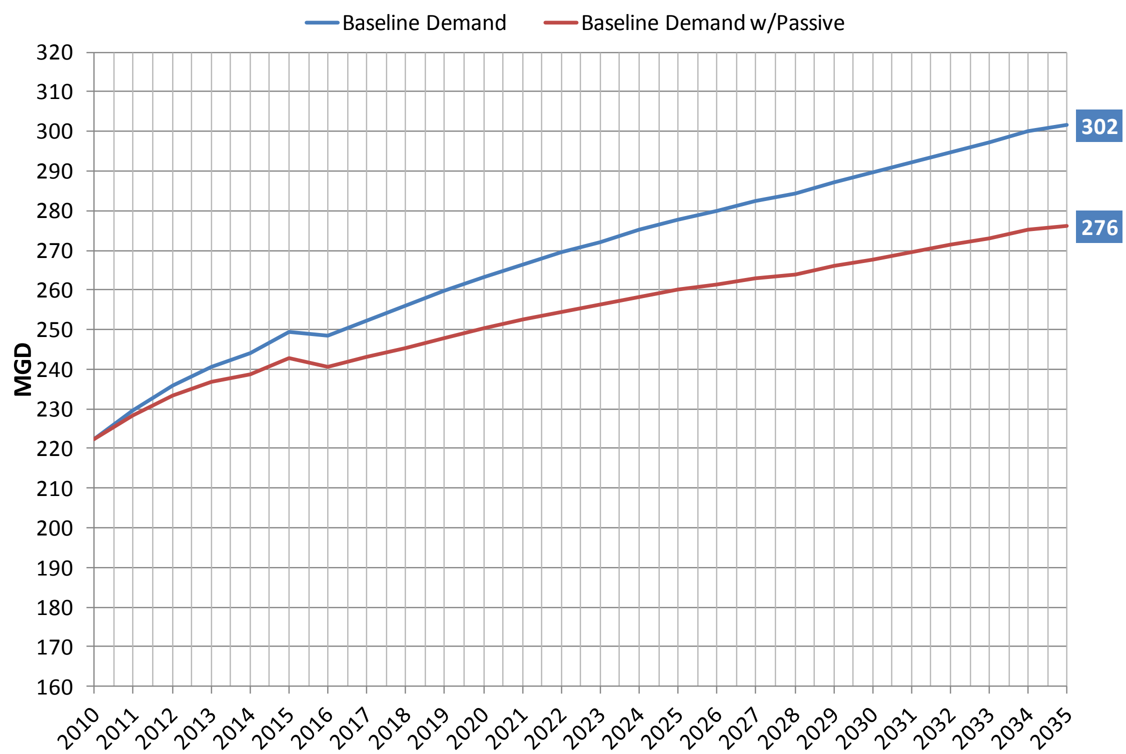

Figure ES.4: Baseline Demand Forecast with Passive Savings

ES.5.2 Active Water Efficiency Alternatives Evaluation

ES.5.2.1 Screening and Selection of Active Efficiency Technologies / Programs

Remaining market potential for water efficient technology (beyond what is likely accounted for by passive measures) was determined through the 2035 demand forecast planning horizon by screening the applicability of several active (utility-sponsored) programs. The screening process included 24 programs / technologies, either applied through existing programs (regionally and nationally), or developed based upon specific application of technologies in specific sectors or water end uses. Regional and national literature and other secondary sources, along with information gleaned from survey and analysis of regional water use characteristics supported the screening process.

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The 10 programs meeting screening criteria and selected for inclusion in the Demand Management Plan portfolio are shown in Table 2. Of the 10 programs, 6 programs are applicable to the nonresidential (NR) sector, 3 to the single-family (SF) sector and 1 to the multi-family (MF) sector. Estimates of gallons saved reflect savings over the life of each measure, which vary depending on measure implementation assumptions, unit savings rates, and useful life of the technology. Programs not meeting this criteria may be cost effective for public use but do not offset future regional variable costs of water.

Estimates of cost-effectiveness were critical for screening, ranking and selection of conservation measures. Evaluation of relative cost-effectiveness of measures required estimation of the unit cost of water saved ($/1000 gallons) for each active measure. Estimated unit costs were compared with unit costs of supply alternatives to evaluate the viability of demand management alternatives. As identified in Table ES-2, the most cost-effective program is cooling tower retrofits at an average cost of $0.07/1000 gallons. The least cost-effective program identified selected is the Conveyor Dishwasher incentive program at an average cost of $0.42/1000 gallons.

Table ES-2
Water Efficiency Measures Meeting Screening Criteria

Activity Name	Class	Utility Costs ($/unit)	Savings, Useful Life (yrs)	Unit Savings, (gpy)	Gallons Saved Over Useful Life	$/1000 gal	BCR
Cooling Tower	NR	$1,000	10	1,386,530	13,865,300	$0.07	8.15
PRSV	NR	$30	10	37,426	374,260	$0.08	5.93
HEU (1/2 Gallon)	NR	$125	30	18,928	567,853	$0.22	1.24
ULFT (Valve-Type)	NR	$125	30	17,970	539,100	$0.23	1.29
Alternative Irrigation Source	SF	$750	25	94,034	2,350,850	$0.32	1.17
HET (Tank-Type)	NR	$125	30	12,843	385,290	$0.32	0.88
Residential HET	SF	$100	25	11,542	288,550	$0.35	1.09
ET/SMS Irrigation Controller	SF	$200	10	56,645	566,450	$0.35	1.82
Residential HET	MF	$75	25	8,111	202,775	$0.37	1.01
Conveyor Dishwasher	NR	$500	20	59,951	1,199,020	$0.42	1.08

ES.5.2.2 Development of Alternative “with Conservation” Demand Forecasts

Estimated impacts of passive water savings and potential active demand management alternatives on the region’s long-term demands were evaluated over the planning horizon. Table ES-3 presents the 2010-2035 reliability-based (75th percentile) baseline water demand projections in five-year increments as compared to the demand projections produced when passive and active demand management programs are considered. Figure ES.5 illustrates the magnitude of estimated water demand reductions from both passive and active savings relative to the 75th percentile baseline demand forecast and current sustainable system capacity. As shown in Table ES-4, by 2035, a total of 37.8 MGD of water use reduction and savings potential was identified. Of this total, 25.5 MGD of water use reduction is associated with the impact of passive changes, while the estimated additional savings from active efficiency is 12.3 MGD.

Table ES-3
Comparison of Demand Projections Scenarios with Passive and Active Savings

Forecast Scenario (75th percentile)	Projected Water Demand (MGD)						Absolute Change	% Change 2008-2035	Average Annual % Change
	2010	2015	2020	2025	2030	2035			
Baseline Demand	222.2	249.3	263.3	277.8	289.7	301.5	79.3	35.7%	1.23%
Passive Savings	222.2	242.8	250.4	260.0	267.8	276.0	53.8	24.2%	0.87%
Passive/Active Savings	222.2	242.4	246.9	252.7	257.8	263.7	41.5	18.7%	0.69%

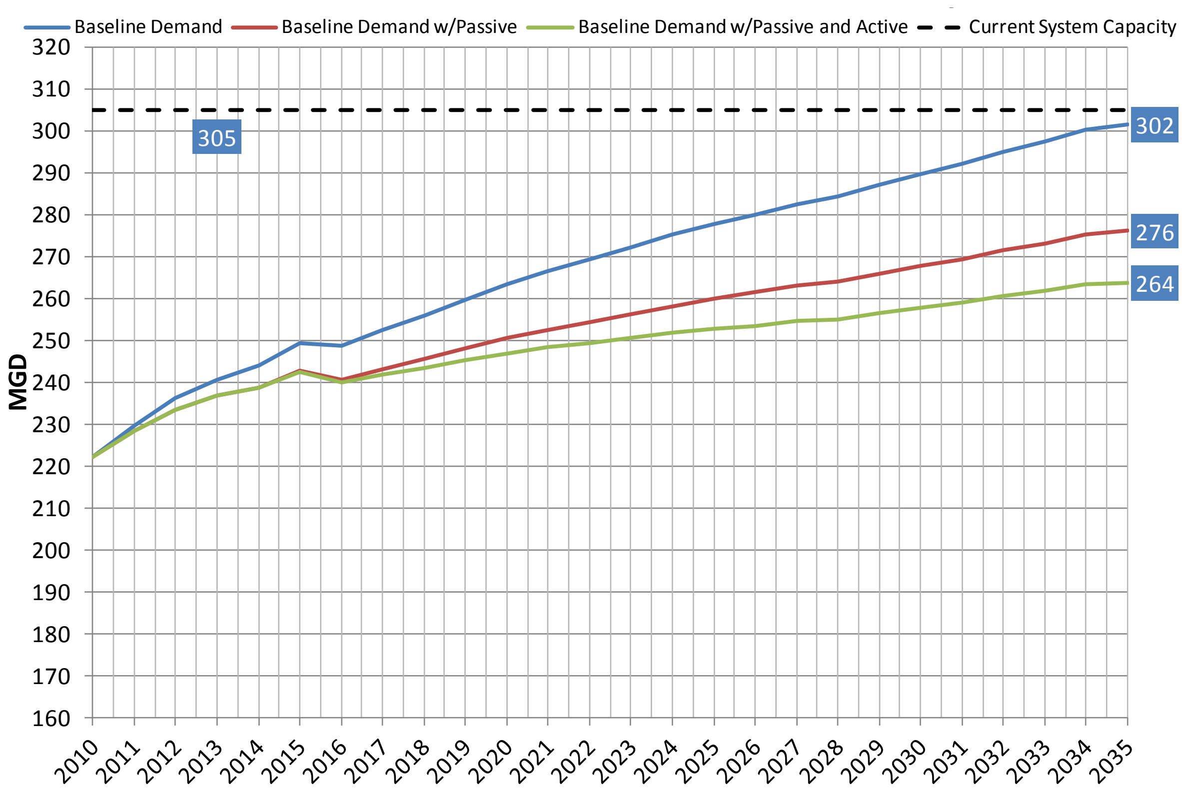

Figure ES.5: Baseline Demand Forecast with Passive and Active Savings

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Table ES-4
Projected Water Savings from Passive and Active Water Conservation

Forecast Scenario (75th percentile)	Projected Water Savings (MGD) / Percent Reduction					
	2010	2015	2020	2025	2030	2035
Passive Savings	0/0	6.6/2.6	12.9/4.9	17.8/6.4	21.9/7.6	25.5/8.5
Active Savings	0/0	0.3/0.1	3.5/1.3	7.3/2.6	10.0/3.5	12.3/4.1
Passive and Active Savings	0/0	6.9/2.8	16.4/6.2	25.1/9.0	31.9/11	37.8/12.5

ES.5.2.3 Avoided Cost Analysis of Alternative Demand Management Strategies

Quantification of supply-side benefits are based on the accrual of avoided costs demonstrates the benefits of proposed efficiency measures and deferral of source development. Avoided costs (or benefits) from water use efficiency generally result from[1]:

- Capital deferral;
- Capital elimination; and
- Reduction in variable cost.

Savings and costs were determined over a 60-year planning horizon (2010-2069) allowing savings rates in this analysis to mature over the life of the technology installed. Net avoided costs of viable demand management alternatives were evaluated over two separate timeframes; the total life of all savings and through the 2035 forecast horizon. When costs and benefits of the portfolio of viable demand management alternatives are evaluated over total life of the savings (through the end of 2065), a net present value of $25.8 million in benefits was identified (as shown in Table ES-5). Given these benefits and costs, the collective portfolio of demand management alternatives has a B/C ratio (benefits / costs) of 1.82. When costs and benefits are evaluated over the much shorter 2035 forecast horizon, the net present value of avoided costs remain positive but is reduced to $8.6 million.

Table ES-5
Net Present Value (NPV) of Avoided Costs

	PV Cost ($M)	PV Benefit ($M)	NPV ($M)	BCR
Life of Savings to 2065	$31.3	$57.1	$25.8	1.82
Life of Savings to 2035	$31.3	$39.9	$8.6	1.28

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[1]*Typically, avoided capital and operating costs from greater water efficiency are also associated with greater environmental benefits, because more water is available to serve ecological purposes. Environmental benefits of greater efficiency were not quantified as part of the Demand Management Plan Update.*

ES.6 Tampa Bay Water Demand Management Plan Directives

As exemplified in Figure 5, incorporation of passive water use efficiency projections into the forecast reduces the demand forecast by 26 mgd in 2035, creating additional regional operational and supply flexibility. Based on this analysis and the need to track passive water use efficiency changes over time, The Tampa Bay Water Board of Directors adopted Board Resolution No. 2013-006 in February 2013 (Appendix Q). This resolution incorporates water use efficiency evaluation efforts into the Agency long-term water supply planning process consistent and in concert with the recommendations of this DMP. This resolution directs the Agency to:

- Develop and implement data collection, management and analysis protocols and procedures for the continued assessment of passive water use efficiency within Tampa Bay Water's service area.
- Integrate passive water-use efficiency into the Agency's Long-term Demand Forecast and Future Need Analysis.
- Include the Water Use Efficiency Evaluation as an element of the Long-term Water Supply Plan and include an updated evaluation of potential active measures for implementing efficient water-use products as part of future options for the next Long-term Water Supply

Incorporation of the effects of increased water-use efficiency into the Agency's long-term planning process provides the Board of Directors with more supply policy options, affords Tampa Bay Water and its member governments a supply buffer (increased water use efficiency reduces demand) and allows Tampa Bay Water to prepare and plan for observed and anticipated changes in water use efficiency. These activities should continue to be supported by the types of analytical methods and strategies described in this DMP, and through deliberate integration of anticipated water savings into ongoing water demand forecasting and supply planning.

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Section 1.0
Introduction

1.1 Background

Tampa Bay Water, a regional wholesale water supplier, helps meet the water demands of more than 2.3 million people among six member government service areas in the tri-county region. Regional water demands amount to over 230 million gallons per day (mgd). Residential demands account for nearly 75 percent of billed water consumption with the remainder associated with the needs of commercial businesses and industry.

Tampa Bay Water's reliance on surface water and other alternative water sources has increased and the value of integrating water use efficiency in managing future long-term supply needs is evident. As new supply development costs continue to increase, avoided costs of water supply becomes a more critical element of the water supply planning process.

The Demand Management Plan (DMP) investigates the benefits and costs of water demand management as a quantifiable, alternative to water supply source development. The DMP is one component of the agency's strategic goals to achieve reliability of its water supply and delivery system to it member governments.

Tampa Bay Water's demand management goals have not been updated since the development of the 1995 Master Water Plan. The 1995 plan identifies appropriate best management practices for achieving the conservation goals adopted by the Board. However, these original goals were developed without a comprehensive assessment of savings potential across the principal water using sectors. Furthermore, several new water efficient technologies have emerged since the 1995 plan and others have matured both in reliability and market coverage. Finally, the adopted goals and estimates of water savings potential lacked direct consideration of the relative economic benefits and costs of demand management activities as an alternative source of water supply.

In December 2008, the Board of Directors approved a resolution directing the agency to prepare a revised DMP as a part of the regional long-term water supply plan. The DMP update consists of a comprehensive investigation of benefits and costs of integrated water demand management as a quantifiable, alternative to conventional water supply sources, reflecting improvements in the state of water use efficiency occurring since 1995 (the first DMP). The update also includes an evaluation of potential demand management projects as a beneficial tool for long-term water supply planning. Results define how water efficiency activities may fit into Tampa Bay Water's long-term water supply

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planning process, which includes supply reliability and member government long range demand projections.

1.2 Goals and Objectives

The primary goal of the DMP is to assess available water efficiency potential and help articulate and validate a long-term water demand management and planning strategy for Tampa Bay Water and its member governments. This goal is accomplished by:

- Explicitly defining demand-side management (DSM) as a beneficial tool for long-term supply planning and how it relates to Tampa Bay Water's long-term planning process, supply reliability and member government demand.
- Measuring the benefits and costs of integrated water demand management as a quantifiable, alternative water supply source.
- Defining how passive or active implementation of demand management activities fits into Tampa Bay Water's long-term water supply planning process.
- Quantifying water savings (past and future) related to improved water use efficiency.
- Comparing costs of conserved water to the cost to operate existing water supply sources and the total cost (capital and operating costs) to develop new water supply.

These activities are supported by the analytical methods and strategies described herein and through integration of anticipated water savings into ongoing water demand forecasting efforts and decisions concerning the timing of additional water supply needs.

1.3 Organization of Report

The DMP includes an analysis of water savings and an assessment of avoided supply costs related to improved water use efficiency. The "avoided supply cost" analysis relates increments of conserved water to changes in (a) costs to operate existing water supply sources and (b) total costs (capital and operating costs) to develop new water supply. Consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water supply alternatives.

The DMP is comprised of six main research components as illustrated in Figure 1-1:

- Section 2: Data Collection and Database Integration
- Section 3: Regional Baseline Water Demand Profile
- Section 4: Analysis of Water Technologies and Baseline Water Use Efficiency
- Section 5: Passive Water Efficiency Evaluation

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- Section 6: Active Water Efficiency Alternatives Evaluation
- Section 7: Summary and Recommended Strategies

The ***Data Collection and Database Integration*** section provides an overview and introduction to the relevant data and processing procedures used to create functional datasets for developing sectoral profiles of water demand and assessing conservation potential within the Tampa Bay Region.

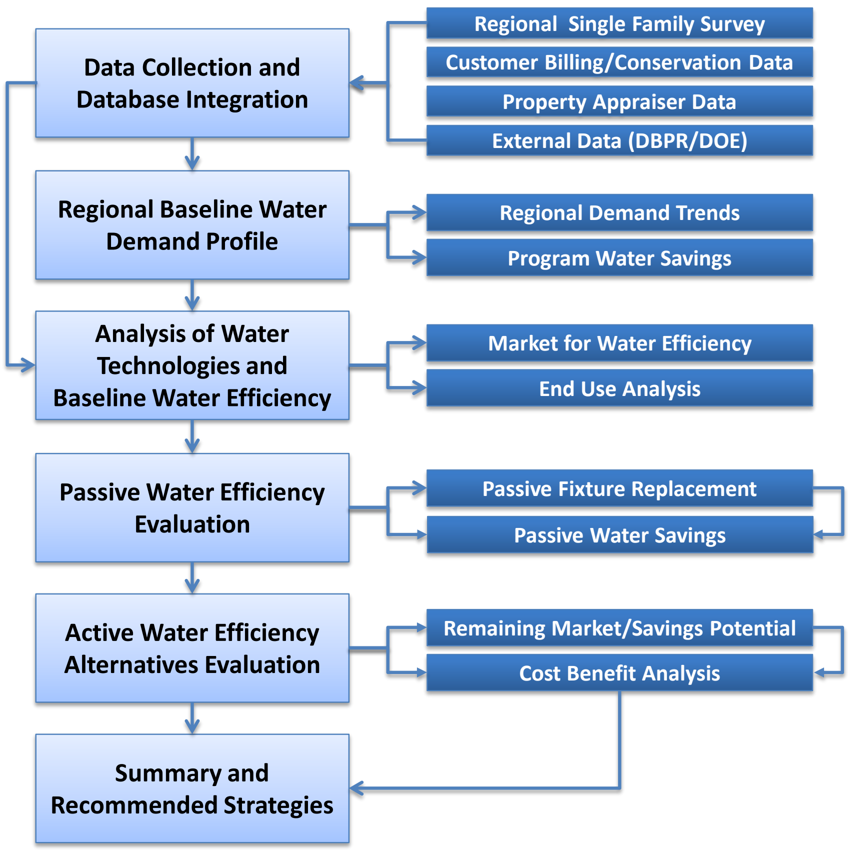

Figure 1-1: Demand Management Plan Overview

The ***Regional Baseline Water Demand Profile*** *quantifies and describes water-using* and economic characteristics of Tampa Bay Water's member government water customers and explores parameters effecting trends and variation in water use across sectors, time and geography. Analyses of water use patterns among the major water using sectors in the Tampa Bay region provide a greater understanding of demand trends and how these trends relate to (or can be affected by) water use efficiency improvements.

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Statistical evaluations of customer samples and survey groups measure and verify impacts of existing conservation programs and develop a more thorough understanding of the market for water efficiency technologies and water savings potential in the Tampa Bay Region.

The ***Analysis of Water Technologies and Baseline Water Use Efficiency*** evaluates the market for water efficiency in terms of the current market saturation and average rate of use of existing water technologies. A regional single-family survey and literature review assist in quantifying prevailing water end uses, consumer behaviors and the remaining market potential for efficient technology. Estimates of prevailing average rates of use by water end use provide the baseline for examining remaining water efficiency potential over the agency's long-term water demand horizon (2035).

The ***Passive Water Efficiency Evaluation*** highlights efficiency standards assumptions, fixture life and market penetration of high efficiency products, which are used to estimate the water-using characteristics of water fixtures for each year contained in the long-term demand forecast. Estimates are then used to assess passive water savings and help define applicability and timing of active (utility-sponsored) programs. Passive water savings estimates are based on changing water-use intensities across time and technology in comparison to baseline efficiency.

The ***Active Water Efficiency Alternatives Evaluation*** assesses remaining market potential for water efficient technology (beyond what is likely accounted for by passive measures) is determined by screening the applicability of several active (utility-sponsored) programs. Regional and national literature and other secondary sources, along with information gleaned from survey and analysis of regional water use characteristics support the screening process. An "avoided supply cost" analysis subjects all demand management alternatives judged to be potentially viable for implementation to economic evaluation. Viability is determined by comparing estimated unit costs of these alternatives to unit costs of supply alternatives. An avoided cost analysis evaluates the cost and timing of identified water supply projects, and estimates the level of demand reductions that would be necessary to eliminate or defer meaningful amounts of capital and operating costs associated new supply projects.

Tampa Bay Water's current baseline demand forecast reflects the water use of products currently in use, but does not account for the expected rate of increase in high-efficiency product market penetration. The ***Summary and Recommended Strategies*** section identifies on-going monitoring and evaluation protocols related to future planning and include a comprehensive assessment of passive efficiency and potential active measures as part of future options and routine updates. Regular monitoring and routine updates to the passive forecast, in conjunction with long term demand forecasting, future need analysis, and long-term water supply plan updates, is critical to reduce associated uncertainties over the water supply planning horizon.

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Section 2.0
Data Collection and Database Integration

The analyses undertaken herein are based on extensive data collection and intensive data processing efforts. Member government customer billing records and parcel information obtained from Hillsborough, Pasco and Pinellas County Property Appraiser's (CPA) are the principal data sources used for water use profiling and assessment of efficiency potential. A single-family survey and various supplemental data from Florida government agencies and literature further support characterization of water use and efficiency. In addition to Florida Department of Revenue (FDOR) property use designations contained in CPA datasets, data from the Florida Department of Business and Professional Regulation (DBPR) and Florida Department of Education (FDOE) are the primary sources of government agency data.

Datasets compiled include variables known to influence water use and provide increased levels of sectoral disaggregation. Most data were compiled in tabular form allowing integration into Microsoft SQL Server databases to support characterization of water use (Figure 2.1). Once integrated, data are simultaneously analyzed to assess baseline water use and the market for water efficiency technologies. Other relevant data obtained through a literature review of available and emerging technologies/programs are stored in an Excel-based water efficiency program library (WEPL).

Integration of geographic property features and other attribute data with water consumption data supports implementation of a diverse assortment of spatial, seasonal and sectoral demand analyses designed to:

- Define water use metrics and profile sectoral water use,
- Verify impacts of existing conservation programs and
- Assess the current and future market for water efficiency technologies.

The following sections provide an overview and introduction to the relevant data and processing procedures used to create functional datasets for developing sectoral profiles of water demand and assessing conservation potential within the Tampa Bay Region. Appendix A fully describes the data requirements and procedures used to develop and integrate DMP databases while Appendix B is the WEPL.

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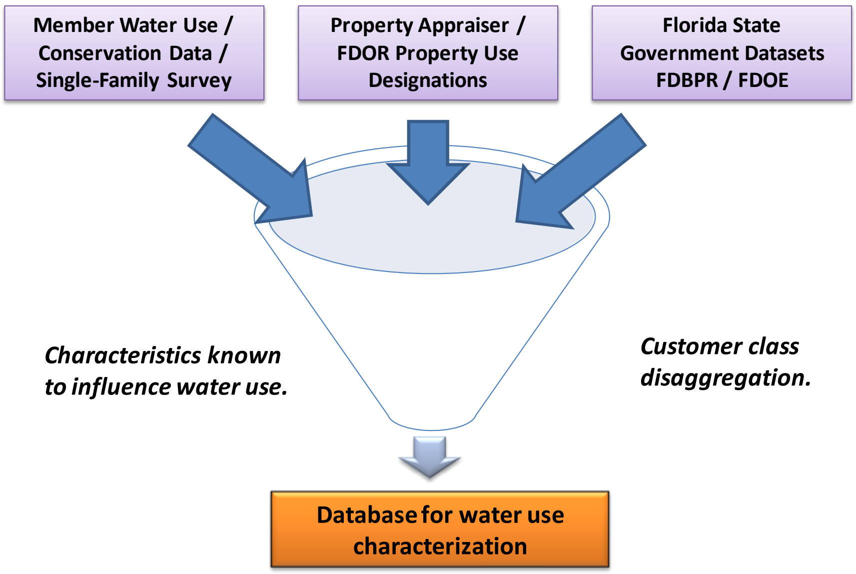

Figure 2.1: Illustration of Integrated Database Components

2.1 Member Government Account, Water Use and Conservation Data

Tampa Bay Water regional water demands are composed of the retail and wholesale needs of its six distinct member governments. Seven water demand planning areas (WDPAs) are defined to capture spatially distinct geographic sub-areas. Figure 2.2 illustrates the geographic areas currently served by Tampa Bay Water member governments:

- Pasco County
- New Port Richey
- Northwest Hillsborough County
- South Central Hillsborough County
- City of Tampa
- Pinellas County
- St. Petersburg

Tampa Bay Water regularly collects and processes monthly water billing and conservation program data from its member governments. Water use records are categorized according to three distinct classes of predominant use as defined by Tampa Bay Water, including single-family, multifamily and nonresidential customer classifications. Monthly customer billing data used in DMP analyses cover Water Years 2002-2008.

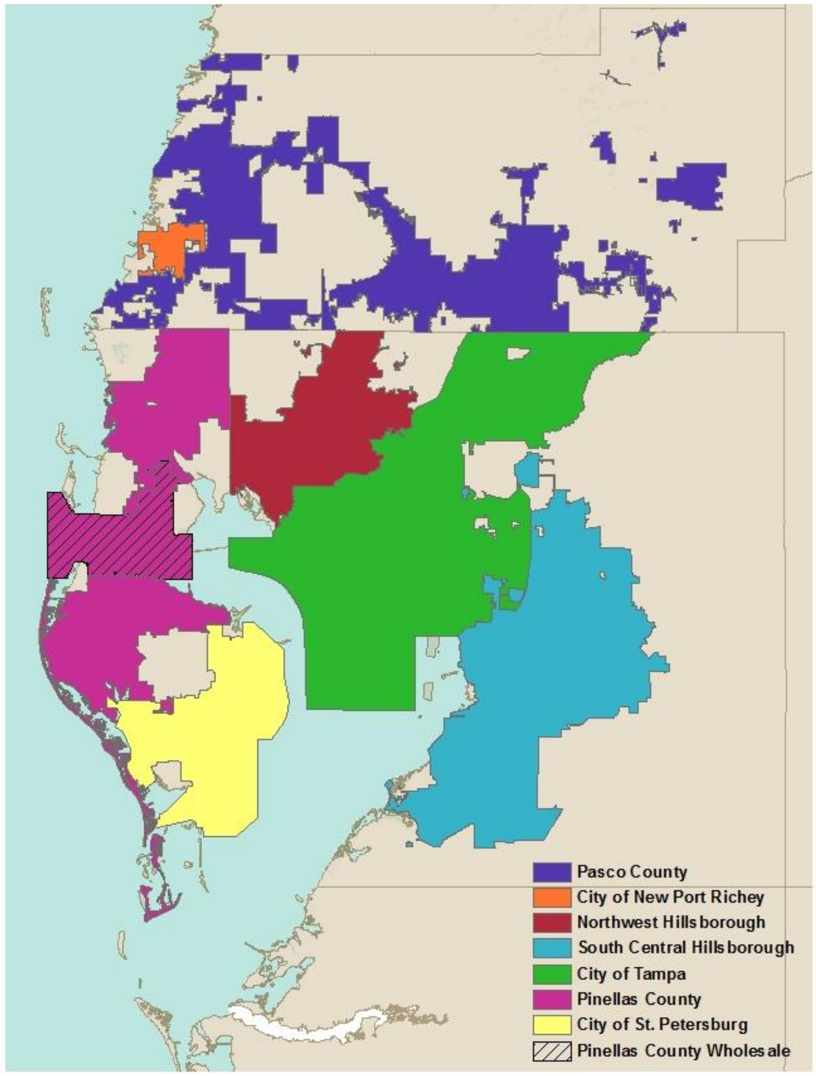

Figure 2.2: Tampa Bay Water WDPA's

2.2 County Property Appraiser Parcel Data

Association of property characteristics with customer water use permits the development of various attributes for individual customers. Specifically, three types of CPA data files are used in DMP analyses:

- Parcel layers (i.e. shapefiles)
- Name, address, legal (NAL)
- Master appraisal file (MAF)

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Parcel layers and NAL data files contain a number of property attributes aggregated to a parcel level including residential units, year built, building area and predominant FDOR property use designations. Parcel layer shapefiles provide geographic reference points used to relate property attributes such to utility customers and water use data through matching physical water meter locations to parcels—a process known as geocoding.

MAF data provides an even greater number of parcel attributes at a finer resolution than parcel and NAL data files. Unlike the parcel level files, MAF data includes information such as the number of individual units within condominium-type building and the number of bathrooms and/or fixtures in a structure. Data required to derive building and green area footprints and to identify the presence of extra features on the property (such as pools or detached structures) are also available.

FDOR requires the use of a standard 2-digit economic coding system to classify parcels, however, interpretation and application of this system tends to vary considerably across county jurisdictions. In addition to the requisite 2-digit code, CPAs have the option to maintain 4-digit property use codes where the first two digits represent the FDOR property designation and the last two digits represent a finer resolution designation. Inconsistencies in the 4-digit property use designations of Hillsborough, Pasco, and Pinellas counties were evaluated and overcome by qualitatively defining and standardizing according to a three-tier hierarchy:

- Super Sector
- Sector
- Sector Type

The three tiers provide a single customer classification system for all three counties. This process enables consistent classification of 8 Super Sectors, 33 Sectors, and 90 Sector Types as listed in Table 2-1. These standardized FDOR-based customer classifications are mapped to parcels through property use codes. A complete mapping of Super Sector, Sector, and Sectors to Hillsborough, Pasco, and Pinellas counties 4-digit property use codes is provided in Appendix C.

2.3 Tampa Bay Water Regional Single-Family Survey

A regional single-family survey was conducted to assist in quantifying prevailing water end uses and behaviors and the remaining potential for efficient technology. The results of the survey assist in identifying the relative presence of water efficient technologies and other information needed for development of savings estimates for existing efficiency measures.

Table 2-1
Standardized FDOR-Based Customer Classification System

Super Sector	Sector	Sector Type
Single Family	Single Family	Single-family home
Multifamily	Multifamily	Mobile home
		RV Park
		more than 10 units
		less than 10 units
		Condo
		Townhouse
		Cooperative
Commercial	Convenience Store	Convenience Store
	Grocer/Food Store	Grocer/Food Store
	Retail Stores	Retail
		Department
		Shopping Centers
	Office Buildings	1 story
		MULTISTORY
		Finance/Insurance
	Restaurants and Fast Food Outlets	Full Service
		Fast Food
	Hotels, motels	Full Service
		Limited Service
		Extended Stay
		Full/Limited/Extended
	Entertainment	THEATER - Enclosed
		THEATER - Drive in
		NIGHT CLUBS
		Bowling Alley/Skating Rink/Arena
		Attraction/Exhibit
		Race Tracks
		Camp
	Service shops	Electrical, Laundry & Dry Cleaner
	Auto Service and Repair Shops	Service (Gas) Station
		Sales/Repair
	Vehicle Wash	Full Service
		Self Service
	Florist/Greenhouses	Florist, Greenhouses, Wholesale
		Florist, Greenhouses, Retail
	Golf	Golf Regulation
		Golf Practice
	Warehouse/Transportation	Warehouse/Truck Terminal
		Mini Storage
		Warehouse/Office
		Open Storage
		Airport/Bus Passenger Terminal
		Marine Passenger Terminal
	Mixed Use Commercial	Store and office or store and residential or residential combination
	HOA	HOA SF

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Table 2-1
Standardized FDOR-Based Customer Classification System

Super Sector	Sector	Sector Type
		HOA Condo
		HOA Townhouse
		HOA Commercial
	Parking	Parking Lot
Industrial	Light Manufacturing	Small equipment manufacturing plants, small machine shops, instrument manufacturing printing plants
	Heavy Manufacturing	Heavy equipment manufacturing, large machine shops, foundries, steel fabricating plants, auto or aircraft plants
		Lumber Yards
		Packing Plants
		Bottler/Cannery
		FOOD PROCESSING
		Mineral Processing
Institutional	Churches	Churches
	Education	Private Schools
		Public Schools
		Public Colleges
	Retirement	Independent/Assisted Living
	Health Care	Hospitals
		Nursing/Rest Homes
		Medical Services
	Non-profit services	Orphanages
		Charitable Services
	Mortuaries, cemeteries, crematoriums	Mortuaries, cemeteries, crematoriums
	Parks and Recreation	Parks and Recreation
	Fitness and Leisure	FITNESS CENTER
		Country Clubs
		Clubs/Lodges/Union Halls
		Cultural
		Professional Sports Facilities
	Government	County
		State
		Federal
		Municipal
		Military
Agriculture	Crops	Crops
		Timber
		Grazing
		Orchards
	Livestock	Poultry/Livestock
Miscellaneous	Miscellaneous	Miscellaneous
Vacant	Vacant	Vacant Residential
		Vacant Commercial
		Vacant Industrial
		Vacant Institutional

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The survey was designed to gather information on five general topics:

- Participation in past programs
- Willingness to participate in future programs
- Indoor water fixtures and appliances
- Outdoor water fixtures and practices
- Socioeconomic characteristics

A 45 question survey instrument was designed and used to conduct 1,205 head of household phone interviews between November 8, 2009 and November 23, 2009.[1] Table 2-2 provides the number of phone interviews conducted for each member government.

Table 2-2
Tampa Bay Water Single-Family Survey Samples

Member Government	Samples
Pasco County	195
City of New Port Richey	171
Hillsborough County	229
City of Tampa	204
Pinellas County	218
City of St. Petersburg	188
Tampa Bay Water	**1205**

A random sampling of single-family households from Tampa Bay Water's member government water consumption database ensured linkage was maintained among survey results, water use records and parcel data. The survey was implemented through the Florida Center for Community Design and Research (FCCDR) at the University of South Florida. Phone numbers for sampled customers were obtained through Possible Now Data Services and provided to the FCCDR to conduct phone interviews. Surveys were conducted in both English and Spanish. The survey report prepared by FCCDR is provided in Appendix D.

2.4 Florida Department of Business and Professional Regulation

Business license data from the Florida Department of Business and Professional Regulation (DBPR) provide number of hotel rooms[2] in public lodging establishments and number of seats in public food service establishments. These data support the develop-

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[1] *Member sample sizes were defined and are sufficient to yield a sampling response error rate of ±5% based on the single-family population size within each service area (per U.S. Census 2008 ACS update).*
[2] *http://www.myfloridalicense.com/dbpr/sto/file_download/public-records-lodging.html*

ment of water use metrics (water use per room and water use per seat) to benchmark and compare hotel and restaurant water use as described in the regional baseline demand profile (Section 3). DBPR data are also used to estimate and measure the intensity of water end uses such as fixture and commercial dishwasher water use. Inclusion of property addresses in the DBPR datasets permits hotel and restaurant establishments to be geocoded to parcel records and member government customer water use.

2.5 Florida Department of Education

Student and teacher populations for all public and private schools in the Tampa Bay region were obtained from Florida Department of Education (DOE)[3]. These data supported development of water use per student metrics to benchmark and compare school water use. DOE data are also used to estimate and measure the intensity of fixture (e.g. toilet) end use. Similar to DBPR data, the DOE datasets also provides a physical address allowing geocoding of public and private school data to parcel attributes and water use.

2.6 Literature Review

Through a literature review of available and emerging technologies/programs, a WEPL (Appendix B) of technically-applicable demand management technologies, programs and best management practices was developed for potential application in new homes, existing homes, and nonresidential establishments in the Tampa Bay region. The WEPL includes technologies and programs identified for preliminary assessment and information relating to cost, end use reduction, and durability, providing a menu of water conservation options expected to result in measurable water savings.

The primary sources of literature for the library include:

- Alliance for Water Efficiency,
- AWWARF Residential and Nonresidential End Uses of Water Studies
- California Urban Water Conservation Council,
- Conserve Florida,
- Consortium for Energy Efficiency,
- East Bay Municipal Utility Development District, CII Guide
- U.S. Environmental Protection Agency, WaterSense Program
- U.S. Department of Energy, Energy Star Program
- Food Service Technology Center
- Tampa Bay Water Best Management Practices
- University of Florida Research

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[3] *http://www.fldoehub.org/Facilities/Pages/NumofStudentStationsbySchool.aspx*

Each item in the library is categorized according to water end use. Examples of residential end use technologies include toilets, showerheads, faucets, clothes washers, dishwashers and irrigation. Nonresidential end uses generally include those in the residential customer class, but also consist of technologies that can use substantial quantities of water used for cooling, heating and process water including product development (e.g. food service).

2.7 Integration of Data Sources

Water use profiling and potential savings analyses rely greatly on the accuracy of water consumption records and the ability to relate this information to external sources of supplemental data. This relationship supports investigations of the underlying causes for variation in demand. External data sources offer valuable property and socioeconomic characteristics known to influence water use. Once matched, customer water use and supplemental attributes can be simultaneously analyzed to characterize water use patterns and trends and identify water efficiency potential.

Parcel layer shapefiles spatially describe parcel geometries in the form of points and polygons providing geographic reference points for association of data from multiple sources. Since water consumption records and supplemental data do not typically exist at the same geographical level in their original form and often lack a common variable to relate data, parcel shapefiles provide a critical link among the data. As such, the data processing requirements developed for the DMP utilizes parcels as the fundamental geographic unit to which all data is processed. Account-to-parcel relationships formed through a physical street address and various processing procedures establish a geographic reference for utility records. This enables water use and other data associated with a physical address to be spatially manipulated and mapped to parcels.

There were a number of practical difficulties in the process of matching utility water data to other information according to a common geographic unit that required a significant amount of resources to remedy. Data collection and processing efforts revealed several critical issues associated with integrating member utility billing records and property appraiser data. Three key difficulties and their resolution include:

- ***Standardization of variable formats*** in member government billing and CPA parcel data to optimize dataset matching
- ***Definition and creation of unique location identifier's*** for grouping account-level billing and parcel-level CPA data to a single common customer, or location-level
- ***Generation of water use profiling and end-use modeling datasets*** through development and implementation of integration procedures

Through implementation of various data processes, data are linked together to provide an extensive amount of explanatory information to support analytical assessments of baseline water use patterns and trends, which forms the basis for evaluating the market for water efficient technology and potential impacts of consumer behaviors and market trends. The following sections describe the processes developed to resolve the difficulties identified.

2.7.1 Standardization and Geocoding of Member Government Billing Data

As previously mentioned, parcels are the primary geographic unit used in data processing. The availability of a physical address as a common variable to relate datasets to a parcel was a key determinant in selecting datasets for use in DMP analyses. Address geocoding is the process of finding geographic referencing points or coordinates (i.e. latitude and longitude) from associated street addresses. This task is typically accomplished by passing data files through online geocoding engines. Since CPA parcel layers characterize parcels in terms of spatial features and addresses, geographic association of utility water use and supplemental data to a parcel can be established through two methods:

- ***Spatial Intersection*** of the geographic coordinates (points) obtained through address geocoding with GIS shapefiles (polygons).
- ***Address matching*** of data records through address comparison in a database environment. The format of addresses in each file being compared must be identical for successful implementation. Although it is uncommon for addresses from different sources to be stored in a truly identical format, most geocoding engines also parse, cleanse and standardize each address record passed at no additional cost.

Extensive data cleansing procedures were employed to prepare data for geographic association. Critical issues associated with inconsistencies in member government account identifiers (Customer ID, Location ID) and address formats were corrected to ensure proper indexing of water consumption records over the entire period of record available. Following the standardization of time-indexed variables, all datasets addresses were further cleansed, standardized and geocoded in a Google geocoding engine to enhance match performance. Table 2-3 provides an example of address formatting inconsistencies found in billing data and parcel data and how cleansing results in standardized formats required for attaining a match.

Utility billing records typically use a system of identifying water customers and meters through the assignment of Customer ID's (CID) and Location ID's (LID) respectively. Collectively, these identifiers form a utility account. LIDs correspond to a physical a point of service (meter/address) and thus provide the geographic connection used to relate water use to parcels.

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Table 2-3
Example of Address Cleansing Enhancement

Attribute	Billing Data	Property Appraiser
Original Format	2599 W Bay Isle Dr	2599 West Bay Isle Dr
Standardized Format	2599 West Bay Isle Dr	2599 West Bay Isle Dr

Geographic association relies on the implementation of three separate assignment methods to maximize matching. Given the potential for coordinate errors in interpolated geocoding, procedures employed for DMP processing prioritize address matching. Geographic coordinates available for unmatched water meters were then spatially intersected with property appraiser parcel layer. In cases where address matching and spatial intersection did not result in a match, results of prior geocoding efforts were used to fill in missing values.

Table 2-4 summarizes the results of water meter geocoding and assignment methods by WPDA. Of the 603,651 meters identified regionally, more than 97 percent have parcel assignments within the correct member's defined service area as a result of the DMP geocoding update. This level of geocoding varies by WDPA, ranging from 93.1 percent in New Port Richey to 99.4 percent in Northwest Hillsborough and should be considered the minimum level of acceptable matching in future efforts.

Altogether, address matching accounts for an overwhelming majority (92 percent) of parcel assignments. The WDPA's with the lowest relative proportion of success with this method are New Port Richey at 88% percent and City of Tampa at 91%. Accordingly, these WDPA also have the highest proportion of spatial intersection assignments.

Table 2-4
Summary of Water Meter Geocoding by WPDA

				Geocoded Meters by Assignment Method					
		Meters Geocoded	% Meters	Address Matching		Spatial Intersection		Prior Assignment	
WDPA	Meters	to PIN	Geocoded	Meters	%	Meters	%	Meters	%
PAS	102,571	97,008	94.6%	90,290	93.1%	2,411	2.5%	2,155	2.2%
NPR	10,428	9,706	93.1%	8,571	88.3%	991	10.2%	144	1.5%
NWH	51,111	50,803	99.4%	47,671	93.8%	2,199	4.3%	891	1.8%
SCH	95,151	94,183	99.0%	85,806	91.1%	5,346	5.7%	2,926	3.1%
COT	134,956	126,252	93.6%	114,782	90.9%	11,470	9.1%	0	0.0%
PIN	114,092	113,880	99.8%	103,093	90.5%	2,739	2.4%	8,048	7.1%
STP	95,342	93,815	98.4%	87,613	93.4%	1,245	1.3%	4,957	5.3%
TBW	**603,651**	**585,647**	**97.0%**	**537,826**	**91.8%**	**26,401**	**4.5%**	**19,121**	**3.3%**

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2.7.2 Distinct Water Use Locations

Water use profiling employs the use of water use metrics and customer characteristics to assess variation in water use. Metrics measure the rate of water use and are developed using a unit measurement that can be matched to observed water use. Some examples of common rate of use metrics include water use per account per day, water use per location per day, water use per square foot per day. In some cases, specific values or thresholds of a given metric can be used to establish benchmarks and various other performance measures.

The reliability of any water use metric is heavily dependent on the quality and correspondence of data used to define the unit of measure. Accurately compiling water use and property data to a single common geographic level is a critical factor in ensuring metric reliability. The most common and lowest geographical unit in water use and property records is a parcel wherein a one-to-one relationship between a water meter and parcel exists. However, it is not uncommon for a utility customer to have one or more water meters serving one or more parcels. Thus, one-to-many and many-to-many associations frequently exist in water meter and parcel relationships, particularly in the multifamily and nonresidential customer classes. These cases can generally be characterized by four possible scenarios:

- A single meter to a single parcel (SF, MF and NR)
- A single meter matched to multiple parcels (MF and NR)
- Multiple meters matched to a single parcel (MF and NR)
- Multiple meters matched to multiple parcels (MF and NR)

Figure 2-3 illustrates the account-to-parcel relationship for an example multifamily customer with two parcels and one utility account. Using traditional approaches of address matching or geocoding, account water use is aligned with a single PIN (Parcel 1). Due to the lack of a common identifier, the relationship between the utility account and Parcel 2 remains undetected.

If overlooked, one-to-many and many-to-many account-to-parcel relationships can cause incomplete or duplicate information to be used in the development of water use metrics. For example, Table 2-5 compares the rate of use and other variables values with and without multiple parcel definition for the property illustrated in Figure 2.3 when the second parcel is not considered. Because only half of the units consuming water on the utility account are considered when the second parcel is excluded, the average water use per unit for this property is overestimated at two times the actual rate use.

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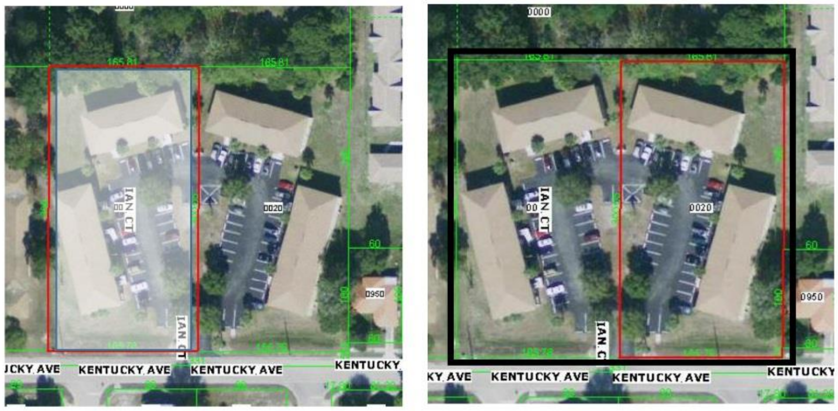

Attribute	Utility Account	Parcel 1	Parcel 2
PIN	16260400100040000**10**	16260400100040000**10**	16260400100040000**20**
Address	**6901 IAN CT 13**	**6901 IAN CT 13**	**6921 IAN CT 11**
Units	18	18	18
Neighborhood	NA	5MF113A	5MF113A
Value	NA	543,310	541,837
Heated Area (sq ft)	NA	19,460	19,460
Land Area (sq ft)	NA	49,721	49,731

Figure 2.3: Illustration of One-to-Many Account-Parcel Relationship

Table 2-5
One-to-Many Account-Parcel Attributes With and Without Multiple Parcel Definition

Attribute	One Parcel	Two Parcels
PIN	1626040010004000010	1626040010004000010 1626040010004000020
Units	18	36
Consumption (gpd)	40,750	40,750
Gallons per Unit per Day	260	130
Building Area (sq ft)	19,460	38,920
Land Area (sq ft)	49,721	99,452
Property Value	543,310	1,085,147

To meet the project goal of accurately portraying consistent water usage metrics, the process of aggregation allows groups of records, such as water use and parcel attributes, to be combined together on certain common criteria to form a single geographical unit, or distinct water use location.

Distinct water use locations serve as the geographic unit for detailed customer-level water profiling analyses. This approach consists of developing a new level of aggregation that defines groups of parcels and water use accounts using grouping criteria. The groups defined by these criteria are termed distinct water use locations and the indices for these locations are termed unique identifiers (UIDs). Definition of distinct locations ensures no water use and parcel data within any individual location are inadvertently duplicated or omitted, thereby:

- aligning water use and property characteristics at the location level,
- accurately portraying the attributes associated with a given quantity of water use
- providing greater accuracy in rate of use estimates
- allowing meaningful inferences of water use behavior with less data error

The primary impediment to this process is that water use and property attributes associated with an individual customer or location are typically maintained by different agencies at different geographic levels of aggregation (e.g. customer account vs. parcel) and typically lack a common identifier or instrument to match parcels and water use in a one-to-one fashion. For example, CPA records identify parcels through parcel identification numbers (PIN) while utility billing records track water use through meter numbers (as previously discussed).

2.7.2.1 Summary of Distinct Locations

Table 2-6 summarizes the number of UIDs created by WDPA from grouping water meters and parcels for each of the four associations previously described. Regionally, there are 8 percent (532,238) fewer distinct water use locations than geocoded meters (581,290). The total number of geocoded meters provided in Table 2-7 is slightly lower than provided in Table 2-5 as geocoded meters missing parcel data, required to define grouping criteria for the UIDs assignment process (e.g. parcels missing FDOR designations), were omitted from DMP analyses. Although the vast majority (97%) of regional UIDs meter-parcel relationships are one-to-one (single-meter, single-PIN), consideration of one-to-many and many-to-many relationships provided a 20 percent increase (% change) in total parcels supporting DMP analyses.

Table 2-7 summarizes the number of UIDs by super sector. Sectorally, UID assignment has the greatest effect on multifamily and nonresidential data accuracy and completeness. While the single-family super sector comprises 91 percent of all UIDs and is predominantly characterized by one-to-one meter-parcel relationships (98%), the multifamily super sector experienced a 253 percent increase in matched parcels (UID PIN) when multiple relationships are considered. While the multifamily and nonresidential (commercial, institutional and industrial super sectors) classes each account for less than 3 percent of total UIDs, 20 to 30 percent of the UIDs in these classes are characterized as distinct locations with multiple meter-parcel relationships, demonstrating the deficiency

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of the traditional one-to-one relationships used to match property characteristics with water use.

The database framework and data described herein were used to develop functional datasets for developing profiles of customer class water demand and assessing conservation potential within the Tampa Bay Region. The supplemental data sources described provide invaluable property and socioeconomic characteristics known to influence water and support investigations of the underlying causes for variation in demand. Appendix A details the data and procedures used in the development of DMP databases.

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Table 2-6
Summary Parcels and Meters Associated with Distinct Water Use Locations by WDPA

	Geocoded Meters				PIN			Single Meter, Single PIN			Multiple Meter, Single PIN			Single Meter, Multiple PIN			Multiple Meter, Multiple PIN		
WDPA	UID	Meter w/UID	% of Total	% Change	UID PIN	Meter PIN	% Change	UID	% of Total	% of WDPA	UID	% of Total	% of WDPA	UID	% of Total	% of WDPA	UID	% of Total	% of WDPA
PAS	84,694	96,815	15.9%	-13%	96,520	92,339	5%	81,351	15.8%	96.1%	3,025	23.3%	3.6%	86	3.9%	0.1%	232	9.6%	0.3%
NPR	7,897	9,703	1.5%	-19%	10,150	8,770	16%	7,453	1.4%	94.4%	359	2.8%	4.5%	31	1.4%	0.4%	54	2.2%	0.7%
NWH	46,011	50,743	8.6%	-9%	56,398	49,650	14%	45,302	8.8%	98.5%	460	3.6%	1.0%	107	4.9%	0.2%	142	5.9%	0.3%
SCH	90,165	93,979	16.9%	-4%	99,078	92,182	7%	88,655	17.2%	98.3%	1,100	8.5%	1.2%	242	11.0%	0.3%	168	6.9%	0.2%
COT	118,314	125,385	22.2%	-6%	139,405	122,313	14%	115,080	22.4%	97.3%	1,785	13.8%	1.5%	738	33.5%	0.6%	711	29.4%	0.6%
PIN	98,460	112,079	18.5%	-12%	158,086	104,019	52%	93,401	18.1%	94.9%	3,614	27.9%	3.7%	733	33.3%	0.7%	712	29.4%	0.7%
STP	86,697	92,586	16.3%	-6%	110,578	87,720	26%	83,416	16.2%	96.2%	2,613	20.2%	3.0%	267	12.1%	0.3%	401	16.6%	0.5%
TBW	532,238	581,290	100%	-8%	670,215	556,993	20%	514,658	100%	96.7%	12,956	100%	2.4%	2,204	100%	0.4%	2,420	100%	0.5%

Table 2-7
Summary Parcels and Meters Associated with Distinct Water Use Locations by Super Sector

	Geocoded Meters				PIN			Single Meter, Single PIN			Multiple Meter, Single PIN			Single Meter, Multiple PIN			Multiple Meter, Multiple PIN		
WDPA	UID	Meter w/UID	% of Total	% Change	UID PIN	Meter PIN	% Change	UID	% of Total	% of Sector	UID	% of Total	% of Sector	UID	% of Total	% of Sector	UID	% of Total	% of Sector
Single Family	484,571	496,270	91.0%	-2%	494,962	489,873	1%	479,142	93.1%	98.9%	5,092	39.3%	1.1%	142	6.4%	0.0%	195	8.1%	0.0%
Multifamily	21,500	49,066	4.0%	-56%	141,089	39,973	253%	15,027	2.9%	69.9%	4,165	32.1%	19.4%	1,027	46.6%	4.8%	1,281	53.0%	6.0%
Commercial	16,312	22,691	3.1%	-28%	19,868	16,803	18%	13,037	2.5%	79.9%	2,404	18.6%	14.7%	410	18.6%	2.5%	461	19.1%	2.8%
Institutional	5,839	7,988	1.1%	-27%	6,814	6,010	13%	4,516	0.9%	77.3%	936	7.2%	16.0%	190	8.6%	3.3%	197	8.1%	3.4%
Industrial	1,050	1,422	0.2%	-26%	1,324	1,139	16%	804	0.2%	76.6%	136	1.0%	13.0%	29	1.3%	2.8%	81	3.3%	7.7%
Misc/Other	2,966	3,852	0.6%	-23%	6,158	3,195	93%	2,132	0.4%	71.9%	223	1.7%	7.5%	407	18.5%	13.7%	204	8.4%	6.9%
Total	532,238	581,289	100%	-8%	670,215	556,993	20%	514,658	100%	96.7%	12,956	100%	2.4%	2,205	100%	0.4%	2,419	100%	0.5%

Note: Other includes FDOR code classified as Agricultural, Miscellaneous, Vacant and Unassigned.

TAMPA BAY WATER
Supplying Water To The Region

Section 3.0
Regional Baseline Water Demand Profile

A demand profile reveals how and why water use varies between customers and quantitatively identifies efficiency measures for specific end uses that, if promoted in a demand management plan and adopted for implementation, can yield significant, cost-effective, and generally worthwhile demand reductions for improving regional supply reliability. Demand profiling is intended to provide a greater understanding of demand trends for individual customers of various types and how these trends relate to or can be affected by improvements in water using efficiency. Profiles provide information such as:

- The number and types of water users and water use locations existing in a defined geographic area (single-family houses, various types of multifamily dwellings and complexes, various types of businesses, institutions, and industries). Single-family (SF), multifamily (MF), and nonresidential (NR) location types are called *water use classifications.* Demand across these three customer classifications reflects total retail sales of Tampa Bay Water member governments.
- Water use related locational characteristics (e.g. amount of green space, amount of covered space, property value, price of water, presence of pools, irrigation systems, and cooling towers, number of seats in restaurants and rooms in hotels)
- Historical regional water use statistics and forecasted regional use (and geographic and customer class breakdowns of these uses)
- Distribution of historical water use across individual locations in each customer class
- The sensitivity of historical water use in each customer class and at individual locations to weather and seasons, and estimates of water used for indoor versus outdoor purposes
- Presence and prevalence of specific end-uses within customer classes and at individual locations (e.g. irrigation, cooling towers, indoor sanitation, food preparation, pool filling)
- Presence and prevalence of water use technologies within customer classes and at individual locations (e.g. low- and high-efficiency toilets and appliances, various forms of irrigation)
- Descriptions and analyses of existing and historical demand management efforts

All of this information is used to evaluate efficiency measures that may provide cost-effective reductions in water use regionally and specifically in customer class use.

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This section presents the regional baseline water demand profile for Tampa Bay Water's existing member government customers. The regional profile consists of three individual profiles of single-family, multifamily, and nonresidential customer classes. The profile does not address wholesale or unbilled demand as this data is not available within the member government billing data.

Section 3.1, ***Regional Water Use Patterns and Trends,*** provides historical and forecasted total retail demand by Water Demand Planning Area (WDPA) and customer class. These results show that customer class composition of demand varies significantly between WDPAs; single-family demand is predominant in all WDPAs, but proportions of multifamily and nonresidential demand vary widely between WDPAs.

Section 3.2, ***Single-Family Demand Profile,*** contains a demand profile of the single-family customer class. In this profile, analyses drill down from regional demand trends to presence and efficiency of water use at individual locations, illustrating how new and continued management efforts might further impact single-family demand. Historical single-family demand trends are analyzed for water use per location and per capita. Seasonal trends in mean single-family demand and demand distributions are developed and minimum-month approaches are used to estimate weather-sensitive and weather-insensitive use for the customer class as a whole and for individual single-family locations. Assuming the majority of weather-sensitive use is outdoor, relationships are developed between individual-location outdoor use, presence of specific outdoor end uses, efficiency levels for those technologies, and participation in demand management programs, including

- Ultra Low-Flow Toilet (ULFT) Rebate programs,
- Florida-Friendly Landscape (FFL) programs, and
- Irrigation System Evaluation (ISE) programs.

Data for end use presence, efficiency levels, and program participation are obtained from parcel data and from direct surveys of single-family customers. These relationships identify the potential effectiveness and counter-effectiveness of outdoor use technologies and programs. Additional analyses focus on relationships between demand and other characteristics, such as age of home, property value, price of water, number of bathrooms, and presence of various types of indoor water use appliances.

Section 3.3, ***Multifamily Demand Profile,*** contains a demand profile of the multifamily customer class. Historical multifamily demand trends were analyzed by water use per location. Seasonal trends in mean multifamily demand and demand distributions are developed, and minimum-month approaches are used to estimate weather-sensitive and weather-insensitive use for the for the customer class as a whole and for individual cus-

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tomer class locations. These results reveal weather-sensitive demand is a much smaller component of total demand in the multifamily customer class than in the single-family class.

Locations in the multifamily sector have more diverse characteristics than the single-family sector. The variability within this water use classification includes large apartment complexes with large landscapes and apartment complexes with no landscapes. Differences between these types of properties and their occupants have the potential to cause differences in weather-sensitive demands. To identify weather sensitivity more precisely, the multifamily customer class is disaggregated into the four above location types and weather-sensitive use is analyzed for each type of location. These analyses identify the potential for improvement in outdoor use efficiency for some location types as indicated by higher weather-sensitive demands relative to other types. Further analyses of the types performed for the single-family class would be necessary to more fully quantify efficiency potentials.

Section 3.4, ***Nonresidential Demand Profile,*** contains a demand profile of the nonresidential customer class. In this profile, analyses disaggregate regional demand trends into trends within specific nonresidential sectors or use, thereby showing which sectors have the greatest potential for efficiency improvement. The profile begins by breaking regional nonresidential demand down into nonresidential sectors (as defined by the Florida Department of Revenue). Sectors are ranked in terms of potential for efficiency improvement according to methods in the Commercial and Institutional End Uses of Water Study (Dziegielewski et al., 2000). Sectors are ranked high if they compose a large proportion of total nonresidential demand and also have large average demand per location (high demand intensity). Several high-ranking sectors were then further analyzed to determine various details of water use distributions, concentration, and weather sensitivity.

- Distributions of individual-location demand in each sector are determined, and proportions of locations whose demand exceeds AWWA efficiency benchmarks are identified.
- The concentration of individual-location demand in each sector is determined. These analyses quantify statements such as “the highest X% water-using locations in this subsector account for Y% of total nonresidential water use). These analyses determine the potential to produce large reductions in sectoral demand by targeting efficiency measures on relatively a small number of high-water-use locations.
- Weather-sensitive demands are estimated for each sector using the same methods used for single-family and multifamily customer classes. These estimates suggest which sectors have the potential for large outdoor-use efficiency improvement and, through the timing of weather-sensitive demand cycles, the end-uses that are primarily responsible for weather-sensitive demand (namely, cooling towers versus irrigation).

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3.1 Regional Water Use Patterns and Trends

3.1.1 Annual Average Water Demand, WY02 – WY08

Table 3-1 provides the regional distribution of retail demand (i.e., excluding wholesale and unbilled demand) by customer class for WYs 2002-2008. The distribution of total retail demands across customer classes in WY 2008 are illustrated in Figure 3.1, with single-family demand composing largest proportion of total retail water use at 56%, followed by nonresidential (24%) and multifamily demand (20%).

Table 3-1
Distribution of Historical Total Regional Water Use by Customer Class (WY2002-WY2008)

	Demand, MGD				% of total retail		
WY	**Total Retail**	**SF**	**MF**	**NR**	**SF**	**MF**	**NR**
2002	199.9	109	42.3	48.6	54.5%	21.2%	24.3%
2003	181.6	95.1	39	47.6	52.4%	21.5%	26.2%
2004	190.7	102	40.1	48.6	53.5%	21.0%	25.5%
2005	199.4	108	40.7	50.8	54.2%	20.4%	25.5%
2006	213	118.4	42.3	52.3	55.6%	19.9%	24.6%
2007	207.4	116.5	40.9	50.1	56.2%	19.7%	24.2%
2008	197.2	110.1	39.2	47.9	55.8%	19.9%	24.3%
Average, WY 02-08	198.5	108.4	40.6	49.4	54.6%	20.5%	24.9%
Change, WY 02-08	-2.7	1.1	-3.1	-0.7			
% Change, WY 02-08	-1.4%	1.0%	-7.3%	-1.4%			

Distributions of demand by WDPA and customer class are shown in Appendix E and Table 3-1; this table shows that, in each individual WDPA, single-family demand is predominant and larger than multifamily and nonresidential demand together. Region-wide, total retail water use slightly decreased by 1.3 percent between WYs 2002-2008. Even though single-family demands increased by 1.1 MGD (1%), decreases in the multifamily and nonresidential sectors, 3.1 MGD (-7.3%) and 0.7 MGD (-1.3%) respectively, exceeded the single-family increase thus resulting in a total decrease in retail demand.

Figure 3.2 illustrates the distribution of total retail demand for WY 2008 across Tampa Bay Water's seven WPDAs. Tampa had the largest proportion of total regional retail demands at 32.6 percent (64.2 MGD), followed by Pinellas (18.6%, 36.8 MGD), South Central Hillsborough (15.2%, 30.0 MGD), St. Petersburg (12.1%, 23.9 MGD), Pasco (11.6%, 22.8 MGD), Northwest Hillsborough (8.6%, 17 MGD), and New Port Richey (1.2%, 2.4 MGD). Holistically, Hillsborough is the second largest demand use at 33.8 percent and 47.0 mgd, but service areas are split by the City of Tampa.

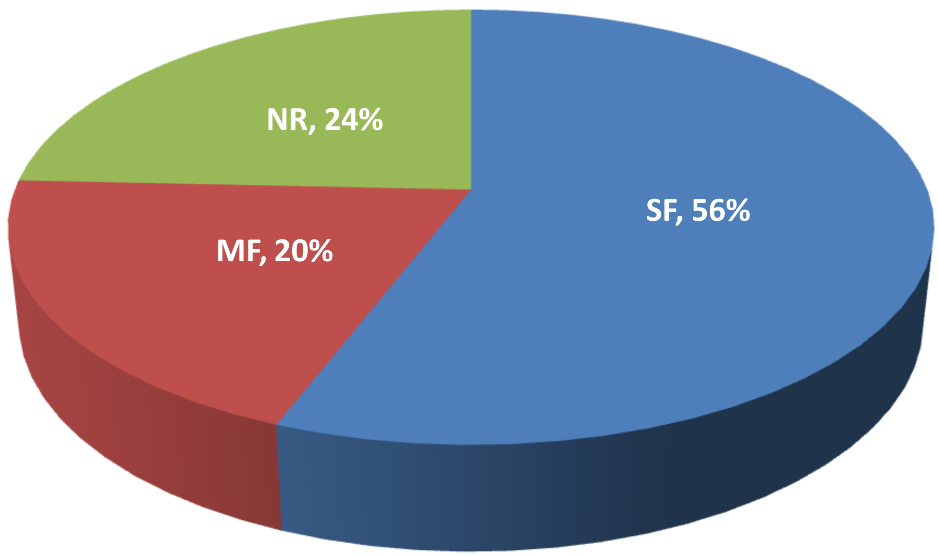

Figure 3.1: Distribution of Total Regional Water Use by Customer Class for WY 2008

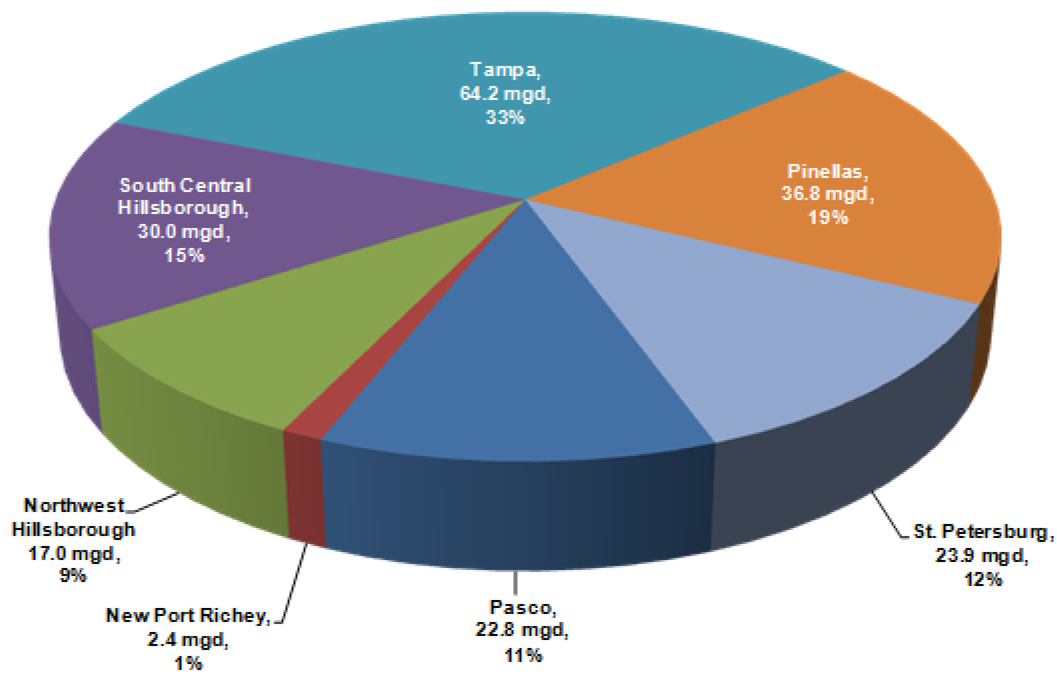

Figure 3.2: Distribution of Total Regional Water Use by WDPA for WY 2008

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3.1.2 Long-Term Water Demand Forecast

Tampa Bay Water develops regional water demand forecasts for the seven WDPA's and its six member governments to project the amount of water supply needed within Tampa Bay Water's service area. Retail demand is modeled using three class-specific econometric models as described in the Long-term Demand Forecasting Model documentation (Hazen and Sawyer, 2010). Each model generates demand forecasts based on WDPA-specific weather and socioeconomic projections.

Each year the model forecast is evaluated and verified, and new water demand projections are developed based on updated socioeconomic projections. Although demand profiles are for the WY 2002-2008 timeframe, the demand forecast for the WY 2010 base-year was the most recent forecast available during the development the DMP. This forecast thus provides the baseline from which the impacts of passive and active savings potential are assessed.

Table 3-2 through Table 3-4 summarize Tampa Bay Water's regional total regional baseline water demand forecast for the WY 2010 base year. The forecast is provided in five year increments through 2035, and includes observed demands for WY 2008 and WY 2010. In terms of total baseline demands, retail water use accounts for nearly 80 percent (197 MGD) of total WY 2008 observed demand (247 MGD), with the remaining demand arising from wholesale and unbilled use.

Key findings in terms of long-term demand projections include the following:

- Regional demands (i.e. total demands, including wholesale and unbilled portions) are expected to increase by 11 percent (27 MGD) between WY 2008 and WY 2035, while retail demands are forecasted to increase by 17 percent (34 MGD).
- The regional demand increase is forecasted to be lower than retail increase due to a 14 MGD (60%) decrease in wholesale demands expected to occur between 2010 and 2020 (mostly associated with changes in Pinellas County wholesale customers).
- It is important to note water use declined substantially following an all-time high in 2006. Although customer class growth is expected to resume, water use between WYs 2008-2010 was significantly impacted by economic recession. Water demand is not expected to recover to 2008 levels until 2015, at which time growth in projected water demand is expected to resume.
- During the economic recession, total retail demands decreased by 10 percent (20 MGD). Single-family experienced the greatest decrease at 13.5 MGD (12%), followed by nonresidential (11%, 5.2 MGD) and multifamily (4%, 1.6 MGD).
- Despite the short-term downturn, substantial growth in demand is forecasted over the forecast horizon. Nonresidential demand is forecasted to experience the greatest growth at 27 percent by 2035 followed by single-family (17%) and multifamily (5%).

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- Overall, the relative distribution of customer class demands will remain about the same through 2035, with a slight 2% shift from multifamily to nonresidential.

Table 3-2
Regional Baseline Demand Forecast by Customer Class for 2010-2035

Customer Class	Observed (MGD)		Forecast (MGD)				
	2008	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
SF	110	97	111	118	123	127	129
MF	39	38	39	40	41	42	41
NR	48	43	47	49	52	56	61
WS	24	18	14	9	9	9	9
Unbilled	27	27	29	30	32	33	34
Total Retail	**197**	**177**	**197**	**208**	**217**	**224**	**231**
Total Baseline	**247**	**222**	**240**	**248**	**258**	**266**	**274**

Table 3-3
Distribution of Regional Baseline Demand Forecast by Customer Class for 2010-2035

Customer Class	Percent of Baseline Demands			Percent of Customer Class Demands		
	2008	**2035**	**Change**	**2008**	**2035**	**Change**
SF	44.5%	47.1%	2.7%	55.8%	55.9%	0.1%
MF	15.8%	15.0%	-0.8%	19.9%	17.8%	-2.1%
NR	19.4%	22.1%	2.8%	24.3%	26.3%	2.0%
WS	9.5%	3.4%	-6.1%	12.2%	3.9%	-8.3%
Unbilled	**10.8%**	**12.3%**	**1.5%**	**13.7%**	**14.7%**	**1.0%**
Total Retail	**79.7%**	**84.3%**	**4.6%**	**100%**	**100%**	**0%**

Table 3-4
Demand Changes Implied By Regional Baseline Demand Forecast for 2010-2035

Customer Class	Change, 2008-2035			Change, 2008-2010	
	MGD	**Total %**	**Avg Ann %**	**MGD**	**Total %**
SF	19.2	17%	0.6%	13.5	-12%
MF	1.9	5%	0.2%	1.6	-4%
NR	12.8	27%	0.9%	5.2	-11%
WS	14.3	-60%	-3.4%	5.1	-22%
Unbilled	7.1	27%	0.9%	-0.3	1%
Total Retail	**33.9**	**17.2%**	**0.6%**	**20.3**	**-10%**
Total Baseline	**26.7**	**23.3%**	**0.8%**	**25.1**	**-10%**

While the current baseline demand forecast only reflects the presence of existing high-efficiency products within customer class per account water use calculations, the penetration of high-efficiency products is expected to increase over time, resulting in even greater passive water savings. Ultimately, the results of this DMP are used to create a passive efficiency forecast that incorporates natural replacement of fixtures over time.

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3.2 Single-Family Demand Profile

3.2.1 Baseline Annual Average Per Unit Use

Table 3-5 provides single-family annual average daily rates of water use in gallons per (housing) unit per day (gpud) for each WDPA for WYs 2002-2008. Table 3-6 shows the percentage difference of WDPA demands from the regional average for WYs 2002-2008. Single-family annual average water use region wide is about 229 gpud over the historical period, but varies greatly by member government. As illustrated in table 3-6, the regional average is composed of WDPA numbers above and below the average, with most newer growth areas (NWH and SCH, Tampa) exceeding the average and more mature growth areas (St. Pete, New Port Richey and Pinellas) below average.

Figure 3.3 illustrates the range of WDPA WY 2008 average rates of use; variation in single-family water use across the region in the base year was similar to regional variation seen across the entire record. Figure 3.4 illustrates regional single-family demands over WYs 2002-2008; fluctuations in total single-family use over time are much smaller than differences between WDPAs, illustrating geographic differences are somewhat consistent by year over the period.

Table 3-5
Single-Family Annual Average Water Use by WDPA, (gpud) for WY 2002-2008

WY	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	235	232	202	263	250	252	250	166
2003	214	215	186	240	231	231	222	156
2004	225	210	193	260	252	254	230	159
2005	229	222	197	266	246	259	224	158
2006	242	228	216	279	277	274	233	160
2007	237	226	184	284	283	263	220	156
2008	223	221	175	264	255	247	208	151
2002-2008 Mean	**229**	**222**	**193**	**265**	**256**	**254**	**227**	**158**

Table 3-6
Variation in Single-Family Annual Average Water Use by WDPA for WY 2002-2008
(as percentages of regional averages)

WY	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	-1.3%	-14.0%	11.9%	6.4%	7.2%	6.4%	-29.4%
2003	0.5%	-13.1%	12.1%	7.9%	7.9%	3.7%	-27.1%
2004	-6.7%	-14.2%	15.6%	12.0%	12.9%	2.2%	-29.3%
2005	-3.1%	-14.0%	16.2%	7.4%	13.1%	-2.2%	-31.0%
2006	-5.8%	-10.7%	15.3%	14.5%	13.2%	-3.7%	-33.9%
2007	-4.6%	-22.4%	19.8%	19.4%	11.0%	-7.2%	-34.2%
2008	-0.9%	-21.5%	18.4%	14.3%	10.8%	-6.7%	-32.3%
2002-2008 Mean	**-3.2%**	**-15.7%**	**15.6%**	**11.8%**	**10.9%**	**-1.1%**	**-31.1%**

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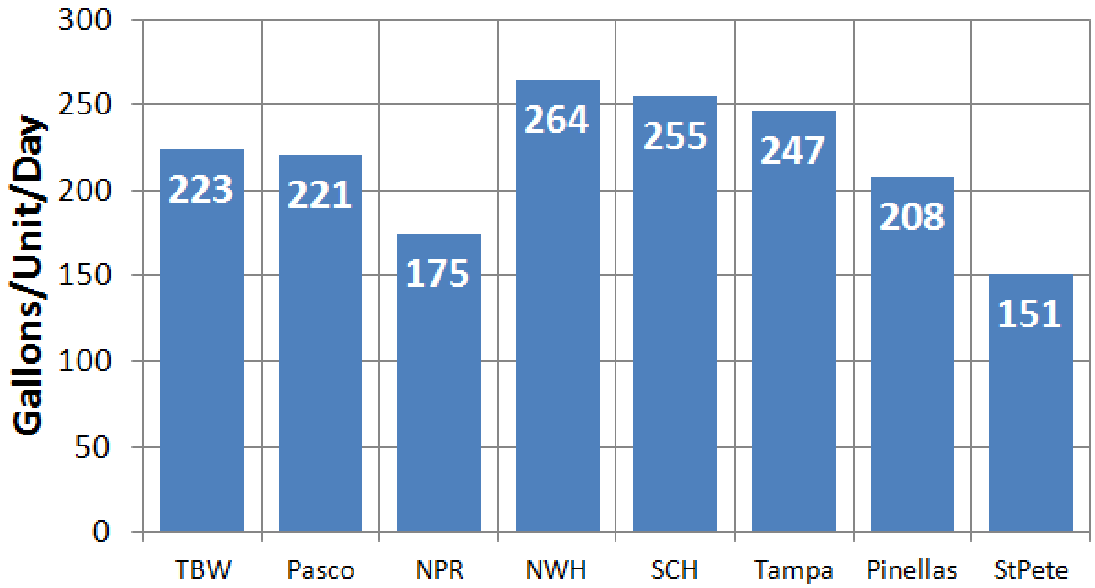

Figure 3.3: Single-Family Per-Unit Consumption by WDPA for WY 2002-2008

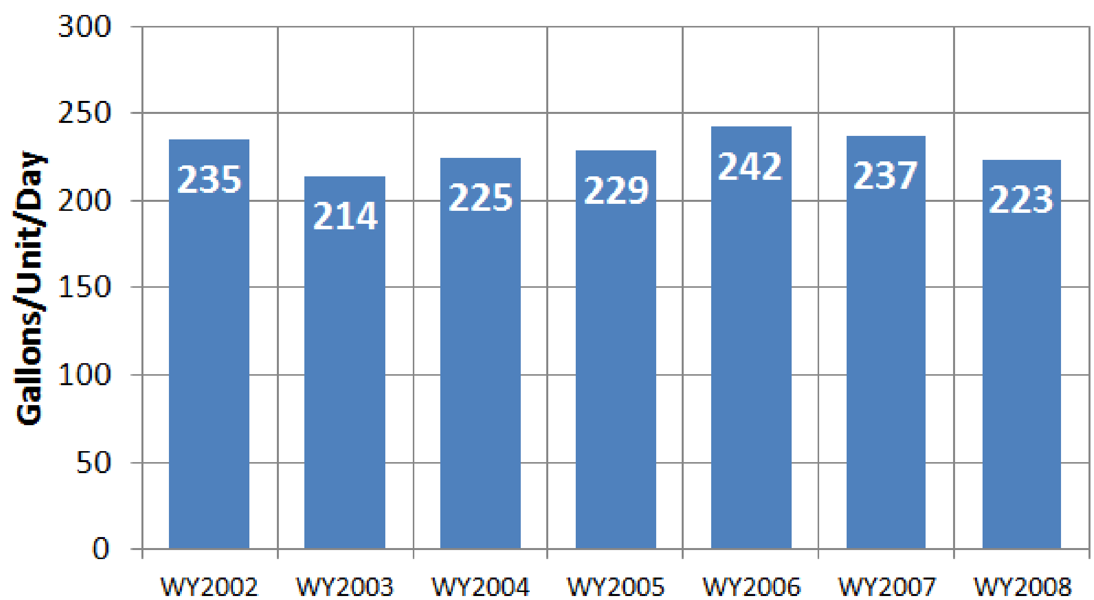

Figure 3.4: Regional WY-Average Single-Family Per-Unit Consumption for WY 2002-2008

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3.2.2 Baseline Per Capita Water Use

Table 3-7 provides estimates of the average gallons per capita day (gpcd) by WPDA for WY 2008 estimated using 2008 single-family persons per household (PPH) estimates.[1] Regionally, per-capita single-family use is about 85 gallons per person per day. Per-capita single-family demands for individual member governments range from 85-94 gpcd, except for St. Petersburg (61 gpcd) and New Port Richey (74 gpcd). The regional per-capita estimate is disaggregated into estimates of indoor and outdoor per-capita use in Section 3.2.4. Those estimates will be used to estimate indoor and outdoor components of water use for survey participants.

Table 3-7
Single-Family Annual Average Gallons Per Capita per Day (WY 2008)

WDPA	2008 Annual Avg Water Use (gpud)	2008 SF PPH	Gallons Per Capita Day
PAS	221	2.56	86.1
NPR	175	2.38	73.4
NWH	264	2.81	94.2
SCH	255	2.79	91.5
COT	247	2.69	91.8
PIN	208	2.46	84.6
STP	151	2.46	61.1
TBW	223	2.62	85.4

3.2.3 Distribution of WY 2008 Water Use by Month

Figure 3.5 presents distributions (means and 5th and 95th percentiles) of monthly demand at individual single-family locations during WY 2008 (top panel) as well as observed monthly average maximum daily temperature and monthly total rainfall observed at Tampa International Airport for that WY (bottom panel). This type of figure permits inferences to be made about the impact of weather on water demand. At the 5th percentile, location demands are fairly stable year-round ranging from 41-55 gpd, meaning 95 percent of users generally use more than this volume of water daily. This can be interpreted as an initial indicator of minimum levels of indoor consumption. However, location demand at the 95th percentile varies widely from month to month ranging from 512 gpd in July, one of the wettest months of the year, up to 835 gpd in May, one of the driest and hottest months each year. The highest demands tend to occur between the months of April and June, peaking in May, corresponding to the regions annual dry season, which occurs when temperatures are warming into summer normals.

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[1] PPH obtained from historical Tampa Bay Water's Long-Term Demand Forecast System estimates.

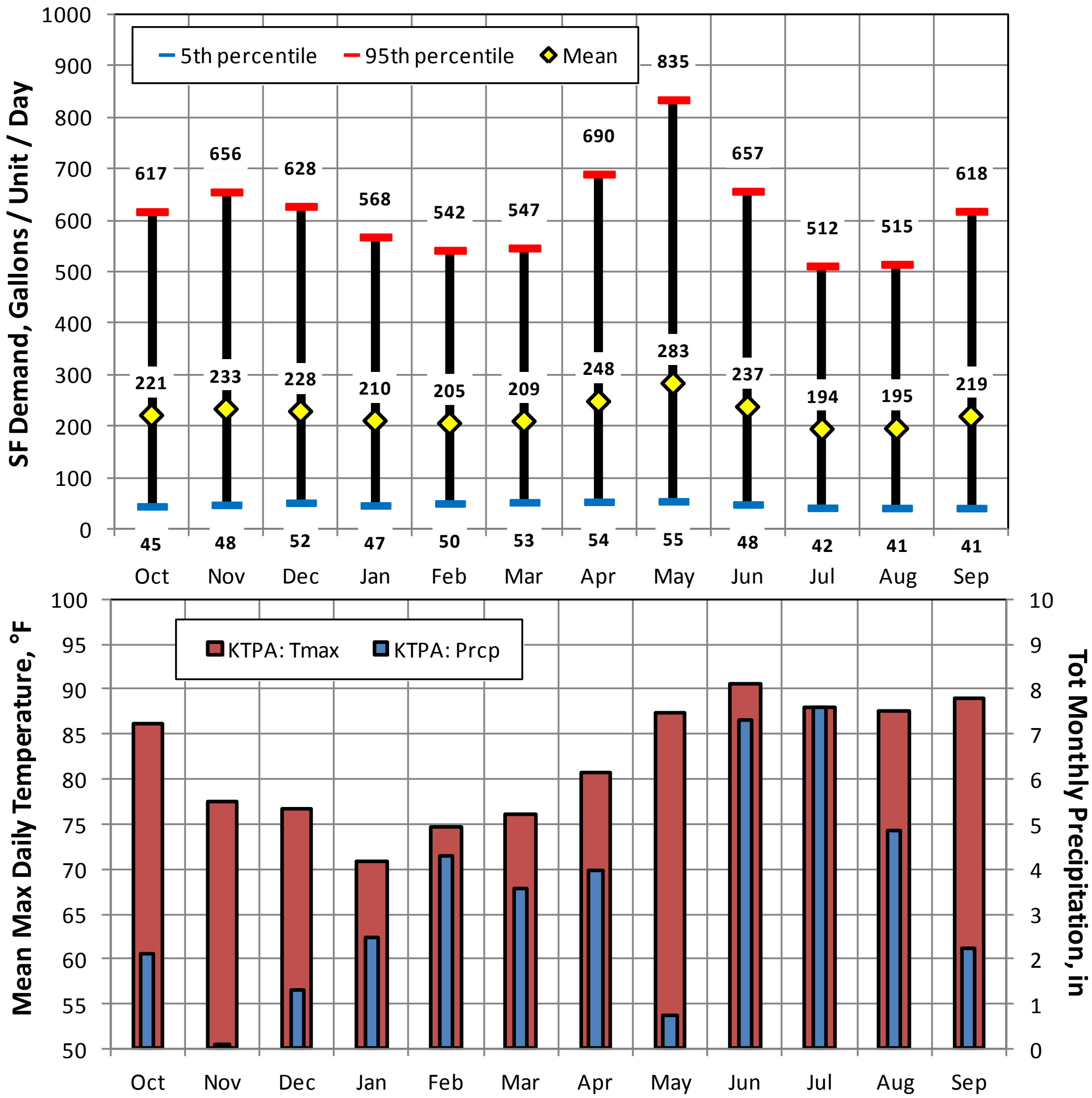

Figure 3.5: Tampa Bay Water Regional Distribution of Single-Family Water Use and Observed Weather for Tampa International Airport (WY 2008)

3.2.4 Seasonal and Non-Seasonal Water Use

Weather-sensitive (seasonal) and weather-insensitive (non-seasonal) components of single-family demand are estimated for the region as a whole and for each member government over WYs 2002-2008. Estimates are developed by performing minimum-month analyses on the time series of average monthly single-family per-unit demand for each member government and the region as a whole. Table 3-8 presents regional single-family monthly water demands in gallons per unit per day used for the weather sensitivity analysis, while Figure 3.6 illustrates a monthly time series of regional demand trends.

Table 3-8
Regional Single-Family Monthly Water Demand, Gallons per Unit per Day (GPUD)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average	Min	Max
WY2002	233	250	239	221	223	249	267	291	248	199	197	197	235	197	291
WY2003	207	207	201	204	206	213	237	251	225	206	198	209	214	198	251
WY2004	222	223	221	211	207	236	260	276	257	215	189	177	225	177	276
WY2005	224	242	234	221	225	218	241	242	224	212	223	241	229	212	242
WY2006	230	225	218	217	227	281	303	295	257	216	215	219	242	215	303
WY2007	253	245	227	212	217	247	259	275	243	226	224	218	237	212	275
WY2008	221	233	228	210	205	209	248	283	237	194	195	219	223	194	283
Min	**207**	**207**	**201**	**204**	**205**	**209**	**237**	**242**	**224**	**194**	**189**	**177**	**214**	**177**	**242**
Max	**253**	**250**	**239**	**221**	**227**	**281**	**303**	**295**	**257**	**226**	**224**	**241**	**242**	**215**	**303**
Range	**46**	**43**	**37**	**18**	**22**	**72**	**66**	**53**	**33**	**32**	**35**	**63**	**28**	**38**	**61**
Mean	**227**	**232**	**224**	**214**	**216**	**236**	**259**	**273**	**241**	**210**	**206**	**211**	**229**	**201**	**274**
Median	**224**	**233**	**227**	**212**	**217**	**236**	**259**	**276**	**243**	**212**	**198**	**218**	**229**	**198**	**276**

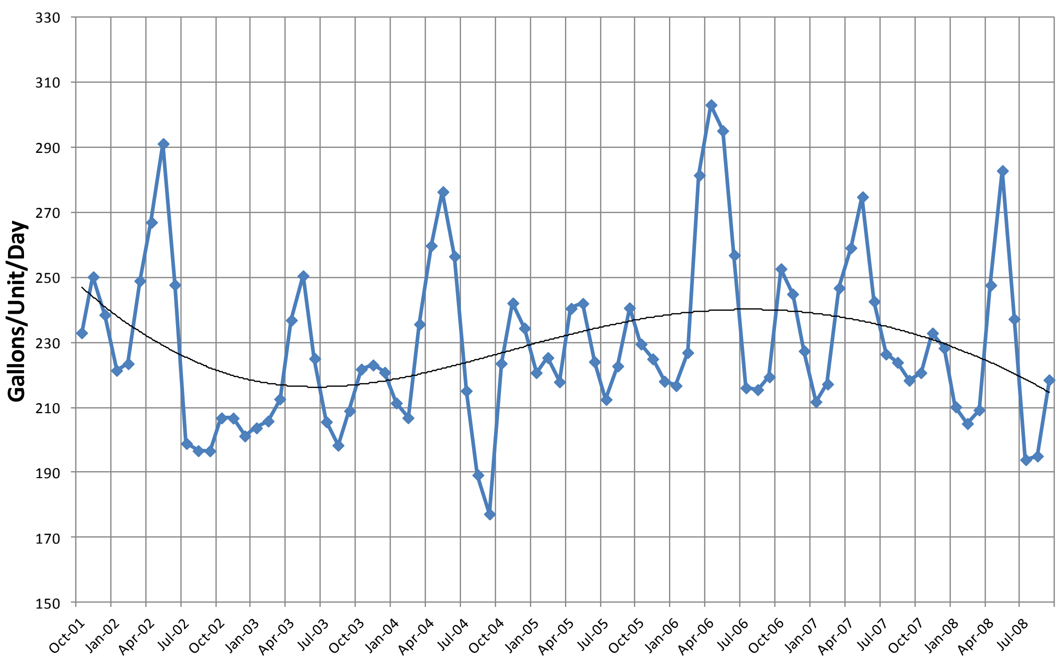

Figure 3.6: Regional Single-Family Average Water Use for WY 2002-2008 (with polynomial trendline)

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As illustrated in Figure 3.6:

- July and August are the lowest-demand months on average.
- High demand variability during low-demand summer months indicates influence of weather variability on observed water usage patterns.
- Winter demands are similar in magnitude to summer demand.
- High demand variability during low-demand winter months, indicates that outdoor or weather-sensitive uses have impacts on total demand during these months as well.

Two forms of minimum-month analyses were initially evaluated as part of the weather sensitivity analysis:

- Method A: Determination of minimum month average water use in each WY
- Method B: Determination of minimum month average water use across all WYs

The results of the Method A and Method B analyses are provided and further discussed in Appendix F. Of the two methods, Method A is more traditional for analyses in regions with climates that do not support year-round irrigation, Method B, however, is better suited for Tampa Bay regional climate, which consists of a set of seasonal weather patterns that generally support year-round growth of vegetation. Because of the potential for weather-sensitive demands to occur year-round in the Tampa Bay Region, it is preferable to use the minimum demand month across all years, (i.e. Method B) to better estimate weather-insensitive demand,

Using Method B, the lowest monthly average single family per-unit consumption rate for Tampa Bay Water as a whole is 177 gallons per unit per day (occurring in August 2004) as illustrated in Figure 3.7. For the region as a whole, weather-sensitive use is estimated by assuming any water use above 177 gpud is related to weather-sensitive uses (such as irrigation and swimming pools)The 177 gpud represents about 77 percent of annual average demand in the single-family customer class.

Annual average weather-sensitive use is 52 MGD, or 23 percent of total annual average use. However, estimates of average weather-sensitive demand varies seasonally, ranging from 34 gpud (15% of non-sensitive demand) in September to 96 gpud (35% of non-sensitive demand) in May. Variability exists around seasonal means for weather-sensitive demand as well (as evidenced in minimum and maximum statistics in Table 3-9 and Table 3-10). This variability is further illustrated in Figure 3.7, which shows the time series of average single-family demand per unit per day for the Tampa Bay Water region as broken down into estimated weather-sensitive and weather-insensitive components.

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Table 3-9
Estimates of Weather-Sensitive Regional Single-Family Water Use (Gallons per Unit per Day), Method B

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Weather-Sensitive Demand (Ann Avg)	Weather-Insensitive Demand (Ann Avg)
WY2002	55.7	73	61.3	44.2	46.2	71.7	89.8	114	70.5	21.7	19.5	19.4	57.3	177.2
WY2003	29.6	29.5	24	26.5	28.6	35.4	59.6	73.3	47.8	28.4	21.2	31.8	36.3	177.2
WY2004	44.6	45.8	43.6	34.1	29.6	58.4	82.6	99.1	79.3	37.9	12	0	47.3	177.2
WY2005	46.3	64.9	57.2	43.5	48.1	40.7	63.3	64.8	46.9	35.2	45.5	63.4	51.6	177.2
WY2006	52.3	47.7	40.8	39.5	49.7	104.2	125.9	117.9	79.6	38.8	38.3	42.2	64.8	177.2
WY2007	75.4	67.7	50.2	34.5	40	69.5	81.9	97.6	65.4	49.2	46.6	41.1	60	177.2
WY2008	43.5	55.7	51	33	27.8	32	70.4	105.6	60	16.7	17.8	41.3	46.2	177.2
Min	**29.6**	**29.5**	**24.0**	**26.5**	**27.8**	**32.0**	**59.7**	**64.8**	**46.9**	**16.7**	**12.0**	**0.0**	**36.3**	**177.2**
Max	**75.4**	**73.0**	**61.3**	**44.2**	**49.7**	**104.3**	**125.9**	**117.9**	**79.6**	**49.2**	**46.7**	**63.4**	**64.8**	**177.2**
Monthly Average	**49.6**	**54.9**	**46.9**	**36.5**	**38.6**	**58.9**	**81.9**	**96.0**	**64.2**	**32.6**	**28.7**	**34.2**	**51.9**	**177.2**

Table 3-10
Estimates of Percentage of Weather-Sensitive Regional Single-Family Demand, Method B

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	% Weather-Sensitive Demand (Ann Avg)	% Weather-Insensitive Demand (Ann Avg)
WY2002	24%	29%	26%	20%	21%	29%	34%	39%	28%	11%	10%	10%	24%	76%
WY2003	14%	14%	12%	13%	14%	17%	25%	29%	21%	14%	11%	15%	17%	83%
WY2004	20%	21%	20%	16%	14%	25%	32%	36%	31%	18%	6%	0%	21%	79%
WY2005	21%	27%	24%	20%	21%	19%	26%	27%	21%	17%	20%	26%	23%	77%
WY2006	23%	21%	19%	18%	22%	37%	42%	40%	31%	18%	18%	19%	27%	73%
WY2007	30%	28%	22%	16%	18%	28%	32%	36%	27%	22%	21%	19%	25%	75%
WY2008	20%	24%	22%	16%	14%	15%	28%	37%	25%	9%	9%	19%	21%	79%
Min	**14%**	**14%**	**12%**	**13%**	**14%**	**15%**	**25%**	**27%**	**21%**	**9%**	**6%**	**0%**	**17%**	**83%**
Max	**30%**	**29%**	**26%**	**20%**	**22%**	**37%**	**42%**	**40%**	**31%**	**22%**	**21%**	**26%**	**27%**	**73%**
Monthly Average	**22%**	**23%**	**21%**	**17%**	**18%**	**24%**	**31%**	**35%**	**26%**	**15%**	**14%**	**15%**	**23%**	**77%**

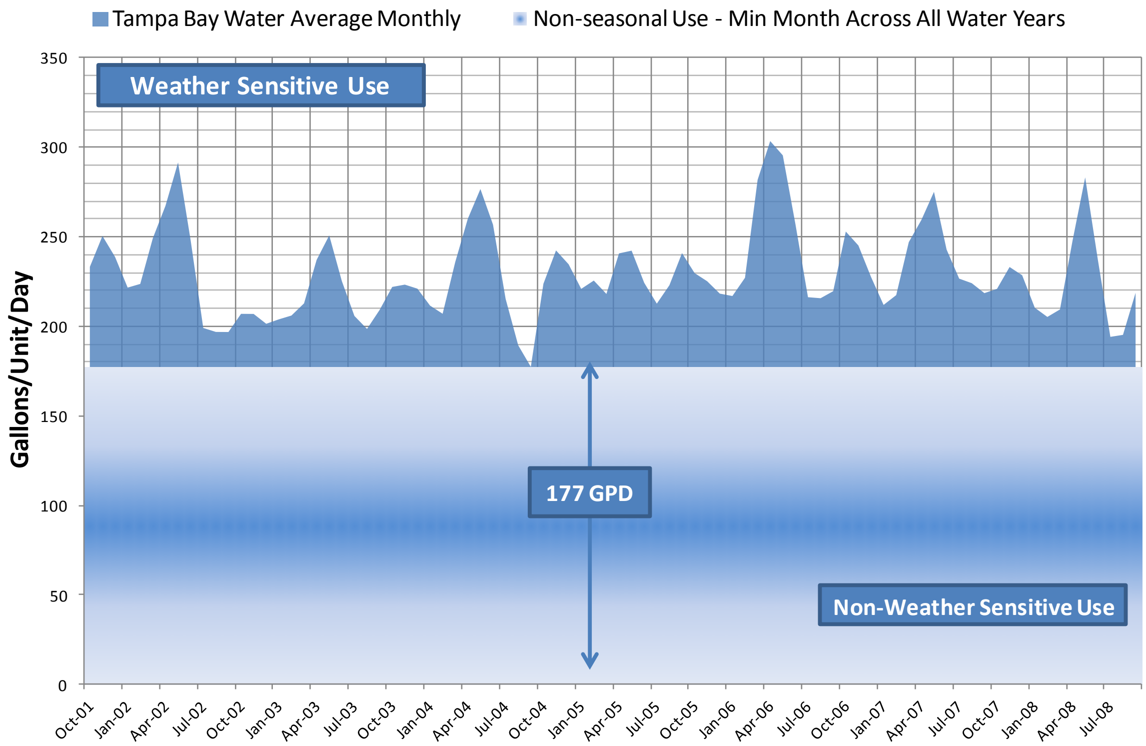

Figure 3.7: Single-Family Weather-Sensitive and Weather-Insensitive Use (Method B)

As verification of the weather-insensitive demand estimate, cohort analyses are performed for single-family consumption in locations with and without access to reclaimed water or irrigation meters. Average WY 2008 demand is calculated for

- homes with neither irrigation meters nor reclaimed water service (water use reflects both indoor and outdoor use)
- homes with irrigation meters, with irrigation amounts subtracted from total demand (water use reflects indoor use only), and
- homes with active reclaimed water service (water use reflects indoor use and some outdoor use where potable water is necessary).

Figure 3.8 shows average WY 2008 demand for these three cohorts. Average water use in locations having reclaimed service is 178 gpud, which is in near precise agreement with the 177 gpud estimate of weather-insensitive use according to the minimum-month method. Domestic (non-irrigation) use in locations with irrigation meters average 191 gpud, which is higher than the minimum-month, but is still only 14 gpud (8% higher) than the 177 gpud estimate. The results in Figure 3.8 confirm that the minimum-month esti-

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mate of weather-insensitive demand indeed reflects a fair estimate of average indoor water use (i.e. with practically all outdoor uses removed).

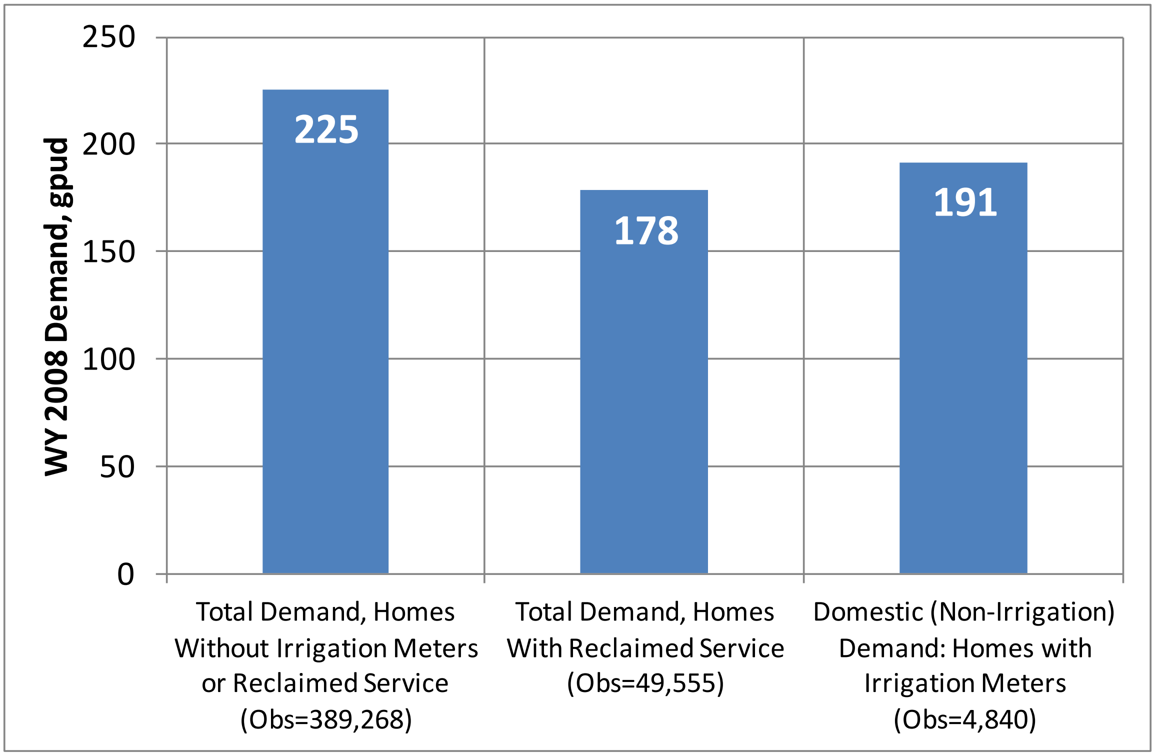

Figure 3.8: Average Water Use for Three Classes of Single-Family Locations (WY 2008)

The results of minimum-month analyses can be used to disaggregate average regional single family per capita use into average indoor and outdoor per-capita uses. Taking regional average per capita use as 85 gpcd,

- Average annual indoor single-family per capita use = 85 gpcd × 77% = 65 gpcd
- Average annual outdoor single-family per capita use = 85 gpcd × 23% = 20 gpcd

These estimates are used in Section 3.2.5 to estimate indoor and outdoor components of water use for survey participants.

3.2.5 Analysis of Seasonal Water Use

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Although adjusting water use practices seasonally is clearly a water efficient behavior in itself, the annual variability in seasonal single-family demand suggests efficiency potential in outdoor and weather-sensitive use. As previously illustrated in Figure 3.7, individual months (typically during the spring) in the region can experience average total demand well above 229 gpud, due to seasonal increases in weather-sensitive demand. Furthermore, the degree of seasonal increase varies significantly from year to year, indicating a high level of demand weather-induced variability; this sensitivity could potentially be reduced by changes in weather-sensitive water use behavior such as landscaping strategies and irrigation practices.

To further analyze the potential for reducing seasonal demand via efficiency improvement, estimates of irrigation efficiency for individual single-family locations assumed to irrigate with potable water are made as follows:

- Locations with average annual water use greater than 177 gpud (WY 2002-2008) are classified as "irrigators", while those with less are labeled "non-irrigators".
- Outdoor use is estimated as WY 2002-2008 average annual use minus 177 gpud
- Theoretical irrigation requirements are determined using effective rainfall over WYs 2002-2008 and parcel green-space area estimates.
- Estimated outdoor use is compared to the theoretical irrigation requirement.
- Irrigators are labeled "surplus" or "deficit" irrigators based on whether estimated outdoor uses are greater or less than theoretical requirements (it should be noted deficit irrigation does not imply poor landscape quality).

Table 3-11 shows the result of the surplus/deficit water use analyses. Using this framework, only 9.2 percent of all single-family locations not using reclaimed water or another identifiable alternative source (e.g. well) are classified as surplus irrigators, with a group average of 155 gpud surplus use. While surplus users comprise a small fraction of the overall single-family customer population, the surplus use is significant for those users, as 155 gpud overuse corresponds to an average of nearly 57,000 gallons of excess water use per location per year. Total excess use among surplus users is estimated at 6.1 MGD (by multiplying number of surplus irrigators by average surplus use), which is more than 10 percent of average outdoor use as estimated by the minimum month method (Table 3-9). Reducing surplus irrigation therefore represents a potentially effective target for outdoor efficiency programs.

On the other hand, 52.7 percent of single-family locations are classified as deficit irrigators, with an average of 274 gpud theoretical deficit. Thus, if all theoretical deficit and surplus irrigators -were to be induced to irrigate at theoretically-required rates, the result would be a large net increase in water use for the region. Therefore efforts to improve outdoor use efficiency should be selective; attempts to bring irrigation rates towards theoretically-needed levels should be focused on surplus irrigators only and any research toward plant water use requirements affecting theoretical plant requirements versus user preference should be included in future evaluations.

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Table 3-11
Estimation and Characterization of Surplus/Deficit Irrigation for Single-Family Locations

	All SF Customers	All Irrigators	Deficit Irrigators	Surplus Irrigators
Total Customers*	424,422	223,866	184,841	39,026
% of Total Customers	100.0%	52.7%	43.6%	9.2%
Average Green Space (sq ft)	7,636	8,444	8,955	6,026
Average Water Use (gpud)	233.3	339.1	286.3	588.8
Estimated Average Indoor Use (gpud)	177	177	177	177
Estimated Average Irrigation Use (gpud)	56.3	162.1	109.3	411.8
Average % Total Annual Use as Irrigation	24.1%	47.8%	38.2%	69.9%
Average Theoretical Irrigation Req.	327.8	361.1	383.2	256.6
Average Deficit / Surplus Use (gpud)	-271.5	-199.0	-273.8	155.2
Average Deficit / Surplus % of Theoretical Req.	-82.8%	-55.1%	-71.5%	60.5%
Surplus Irrigation Savings Potential (gal/location/year)				56,756

**Customers without reclaimed water*

To verify the results of Table 3-11, similar analyses were performed using data for single-family survey respondents. In these analyses:

- theoretical irrigation requirements are taken as the same calculated values as before, but only for those locations that were survey participants,
- survey irrigators are identified as those respondents who responded in the affirmative that they performed irrigation with potable water using an automated system,
- indoor use is estimated for each survey irrigator by multiplying the number of residents indicated in the survey response by the regional average indoor per-capita use estimate of 68 gpcd (Section 3.2.4),
- outdoor use for each survey irrigator is estimated as WY 2002-2008 average annual water average use (from the water use records matching the respondent) minus the indoor use estimated from number of residents,[2] and
- survey irrigators are classified as deficit or surplus irrigators by comparing theoretical irrigation requirements to outdoor use estimates.

Table 3-12 contains results for these analyses. In comparing estimates based on survey respondents and all single-family locations:

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[2] Survey respondents with indoor water use estimate exceeding their annual average use estimates (providing for a negative outdoor value) are excluded from the analysis.

- similar percentages survey respondents are classified as irrigators (44% of respondents vs. 53% of all locations), deficit irrigators (38% of respondents vs. 44% of all locations), and surplus irrigators (6% of respondents vs. 9% of all locations),
- surplus and deficit irrigation users in both analyses have fairly similar estimated surplus use rates (138 gpud for respondents vs. 155 gpud for all locations) and deficit use rates (-291 gpud for respondents vs. -274 gpud for all locations), and
- surplus use in each analysis implies a similar potential water savings per year (50,312 gpy for respondents vs. 56,756 gpy for all locations).

Table 3-12
Characterization of Surplus/Deficit Irrigation Among Single-Family Survey Respondents

	All Survey Responses	All Survey Irrigators	Deficit Survey Irrigators	Surplus Survey Irrigators
Total Customers	1,075	477	413	64
% of Total Customers	100%	44.40%	38.40%	6.00%
Average Green Space (sq ft)	8,363	8,265	2025	6,240
Average Water Use (gpud)	214.5	261.4	218.3	543.6
Estimated Indoor Use (gpud)	137.4	138.5	139.5	135.9
Estimated Irrigation Use (gpud)	77	122.9	78.8	407.7
Average % Total Use as Irrigation	35.90%	47.00%	36.10%	75.00%
Theoretical Irrigation Requirement	359.5	356.6	370.1	269.8
Deficit / Surplus Use (gpud)	-282.4	-233.7	-291.2	137.8
Deficit / Surplus % of Theoretical Req.	-78.60%	-65.50%	-78.70%	51.10%
Surplus Irrigation Savings Potential (gal/location/year)				50,312

These comparisons lend credence to the finding that surplus irrigation use and potential savings from outdoor efficiency promotion are concentrated in a small proportion of single-family locations whose outdoor uses are exceptionally high.

3.2.6 Factors Affecting Single-Family Water Use

Many location-specific factors influence total water use and efficiency of that use for a given single-family property. Table 3-13 provides listings of common end uses and location characteristics affecting single-family water use. To quantify how these characteristics influence water use at individual locations, and to estimate the potential for water use efficiency improvement at individual locations, one must:

- quantify location characteristics,
- identify presence of specific end uses at locations, and
- relate location characteristics and presence of end uses to location water use

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Table 3-13
Common End Uses and Location Characteristics Affecting Single-Family Water Use

End uses	Location characteristics
• irrigation • pools • clothes/dish washing • bathing • toilet flushing • eating/drinking • leaks	• number of occupants • home value • age of house and/or plumbing • building/ irrigable area • number/ages/types of toilets, fixtures, and appliances • price of water and income level of occupants • alternative water sources (e.g. reclaimed water, shallow wells)

Understanding these relationships can allow the potential for efficiency improvement to be inferred through identification of end uses and location characteristics that tend to generate high water use. As part of the single-family water use profile, single-family customer and water use data are further analyzed to determine relationships between location characteristics, end use presence, and water use.

3.2.6.1 Random Survey of Single-Family Customers

As previously discussed in Section 2, a random telephone survey of single-family customers was designed and performed in collaboration with the Florida Center for Community Design and Research at the University of South Florida to supplement the location-water use data and allow more detailed customer-water use analyses in the single-family customer class. The survey was designed to address:

- Water end uses and water using activities
  - Indoor fixtures, including efficiency of existing fixtures
  - Outdoor uses, including frequency of irrigation and types of irrigation technology
- Participation in past conservation programs and willingness to participate in additional programs
- Access to alternative water supply sources, such as wells or reclaimed water

Selected survey results are summarized in Table 3-14. Survey responses for individual customers are applied in developing end-use models to assess impacts and market penetration of specific end-use technologies. Using location data (Section 2) and survey results, single family customers are characterized according to property characteristics and presence/absence of end uses. Through statistical analyses (including cohort analyses and regression analysis), relationships between property characteristics, end uses, and water use rates are identified, highlighting those characteristics leading to differences in water use among single-family households.

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Table 3-14
Summaries of Responses for Selected Questions in the Single-Family Water Use Survey

	Tampa Bay Water (N=1205)		Hillsborough County (N=228)		New Port Richey (N=171)		Pasco County (N=195)		Pinellas County (N=218)		St. Petersburg (N=188)		City of Tampa (N=205)	
Variable	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**
Swimming Pool?	1204	28.5%	228	33.8%	171	19.3%	195	26.2%	218	43.1%	188	19.7%	204	25.0%
Spa?	1205	11.3%	228	14.9%	171	5.3%	195	10.3%	218	17.9%	188	8.5%	205	8.8%
Solar Cover?	1205	5.1%	228	3.5%	171	5.8%	195	5.6%	218	9.6%	188	3.2%	205	2.9%
Irrigation?	1205	62.5%	228	66.7%	171	49.1%	195	60.0%	218	72.9%	188	63.8%	205	59.0%
Reclaimed Water (self-reported)?	1205	12.4%	228	15.8%	171	3.5%	195	9.2%	218	22.0%	188	12.2%	205	8.8%
Shallow Well?	1205	14.5%	228	5.3%	171	8.8%	195	16.9%	218	22.9%	188	27.7%	205	6.3%
Irrigation System?	1205	49.0%	228	55.3%	171	33.3%	195	50.3%	218	62.8%	188	47.9%	205	40.5%
Rain Sensor?	1205	26.5%	228	39.0%	171	18.7%	195	30.3%	218	22.5%	188	24.5%	205	21.5%
Mostly Grass Landscape (>=70%)?	1205	49.0%	228	45.2%	171	56.7%	195	59.5%	218	45.0%	188	48.4%	205	42.0%
Other Outdoor Feature?	1205	6.5%	228	5.7%	171	2.9%	195	6.2%	218	6.9%	188	7.4%	205	9.3%
Washing Machine	1205	97.0%	228	99.1%	171	94.2%	195	99.0%	218	98.6%	188	94.1%	205	96.1%
Front-Loading?	1205	22.1%	228	29.8%	171	11.7%	195	22.1%	218	20.6%	188	17.6%	205	27.8%
Dish-Washer?	1205	76.8%	228	91.7%	171	69.6%	195	81.0%	218	85.3%	188	58.5%	205	69.8%
Number of Toilets?	1205	2.17	228	2.37	171	1.96	195	2.12	218	2.34	188	1.99	205	2.14
Replacement Rate	1205	53.2%	228	47.7%	171	51.6%	195	44.9%	218	53.5%	188	64.4%	205	57.8%
Number of Showers?	1205	1.96	228	2.14	171	1.82	195	1.92	218	2.16	188	1.78	205	1.86
Replacement Rate	1190	27.4%	227	30.3%	167	23.3%	194	24.1%	217	31.6%	187	25.3%	198	27.9%
Renter?	1205	5.1%	228	4.4%	171	12.3%	195	4.6%	218	2.3%	188	1.6%	205	6.3%
Belongs to HOA?	1205	41.3%	228	61.0%	171	21.6%	195	64.1%	218	39.4%	188	26.1%	205	30.2%

3.2.6.2 Impact of Age of Home (Distribution of Water Use by Year Built)

Figure 3.9 shows how single-family water use varies with construction year of single-family houses across the Tampa Bay Water region. Single-family locations are grouped according to three construction year cohorts, including construction in 1983 or earlier, 1984-1994, and 1995 or later. The number and percent of single-family locations in each cohort and the mean, 5th percentile, and 95th percentile of WY 2008 water use in each cohort are then determined.

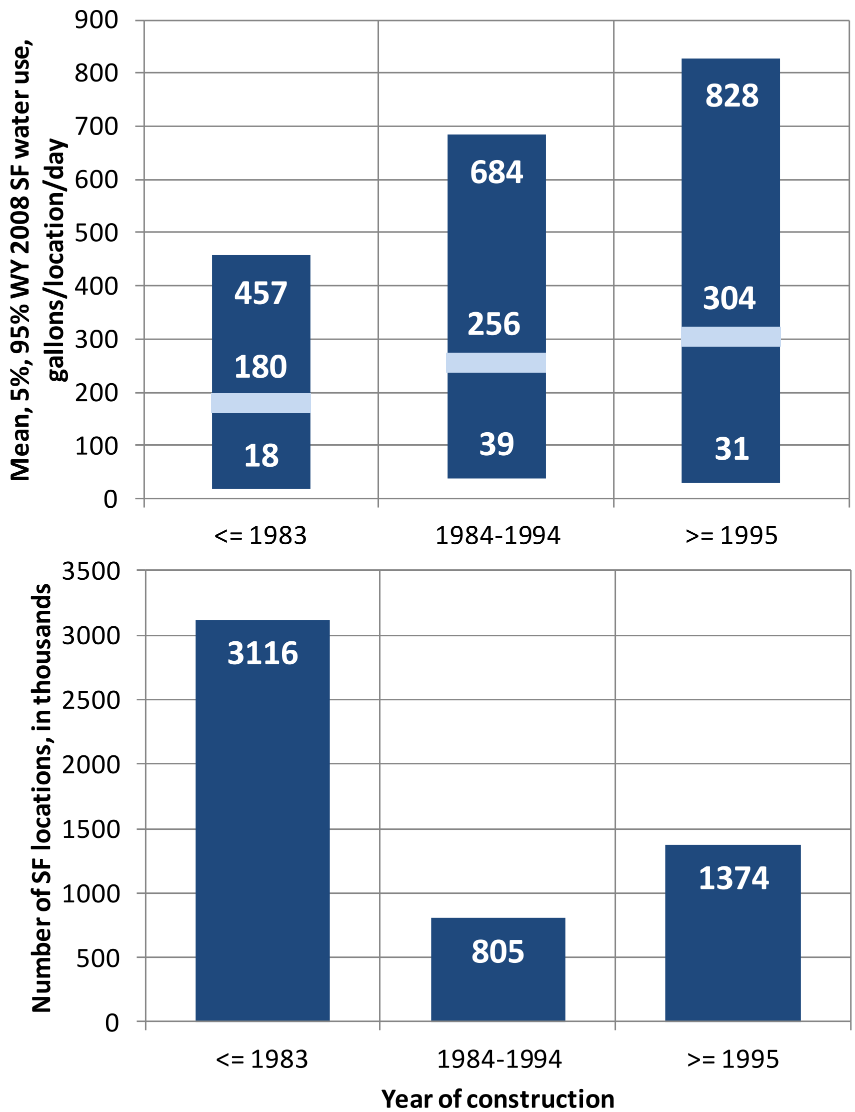

Figure 3.9: Regional Single-Family Location Water Use by Construction Year (WY 2008). Top: distributions (mean, 5th percentile, 95th percentile) of water use in each cohort. Bottom: number and percent of single-family locations in each construction year cohort.

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On average, newer homes use more water and have higher variability in use across locations as illustrated in Figure 3.9. One might expect the opposite; that newer houses use less water due to newer (and less degraded) plumbing, and newer, more efficient appliances and fixtures. The likely explanation for the observed trend is that newer houses are more likely to have larger, high-water-demand landscapes and therefore require more outdoor use.

Figure 3.10 shows that homes largely fall in two cohorts; either 1983/earlier or 1995/later construction. The relatively large proportion of homes in the latter category, coupled with the category's higher water use, indicates that this population of houses may merit being targeted by efficiency improvement efforts. Furthermore, assuming that this higher use arises from increased outdoor use, then efficiency efforts aimed at reducing outdoor use for newer houses may be appropriate.

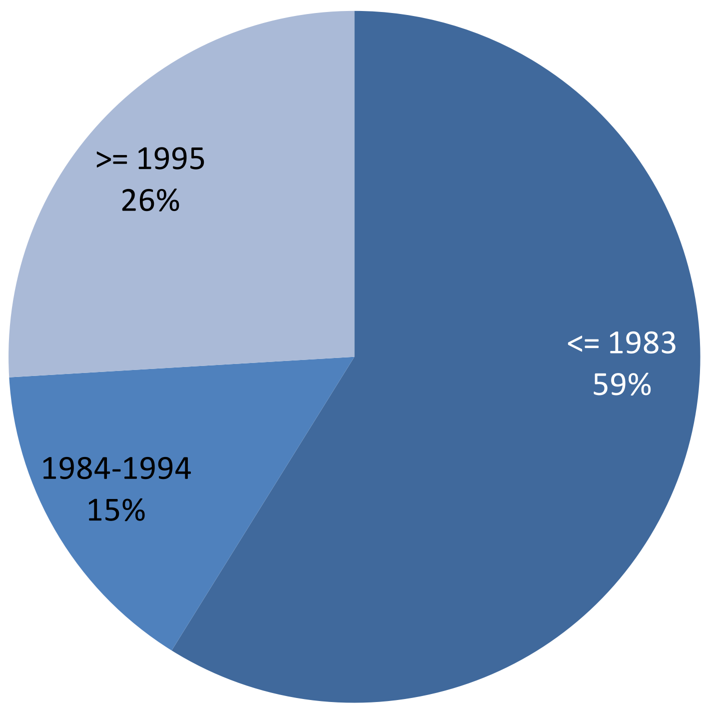

Figure 3.10: Distribution of Regional Single-Family Locations by Construction Year

3.2.6.3 Impact of Reclaimed Water Service and Irrigation Meters

As illustrated previously in Figure 3.8 (Section 3.2.5), single-family water use varies with presence of active reclaimed service and irrigation meters. In these analyses, water consumption is taken as total monthly use at a location divided by number of days in the month except for locations with irrigation meters. In these latter cases, monthly metered

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irrigation use is first subtracted from total use prior to division by number of days. Demand for these locations is assumed to reflect domestic (non-irrigation) use only. Figure 3.8 shows the following:

- Single-family homes with active reclaimed service average 178 gpud water use, compared to 225 gpud for homes without active reclaimed service or irrigation meters. Availability of reclaimed water service clearly has an effect of reducing total single-family demand. The difference in these measurements suggest an estimated 47 gpud of annual average irrigation use, which aligns well with the results of the seasonality (52 gpud) and surplus/deficit (56 gpud) analyses previously described.
- Average domestic use at homes with irrigation meters (192 gpud) is similar to total use at homes with reclaimed service. This indicates presence of active reclaimed service eliminates most outdoor potable use at a single family location.

Estimates of irrigation meter and reclaimed service impacts provided by cohort analyses do not control for other factors that might vary within and between cohorts. To control for these factors and better isolate and quantify the impacts of irrigation meters and reclaimed service, regression modeling is employed. A multiple regression model is developed to relate single-family water consumption (gallons per day) for individual locations in individual month/years to independent variables describing presence or absence of reclaimed service and irrigation meters, weather/seasonality, and property and occupant characteristics. Equation 3-1 specifies the general explanatory model used to relate single-family water consumption to independent variables.

Equation 3-1

$$\begin{aligned}\ln\big(QSF(k,t)\big) &= \alpha_0 + \sum_{\substack{continuous\\ variables\ q}} \beta_q \ln\big(q(k,t)\big) + \sum_{\substack{categorical\\ variables\ d}} \beta_d d(k,t) \\ &+ \sum_{l=0}^{2} \beta_{T_l}\Big(\ln\big(maxT(k,t-l)\big) - LTT(k,m(t)-l)\Big) \\ &+ \sum_{l=0}^{1} \beta_{P_l}\big(\ln(Prcp(k,t-l)+1) - LTP(k,m(t)-l)\big)\end{aligned}$$

Where:

QSF = Total single-family water use
k = Location
t = Time (month-and-year)
m = Month of year
q = Continuous variables (see Table 3-15)
d = Categorical variables (see Table 3-15)
l = Number of lag months
T = Temperature
$Prcp$ = Precipitation

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In this model, the dependent variable is taken as total monthly use divided by number of days in the month except for parcels with irrigation meters (in which cases metered irrigation use is first subtracted from total use). This treatment allows reductions in total water use through presence of reclaimed service (through the reclaimed service coefficient) to be compared to the portion of total use attributable to irrigation at locations with irrigation meters (through the irrigation meter coefficient) as part of the regression model.

Continuous and categorical variables used in the model are listed in Table 3-15. The model was fitted using a Statistical Analysis System (SAS) regression procedure. Table 3-16 shows fitting results and contains percent change results for all categorical variables in Table 3-15.[3]

The parcel regression model shows similar impacts of active reclaimed service and irrigation meters as the cohort analyses; coefficients for presence of active reclaimed service and an irrigation meter are nearly identical at -0.35764 and -0.35795, respectively meaning the impact of having a reclaimed water and an irrigation meter is virtually the same on domestic (weather-insensitive) demands.

According to the results provided in Table 3-16, the presence or absence of either irrigation meters or active reclaimed service results in approximately 30 percent reduction in demand from the domestic (non-irrigation) water meter. The regression in Table 3-16 also contains variables and parameters for other location characteristics such as presence of a pool, price of water, and property value. These results will be discussed in Section 3.2.6.7.

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[3] *Estimates of percent change for dependent variables implied by incrementing a categorical variable by 1 (e.g. 0 to 1 for presence of an irrigation meter or 3 to 4 for number of bathrooms) are specified as follows:*

$$p = \left[\frac{e^{\beta(d+1)}}{e^{\beta d}}\right] \times 100\% = e^{\beta} \times 100\%$$

where d is the categorical variable value before incrementing, β is the coefficient for the categorical variable, and f is the fractional change in the dependent variable due to incrementing from d to $d+1$. This equation results from exponentiating both sides of Equation 3-1, constructing a ratio of model results substituting $d+1$ and d for the categorical variable of choice in the numerator and denominator, respectively, and noting that all other numerator and denominator terms are identical (therefore cancelling out). This equation is biased for models derived from a small number of data points or for categorical parameters with standard errors that are large in relation to parameter estimates. In these cases, a bias-corrected calculation is $f = e^{\beta} - 0.5\sigma_{\beta}^{2}$, where σ_{β} is the standard error of the coefficient estimate.

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Table 3-15
Variables in Single-Family Parcel Data Regression Model

Variable	Raw Units	Var Type	Comment
Time (month-and-year)	-	Index: t	-
Month of year	-	Index: m	Also a function $m(t)$: if t = Feb 2004, $m(t)$ = Feb
Location	-	Index: k	-
Single family water consumption	Gal/day	Continuous (Dependent)	Varies with time, location
Gross covered area	Sq. ft.	Continuous	Varies with location
Just value of the property	2009 $		Varies with location
Fraction of green space	Fraction		Varies with location
Real marginal price of water/sewer	2006 $		Varies with time, location
Lag-l total monthly precipitation*	Inches	Continuous (Weather)	Varies with time, location
Lag-l maximum temperature*	° F		Varies with time, location
Lag-l transformed long-term normal precipitation*	Inches		Long-term avgs of $\ln(maxT(k,t))$, $\ln(Prcp(k,t)+1)$ for $m(t)=m$. Varies with location, month of year
Lag-l transformed long-term normal temperature*	° F		
Number of Bathrooms	count	Categorical	Varies with location
Monthly dummy ($m \in \{Jan \ldots Nov\}$)	unitless		1 if $m(t)=m$, 0 otherwise, varies with month of year
Presence of pool	unitless		1 if present, 0 if absent, varies with location
Presence of irrigation meter	unitless		1 if present, 0 if absent, varies with location
Presence of active reclaimed water service	unitless		1 if present, 0 if absent, varies with location

**Observed and long-term weather values are from historical WDPA-level transformed and station-distance-weighted weather data used in development of Tampa Bay Water's LTDFS. Each customer is assigned weather data estimated for the corresponding WDPA.*

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Table 3-16
Regression Model of Single-Family Water Use (gpud) Using Parcel Data

Parameter	Estimate	Standard Error	t	P	Categorical impact on demand*
Intercept	1.0185	0.00538	189.15	<.0001	-
Dummy: Jan	-0.05616	0.00076182	-73.72	<.0001	-5.5%
Dummy: Feb	-0.02527	0.00072595	-34.81	<.0001	-2.5%
Dummy: Mar	0.02516	0.00076252	32.99	<.0001	2.5%
Dummy: Apr	0.1108	0.00072699	152.41	<.0001	11.7%
Dummy: May	0.13317	0.00074348	179.11	<.0001	14.2%
Dummy: Jun	0.06156	0.00072354	85.08	<.0001	6.3%
Dummy: Jul	-0.04845	0.00075984	-63.77	<.0001	-4.7%
Dummy: Aug	-0.07121	0.00074699	-95.32	<.0001	-6.9%
Dummy: Sep	-0.06753	0.00074316	-90.86	<.0001	-6.5%
Dummy: Oct	-0.01421	0.0007321	-19.41	<.0001	-1.4%
Dummy: Nov	0.00142	0.00074613	1.91	0.0568	0.1%
Lag-0 temperature departure	0.45081	0.00641	70.28	<.0001	-
Lag-1 temperature departure	0.15207	0.00617	24.66	<.0001	-
Lag-2 temperature departure	0.18113	0.00599	30.23	<.0001	-
Lag-0 precipitation departure	-0.03999	0.00033664	-118.8	<.0001	-
Lag-1 precipitation departure	-0.01325	0.00035487	-37.35	<.0001	-
Real marginal price of water/sewer	-0.14191	0.00114	-124.66	<.0001	-
Gross covered area	0.41885	0.00074566	561.72	<.0001	-
Just Value of Property	0.07796	0.0004816	161.89	<.0001	-
Fraction Green Space	0.09804	0.00076497	128.16	<.0001	-
Number of Bathrooms	0.0906	0.00029846	303.55	<.0001	9%
Presence of pool	0.27818	0.00037618	739.49	<.0001	32%
Presence of irrigation meter	-0.35795	0.00169	-212.24	<.0001	-30%
Presence of reclaimed water service	-0.35764	0.0005041	-709.47	<.0001	-30%
# Obs Read	**35,091,905**				
# Obs Used	**33,911,194 (97%)**				
# Obs w/ missing data	**1,180,711 (3%)**				
Adjusted r2	**0.1375**				

** Percent impact implied by incrementing any categorical variable by 1.*

3.2.6.4 Impact of Automated Lawn Irrigation and Rain Sensors

To assess the impact of irrigation automation at various levels, another regression is performed using survey data combined with parcel data. This parcel-survey regression model relates single-family water consumption (monthly average gallons per day) for individual locations in individual month/years to independent variables describing presence or absence of reclaimed service and irrigation meters, weather/seasonality, property and occupant characteristics from parcel data, and survey responses describing presence of:

- irrigation activity by various mechanisms and using various sources,
- appliances of various types, and

- pools with or without solar covers and fed by various sources.

The parcel-survey regression model utilizes the continuous variables in Table 3-17 and the categorical variables in Table 3-18. Several of these variables are also used in the parcel regression model (Table 3-15). The form of the parcel-survey regression model is the same as in ***Equation 3-1***, but with different selections of categorical and continuous variables. The model was fitted using SAS regression procedures. Table 3-19 and Table 3-20 show fitting results for continuous and categorical variables, respectively.

Categorical variable results show trends in water use with degree of irrigation automation (Figure 3.11).

- Locations that irrigate without automated systems (i.e. manually) use 12 percent more water, on average, than locations that do not irrigate at all.
- Locations that use an automated irrigation system (with potable water as a source) use 32 percent more water than locations that do not irrigate
- Locations that use an automated irrigation system and rain sensor (with potable water as a source) use 41 percent more water than locations that do not irrigate, an increase of 29 percent over locations that irrigate manually and of 9 percent that use an irrigation system without a rain sensor.

Figure 3.11 also shows locations with an automated irrigation system and irrigation meter (with potable water as a source) use 67 percent more water than locations not irrigating, an increase of 55 percent over locations irrigating manually and an increase of 35 percent over locations irrigating with an automated system and no irrigation meter.

Comparison of these results with those in Section 3.2.6 indicates surplus irrigators are likely to be composed of locations having high levels of irrigation system automation and/or irrigation meters. As a customer asserts less direct control over irrigation, that customer may be less likely to be aware of inefficiencies. Figure 3.11 indicates it is not likely manual irrigators apply surplus amounts of water to their landscapes. Thus, this profile item suggests efficiency measures intended to eliminate surplus or excess irrigation will likely be facilitated by identifying irrigators with highly automated and/or separately metered irrigation.

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Table 3-17
Index and Continuous Variables in Parcel-Survey Regression Model

Variable	Raw Units	Variable Type	Comment
Time (month-and-year)	-	Index: t	-
Month of year	-	Index: m	Also a function $m(t)$: if t = Feb 2004, $m(t)$ = Feb
Location	-	Index: k	-
Single family water consumption	Gal/day	Dependent	Varies with time, location
Lag-l total monthly precipitation*	Inches	Independent (Weather)	Varies with time, location
Lag-l maximum temperature*	° F		Varies with time, location
Lag-l transformed long-term normal precipitation*	Inches		Long-term avgs of $\ln(maxT(k,t))$, $\ln(Prcp(k,t)+1)$ for $m(t) = m$. Varies with location, month
Lag-l transformed long-term normal temperature*	° F		
Real marginal price of water/sewer	2006 $	Independent	Varies with time, location
Persons per household	unitless		Varies with location
Gross covered area	Sq. ft.		Varies with location
Just value of the property	2009 $		Varies with location
Fraction of green space	Fraction		Varies with location
tret_rate	Toilet Retrofit Rates		Varies with location, month
sret_rate	Showerhead Retrofit Rates		Varies with location, month

**Observed and long-term weather values are WDPA-level transformed and station-distance-weighted weather data used in development of Tampa Bay Water's LTDFS. Each customer is assigned weather data estimated for the corresponding WDPA.*

Table 3-18
Categorical Variables in Parcel-Survey Regression Model

Variable	Raw Units	Variable Type	Comment
Monthly dummy ($m \in \{Jan \dots Nov\}$)	unitless	Independent	1 if $m(t) = m$, 0 otherwise, varies w/mth
Presence of front-loading washing machine	unitless	Independent	1 if present, 0 if absent, varies w/location
Presence of dishwasher	unitless	Independent	1 if present, 0 if absent, varies w/location
Survey Respondent Affirms that Irrigates…	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. System	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. System and Rain Sensor	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Well	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. System and Well	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. System, Well, and Rain Sensor	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Reclaimed Water	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Reclaimed Water and Rain Sensor	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. Meter	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. Meter and Rain Sensor	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. Meter and Well	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irr. Meter and Reclaimed Water	unitless	Independent	1 if yes, 0 if no, varies w/location
… by Other Means	unitless	Independent	1 if yes, 0 if no, varies w/location
Location has a Pool…	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Well	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Irrigation Meter	unitless	Independent	1 if yes, 0 if no, varies w/location
… w/Solar Cover	unitless	Independent	1 if yes, 0 if no, varies w/location

Table 3-19
Parcel-Survey Regression Model (continuous variables)

Parameter	Estimate	Standard Error	t	P
Intercept	0.6843	0.069	9.92	<.0001
Real Marginal Price	-0.3721	0.0125	-29.74	<.0001
Lag-0 temperature departure	1.373	0.0907	15.14	<.0001
Lag-1 temperature departure	0.5609	0.0952	5.89	<.0001
Lag-2 temperature departure	0.201	0.0871	2.31	0.0211
Lag-0 precipitation departure	-0.0546	0.0054	-10.2	<.0001
Lag-1 precipitation departure	-0.032	0.0054	-5.97	<.0001
Persons per household	0.402	0.0054	74.49	<.0001
Gross covered area	0.3992	0.0115	34.71	<.0001
Just Value of Property	0.1038	0.0077	13.5	<.0001
Fraction Green Space	0.6291	0.0359	17.5	<.0001
tret_rate	-0.0067	0.0058	-1.14	0.2526
sret_rate	0.0084	0.0092	0.91	0.3624

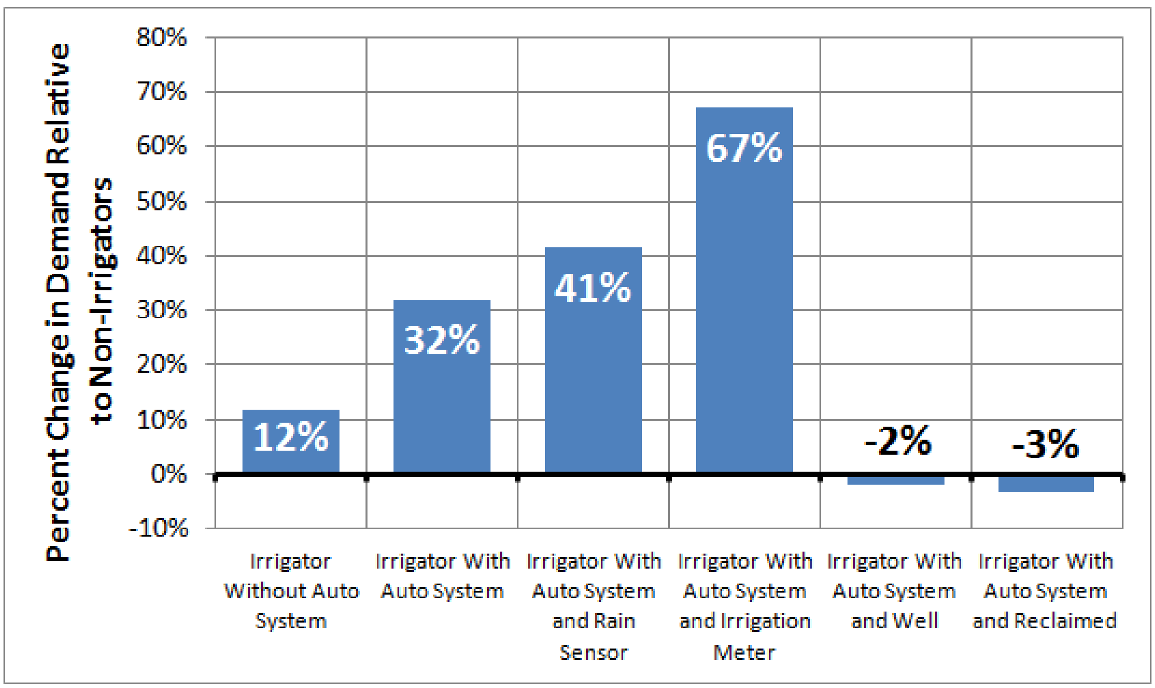

Figure 3.11: Percent Change in Regional Single-Family Average Daily Water Use Associated with Irrigation Practices of Various Levels of Automation (relative to non-irrigators).

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Table 3-20
Parcel-Survey Regression Model (categorical variables)

Parameter	Estimate	Standard Error	t	P	Categorical impact on demand*
Dummy: Jan	-0.0804	0.0121	-6.63	<.0001	-8%
Dummy: Feb	-0.0573	0.0119	-4.83	<.0001	-6%
Dummy: Mar	0.0407	0.0121	3.35	0.0008	4%
Dummy: Apr	0.119	0.012	9.96	<.0001	13%
Dummy: May	0.1262	0.012	10.49	<.0001	13%
Dummy: Jun	0.0414	0.012	3.46	0.0005	4%
Dummy: Jul	-0.0524	0.0124	-4.22	<.0001	-5%
Dummy: Aug	-0.1102	0.0122	-9.03	<.0001	-10%
Dummy: Sep	-0.0719	0.0121	-5.96	<.0001	-7%
Dummy: Oct	-0.0064	0.0119	-0.54	0.587	-1%
Dummy: Nov	0.0321	0.0121	2.65	0.008	3%
Presence of front-load clothes washer.	0.0217	0.006	3.62	0.0003	2%
Presence of dishwasher	-0.0457	0.0064	-7.15	<.0001	-4%
Irrigates…	0.1109	0.0078	14.24	<.0001	12%
… w/ Irr. System	0.1832	0.0102	17.98	<.0001	20%
… w/ Irr. System, Rain Sensor	0.0913	0.0096	9.52	<.0001	10%
… w/ Well	-0.2645	0.0207	-12.8	<.0001	-23%
… w/ Irr. System, Well	-0.1117	0.0236	-4.72	<.0001	-11%
… w/ Irr. System, Well, Rain Sensor	-0.2694	0.0175	-15.4	<.0001	-24%
… w/ Reclaimed Water	-0.4306	0.0145	-29.7	<.0001	-35%
… w/ Reclaimed Water, Rain Sensor	-0.1507	0.0202	-7.46	<.0001	-14%
… w/ Irr. Meter	0.3041	0.0274	11.09	<.0001	35%
… w/ Irr. Meter, Rain Sensor	-0.1773	0.0364	-4.87	<.0001	-16%
… w/ Irr. Meter, Well	0.6726	0.0915	7.35	<.0001	95%
… w/ Irr. Meter, Reclaimed Water	0.9827	0.043	22.87	<.0001	167%
… by Other Means	0.1213	0.0098	12.35	<.0001	13%
Location has a Pool…	0.2271	0.0068	33.26	<.0001	25%
… w/ Well	-0.0208	0.0161	-1.29	0.198	-2%
… w/ Irrigation Meter	0.0838	0.0289	2.9	0.0038	9%
… w/ Solar Cover	-0.1396	0.0121	-11.6	<.0001	-13%

** Percent impact implied by incrementing any categorical variable by 1*

3.2.6.5 Impact of Reclaimed Water / Alternative Sources

Figure 3.11 also illustrates irrigators who use alternative water sources as a group use approximately the same amount of potable water use as non-irrigators on average. This outcome implies , when alternative sources are used for irrigation, those sources tend to offset about all outdoor use that would otherwise be served with potable water. These results do not indicate all water uses are reduced by alternative sources; only potable outdoor use is reduced.

3.2.6.6 Impact of Pools and Solar Covers

Figure 3.12 illustrates that a single-family location with a pool uses about 25 percent more water, on average, than a location without a pool (holding all other variables in the model constant). Addition of a solar cover for the pool reduces use; it is estimated that locations with pools and a cover use only 12 percent more water, on average, than locations without pools. These results imply that promoting the use of solar covers for pools may be an effectively reduce outdoor use.

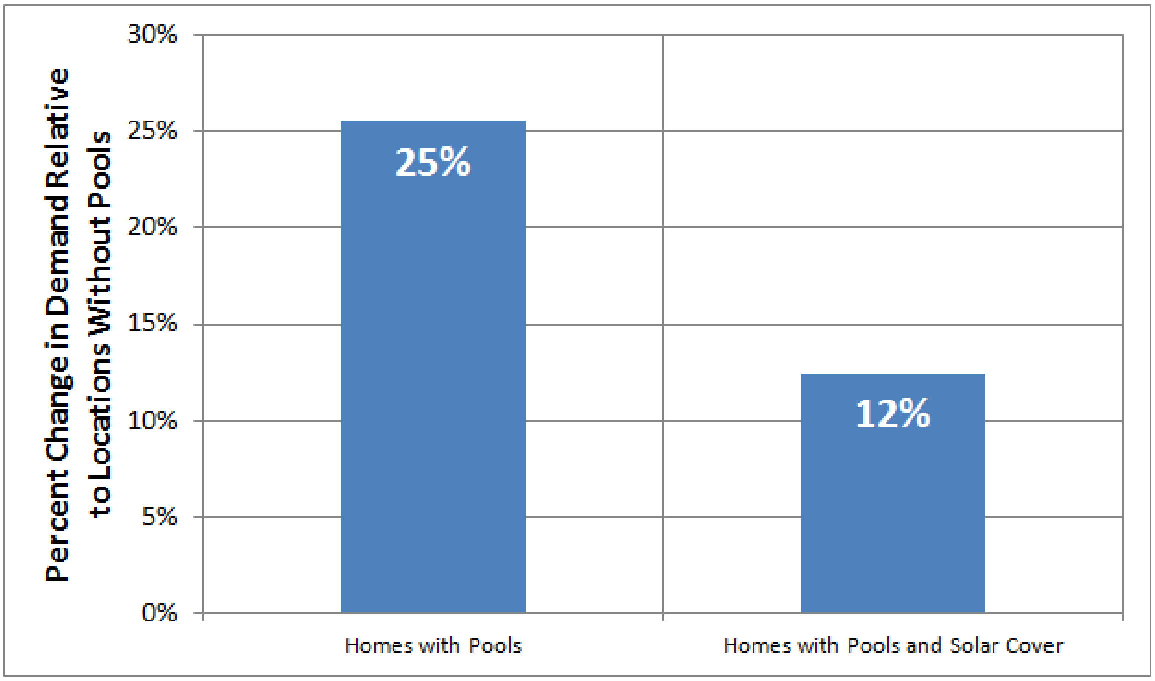

Figure 3.12: Percent Change in Single-Family Homes with Pools Average Daily Water Use With and Without Solar Covers (relative to locations without pools)

3.2.6.7 Impact of Other Location Characteristics

The two regression models presented above also informs on how single-family consumption relates to other locational characteristics. Both models show statistically significant impact of weather. Increases in temperature lead to increases in demand (positive temperature coefficients), while increases in precipitation lead to decreases in demand (negative precipitation coefficients). The strength of weather-demand relationship is strongest for weather occurring in the same month as use, while weather in progressively antecedent months has diminishing impacts on current-month demand. These trends agree with prior Tampa Bay Water modeling experience and common general understanding of weather impacts on demand.

Both models indicate that demands increase with:

- decreasing price of water and sewer,
- increasing gross covered area
- increasing property value, and
- increasing fraction of the property that is green space.

The parcel-survey model indicates that demands increase with more:

- persons per household and
- bathrooms

All of these outcomes are rational and consistent with theory and previous observations on the influence and correlation of socioeconomic and property characteristics on single-family water use.

3.2.6.8 Achieved Savings from Existing Efficiency Efforts

Statistical evaluations were undertaken to measure and verify impacts of existing conservation programs implemented by member governments. Tampa Bay Water member government conservation programs are intended to promote and improve the adoption of Best Management Practices (BMPs) for water efficiency by single-family customers. Currently, member government efficiency programs consist of:

- Ultra Low Flow Toilet (ULFT) Rebate program
- Florida-Friendly Landscape (FFL) program
- Irrigation System Evaluation (ISE) program
- Soil Moisture Sensor (SMS) program

As part of the single-family demand profile, each program is assessed for effectiveness in reducing water use at individual participating locations. These assessments consist of regression models for water consumption at individual locations where BMPs have been implemented. Each model compares consumption at each location before and after implementation, attributing changes in water use with program participation.

Two different regression model forms are specified for the stated purpose: explanatory and fixed-effects water consumption models. *Explanatory water consumption models* relate consumption (monthly gallons per day) for individual locations k in individual month/years t to independent variables describing weather/seasonality, BMP implementation, and various customer characteristics at those locations and times. The explanatory model specification is the same as in ***Equation 3-1***, whereas the models for individual programs employ some or all of the continuous and categorical variable specifications listed in Table 3-21 and Table 3-22. The main structural difference from prior models is

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the inclusion of a categorical variable representing BMP implementation at a specific location and time, with a value of 0 indicating periods before participating and a value of 1 indicating periods after participation.

Unlike explanatory models, *fixed effects water consumption models* relate consumption for each individual customer in each month/year to independent variables describing weather/seasonality and BMP implementation only. Each fixed effect model contains

- a separate categorical variable (or fixed effect variable) for each individual location in the model data set, along with
- a smaller set of categorical and continuous explanatory variables targeting water use relationships of principal interest, namely lag-0 weather variables, monthly dummy variable, a categorical variable for BMP implementation, and other selected categorical variables describing location characteristics.

The fixed effect variables adjust the model intercept for each individual location, explicitly controlling for systematic differences in water consumption between locations not explained by explanatory variables in the model. Equation 3-2 provides the fixed-effects model specification.

Equation 3-2

$$\ln\left(QSF(k,t)\right) = \sum_{\substack{categorical\\variables\ d}} \beta_d d(k,t) + \sum_{\substack{fixed-effect\\variables\ f}} \beta_f f(k,t) + \beta_{T_0}\left(\ln\left(maxT(k,t)\right) - LTT\left(k,m(t)\right)\right) + \beta_{P_{0l}}\left(\ln(Prcp(k,t)+1) - LTP\left(k,m(t)\right)\right)$$

Each program is analyzed by developing several regression models of one or both forms. Both model forms are fitted using SAS regression procedures.

3.2.6.9 The Ultra Low Flow Toilet Rebate (ULFT) Program

The ULFT program offers rebates to single-family customers that purchase and install ULFTs (1.6 gallons per flush). Through 2008 the ULFT program was only offered in Hillsborough and Pinellas counties, including Northwest Hillsborough WDPA, South Central Hillsborough WDPA, City of Tampa WDPA, Pinellas WDPA, and St. Petersburg WDPA. A total of three explanatory models were developed for three different groups of ULFT-participating customers:

- All participating locations (19,481)
- Locations having one intervention and rebate (12,311)
- Locations having two interventions rebates (6,600)

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Table 3-21
Index and Continuous Variables in Explanatory BMP Regression Models

Variable	Raw Units	Variable Type	Comment
Time (month-and-year)	-	Index: t	-
Month of year	-	Index: m	Also a function $m(t)$: if t = Feb 2004, $m(t)$ = Feb
Location	-	Index: k	-
Single family water consumption	Gal/day	Dependent	Varies with time, location
Lag-l total monthly precipitation*	Inches	Independent (Weather)	Varies with time, location
Lag-l maximum temperature*	° F		Varies with time, location
Lag-l transformed long-term normal precipitation*	Inches		Long-term avgs of $\ln(maxT(k,t))$, $\ln(Prcp(k,t)+1)$ for $m(t)=m$. Varies with location, month of year
Lag-l transformed long-term normal temperature*	° F		
Real marginal price of water/sewer	2006 $	Independent	Varies with time, location
Persons per household	unitless		Varies with location
Gross covered area	Sq. ft.		Varies with location
Just value of the property	2009 $		Varies with location
Fraction of green space	Fraction		Varies with location

**Observed and long-term weather values are from historical WDPA-level transformed and station-distance-weighted weather data used in development of Tampa Bay Water's LTDFS. Each customer is assigned weather data estimated for the corresponding WDPA.*

Table 3-22
Categorical Variables in Explanatory BMP Regression Models

Variable	Raw Units	Variable Type	Comment
Monthly dummy ($m \in \{Jan \ldots Nov\}$)	unitless	Independent	1 if $m(t)=m$, 0 otherwise, varies w/ month of year
Number of bathrooms	unitless	Independent	Count, varies with location
Location has a Pool	unitless	Independent	1 if yes, 0 if no, varies with location
Location has an Irrigation Meter	unitless	Independent	1 if yes, 0 if no, varies with location
Location has Active Reclaimed Water Service	unitless	Independent	1 if yes, 0 if no, varies with location
Location has BMP implementation	unitless	Independent	1 if yes, 0 if no, varies with location and time

Table 3-23 shows how these ULFT-participating customers are allocated across WDPAs. To be included in ULFT explanatory models, a location must have a minimum of one month of water consumption data prior to and following intervention (toilet replacement). Furthermore, water consumption data occurring less than one month prior to or following the intervention are disregarded. For locations having two or more interventions, consumption data between the first and last interventions are disregarded; all comparisons of water use over time focus on use before initial and after final interventions. The dependent variable in each model is water use per day for each location and month/year, with the exception of 82 participants in Tampa with irrigation water use. For these exceptions, irrigation water use is subtracted from total water use (for the same reasons as described in Section 3.2.6.3).

Table 3-23
ULFT Program Customer Participation by WDPA

	All Participants	One Rebate	Two Rebates
NWH	2,004	982	908
SCH	2,650	1,360	1,188
COT	1,692	1,238	406
PIN	8,765	5,480	2,983
STP	4,370	3,251	1,115
Total	19,481	12,311	6,600

Table 3-24 and Table 3-25 provide regression results for the explanatory models. The impact of the ULFT program (across all member governments) is evaluated through the program dummy variable coefficient in each model. Participating locations use 11.7 percent less water after all interventions are complete. Locations with one toilet replacement average 10.8 percent water savings after intervention. Locations with two replacements average 12.8 percent water savings, on average, after the final intervention. These results imply that multiple toilet replacements lead to only a small (roughly 2%) incremental increase in water savings (relative to pre-intervention water use), supporting the assertion that customers tend to replace their most frequently-used toilets first and suggesting that most of the effectiveness of a ULFT program that offers multiple toilets is derived from replacement of a single toilet.

3.2.6.10 The Florida Friendly Landscapes (FFL) Program

The Florida Friendly Landscapes (FFL) Program is the application of science-based landscape practices to help design and maintain attractive and sustainable landscapes. The purpose of the FFL program is to minimize the need for supplemental water, fertilizer, and pesticides by selecting proper native plants for landscaping and locating those plants properly within the landscape.

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The effectiveness of the FFL program is evaluated using both fixed-effect and explanatory models of single-family water consumption. Models of each type are developed using one-year and two-year time scales.

- One-year scale: models are developed using 12-months of water consumption data prior to and following intervention.
- Two-year scale: models are developed using 24-months of water consumption data prior to and following intervention.

For both time scales, locations with insufficient data before and after intervention are omitted. Furthermore, consumption records between WYs 1999 and 2009 (inclusive) are used for all WDPA's.[4] Locations whose one or two years of pre- and post-intervention data fall outside of these ranges are omitted from analysis. Table 3-26 provides the number of participant locations by member government and time scale along with the range of intervention dates encountered for each time scale. In all, four models are developed, a fixed effect model and an explanatory model at each time scale. Regression results for fixed effects and explanatory models are provided in Table 3-27 and Table 3-28, respectively. The impact of the program (across all member governments) is evaluated through the program dummy variable coefficient in each model.

- At a one-year time scale, fixed-effect and explanatory models estimate 4.7 percent and 3.0 percent water consumption savings due to FFL intervention, respectively.
- At a two-year time scale, fixed-effect and explanatory models estimate 8.3 percent and 5.0 percent water consumption savings due to FFL intervention, respectively.

The increased water savings at the two-year time scale relative to the one-year scale may imply that the FFL program helps save more water as plants grow larger and more mature. The increased savings may also arise from increasing experience over time among participants in maintaining their landscapes.

Estimates of water savings from either model specification can be considered valid, depending on whether one considers and accepts the role of other explanatory factors that are not captured by the variables available from parcel data By controlling explicitly for inter-location consumption differences, the fixed-effects model maximizes explanation of water consumption differences over time within the BMP implementation variable. However, the explanatory model shows that some change in consumption over time and between locations can be explained by other factors that are defined, such as price effects that could be reducing use that might otherwise be attributable to the program. It is therefore reasonable to express water savings due to Florida Friendly Landscaping as a range: from 3.0-4.7 percent after one year and from 5-8.3 percent after two years.

[4] *Water consumption data prior to WY 2003 are omitted for Tampa customers with irrigation meters due to indications of systematic excessively high consumption between WY 1998 and WY 2002.*

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Table 3-24
Explanatory Model for Consumption for ULFT Rebate Participants: Categorical

	All Interventions 2,181,300 obs, adj. r^2 = 0.129			One Rebate 1,386,331 obs, adj. r^2 = 0.138			Two Rebates 733,712 obs, adj. r^2 = 0.090		
Parameter	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Intercept	2.21	0.023	96.79	2.402	0.028	85.16	2.036	0.042	49.06
Dummy: Jan	-0.052	0.003	-19.17	-0.046	0.003	-13.54	-0.06	0.005	-12.91
Dummy: Feb	-0.001	0.003	-0.36	0	0.003	0.07	-0.002	0.005	-0.42
Dummy: Mar	0.03	0.003	10.9	0.029	0.003	8.56	0.031	0.005	6.7
Dummy: Apr	0.106	0.003	39.67	0.099	0.003	29.46	0.118	0.005	25.63
Dummy: May	0.114	0.003	42.82	0.107	0.003	31.97	0.125	0.005	27.24
Dummy: Jun	0.063	0.003	23.48	0.054	0.003	16.26	0.075	0.005	16.42
Dummy: Jul	-0.031	0.003	-11.22	-0.032	0.003	-9.29	-0.028	0.005	-5.92
Dummy: Aug	-0.064	0.003	-23.37	-0.062	0.003	-18.09	-0.066	0.005	-14.01
Dummy: Sep	-0.048	0.003	-17.67	-0.046	0.003	-13.75	-0.049	0.005	-10.6
Dummy: Oct	0	0.003	-0.06	-0.002	0.003	-0.6	0.002	0.005	0.4
Dummy: Nov	0.025	0.003	9.55	0.021	0.003	6.3	0.032	0.005	6.96
Number of Bathrooms	0.098	0.001	83.39	0.109	0.001	75.73	0.065	0.002	27.42
Location has a Pool	0.331	0.001	242.38	0.348	0.002	193.88	0.306	0.002	138.11
Location w/ Irr Mtr	-0.097	0.01	-9.52	-0.15	0.013	-11.38	0.03	0.019	1.54
Location w/ Reclaimed	-0.19	0.002	-105.91	-0.186	0.002	-79.95	-0.183	0.003	-61.2
Location w/BMP	-0.125	0.001	-98.08	-0.114	0.002	-70.95	-0.137	0.002	-62.95

Table 3-25
Explanatory Model for Consumption Among ULFT Rebate Participants: Continuous

	All Interventions 2,181,300 obs, adj. r^2 = 0.129			One Rebate 1,386,331 obs, adj. r^2 = 0.138			Two Rebates 733,712 obs, adj. r^2 = 0.090		
Parameter	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Lag-0 Temp Departure	0.377	0.023	16.5	0.325	0.029	11.37	0.464	0.039	11.79
Lag-1 Temp Departure	0.101	0.023	4.45	0.099	0.028	3.46	0.112	0.039	2.88
Lag-2 Temp Departure	0.236	0.022	10.61	0.161	0.028	5.77	0.366	0.038	9.53
Lag-0 Precip Departure	-0.033	0.001	-27.88	-0.028	0.001	-19.34	-0.038	0.002	-18.9
Lag-1 Precip Departure	-0.02	0.001	-16.49	-0.016	0.001	-10.47	-0.026	0.002	-12.42
Price of water/sewer	-0.122	0.006	-20.76	-0.168	0.007	-22.75	-0.042	0.01	-4.11
Gross Covered Area	0.434	0.003	148.39	0.431	0.004	119.68	0.423	0.005	79.47
Just Property Value	-0.043	0.002	-22.13	-0.052	0.002	-21.87	-0.029	0.004	-8.01
Fraction Green Space	0.034	0.003	9.97	0.049	0.004	11.17	0.007	0.006	1.15

Table 3-26
Distribution of FFL Participants by Modeling Time Scale

	Number of Locations								Intervention Date Range	
Time scale	**PAS**	**NPR**	**NWH**	**SCH**	**COT**	**PIN**	**STP**	**Total**	**Min**	**Max**
1-year	5	4	4	9	13	42	53	130	1-Feb	8-Jul
2-year	3	3	4	9	1s1	37	47	114	1-Feb	6-Apr

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Table 3-27
Fixed Effects Model for Consumption Among FFL Participants

	1-year time scale 3,115 obs, adj. r^2 = 0 759			2-year time scale 5,436 obs, adj. r^2 = 0.714		
Variable	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Dummy: Jan	-0.143	0.037	-3.82	-0.115	0.031	-3.67
Dummy: Feb	-0.057	0.036	-1.59	-0.052	0.03	-1.71
Dummy: Mar	-0.002	0.037	-0.06	0.017	0.031	0.55
Dummy: Apr	0.14	0.036	3.86	0.139	0.03	4.56
Dummy: May	0.14	0.036	3.83	0.117	0.031	3.83
Dummy: Jun	0.104	0.037	2.84	0.088	0.031	2.81
Dummy: Jul	-0.065	0.036	-1.79	-0.1	0.031	-3.25
Dummy: Aug	-0.102	0.036	-2.81	-0.13	0.031	-4.27
Dummy: Sep	-0.089	0.036	-2.48	-0.09	0.03	-2.96
Dummy: Oct	-0.061	0.036	-1.69	-0.047	0.031	-1.53
Dummy: Nov	0.002	0.036	0.06	0.012	0.031	0.39
Lag-0 Temp Departure	0.879	0.32	2.74	0.709	0.276	2.57
Lag-0 Precip Departure	-0.068	0.017	-4.04	-0.063	0.014	-4.45
Location w/BMP	-0.048	0.015	-3.25	-0.086	0.012	-6.93

Table 3-28
Explanatory Model for Consumption Among FFL Participants

	1-year time scale 3,115 obs, adj. r^2 = 0.211			2-year time scale 5,436 obs, adj. r^2 = 0.204		
Parameter	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Intercept	6.193	0.571	10.84	6.596	0.439	15.03
Dummy: Jan	-0.135	0.067	-2.02	-0.119	0.049	-2.42
Dummy: Feb	-0.084	0.065	-1.29	-0.069	0.048	-1.43
Dummy: Mar	-0.026	0.067	-0.39	-0.004	0.050	-0.08
Dummy: Apr	0.095	0.065	1.46	0.107	0.048	2.24
Dummy: May	0.088	0.065	1.35	0.086	0.048	1.78
Dummy: Jun	0.053	0.065	0.82	0.022	0.048	0.46
Dummy: Jul	-0.110	0.068	-1.63	-0.144	0.050	-2.86
Dummy: Aug	-0.144	0.067	-2.16	-0.178	0.049	-3.62
Dummy: Sep	-0.150	0.065	-2.30	-0.136	0.049	-2.80
Dummy: Oct	-0.090	0.065	-1.39	-0.069	0.048	-1.44
Dummy: Nov	-0.012	0.064	-0.18	0.011	0.048	0.24
Lag-0 Temperature Departure	1.265	0.557	2.27	1.306	0.423	3.09
Lag-1 Temperature Departure	0.458	0.549	0.83	0.414	0.417	0.99
Lag-2 Temperature Departure	0.722	0.526	1.37	0.420	0.399	1.05
Lag-0 Precipitation Departure	-0.063	0.029	-2.20	-0.030	0.022	-1.40
Lag-1 Precipitation Departure	-0.034	0.029	-1.17	-0.004	0.022	-0.17
Real marginal price of water/sewer	-1.479	0.099	-15.01	-1.117	0.073	-15.36
Gross Covered Area	-0.185	0.070	-2.63	-0.091	0.052	-1.76
Just Value of the Property	0.224	0.056	3.97	0.069	0.042	1.62
Fraction of green space	0.440	0.079	5.54	0.546	0.058	9.46
Number of bathrooms	0.227	0.027	8.38	0.231	0.020	11.26
Location has a Pool	0.489	0.032	15.12	0.552	0.024	22.67
Location has BMP implementation	-0.030	0.026	-1.16	-0.051	0.020	-2.62

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3.2.6.11 Irrigation System Evaluation (ISE) Program

The Irrigation System Evaluation (ISE) program provides customers with landscape-specific irrigation schedules and recommendations to improve technological irrigation efficiency. This program has been offered in the Northwest Hillsborough, South Central Hillsborough, City of Tampa, and St. Petersburg WDPAs.

The effectiveness of the ISE program is evaluated using both fixed-effect and explanatory models of single-family water consumption. As with the FFL program, models of each type are developed using one-year and two-year time scales.

- One-year scale: models are developed using 12 months of water consumption data prior to and following intervention.
- Two-year scale: models are developed using 24 months of water consumption data prior to and following intervention.

For both time scales, locations with insufficient data before and after intervention are omitted. Similar to the FFL program, consumption records between WYs 1999 and 2009 (inclusive) are used for all WDPA's.[5] In addition, some extreme low and high values were screened as outliers. Table 3-29 provides the number of participant locations by member government and time scale along with the range of intervention dates encountered for each time scale.

Table 3-29
Distribution of ISE Participants by Modeling Time Scale

Time scale	Number of Locations					Intervention Date Range	
	NWH	**SCH**	**COT**	**STP**	**Total**	**Min**	**Max**
1-year	4	0	371	25	400	Feb-01	Jul-08
2-year	2	0	188	24	214	Feb-01	Apr-06

A fixed-effect and explanatory model are developed for each time scale resulting in four models. Regression results for fixed effects and explanatory models are provided in Table 3-30 and Table 3-31, respectively. The impact of the program (across all member governments) is evaluated through the program dummy variable coefficient in each model. At each time scale, fixed effects and explanatory models result in small differences in estimates of water use reductions associated with ISE interventions.

- At a one-year time scale, fixed-effect and explanatory models estimate 6.9 percent and 7.4 percent water consumption savings due to FFL intervention, respectively.

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[5] *Water consumption data prior to WY 2003 are omitted for Tampa customers with irrigation meters due to indications of systematic excessively high consumption between WY 1998 and WY 2002.*

- At a two-year time scale, fixed-effect and explanatory models estimate 2.9 percent and 2.6 percent water consumption savings due to FFL intervention, respectively.

It is therefore reasonable to express water savings due to ISEs as a range: from 6.9-7.4 percent after one year and from 2.6-2.9 percent after two years. Unlike the FFL case, the estimated water use reduction is lower at a 2-year timescale than a 1-year timescale, suggesting that the ISE program results in lower water use soon, more than 1 year, after implementation, and program savings erode with time.

Table 3-30
Fixed Effects Model for Consumption Among Irrigation System Evaluation Participants

	1-year time scale 9,600 obs, adj. r^2 = 0.650			2-year time scale 10,272 obs, adj. r^2 = 0.608		
Variable	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Dummy: Jan	-0.114	0.020	-5.65	-0.122	0.020	-5.99
Dummy: Feb	-0.072	0.020	-3.64	-0.067	0.020	-3.39
Dummy: Mar	-0.056	0.020	-2.77	0.005	0.020	0.25
Dummy: Apr	0.092	0.020	4.71	0.164	0.020	8.27
Dummy: May	0.113	0.020	5.73	0.181	0.020	9.01
Dummy: Jun	0.026	0.020	1.32	0.105	0.020	5.21
Dummy: Jul	-0.186	0.020	-9.45	-0.205	0.020	-10.31
Dummy: Aug	-0.240	0.020	-12.21	-0.254	0.020	-12.82
Dummy: Sep	-0.143	0.020	-7.26	-0.140	0.020	-7.10
Dummy: Oct	-0.004	0.020	-0.20	-0.031	0.020	-1.57
Dummy: Nov	0.021	0.020	1.05	0.027	0.020	1.35
Lag-0 Temperature Departure	0.683	0.172	3.98	0.677	0.172	3.93
Lag-0 Precipitation Departure	-0.097	0.009	-11.02	-0.098	0.009	-10.94
Location has BMP implementation	-0.072	0.008	-8.91	-0.029	0.008	-3.60

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Table 3-31
Explanatory Model for Consumption Irrigation System Evaluation Participants

	1-year time scale 9,600 obs, adj. r^2 = 0.221			2-year time scale 10,272 obs, adj. r^2 = 0.228		
Variable	**Est**	**Std Err**	**t Value**	**Est**	**Std Err**	**t Value**
Intercept	1.696	0.272	6.24	3.540	0.263	13.47
Dummy: Jan	-0.089	0.030	-2.93	-0.093	0.029	-3.24
Dummy: Feb	-0.082	0.029	-2.82	-0.087	0.028	-3.11
Dummy: Mar	-0.026	0.030	-0.86	0.030	0.029	1.06
Dummy: Apr	0.086	0.029	2.94	0.147	0.028	5.29
Dummy: May	0.135	0.030	4.56	0.196	0.028	6.94
Dummy: Jun	0.028	0.029	0.95	0.083	0.028	2.94
Dummy: Jul	-0.141	0.031	-4.55	-0.160	0.029	-5.44
Dummy: Aug	-0.210	0.030	-6.94	-0.235	0.029	-8.23
Dummy: Sep	-0.127	0.030	-4.24	-0.131	0.028	-4.64
Dummy: Oct	0.016	0.029	0.55	-0.001	0.028	-0.04
Dummy: Nov	0.026	0.030	0.85	0.032	0.028	1.15
Lag-0 Temperature Departure	-0.345	0.264	-1.31	0.205	0.249	0.82
Lag-1 Temperature Departure	0.263	0.252	1.04	0.412	0.241	1.71
Lag-2 Temperature Departure	-0.032	0.249	-0.13	-0.154	0.233	-0.66
Lag-0 Precipitation Departure	-0.109	0.013	-8.36	-0.097	0.012	-7.76
Lag-1 Precipitation Departure	-0.074	0.014	-5.48	-0.073	0.013	-5.65
Real marginal price of water/sewer	-0.327	0.093	-3.52	-0.815	0.082	-9.93
Gross Covered Area	0.330	0.030	10.85	0.342	0.030	11.56
Just Value of the Property	0.188	0.016	11.77	0.096	0.014	6.95
Fraction of green space	0.407	0.038	10.79	0.423	0.036	11.78
Number of bathrooms	0.019	0.010	1.80	0.051	0.010	4.92
Location has a Pool	0.035	0.013	2.67	0.028	0.013	2.17
Location has an Irrigation Meter	0.318	0.023	13.71	0.441	0.027	16.36
Location has BMP implementation	-0.076	0.012	-6.46	-0.027	0.011	-2.36

3.3 Multifamily Water Use Patterns and Trends

Like the single-family customer class profile, the multifamily analysis evaluates trends in unit usage rates and estimates the average split between indoor and outdoor use. Unlike single-family, however, the multifamily sector encompasses a broader range of occupancy, property, and property management characteristics. Most notably, multifamily locations vary widely by the number of dwelling units at each location. Furthermore, these locations vary by whether occupants own or rent their units, whether or not occupants are responsible for maintaining outdoor areas, and whether or not indoor and/or outdoor water use is sub metered or is not a potable source.

3.3.1 Baseline Annual Average Per Unit Use

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Table 3-32 shows annual average multifamily water use in gallons per unit per day (gpud) for each WDPA and the region as a whole and for each WY over WYs 2002-2008. Table 3-33 shows how annual average multifamily water use in each WDPA varies from the regional average.

Table 3-32
WY-Average Multifamily Per-Unit Consumption (gpud) over WYs 2002-2008 for the Tampa Bay Region and for Individual Member Governments

WY	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	118	94	115	118	107	135	115	113
2003	115	87	112	116	119	133	107	108
2004	117	87	107	119	120	139	109	109
2005	119	97	117	122	120	142	107	111
2006	118	89	134	120	119	143	101	114
2007	114	77	116	124	115	141	97	110
2008	114	77	103	125	114	138	102	107
Mean	117	87	115	120	116	139	106	110

Table 3-33
Variation in Member Government Average Multifamily Per-Unit Consumption (gpud) over WYs 2002-2008 (percent difference from regional average values)

WY	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	-20.6%	-2.4%	-0.2%	-9.6%	13.9%	-2.4%	-4.3%
2003	-24.4%	-2.8%	0.8%	3.3%	15.8%	-6.4%	-5.8%
2004	-25.3%	-8.5%	1.9%	2.2%	18.6%	-7.0%	-6.8%
2005	-18.1%	-1.5%	2.1%	1.1%	19.7%	-10.0%	-6.7%
2006	-24.2%	13.5%	1.5%	1.2%	21.7%	-14.1%	-3.6%
2007	-32.6%	1.6%	8.2%	0.7%	23.4%	-15.4%	-4.0%
2008	-32.4%	-9.4%	9.9%	-0.5%	21.2%	-10.4%	-6.4%
Mean	-25.3%	-1.3%	3.4%	-0.3%	19.1%	-9.4%	-5.4%

Multifamily annual average water use per unit across the region is about 117 gpud, but varies greatly by member government. Between WYs 2002-2008, the 7-year annual average rate of multifamily use per unit in the City of Tampa is higher than the Tampa Bay Water regional average by 19 percent. This could be in part due to older complexes with larger landscapes and limited access to alternative water sources for irrigation. Conversely, the 7-year annual average rate of multifamily use per unit in Pasco County is 25 percent lower than the Tampa Bay Water regional average, followed by Pinellas County at 9.4 percent. This variation may be in part due to a newer multifamily housing stock and customer's having greater access to alternative sources for irrigation such as reclaimed water, surface water or shallow wells.

Figure 3.13 illustrates regional multifamily demands for WYs 2002-2008, while Figure 3.14 illustrates the range of WY 2008 average rates of use by WDPA. As with single-family demand, multifamily demand variability is much larger between WDPAs than over time.

3.3.2 Distribution of WY 2008 Water Use by Month (Distribution Analysis)

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Figure 3.15 presents means and $5^{th}/95^{th}$ percentiles of multifamily location water use by month for WY 2008 (top panel) as well as observed monthly average maximum daily temperature and monthly total rainfall observed at Tampa International Airport for that WY (bottom panel).

Demands in the multifamily customer class are much less seasonally variable, and much less sensitive to weather, than single-family demands with some like comparisons;

- Like in the single-family customer class, 5th percentile demands are fairly stable year-round, ranging from 15 to 45 gpd, with an increase in 5th percentile use from February to March (perhaps indicating an increase in temporary residents during the spring break periods).
- Unlike the single-family customer class, 95th percentile demands vary minimally across the year. The demand distributions for April to June reflect none of the high temperature and low rainfall effects visible in single-family distributions, and the July-September distributions show no effects of increased precipitation during the summer.

The lack of seasonality and weather sensitivity in multifamily demand agrees with findings during development of the Long-Term Demand Forecasting system (LTDFS), where coefficients for weather terms are smaller in magnitude for the multifamily forecast model than for the single-family model. This relative lack of seasonality and weather sensitivity could arise from many factors, such as less irrigated turf area, non-potable irrigation sources (wells) and more centralized (i.e., non-occupant) control of irrigation at multifamily properties.

3.3.3 Non-Seasonal Water Use (Indoor - Minimum Month)

Indoor and outdoor water use for multifamily locations is assessed using the same minimum-month technique (Method B, Section 3.2.4) as employed for the single-family customer class. Results are shown in Figure 3.16 through Figure 3.18 and Table 3-34 through Table 3-36.

- Long-term average multifamily per-unit consumption is 117 gpud.
- The lowest monthly average multifamily per-unit consumption rate for Tampa Bay Water as a whole is 110 gallons per unit per day (occurring in September 2002). For the region and customer class as a whole, weather-sensitive use is estimated as anything above 110 gpud.
- Weather-sensitive use, on average, composes 7 gpud (6%) of total use. Weather-insensitive use (110 gpud) thus is assumed to represent about 94 percent of average demand.
- Depending on time of year, average weather-sensitive uses at individual multifamily locations are estimated to range from 0 to more than 10 percent of total average demand.

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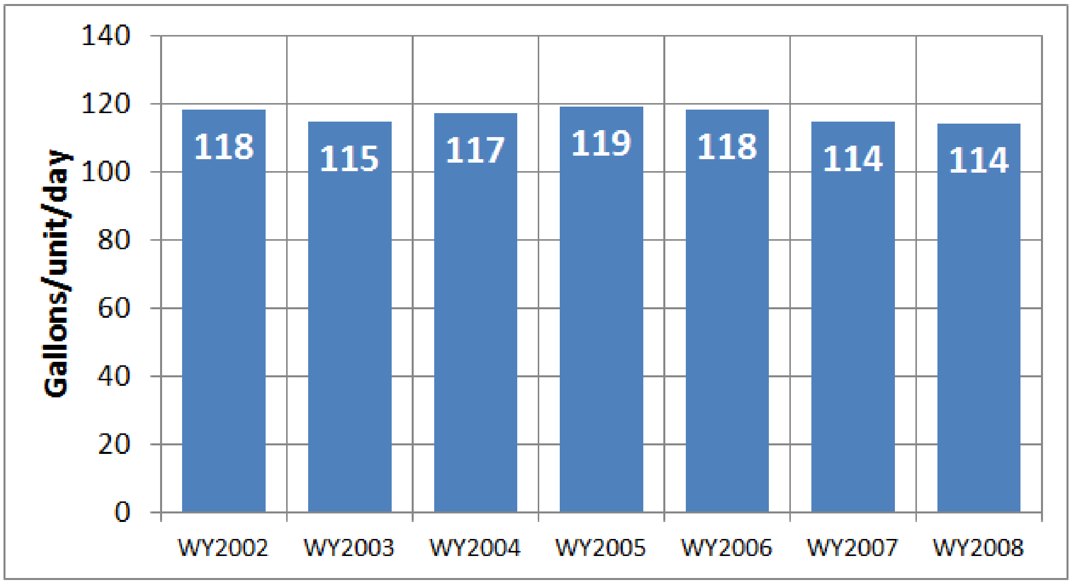

Figure 3.13: WY-Average Multifamily Per-Unit Consumption (gpud) over WYs 2002-2008 for the Tampa Bay Water Region

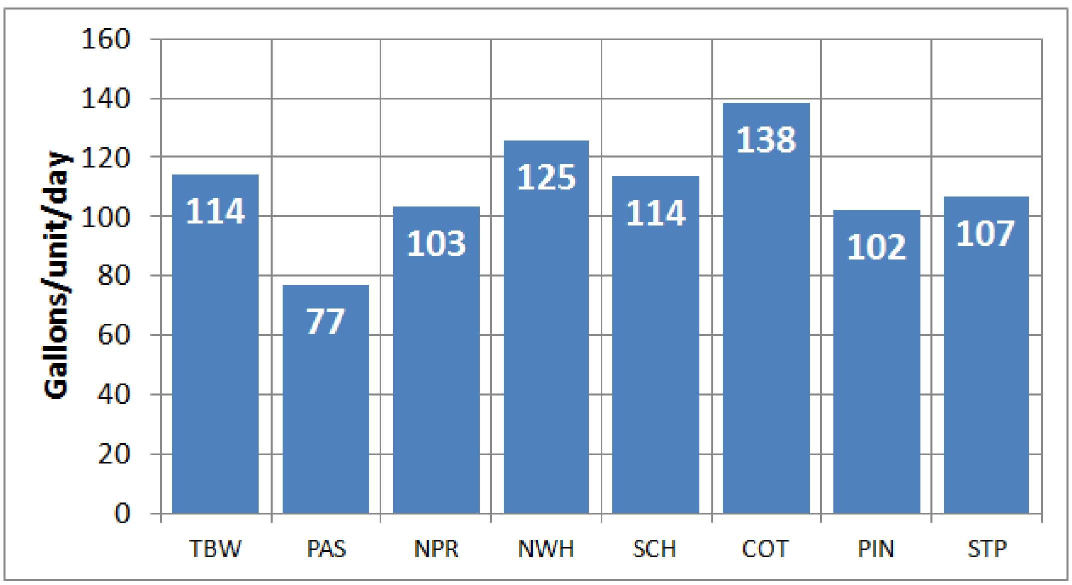

Figure 3.14: Average Multifamily Per-Unit Consumption (gpud) for the Tampa Bay Water Region and Individual WDPAs (WY 2008)

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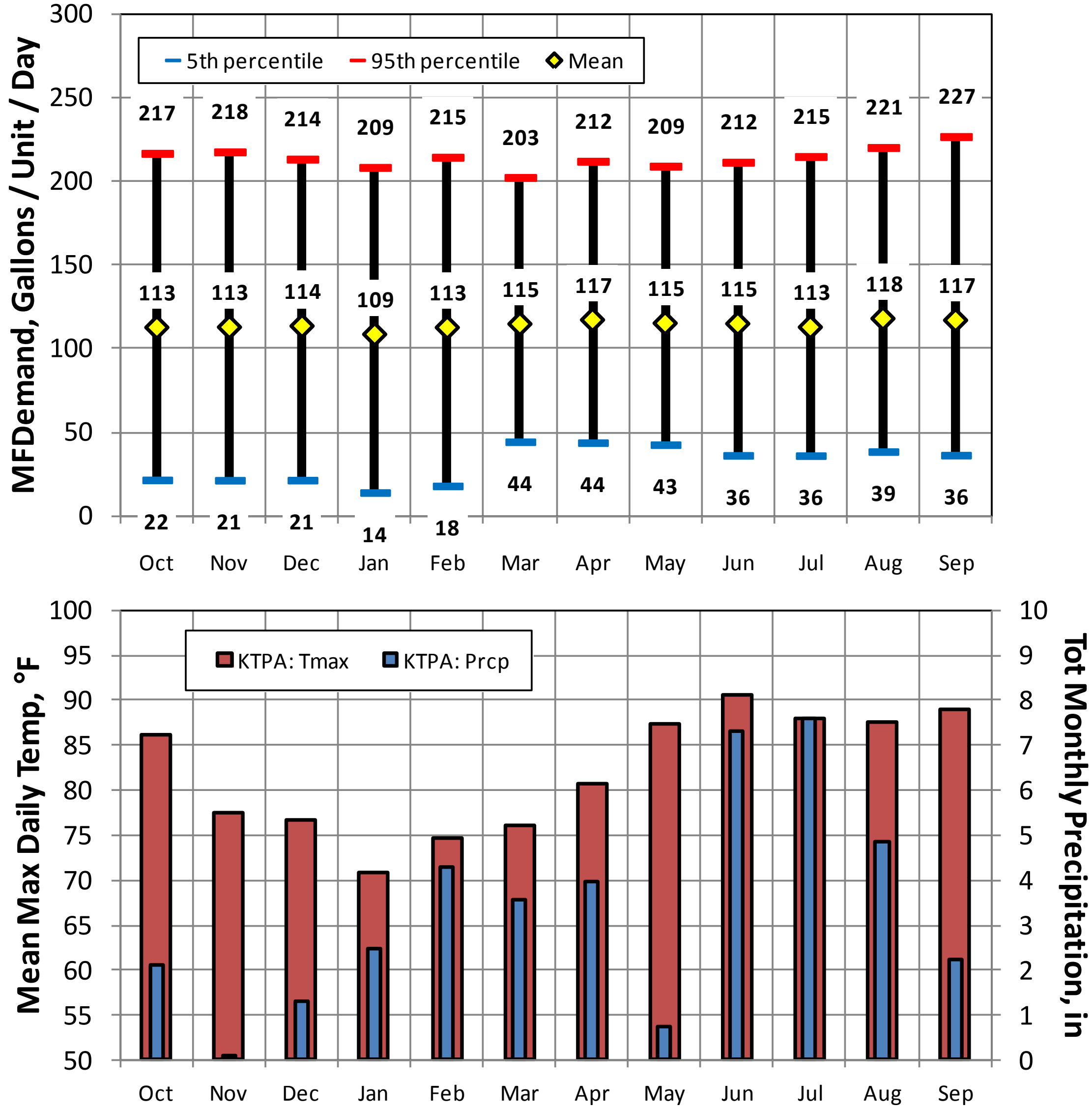

Figure 3.15: Regional Distribution of Multifamily Water Use and Observed Weather for Tampa International Airport (WY 2008)

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Table 3-34
Multifamily Regional Average Total Water Use (gpud) - Minimum Month September 2002

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	118	120	119	120	121	122	120	121	120	117	112	110	**118**	**110**	**122**
2003	111	112	112	116	117	115	116	118	118	117	114	113	**115**	**111**	**118**
2004	115	116	116	116	118	119	117	118	119	118	116	116	**117**	**115**	**119**
2005	117	118	117	117	118	118	120	119	120	121	121	122	**119**	**117**	**122**
2006	122	118	115	115	118	121	119	119	117	116	118	116	**118**	**115**	**122**
2007	117	114	113	112	113	115	116	117	116	113	114	112	**114**	**112**	**117**
2008	113	113	114	NA*	113	115	117	115	115	113	118	117	**115**	**113**	**118**
Avg	**116**	**116**	**115**	**116**	**117**	**118**	**118**	**118**	**118**	**116**	**116**	**115**	**117**		
Min	**111**	**112**	**112**	**112**	**113**	**115**	**116**	**115**	**115**	**113**	**112**	**110**		**110**	
Max	**122**	**120**	**119**	**120**	**121**	**122**	**120**	**121**	**120**	**121**	**121**	**122**			**122**

* Account data irregularities in January 2008; data point omitted.

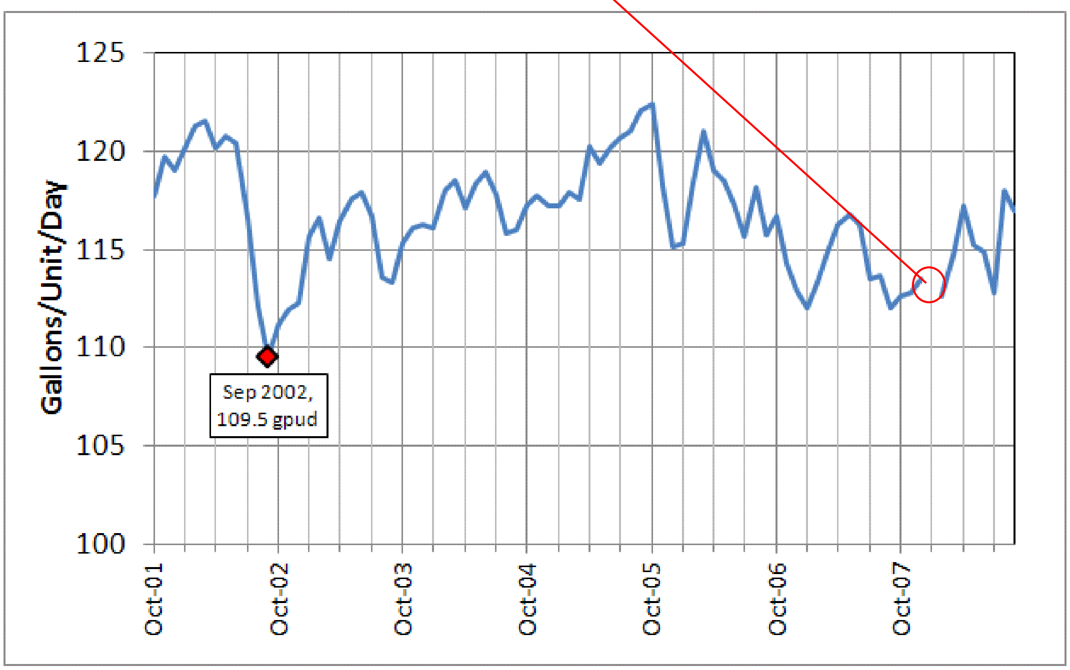

Figure 3.16: Multifamily Regional Average Total Water Use (gpud)

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Table 3-35
Estimates of Mean Regional Multifamily Weather-Sensitive Water Use (gpud)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	8	10	9	11	12	12	11	11	11	7	3	0	**9**	**0**	**12**
2003	2	2	3	6	7	5	7	8	8	7	4	4	**5**	**2**	**8**
2004	6	7	7	7	8	9	8	9	9	8	6	6	**7**	**6**	**9**
2005	8	8	8	8	8	8	11	10	11	11	11	13	**9**	**8**	**13**
2006	13	9	6	6	9	11	9	9	8	6	9	6	**8**	**6**	**13**
2007	7	5	3	2	4	5	7	7	7	4	4	2	**5**	**2**	**7**
2008	3	3	4	NA*	3	5	8	6	5	3	8	7	**5**	**3**	**8**
Avg	**7**	**6**	**6**	**7**	**7**	**8**	**9**	**9**	**8**	**7**	**7**	**6**	**7**		
Min	**2**	**2**	**3**	**2**	**3**	**5**	**7**	**6**	**5**	**3**	**3**	**0**		**0**	
Max	**13**	**10**	**9**	**11**	**12**	**12**	**11**	**11**	**11**	**11**	**11**	**13**			**13**

* Account data irregularities in January 2008; data point omitted.

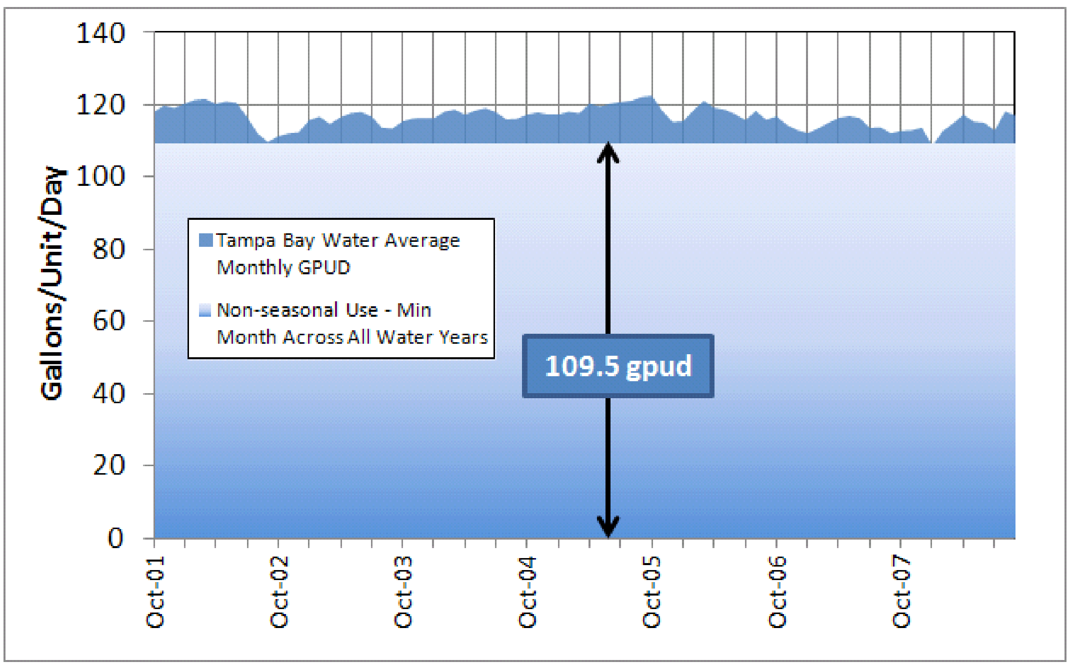

Figure 3.17: Multifamily Determination of Regional Average Weather-Sensitive Water Use

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Table 3-36
Multifamily Weather-Sensitive Use Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	7%	8%	8%	9%	10%	10%	9%	9%	9%	6%	2%	0%	**7%**	**0%**	**10%**
2003	1%	2%	2%	5%	6%	4%	6%	7%	7%	6%	4%	3%	**5%**	**1%**	**7%**
2004	5%	6%	6%	6%	7%	8%	7%	7%	8%	7%	5%	6%	**6%**	**5%**	**8%**
2005	7%	7%	7%	7%	7%	7%	9%	8%	9%	9%	9%	10%	**8%**	**7%**	**10%**
2006	10%	7%	5%	5%	7%	9%	8%	8%	7%	5%	7%	5%	**7%**	**5%**	**10%**
2007	6%	4%	3%	2%	3%	5%	6%	6%	6%	3%	4%	2%	**4%**	**2%**	**6%**
2008	3%	3%	4%	NA*	3%	5%	7%	5%	5%	3%	7%	6%	**4%**	**3%**	**7%**
Avg	**6%**	**5%**	**5%**	**6%**	**6%**	**7%**	**7%**	**7%**	**7%**	**6%**	**6%**	**5%**	**6%**		
Min	**1%**	**2%**	**2%**	**2%**	**3%**	**4%**	**6%**	**5%**	**5%**	**3%**	**2%**	**0%**		**0%**	
Max	**10%**	**8%**	**8%**	**9%**	**10%**	**10%**	**9%**	**9%**	**9%**	**9%**	**9%**	**10%**			**10%**

* Account data irregularities in January 2008; data point omitted.

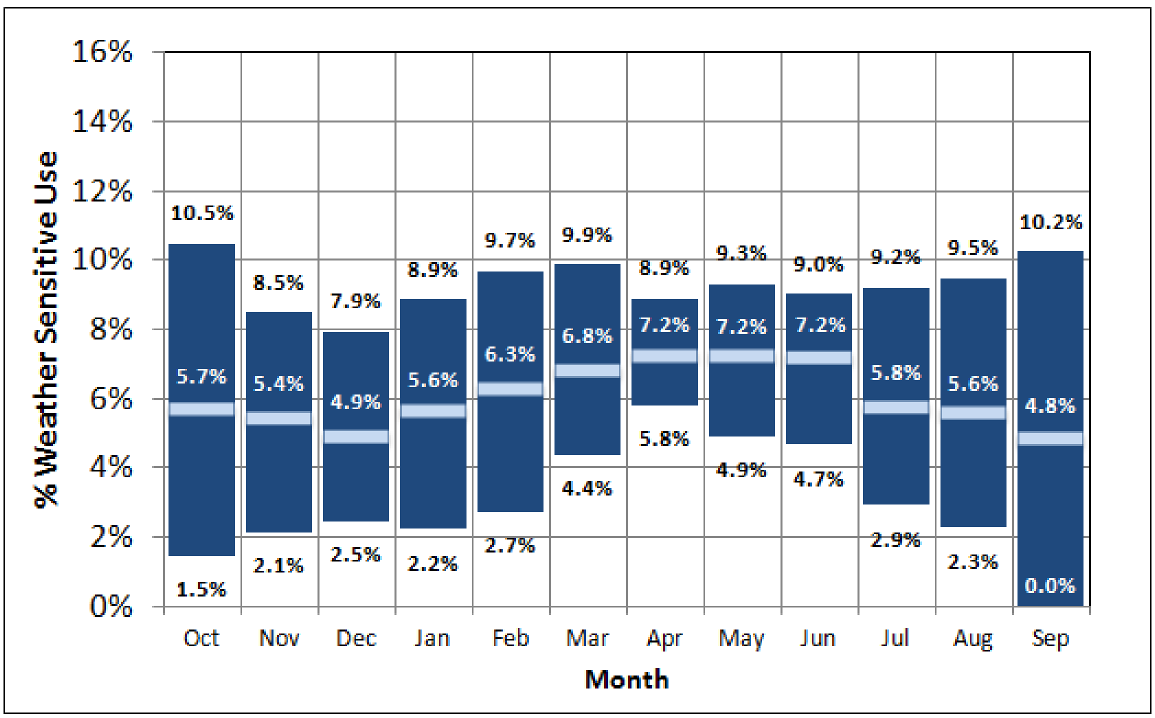

Figure 3.18: Range of Multifamily Weather-Sensitive Use Estimated as Mean Percent of Total Use (WY 2002-2008)

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The multifamily customer class as a whole exhibits lower and less variable weather-sensitive use than the single-family customer class. However, indoor and outdoor uses patterns can vary significantly across individual multifamily properties based on specific factors such as the number of dwelling units in a location, whether or not the occupants control outdoor use, and whether individual units are submetered and individually billed. To accommodate diversity in multifamily property characteristics, multifamily water use locations are further classified according to four categories, including:

- Multifamily locations with 10 dwelling units or more
- Multifamily locations with less than 10 dwelling units
- Condominiums: single-unit multifamily locations whose outdoor use was not controlled by occupants
- Townhomes: single-unit multifamily locations whose outdoor use was controlled by occupants

Minimum-month methods (again, using Method B from Section 3.2.4) are used to estimate indoor and outdoor use for each individual category. Table 3-37 summarizes and compares these results. Detailed results for each category are shown in Appendix F.

Table 3-37
Weather-Sensitive and Weather-Insensitive Demands for the Multifamily Customer Class and for Various Categories of Multifamily Locations

Category	Average total use, gpud	WY 2002-2008 min-month, gpud	Minimum Month	Avg annual weather-sensitive use, gpud (% of min-month)	Max weather-sensitive use, gpud (% of min-month)
MF Class	116.6	109.5	Sept 2002	7.1 (6.1%)	12.8 (10.5%)
≥ 10 units	123.5	111.9	Jan 2004	11.7 (9.5%)	21.8 (16.3%)
< 10 units	120.0	110.8	Jan 2008	9.2 (7.6%)	21.9 (16.5%)
Condos	103.5	90.4	Aug 2007	13.1 (12.7%)	28.9 (24.2%)
Townhomes	116.2	103.6	Sept 2002	12.6 (10.9%)	23.0 (18.2%)

Multifamily locations with 10 or more dwelling units highlights include:

- slightly higher average total and average weather-sensitive per-unit use than the multifamily class-at-large, and
- slightly higher variability in weather-sensitive use than the multifamily customer class-at-large.

Multifamily locations with fewer than 10 units highlights include:

- slightly higher average total and average weather-sensitive per-unit use than the multifamily customer class-at-large,

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- slightly lower average total and average weather-sensitive per-unit use than multi-family locations with 10 or more units,
- slightly higher variability in weather-sensitive use than the multifamily customer class-at-large,

Condominiums highlights include:

- the lowest average total per-unit use of all categories of multifamily locations, well below values for the customer class-at-large,
- the highest average weather-sensitive per-unit use of all categories of multifamily locations (in both volumetric and percentage terms), well above values for the customer class-at-large, and
- the highest variability in weather-sensitive per-unit use of all categories of multifamily locations (in volumetric and percentage terms), well above values for the customer class-at-large.

Townhomes highlights include:

- similar average total per-unit use to the customer class-at-large,
- higher average weather-sensitive per-unit use (in both volumetric and percentage terms) than the customer class-at-large, though lower than condominiums, and
- higher variability in weather-sensitive per-unit use (in both volumetric and percentage terms, than the customer class-at-large, though lower than condominiums.

Weather-sensitive uses among condominiums and townhomes are higher and more variable, which suggests that as a group these types of properties are more like single-family dwellings than apartment buildings. Still, in general, these categories should be expected to have less irrigated area per unit and less direct control of irrigation by occupants relative to the single-family customer class. The higher magnitude and variability of weather-sensitive use in condominiums and townhomes (relative to other multifamily categories) suggests more opportunities may exist for outdoor use efficiency improvements for these categories. Further analyses of water use at multifamily properties is warranted, possibly employing field surveys to better identify the characteristics of weather-sensitive end uses (irrigation and cooling) and to evaluate prevailing efficiency of plumbing fixtures.

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3.4 Nonresidential Water Use Patterns and Trends

Like the single-family and multifamily customer class profiles, the nonresidential analysis evaluates trends in unit usage rates and estimates the average split between indoor and outdoor use. The nonresidential customer class encompasses an extremely broad range of property characteristics, with demands and end uses varying much more widely between locations than the multifamily customer class. Addressing heterogeneity among nonresidential establishments is critical to any meaningful profile of the nonresidential customer class. The following series of analyses were conducted to characterize the nonresidential customer class and distinguish sectors with the potential for reducing water use intensity:

- The ***Baseline Annual Average Unit Use*** assessment evaluates the nonresidential customer class as a whole and by WDPA to illustrate end-use and cross-sectional variability.
- The ***Distribution of Nonresidential Water Use*** analysis disaggregates the nonresidential customer class into 27 discrete sectors and identifies those with the greatest proportion of locations and customer class demands.
- The ***Concentration of Nonresidential Water Use*** analysis furthers the distribution analysis by identifying large volumes of water use occurring within a low proportion of customers (i.e. large users).
- ***Prioritization of Nonresidential Sectors*** consists of constructing indices to reflect prevalence of high total demand and high water use intensity per location sectors.
- The ***Analysis of Water Use Intensity and Scale in High-Priority Nonresidential Sectors*** introduces consistent scaling parameters to further explore the intensity of nonresidential water use separately from size in prioritized sectors.
- The ***Benchmarking Intensity of High Priority Nonresidential Sector Demands*** analysis consists of comparing calculated locations metrics (unit use rates) to performance benchmarks within each sector to identify opportunities for increased efficiency associated the potential for reducing water use intensity.
- ***Weather-Sensitive Demand for High-Priority Nonresidential Sectors*** is assessed through minimum-month analyses to assess the intensity of weather-sensitive water use practices, such as irrigation and cooling.

Given the results of these analyses potential nonresidential efficiency improvements are discussed at the end of Section 3.4.

3.4.1 Baseline Annual Average Unit Use

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Table 3-38 and Table 3-39 provide annual average daily rates of nonresidential water use in gallons per account per day (gpad) and percentage difference of WDPA demands from the regional average for WYs 2002-2008. The initial assessment of unit use for the nonresidential customer class on a whole examines water use in terms of water use per account as an adequate dominator that is universally preferred does not exist at this broad customer classification level.

Table 3-38
Annual Average Nonresidential Use over WYs 2002-2008 by WDPA (gpud)

WY	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	1392	1022	789	899	3135	1764	1312	924
2003	1451	914	740	867	2892	1962	1276	935
2004	1483	961	697	830	2879	2023	1254	998
2005	1502	1025	795	846	2740	2147	1099	1023
2006	1535	1108	925	854	3008	2201	1117	1019
2007	1607	1156	895	857	3001	2211	1461	988
2008	1534	1079	848	797	2804	2108	1473	938
2002-2008 Mean	**1500**	**1038**	**813**	**850**	**2923**	**2060**	**1284**	**975**

Table 3-39
Variation in Annual Average Nonresidential Use over WYs 2002-2008 by WDPA
(as percentages of regional averages)

WY	PAS	NPR	NWH	SCH	COT	PIN	STP
2002	-27%	-43%	-35%	125%	27%	-6%	-34%
2003	-37%	-49%	-40%	99%	35%	-12%	-36%
2004	-35%	-53%	-44%	94%	36%	-15%	-33%
2005	-32%	-47%	-44%	82%	43%	-27%	-32%
2006	-28%	-40%	-44%	96%	43%	-27%	-34%
2007	-28%	-44%	-47%	87%	38%	-9%	-39%
2008	-30%	-45%	-48%	83%	37%	-4%	-39%
2002-2008 Mean	**-31%**	**-46%**	**-43%**	**95%**	**37%**	**-14%**	**-35%**

Regionwide, nonresidential annual average water use is about 1,500 gpad, but varies greatly by member government. Between WYs 2002-2008 the 7-year annual average rate of nonresidential use per account in South Central Hillsborough County exceeds the regional average by 95 percent, while the 7-year annual average rate of nonresidential use per account in New Port Richey is 46 percent lower than the regional average.

Figure 3.19 illustrates the range of WY 2008 average rates of use by WDPA. Variation in nonresidential water use across the region in the base-year was similar to regional variation seen across the entire record. Figure 3.20 illustrates regional nonresidential demands for WYs 2002-2008 and indicates fluctuations in nonresidential use over time are much smaller than differences between WDPAs. Given the amount of water used in nonresidential activities varies greatly, the high cross-sectional variation and low time series variation in nonresidential per-unit demand reflects significant differences in the types of nonresidential customers present in different WDPAs. Thus, the gallons per account metric is insufficient for characterizing use based trends.

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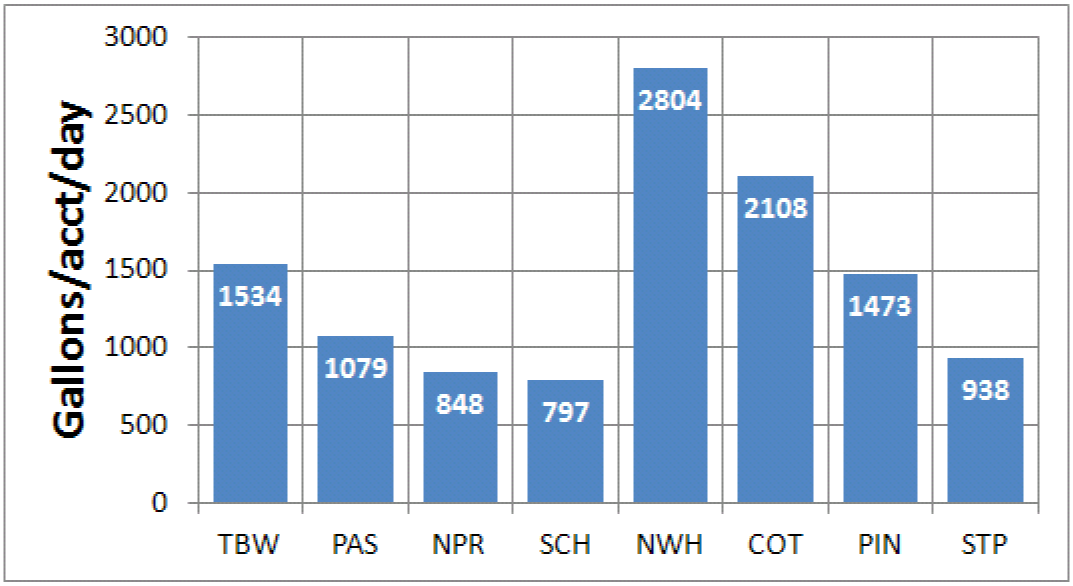

Figure 3.19: WY 2008 Nonresidential Per-Account Consumption by WDPA

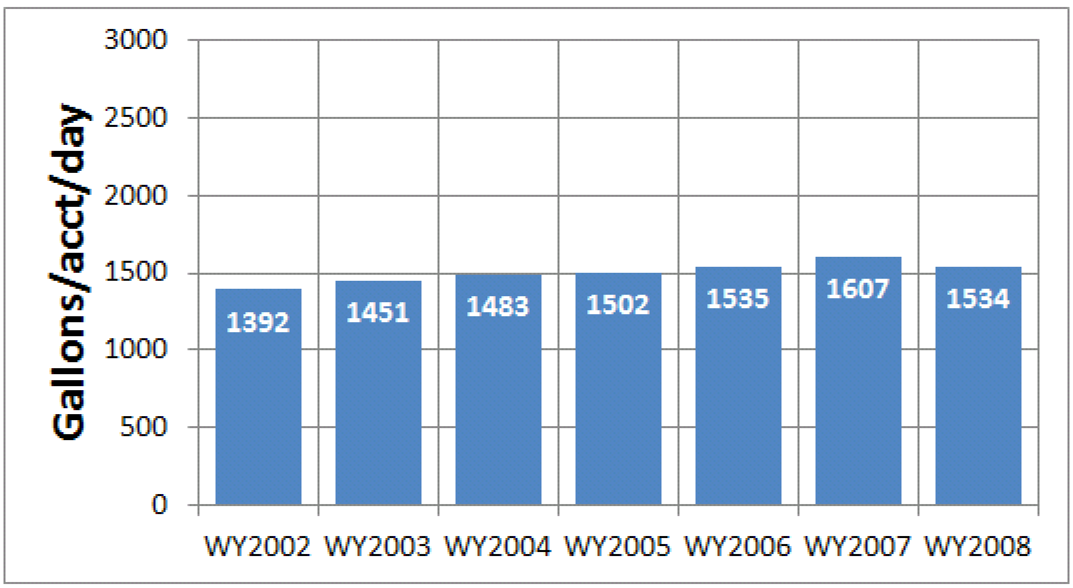

Figure 3.20: Regional WY-Average Nonresidential Water Use Per-Account (WYs 2002-2008)

3.4.2 Distribution of Nonresidential Customer Class Water Use

The cross-sectional variability in nonresidential demand identified in Section 3.4.1 suggests to identify detailed water use characteristics, end uses, and customer class efficiency opportunities, it is necessary to:

- further classify users into business types having relatively common end uses, and
- analyze each business classification as if it were its own customer class.

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As previously described in Section 2, FDOR property use codes are used to classify nonresidential parcels according to the business activity performed on the premises. The standardized FDOR-based 3-tier sector classification system (Super Sector, Sector, Sector Type) is used as a framework for disaggregated profiling of the nonresidential customer class.

Table 3-40 summarizes water use for 27 nonresidential sectors with at least one parcel located in the Tampa Bay Water service area. Sectoral demand ranges from 5.4 MGD (15% of NR customer class demand) for retail stores to less than 0.01 MGD (~0% of NR demand) for livestock. Prevalence of locations of each sector varies widely from 3,839 locations (17%) in the office building subsector to 12 locations (~0%) in the livestock sector.

Table 3-40
Distribution of Nonresidential Sector Water Use (WY 2008)

A	B	C	D	E	F
Super Sector	**Subsector**	**Water Demand (MGD)**	**Locations**	**Distribution of Total Water Use**	**Distribution of Total Locations**
Commercial	Retail Stores	5.40	3238	14.4%	14.8%
Commercial	Office Buildings	4.63	3839	12.3%	17.5%
Commercial	Hotels, motels	3.48	449	9.3%	2.0%
Institutional	Health Care	3.43	1460	9.1%	6.7%
Commercial	Warehouse/Transportation	3.29	2878	8.8%	13.1%
Institutional	Government	3.04	626	8.1%	2.9%
Commercial	Restaurants and Fast Food Outlets	2.65	1202	7.1%	5.5%
Institutional	Education	2.32	692	6.2%	3.2%
Industrial	Light Manufacturing	1.75	882	4.7%	4.0%
Industrial	Heavy Manufacturing	1.40	168	3.7%	0.8%
Institutional	Retirement	1.15	168	3.1%	0.8%
Institutional	Churches	0.91	1505	2.4%	6.9%
Commercial	Auto Service and Repair Shops	0.79	1613	2.1%	7.3%
Commercial	Convenience Store	0.64	657	1.7%	3.0%
Commercial	Mixed Use Commercial	0.53	1004	1.4%	4.6%
Commercial	Entertainment	0.49	261	1.3%	1.2%
Institutional	Fitness and Leisure	0.41	325	1.1%	1.5%
Commercial	Service shops	0.34	339	0.9%	1.5%
Commercial	Grocer/Food Store	0.25	94	0.7%	0.4%
Commercial	Vehicle Wash	0.25	107	0.7%	0.5%
Commercial	Golf	0.18	77	0.5%	0.4%
Institutional	Non-profit services	0.07	45	0.2%	0.2%
Agriculture	Crops	0.06	111	0.2%	0.5%
Institutional	Mortuaries, cemeteries, crematoriums	0.04	77	0.1%	0.4%
Commercial	Florist/Greenhouses	0.02	65	0.0%	0.3%
Institutional	Parks and Recreation	0.01	52	0.0%	0.2%
Agriculture	Livestock	0.00	12	0.0%	0.1%
TOTAL		**37.53**	**21,946**	**100%**	**100%**

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3.4.2.1 Concentration of Nonresidential Water Use

The use of a concentration curve provides a means of assessing the number of customers occurring in the distribution of water use within a single industry. This approach is used to identify large volumes of water use occurring within a low proportion of customers, which helps to identify where conservation opportunities may exist. Generally, these curves identify large users within a subsector occurring as a result of scale (building size or density), water use intensity (unit usage rates) or both.

Concentration curves are generated by:

- ranking locations within a subsector from high to low water use and calculating percentiles of ranked locations (with the highest-water-use location receiving the lowest percentile and the lowest-water-use location receiving the highest percentile),
- calculating cumulative sectoral water use (gallons per year), or the sum of water use for that location and all locations with higher use for each ranked location, and
- plotting cumulative water use versus location percentile.

Figure 3.21 shows concentration curves for six of the 11 water use sectors using more than 1 MGD. Demands in the Office Building sector are the most concentrated among the six subsectors, with 3 percent of locations accounting for 50 percent of total demand in each sector. Although this concentration in the Office Building sector is likely due to building size and occupancy, significant opportunities for efficiency improvement may still be present. While broad sector-wide efforts may be effective, the potential to target a small number of Office Building locations also exists. Key findings for these six sectors include:

- After Office Buildings, Hotel/Motel and Retirement sector demands are the most concentrated among the six sectors, with 10 percent of locations accounting for 50 percent of total demand in each sector followed by Restaurants with 17 percent of location, accounting for 50 percent of total sector demands.
- Demands in the Education and Health Care sectors are the least concentrated among the six sectors, with 21 percent of locations in each sector accounting for 50 percent of total nonresidential customer class demand.
- Demands in the remaining 5 sectors using more than 1 MGD (Retail Stores, Light Manufacturing, Heavy Manufacturing, Warehouse/Transportation and Government) are also heavily concentrated with less than 3 percent of locations within each sector accounting for 50 percent of total nonresidential customer class demand.
- Opportunities at high concentration locations appear to exist, but the ability to profile nonresidential users is constrained by use of secondary data sources only.

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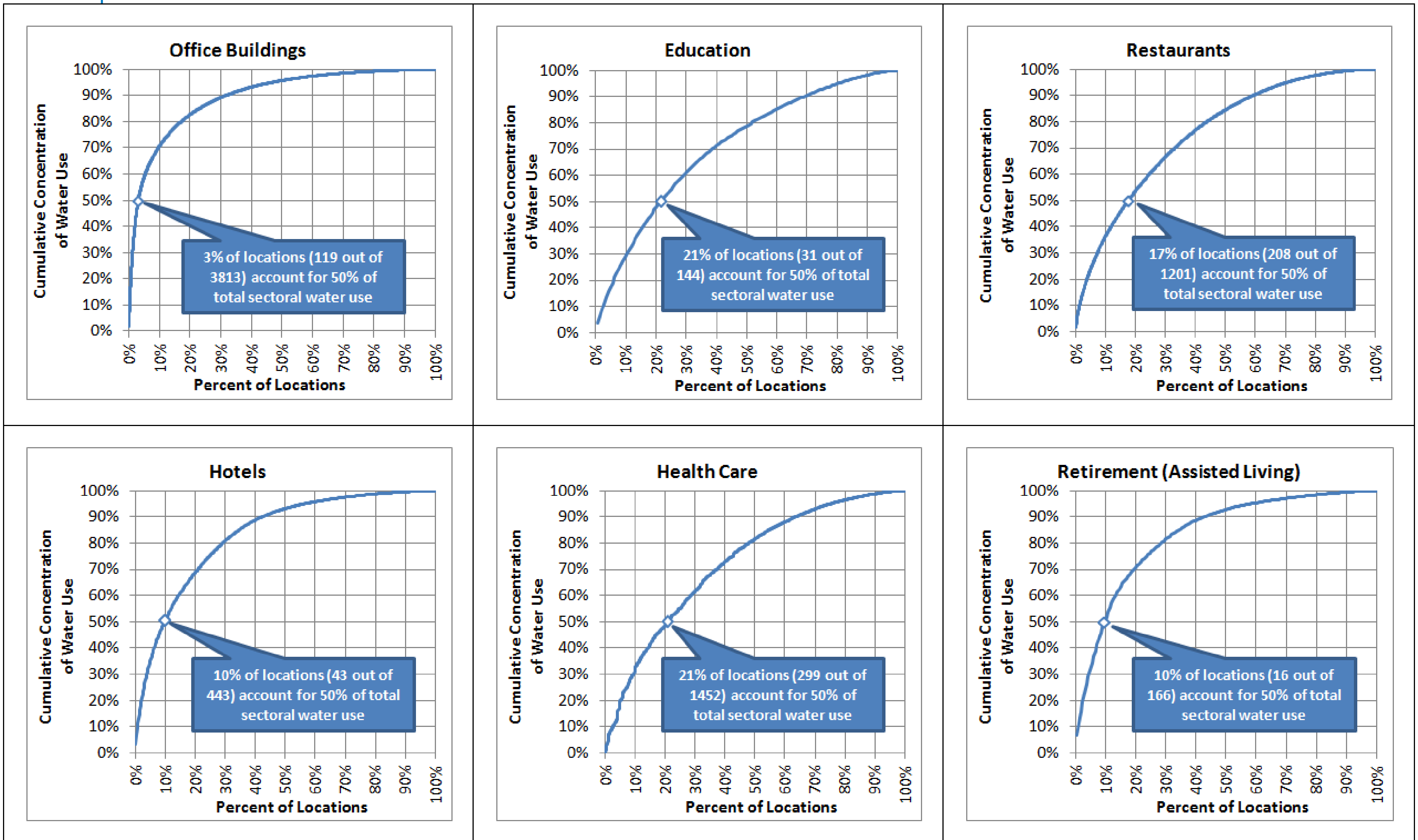

Figure 3.21: Concentration Curves of Annual Average Demand for Sectors Using More than 1 MGD

3.4.2.2 Prioritization of Nonresidential Sectors

An important component of identifying opportunities and developing conservation strategies relates to assessing relative presence of water use and locations. Table 3-41 identifies distributions in prevalence of various sectors in terms of both number of locations and total water use. These metrics alone are insufficient to identify sectors of greatest efficiency potential.

Sector with the greatest efficiency potential should:

- Have a relatively large number of water users, and
- Have a relatively high intensity of water use (e.g. use per location)

To identify potential for increased efficiency, nonresidential sectors are prioritized for analysis based on methods within the Water Research Foundation's Commercial and Institutional End Uses Water Study (Dziegielewski et al, 2000). By employing these methods, indices are constructed for each sector reflecting a match of large end use population and intensity. A water use intensity index (Column G of Table 3-41) is formed by ranking proportions of nonresidential use in each sector (Column E). The index value for the sector with the n^{th}-highest proportion is calculated using Equation 3-3.

Equation 3-3

$$\text{Index}(n) = 1 - \frac{n-1}{26}$$

Through ***Equation 3-3***, sectors with the highest and lowest proportions of total nonresidential demand is given an index value of 1 and 0. Sectors with intermediate proportions are given index values evenly spaced between 1 and 0. A water use prioritization index is formed in two stages:

- Ratios are calculated relating the proportion of total use and the proportion of total locations in each sector (Column H, Table 3-41), such that higher ratios correspond to higher demand across fewer locations. ***Equation 3-3*** is then used to create index values for sectors according to water use-to-location ratios (Column I, Table 3-41).

- A water use prioritization index (Column J, Table 3-41) is calculated for each sector as the product of water use and water use intensity indices. Sectors are then ranked (Column K, Table 3-41), according to those indices. Highly-ranking sectors according to the water use prioritization index are those that have a combination of relatively high total demand and high demand intensity per location.

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Table 3-41
WY 2008 Nonresidential Water Use Ranking by FDOR Sector

A	B	C	D	E	F	G	H	I	J	K
Super Sector	**Sector**	**WY 2008 Demand, MGD**	**Number of Loca-tions**	**Fraction of Total Water Use**	**Fraction of Total Locations**	**Fraction Total Use Divided by Fraction of Total Loca-tions (E/F)**	**Water Use INDEX (% rank of E)**	**Water Use-to-Location INDEX (% Rank of G)**	**Water Use Prioritization INDEX (HxI)**	**Sector Type Ranking**
Commercial	Hotels, motels	3.48	449	0.09	0.02	4.53	0.92	0.96	0.89	1
Institutional	Government	3.04	626	0.08	0.03	2.84	0.81	0.88	0.71	2
Industrial	Heavy Manufacturing	1.40	168	0.04	0.01	4.86	0.65	1.00	0.65	3
Institutional	Health Care	3.43	1460	0.09	0.07	1.38	0.88	0.73	0.65	4
Institutional	Education	2.32	692	0.06	0.03	1.96	0.73	0.85	0.62	5
Institutional	Retirement	1.15	168	0.03	0.01	4.00	0.62	0.92	0.57	6
Commercial	Retail Stores	5.40	3238	0.14	0.15	0.97	1.00	0.54	0.54	7
Commercial	Restaurants and Fast Food Outlets	2.65	1202	0.07	0.05	1.29	0.77	0.65	0.50	8
Industrial	Light Manufacturing	1.75	882	0.05	0.04	1.16	0.69	0.62	0.43	9
Commercial	Office Buildings	4.63	3839	0.12	0.17	0.71	0.96	0.42	0.41	10
Commercial	Warehouse/Transportation	3.29	2878	0.09	0.13	0.67	0.85	0.38	0.33	11
Commercial	Grocer/Food Store	0.25	94	0.01	0.00	1.55	0.31	0.81	0.25	12
Commercial	Entertainment	0.49	261	0.01	0.01	1.11	0.42	0.58	0.24	13
Commercial	Vehicle Wash	0.25	107	0.01	0.00	1.34	0.27	0.69	0.19	14
Institutional	Fitness and Leisure	0.41	325	0.01	0.01	0.75	0.38	0.46	0.18	15
Commercial	Golf	0.18	77	0.00	0.00	1.38	0.23	0.77	0.18	16
Institutional	Churches	0.91	1505	0.02	0.07	0.36	0.58	0.27	0.16	17
Commercial	Convenience Store	0.64	657	0.02	0.03	0.57	0.50	0.31	0.15	18
Commercial	Service shops	0.34	339	0.01	0.02	0.59	0.35	0.35	0.12	19
Institutional	Non-profit services	0.07	45	0.00	0.00	0.88	0.19	0.50	0.10	20
Commercial	Mixed Use Commercial	0.53	1004	0.01	0.05	0.31	0.46	0.19	0.09	21
Commercial	Auto Service and Repair Shops	0.79	1613	0.02	0.07	0.29	0.54	0.12	0.06	22
Institutional	Mortuaries, cemeteries, crematoriums	0.04	77	0.00	0.00	0.32	0.12	0.23	0.03	23
Agriculture	Crops	0.06	111	0.00	0.01	0.30	0.15	0.15	0.02	24
Commercial	Florist/Greenhouses	0.02	65	0.00	0.00	0.15	0.08	0.08	0.01	25
Agriculture	Livestock	0.00	12	0.00	0.00	0.15	0.00	0.04	0.00	26
Institutional	Parks and Recreation	0.01	52	0.00	0.00	0.07	0.04	0.00	0.00	27
TOTAL		38	21946	1.00	1.00	1.00				

According to this procedure and as shown in Table 3-41, the "Top 10" nonresidential water use sectors are generally evaluated for water efficiency potential due to their significant impact on nonresidential customer class demand.

The highest ranking sectors include locations with a combination of relatively high total demand and high water use-per-location intensity indices. Although Office Buildings have a high proportion of total water use (12%) and locations (17%), a low water use-to-location index results in lower prioritization index. In contrast, while hotels also account for a high proportion of total nonresidential water demands at 9 percent, the low proportion of total locations accounting for this use (2%) result in a high water use-per-location index and is thus responsible for the high prioritization.

3.4.2.3 Analysis of Water Use Intensity and Scale in High Priority Nonresidential Sectors

Water consumption (Q) can be defined for any individual user or group of users by a simple a product that differentiates scaling units (N) from water use per scaling unit (q):

$$Q = N * q$$

where the water use per scaling unit is calculated as Q/N. The scaling parameter N derives a consistent denominator that can be used to evaluate the intensity of water use separately from a measure of size. Several possible measures of size can be used to portray water use, such as number of employees, acres, and square-footage. Property appraiser data provides a consistent source of unit information used to develop unit usage rates as consistent metric. In particular, this analysis measures the scale or size associated with nonresidential locations in square footage of building area. Table 3-42 provides the distribution of building area in square feet for each nonresidential sector where size of buildings is used as an indicator of scale.

Using this framework, it can be assumed large users identified in the concentration curves and contributing to high sectoral prioritization consume large quantities of water because they are large in scale, have high unit usage rates, or both. Table 3-42 confirms most of the high-priority sectors are a great deal larger in size (i.e. building area) than other sectors in general, accounting for more than 67 percent of building area region-wide. However, because the scale of water using activity is typically determined by exogenous factors, opportunities for increased efficiency will generally be associated the potential for reducing water use intensity.

For some sectors, demand intensity at a location can be expressed in terms of units other than gallons per square foot per year. Additional unit data obtained from DBPR and DOE datasets support the development of alternative metrics:

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- Water use per seat (Restaurants)

- Water use per room (Hotels)
- Water use per student (Education)

The following section examines the intensity of high-priority nonresidential sectors using the framework described herein.

Table 3-42
Distribution of Building Area for Nonresidential Sectors

High Priority Sectors	Super Sector	Sector	Building Area (sq ft)	Percent of Total Building Area
Y	Commercial	Hotels, motels	20,736,153	4.6%
Y	Institutional	Government	12,714,066	2.8%
Y	Industrial	Heavy Manufacturing	9,991,514	2.2%
Y	Institutional	Health Care	24,678,033	5.4%
Y	Institutional	Education	44,939,035	9.9%
Y	Institutional	Retirement	9,270,699	2.0%
Y	Commercial	Retail Stores	66,203,701	14.6%
Y	Commercial	Restaurants and Fast Food Outlets	5,267,677	1.2%
Y	Industrial	Light Manufacturing	28,314,616	6.2%
Y	Commercial	Office Buildings	82,829,577	18.2%
N	Commercial	Warehouse/Transportation	83,330,318	18.3%
N	Commercial	Grocer/Food Store	5,918,440	1.3%
N	Commercial	Entertainment	4,488,501	1.0%
N	Commercial	Vehicle Wash	405,662	0.1%
N	Institutional	Fitness and Leisure	3,133,956	0.7%
N	Commercial	Golf	1,640,043	0.4%
N	Institutional	Churches	22,735,579	5.0%
N	Commercial	Convenience Store	1,810,916	0.4%
N	Commercial	Service shops	1,608,615	0.4%
N	Institutional	Non-profit services	1,163,942	0.3%
N	Commercial	Mixed Use Commercial	7,527,396	1.7%
N	Commercial	Auto Service and Repair Shops	14,101,615	3.1%
N	Institutional	Mortuaries, cemeteries, crematoriums	629,922	0.1%
N	Agriculture	Crops	520,719	0.1%
N	Commercial	Florist/Greenhouses	283,973	0.1%
N	Agriculture	Livestock	37,748	0.0%
N	Institutional	Parks and Recreation	29,283	0.0%
		Total	**454,311,699**	**100%**
		High Priority Sectors	**304,945,071**	**67%**

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3.4.2.4 Benchmarking Intensity of High Priority Nonresidential Sector Demands

A benchmark is a particular (numerical) value of a metric that denotes a specific level of performance, such as a water efficiency target. Benchmarking involves comparison of a calculated metric to denote a level of performance relative to the benchmark.[6] The unit use rates of all locations within each sector were further evaluated to explore the intensity of nonresidential water use.

Figure 3.22 through Figure 3.23 shows cumulative distributions of average annual demand per indoor square foot over WY 2002-2008 for individual locations in six of the "Top 10" nonresidential sectors identified in Section 3.4.2.2. For assessing potential efficiency opportunities, each plot identifies a range of upper and lower efficiency benchmarks for each sector (except for the Health Care and Retirement sector plots) based on Dziegielewski et al (2000) and the number and proportion of locations exceeding each benchmark. Efficiency potential is assumed to exist for locations exceeding sector benchmark values.

Sectors with substantial number of locations exceeding the lower and upper benchmarks include Hotels/Motels, Restaurants and Office Buildings as provided in Figure 3.22. Although benchmarks were not available for the Health Care and Retirement sectors, the cumulative distribution plots provided in Figure 3.23 indicate a small number of locations in these sectors also have extremely high water use relative to the remainder of those sectors. Conversely, only one of 144 total locations in the Education sector exceeds the lower or upper benchmarks of 40 and 60 gallons per square foot per year, indicating higher levels of efficiency may exist.

As previously mentioned, the intensity of demand at a location can be benchmarked in terms of units other than gallons per square foot per year, depending on the availability of data. Furthermore, some sectors can be easily disaggregated into sector types as shown for the three Heathcare sector types shown in Figure 3.24. In addition to water use per square foot benchmarks, Dziegielewski et al (2000) estimated a range of alternative efficiency benchmarks for various Restaurant, Education and Hotel/Motel sector types. Comparison of distributions based on alternative intensity metrics to these sector type benchmarks are shown in Figure 3.25 through Figure 3.27.

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[6] *Dziegielewski and Kiefer, (2010). Water Conservation Measurement Metrics, AWWA Water Conservation Division Subcommittee Report.*

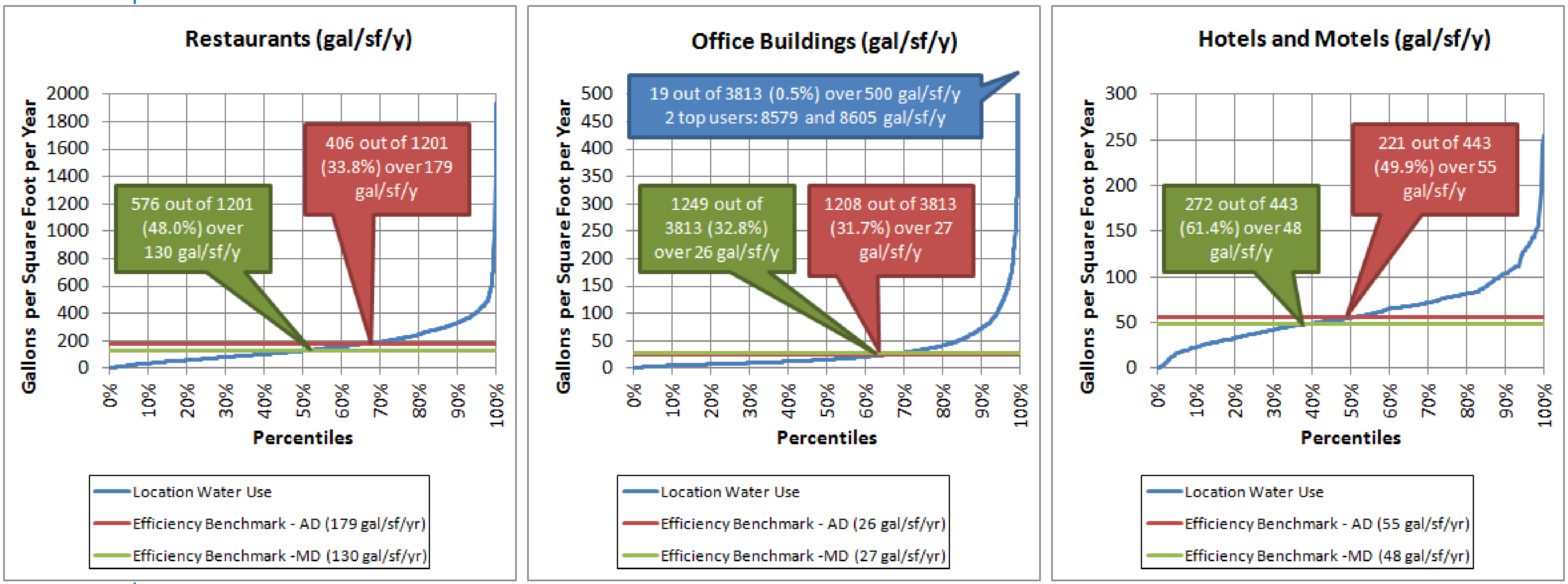

Figure 3.22: Distributions of Average Annual Demand per SqFt for Individual Locations in High-Priority Nonresidential Sectors: Restaurants, Office Buildings, Hotel and Motels

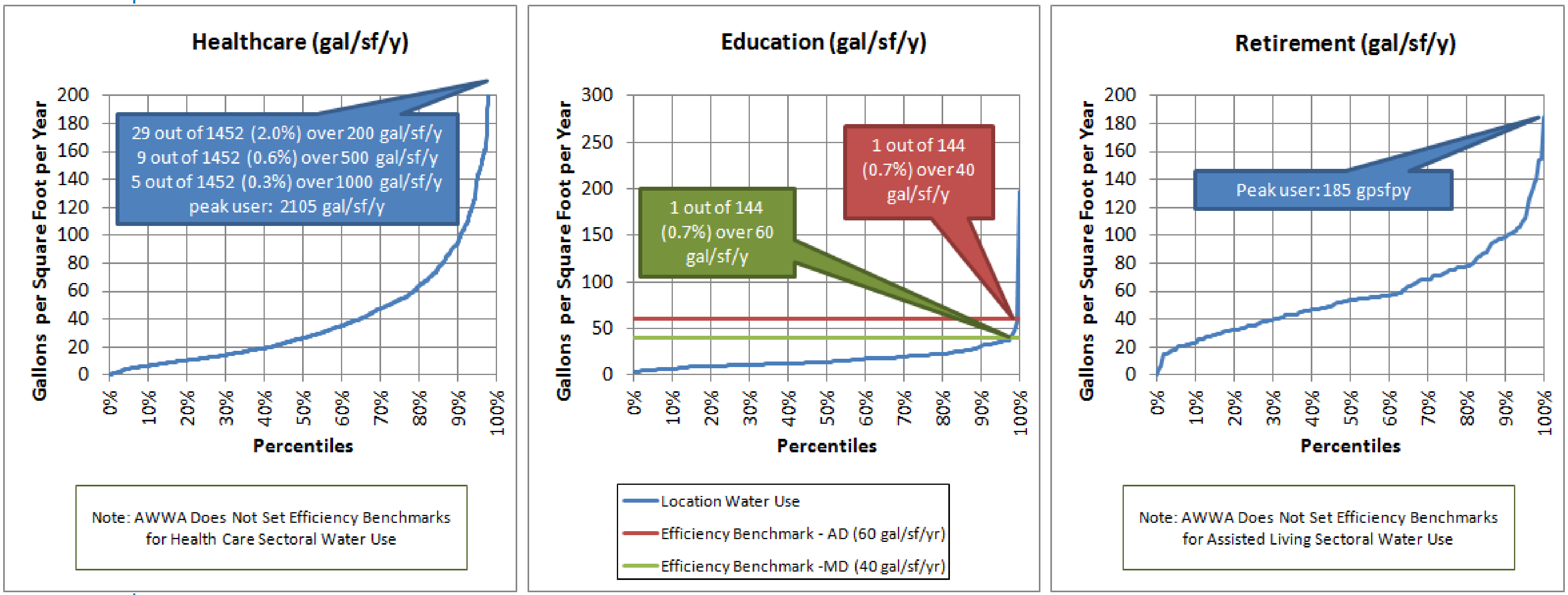

Figure 3.23: Distributions of Average Annual Demand per SqFt for Individual Locations in High-Priority Nonresidential Sectors: Healthcare, Education, and Retirement

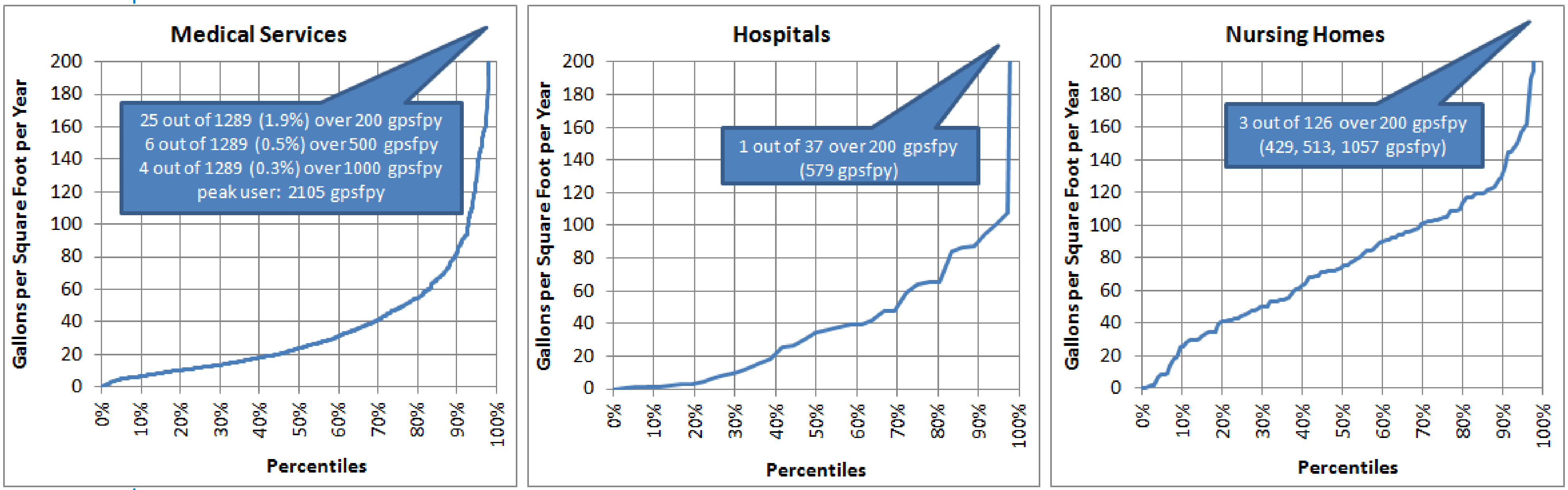

Figure 3.24: Distributions of Average Daily Demand per SqFt for HealthcareSector Types: Medical Services, Hospitals and Nursing Homes

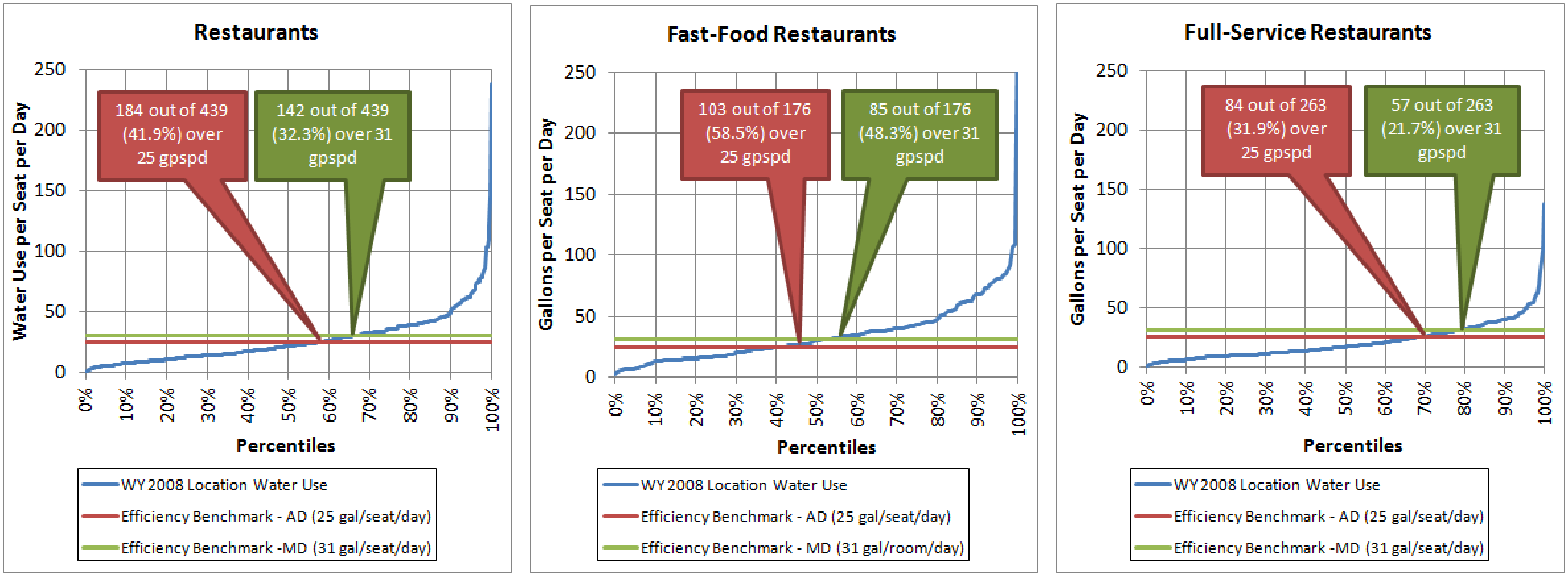

Figure 3.25: Distributions of Average Daily Demand per Seat for Individual Restaurants (Full-Service & Fast Food)

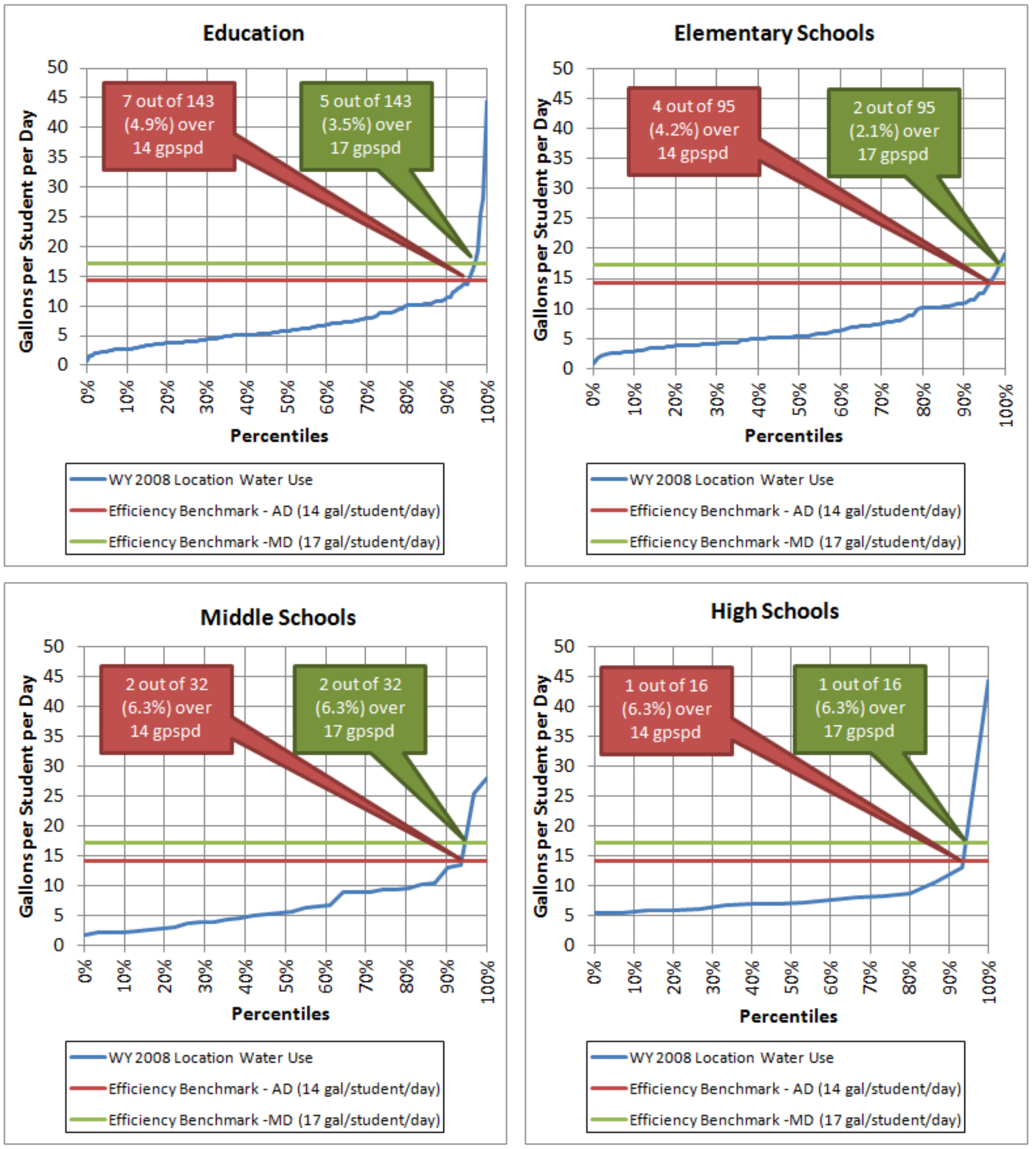

Figure 3.26: Distributions of Average Daily Demand per Student for Individual Education Sector Locations and for Elementary, Middle, and High School Subsectors.

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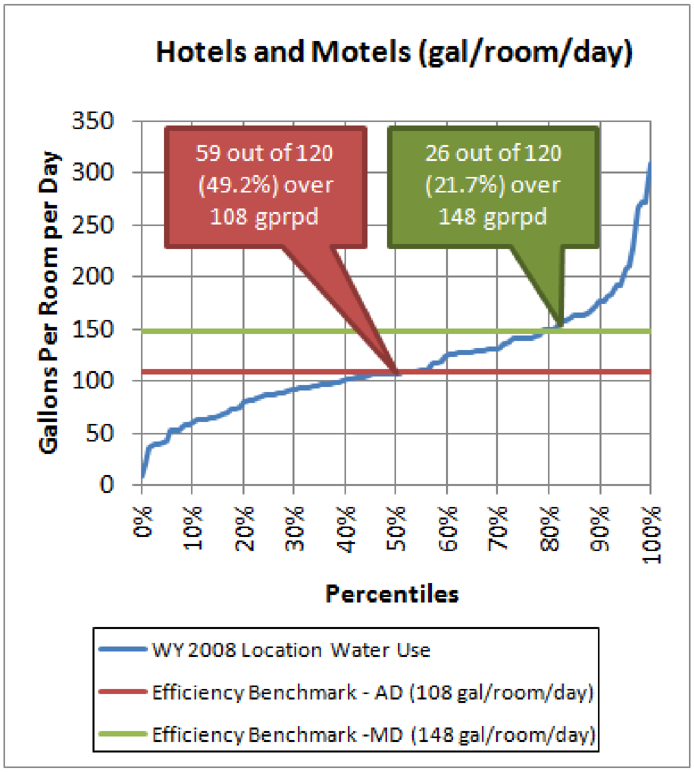

Figure 3.27: Distributions of Average Daily Demand per Room for Individual Hotels/Motels

Overall, water use distributions in Figure 3.22 through Figure 3.27 demonstrate multiple opportunities may exist to improve nonresidential water use efficiency in high-demand, high-intensity sectors. In some cases (e.g. Restaurants, Office Buildings), efficiency improvements may require addressing trends across a large number of locations. In other cases (e.g. Medical Services, Retirement, Education), efficiency improvements may require targeting a small number of locations with extremely high use.

3.4.2.5 Weather-Sensitive Demand for High-Priority Nonresidential Sectors

Indications of weather-sensitive demand are revealed through minimum-month analyses of the types shown in Sections 3.2.4 and 3.3.3 for the single-family and multifamily sectors. Minimum-month analyses are performed for individual high-priority sectors and subsectors identified above with demands generally expressed in gallons/square foot/day.

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In Table 3-43, weather-sensitive demands represent on average 32 percent of ***Education*** sector total demands and are highest in April/May and August/September, the warmest times of year when schools are in session and irrigation and cooling practices are most active. As illustrated in Figure 3.28, weather-sensitive demands are lowest in December/January (months in which weather is cool and school is out of session for a substantial period) and June/July (when school occupancy tends to be lower).

Table 3-43
Education: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	46%	42%	28%	29%	41%	41%	57%	62%	33%	18%	35%	48%	40%	18%	62%
2003	36%	28%	4%	21%	33%	34%	44%	51%	27%	32%	48%	61%	35%	4%	61%
2004	58%	43%	11%	13%	21%	22%	34%	44%	26%	26%	28%	30%	30%	11%	58%
2005	46%	39%	25%	29%	35%	31%	42%	38%	19%	21%	48%	61%	36%	19%	61%
2006	52%	46%	19%	15%	26%	35%	44%	38%	18%	13%	49%	45%	33%	13%	52%
2007	44%	27%	10%	13%	24%	28%	34%	30%	16%	13%	32%	44%	26%	10%	44%
2008	34%	28%	11%	8%	18%	19%	26%	37%	11%	**0%**	22%	45%	22%	0%	45%
Avg	45%	36%	15%	18%	28%	30%	40%	43%	21%	18%	37%	48%	32%		
Min	34%	27%	4%	8%	18%	19%	26%	30%	11%	0%	22%	30%		0%	
Max	58%	46%	28%	29%	41%	41%	57%	62%	33%	32%	49%	61%			62%

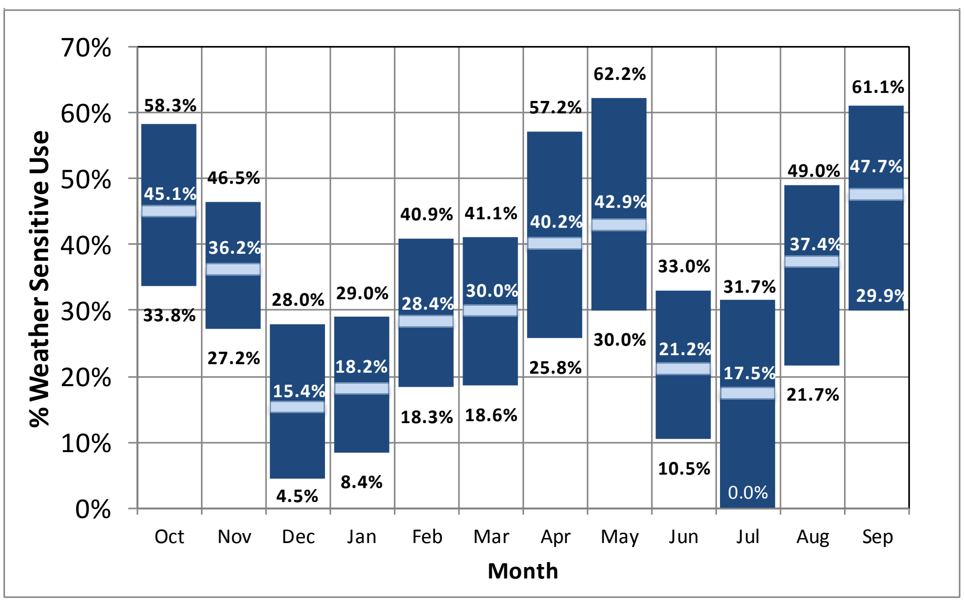

Figure 3.28: Education Sector Weather-Sensitive and Weather-Insensitive Demands

In Table 3-44, weather-sensitive demands represent on average 14 percent of total sectoral demands for the ***Retirement*** sector, a value similar to that of the multifamily customer class. As illustrated in Figure 3.29, weather-sensitive demands are highest in April-October, and lowest in November-March. These patterns indicate the likelihood of potable irrigation or some other seasonally induced activity.

Table 3-44
Retirement: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	20%	15%	7%	8%	9%	14%	15%	16%	15%	20%	13%	**0%**	13%	0%	20%
2003	6%	3%	3%	5%	6%	6%	12%	16%	15%	13%	12%	10%	9%	3%	16%
2004	12%	13%	10%	11%	12%	13%	17%	20%	17%	17%	22%	21%	15%	10%	22%
2005	22%	23%	17%	17%	14%	12%	16%	17%	17%	17%	14%	14%	17%	12%	23%
2006	17%	10%	13%	10%	11%	12%	13%	15%	15%	17%	38%	18%	16%	10%	38%
2007	19%	16%	20%	20%	13%	16%	22%	16%	15%	21%	24%	21%	19%	13%	24%
2008	20%	14%	11%	6%	9%	11%	14%	17%	13%	14%	17%	14%	13%	6%	20%
Avg	17%	13%	12%	11%	11%	12%	16%	17%	15%	17%	20%	14%	14%		
Min	6%	3%	3%	5%	6%	6%	12%	15%	13%	13%	12%	0%		0%	
Max	22%	23%	20%	20%	14%	16%	22%	20%	17%	21%	38%	21%			38%

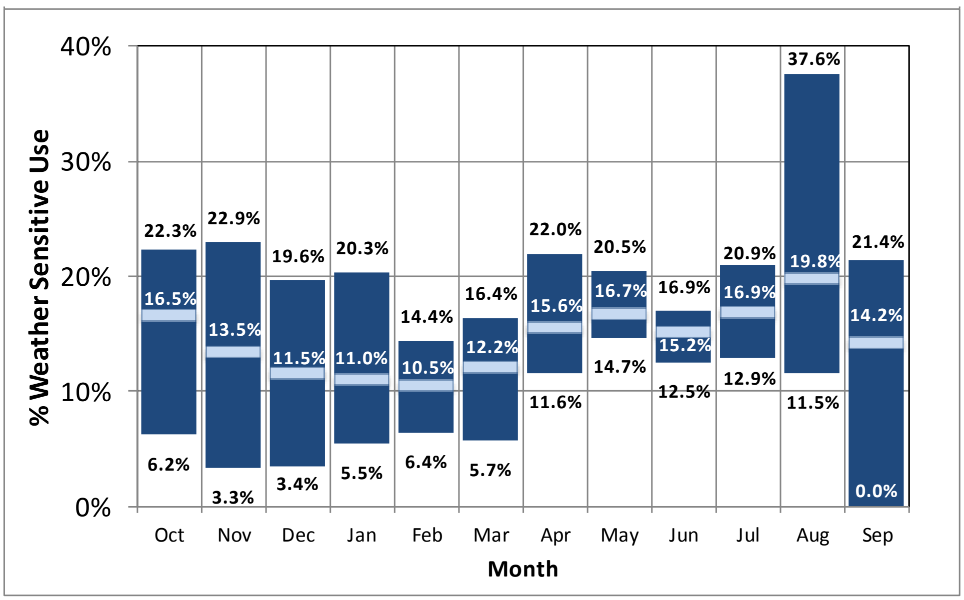

Figure 3.29: Retirement Sector Weather-Sensitive and Weather-Insensitive Demands

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In Table 3-45, the Hospital subsector weather-sensitive demands represent on average 71 percent of total demands, the highest proportion of weather-sensitive demand of any sector examined. As illustrated in Figure 3.30, weather-sensitive demand is highest in April-September, the warmest times of year, and lowest in October-March, the coolest times of the year. Weather-sensitive demand is most variable in March and May-September. These patterns all indicate the likelihood of cooling tower use in addition to irrigation. Hospitals are typically large and multi-story, and climate control in hospitals may be considered essential to patient health, suggesting cooling towers are responsible for high weather-sensitive demand.

Table 3-45
Hospitals: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	77%	51%	46%	43%	55%	76%	81%	124%	114%	91%	86%	77%	77%	43%	124%
2003	39%	54%	48%	18%	48%	0%	50%	38%	85%	36%	34%	34%	40%	0%	85%
2004	32%	66%	57%	65%	59%	69%	80%	43%	44%	39%	36%	32%	52%	32%	80%
2005	34%	26%	18%	20%	66%	78%	81%	87%	101%	101%	113%	99%	69%	18%	113%
2006	92%	70%	68%	67%	72%	76%	88%	103%	108%	118%	155%	110%	94%	67%	155%
2007	96%	71%	76%	73%	68%	98%	99%	51%	104%	112%	109%	110%	89%	51%	112%
2008	58%	73%	78%	67%	79%	85%	86%	89%	65%	49%	102%	90%	77%	49%	102%
Avg	61%	59%	56%	50%	64%	69%	81%	76%	89%	78%	91%	79%	71%		
Min	32%	26%	18%	18%	48%	0%	50%	38%	44%	36%	34%	32%		0%	
Max	96%	73%	78%	73%	79%	98%	99%	124%	114%	118%	155%	110%			155%

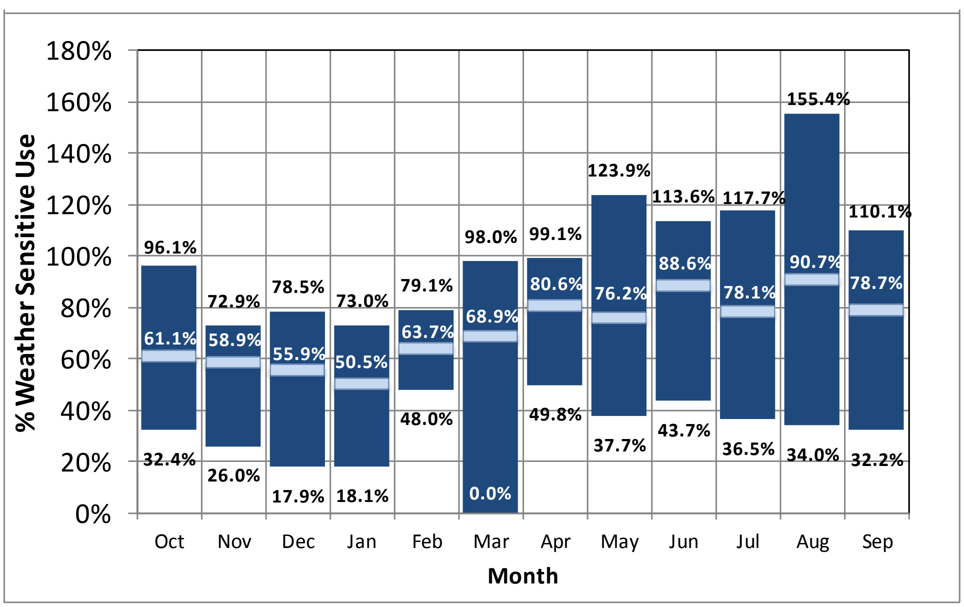

Figure 3.30: Hospital Sector Type Weather-Sensitive and Weather-Insensitive Demands

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In Table 3-46, ***Nursing Home*** subsector, weather-sensitive demand represents on average 22 percent of total demand. As illustrated in Figure 3.31, weather-sensitive demand is highest in April-September, indicating the likelihood of irrigation and perhaps, cooling tower use. Weather-sensitive demands are lowest in October-March, the coolest times of the year.

Table 3-46
Nursing Homes: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	19%	16%	16%	18%	17%	16%	20%	22%	23%	21%	17%	12%	18%	12%	23%
2003	0%	7%	12%	3%	11%	6%	20%	10%	24%	26%	26%	24%	14%	0%	26%
2004	22%	21%	19%	16%	11%	16%	12%	23%	26%	24%	22%	21%	19%	11%	26%
2005	20%	22%	19%	19%	24%	22%	24%	28%	29%	28%	27%	30%	24%	19%	30%
2006	30%	26%	17%	18%	19%	18%	20%	23%	24%	21%	37%	24%	23%	17%	37%
2007	25%	25%	24%	23%	22%	31%	33%	27%	40%	36%	28%	29%	29%	22%	40%
2008	26%	23%	19%	29%	21%	20%	22%	26%	24%	21%	26%	27%	24%	19%	29%
Avg	20%	20%	18%	18%	18%	18%	22%	23%	27%	25%	26%	24%	22%		
Min	0%	7%	12%	3%	11%	6%	12%	10%	23%	21%	17%	12%		0%	
Max	30%	26%	24%	29%	24%	31%	33%	28%	40%	36%	37%	30%			40%

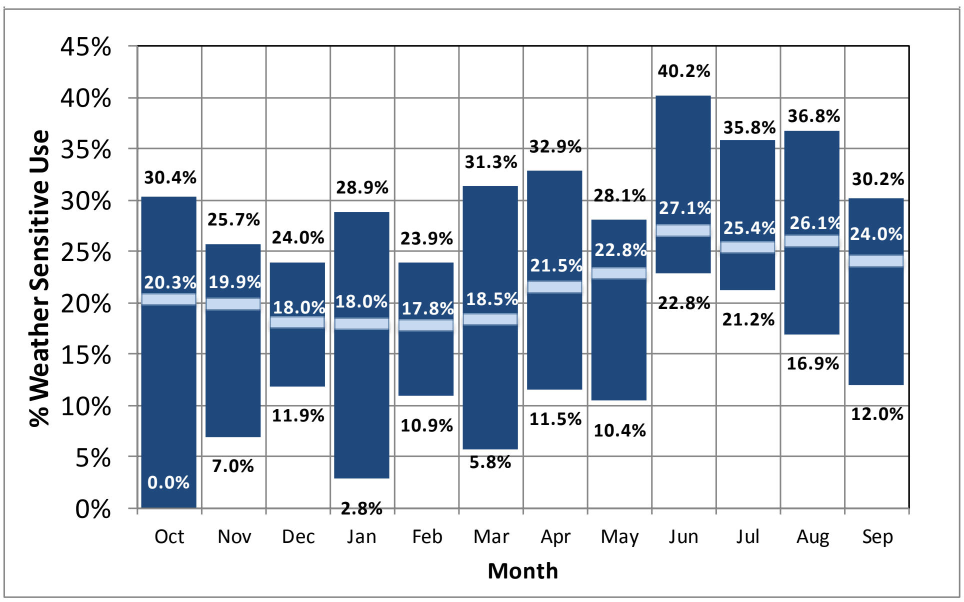

Figure 3.31: Nursing Home Sector Type Weather-Sensitive and Weather-Insensitive Demands

In Table 3-47, the ***Hotel/Motel*** weather-sensitive demands (expressed in gallons/room/day), represent on average 45 percent of total demands. Seasonal use is lower than other sectors except for a March peak largely tied to an increase in hotel occupancy from tourism. As illustrated in Figure 3.32, weather-sensitive demands are highest March through August. While this pattern could indicate elevated April/May/June demands as a result of irrigation and increased cooling during July/August, the seasonal trends in this sector appear to be driven by tourism and occupancy rates.

Table 3-47
Hotels/Motels: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	0%	0%	4%	13%	38%	35%	21%	25%	19%	28%	31%	17%	**19%**	**0%**	**38%**
2003	31%	45%	34%	43%	46%	62%	51%	42%	47%	76%	57%	34%	**47%**	**31%**	**76%**
2004	45%	48%	38%	42%	21%	87%	54%	60%	58%	64%	46%	63%	**52%**	**21%**	**87%**
2005	63%	62%	46%	60%	57%	76%	64%	58%	60%	63%	60%	58%	**61%**	**46%**	**76%**
2006	54%	52%	45%	50%	32%	99%	63%	59%	59%	49%	53%	47%	**55%**	**32%**	**99%**
2007	55%	53%	51%	56%	64%	59%	52%	59%	47%	32%	47%	33%	**51%**	**32%**	**64%**
2008	37%	29%	27%	29%	29%	36%	30%	52%	26%	26%	14%	10%	**29%**	**10%**	**52%**
Avg	**41%**	**41%**	**35%**	**42%**	**41%**	**65%**	**48%**	**51%**	**45%**	**48%**	**44%**	**37%**	**45%**		
Min	**0%**	**0%**	**4%**	**13%**	**21%**	**35%**	**21%**	**25%**	**19%**	**26%**	**14%**	**10%**		**0%**	
Max	**63%**	**62%**	**51%**	**60%**	**64%**	**99%**	**64%**	**60%**	**60%**	**76%**	**60%**	**63%**			**99%**

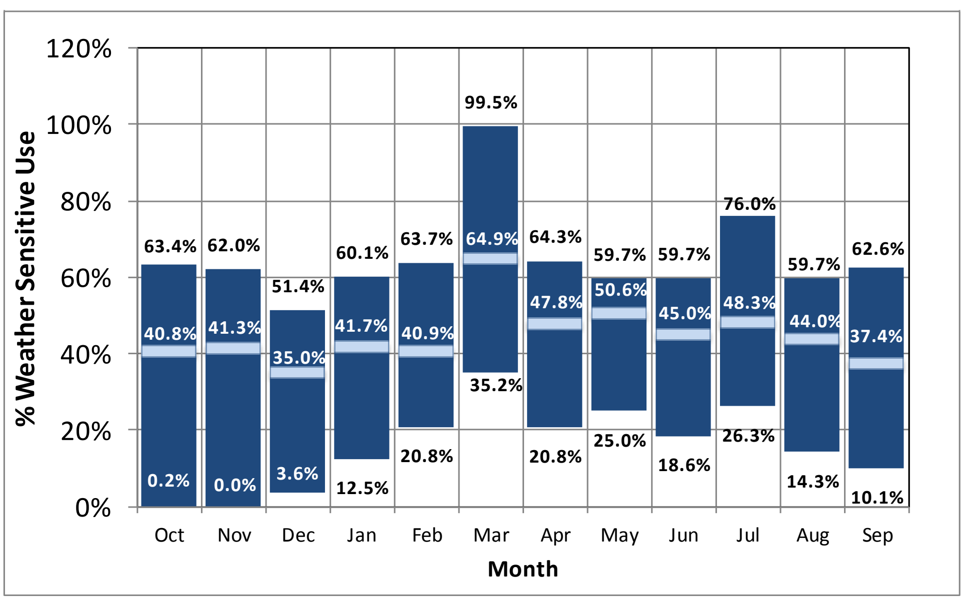

Figure 3.32: Hotel/Motel Sector Weather-Sensitive and Weather-Insensitive Demands

In Table 3-48, ***Restaurant sector***, weather-sensitive demands represent on average 16% of total demands. As illustrated in Figure 3.33, seasonal demands are highest in April-June, and lowest in September, which also happens to be the lowest month of demand in the sector overall. This trend is indicative of irrigation use, with higher use during hot/dry periods and lower use during wet and/or cool periods. However, except for July, seasonal use is most variable between April and September.

Table 3-48
Restaurants: Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	16%	19%	24%	18%	20%	23%	20%	25%	25%	16%	12%	7%	19%	7%	25%
2003	11%	10%	13%	12%	11%	13%	12%	10%	16%	17%	13%	11%	12%	10%	17%
2004	11%	11%	11%	14%	14%	17%	28%	41%	38%	21%	34%	23%	22%	11%	41%
2005	20%	23%	23%	20%	19%	19%	21%	23%	16%	17%	23%	16%	20%	16%	23%
2006	19%	20%	19%	20%	20%	24%	28%	29%	29%	17%	15%	15%	21%	15%	29%
2007	15%	17%	16%	14%	11%	16%	11%	17%	16%	17%	10%	7%	14%	7%	17%
2008	9%	9%	10%	8%	6%	8%	7%	10%	7%	7%	1%	0%	7%	0%	10%
Avg	14%	15%	16%	15%	14%	17%	18%	22%	21%	16%	15%	11%	16%		
Min	9%	9%	10%	8%	6%	8%	7%	10%	7%	7%	1%	0%		0%	
Max	20%	23%	24%	20%	20%	24%	28%	41%	38%	21%	34%	23%			41%

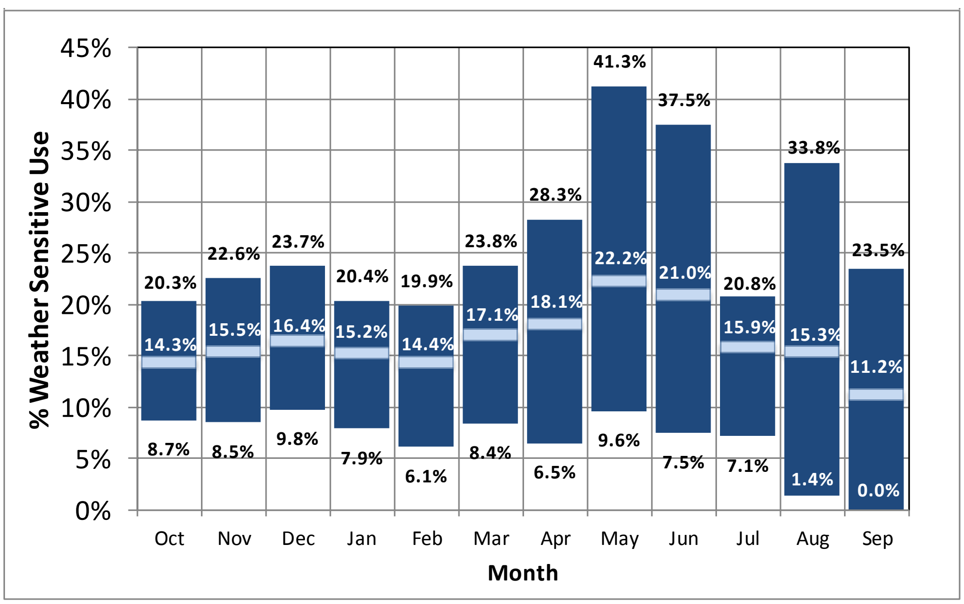

Figure 3.33: Restaurant Sector Weather-Sensitive and Weather-Insensitive Demands

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In Table 3-49 ***Office Building*** weather-sensitive demands represent on average 24 percent of total demands. As illustrated in Figure 3.34 Weather-sensitive demands are highest in April-September, and lowest in October-March. These patterns all indicate the presence of cooling tower and irrigation use.

Table 3-49
Office Buildings: Monthly Average Weather-Sensitive Use
Estimated as Mean Percent of Total Use (WY 2002-2008)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg	Min	Max
2002	48%	46%	42%	41%	41%	47%	58%	63%	52%	42%	34%	29%	45%	29%	63%
2003	7%	11%	0%	6%	10%	9%	14%	23%	16%	33%	20%	19%	14%	0%	33%
2004	23%	16%	8%	6%	8%	21%	21%	37%	40%	35%	24%	24%	22%	6%	40%
2005	22%	21%	20%	12%	15%	15%	25%	28%	31%	31%	24%	36%	23%	12%	36%
2006	31%	21%	11%	12%	8%	28%	32%	32%	37%	26%	44%	28%	26%	8%	44%
2007	30%	23%	17%	10%	11%	15%	21%	27%	35%	33%	31%	25%	23%	10%	35%
2008	19%	31%	13%	6%	7%	8%	15%	28%	20%	34%	16%	19%	18%	6%	34%
Avg	26%	24%	16%	13%	14%	20%	27%	34%	33%	33%	27%	26%	24%		
Min	7%	11%	0%	6%	7%	8%	14%	23%	16%	26%	16%	19%		0%	
Max	48%	46%	42%	41%	41%	47%	58%	63%	52%	42%	44%	36%			63%

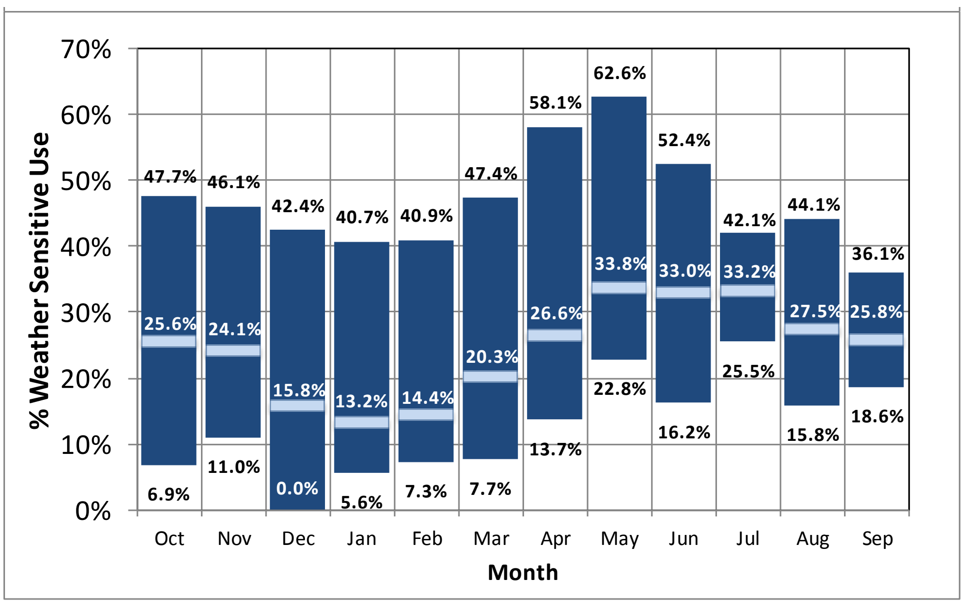

Figure 3.34: Office Building Sector Weather-Sensitive and Weather-Insensitive Demands

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3.4.3 Potential Nonresidential Efficiency Improvements

The nonresidential customer class in general, and many individual high-priority sectors examined have weather-sensitive demands high in summer and spring alike and lower rest of the year. This pattern differs from those of residential customer classes, where demands are high in the spring and low in the summer. However, in general weather-sensitive uses in nonresidential sectors are lower except for a few sectors as described in Section 3.4.2.5.

In terms of seasonal variability, key factors contributing to nonresidential weather-sensitive use include cooling water and irrigation. Nonresidential locations tend to more frequently have large, multistory buildings, which tend to use cooling towers for climate control. Cooling tower use is much more sensitive to temperature than to precipitation, and thus are likely responsible for a significant portion of the sensitivity identified in Section 3.4.2.5. Some nonresidential sectors, in particular Restaurants and Office Buildings, show indications of significant irrigation use as well, with seasonal fluctuations in weather-sensitive demand that are qualitatively similar to those of the single-family customer class.

Given the high likelihood of cooling tower and irrigation use in nonresidential establishments and the relatively low cost of increasing cooling tower water efficiency, these uses are potential targets for end-use efficiency improvements in some nonresidential sectors. Although other general opportunities for nonresidential end-use efficiency improvement are known, the team was not able to quantify through methods developed and used herein. For example, efficiency improvements may be through installation of high-efficiency toilets, fixtures, appliances, and other technologies characteristic of individual sectors (e.g., pre-rinse spray valves in restaurants and technology related to specific production or services processes).

While it was possible to quantify some of these opportunities as further described in Sections 5.0 and 6.0, the ability to profile nonresidential users is constrained by secondary data source information. Additional information collected from field investigations and surveys are needed to enhance secondary data source use, judging water efficiency potential and validating location and end use characteristics.

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Section 4.0
Analysis of Water Technologies and Baseline Water Use Efficiency

Estimates of water savings potential are based on assumptions concerning changes in the mix of water using technology and the rate (or intensity) at which water using technology is used. Assessment of technology and program based savings potential requires starting-point (or base-year) estimates of fixture age distribution and efficiency regionally by water use sector and water efficiency technology market penetration. The base-year for the analysis completed herein is 2008. Using estimates of these main parameters for the base year, remaining water efficiency potential is evaluated over the agency's long-term water demand horizon (2035).

Through a literature review initiated by Tampa Bay Water, a water efficiency program library (WEPL) of technically-applicable demand management technologies, programs and best management practices was developed. The library includes technologies and programs potentially applicable to the Tampa Bay region and information relating to cost, water use reduction, and durability, providing a menu of water conservation options expected to result in measurable water savings.

To use the WEPL it was necessary to use property parcel data to develop sectoral estimates of fixture age distribution and water use efficiency in the region. Passive measure market penetration are assumed associated with plumbing standards and increased efficiency due to an evolving market (supply and demand) for water efficient products recognized or certified through the U.S. Environmental Protection Agency (EPA) WaterSense label and/or Department of Energy (DOE) Energy Star (ES) programs.

Evaluation of existing (or baseline) water efficiency utilizes this parcel information, in conjunction with assumptions of useful life of water fixtures, to estimate baseline average end use flow rates (end use analysis). End use water consumption is commonly defined as the number of gallons consumed daily by a household or nonresidential establishment to satisfy one end use (e.g., a toilet flush, shower, clothes washer event, dishwasher event, etc.). The end use analyses measures or estimates the presence, saturation (distribution levels of efficiency), and intensity (rate of use) of water end uses. This, allows saving estimates associated with passive replacement of water-efficient technologies through the long-term water demand horizon (2035).

4.1 End Use Technologies

The WEPL (Appendix B) organizes relevant end use information to support the review of technically-applicable demand management technologies, programs and best manage-

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ment practices applicable to the Tampa Bay region. As discussed in Section 2, WEPL items are categorized according to water end use technologies and water using sectors allowing water savings and pricing assessments among the three major common customer class uses of water, single-family residential (SF), multifamily residential (MF), and nonresidential (NR). Key information identified in literature review includes:

- End use technologies
- Mechanical efficiency
- Product life expectancy
- Intensity (frequency of use)
- Programmatic savings and pricing

Table 4-1 to Table 4-6 identifies the range of expected water end use for residential and nonresidential customer classes. Residential (single-family/multifamily) end uses of water generally include typical indoor domestic or sanitary uses of water (e.g., toilets, showers, faucets, clothes washers, dishwashers), and outdoor end uses associated with irrigation and swimming pools. Nonresidential end uses are generally inclusive of those found in the residential classes, but also consist of technologies that can use substantial quantities of water for cooling, heating and process water including product development (e.g. food service). Indicators are provided to identify where end uses with the greatest potential for efficiency improvements are most likely to exist along with the relative qualitative impact water efficiency measures would have. These indicators can be interpreted as follows:

- (+) end use likely to exist and moderate impact on water use likely
- (++) end use likely to exist and significant impact on water use likely
- (●) presence of end use is almost certain
- (◌) possible presence but not certain

The nonresidential class includes a variety of facility types (i.e. sectors) and users such as restaurants, hotels/motels, retail stores, office buildings, educational healthcare, retirement, government, heavy/light manufacturing, and industrial users among others. Domestic end uses such as toilets, urinals and faucets, and cooling practices will generally be found in most nonresidential sectors. Significant efficiency improvements are likely to be found within these domestic end uses alone. Opportunities in kitchen, dishwashing and clothes washing end use are likely to exist, particularly in the restaurants, hospitals and health care land use sectors. Although available information on potential savings is limited, cost effective, high impact opportunities are likely to exist in process water for both hospitals/health and heavy industrial/manufacturing buildings.

Table 4-1
Predominant Domestic End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
DOMESTIC	++	++	++	++	+	++	++	++	++	+	++	+	+	+	+	+	++	+	+		+	+
Toilet flushing	●	●	●	●	●	●	●	●	●	●	●	●	●	○		●	●	○	●		●	●
Urinal flushing	●	●	●	○	●	●	●	●	●	●		●				●	●	○	●			
Bathroom sinks	●	●	●	●	●	●	●	●	●	●	●	●	●	○		●	●	○	●		●	●
Kitchen sinks	●	●	●	○		○	●	●	●								○		○			
Showering	●	●		●			●	●	●	●									○			
Bath tubs	●	●		●				●	●													
Dishwashing machine	●	●	●	●		○	●	●	●								○					
Clothes washing machine	●	●		●				●	●	○			●	●								

Table 4-2
Predominant Irrigation End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
IRRIGATION	++	++	+	+	+	+	++	+	+		+			+			+	++	++	++	+	+
Manual watering with hose or can	○	○							○		○						○				○	○
Sprinkler attached to hose	○	○	○	○	○	○	○		○								○					
Sprinkler system with manual control	○	○	●	○	●	○	●	●	○		○						●	○	●	●	○	○
Automatic sprinkler system on timer	○	○	●	●	○	●	●	●	●		○							●	●	●	○	○
Automatic system with ET controller	○	○																●	●	●		
Automatic system with rain sensor	○	○																●	●	●		
Automatic system with soil moisture sensor	○	○		○			○											●	●	●		
Drip irrigation system	○	○		○		○	○											●	○	●		

Table 4-3
Predominant Outdoor/Indoor End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
OUTDOOR/INDOOR FEATURES	+	+	+	++	+	+	+	+	+					+				+	+			
Swimming pools	○	○		●			●											○				
Spas/hot tubs	○	○		●					○									○				
Decorative fountains	○	○	○	●	○	●			○													
Decorative pools/ponds	○	○				●												●	●			
Outdoor misting systems			●	●										○								
Whirlpool for physical therapy								●	●													

Table 4-4
Predominant Food Service End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
FOOD SERVICE			++	++	++	++	++	++	++	+							+		+			
Faucets			●					●	●								○		○			
Wok faucet(s)			○					○														
Dishwashing machines			●	●			○	●	●										○			
Ice machines			●	●		○		●	●										○			
Garbage disposals			●					●	●													
Food preparation			●		○		●	●	●	○									○			
Frozen yogurt and ice cream machines			●		○				○													
Pre-rinse nozzles			●					○	○													
Indoor mist sprayers					○																	

Table 4-5
Predominant Process Water and Sanitation End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
PROCESS WATER			+					++		++		+	++		++	++						++
Inclusion of water in product										●												○
Transporting ingredients										●												○
Ingredient processing and rinsing										●												○
Transporting products										●												○
Lubricating conveyor belts										●												○
Product cleaning and rinsing										●												○
Process rinsing and reaction baths										●												○
Metal finishing rinses										●												○
Wave soldering rinses										●												○
Equipment cleaning and rinsing										●						○						○
Water solvent or chemical reactant										●												○
Surface coating										●						●						○
Paint spray booths										●												○
Photographic and X-ray processing								●														
Waste fluming to sewer			●							●												○
Scrubbing of air pollutants								○		●												○
Water softening - filter backwash										●												○
Pure water systems (RO/stills)			○					●														
Sterile processing (autoclaves)								●														
Large capacity clothes washers													●									
Tunnel clothes washers													●									
Commercial car/truck washing												○			●							
WASHING/SANITATION	+	+	+	+	+	+	+	++	+	++	++	++	+	+	++	++	+	+	+	+	++	++
Facility cleaning			●	●	○	○	●	●	●	●		●	○			●						○
Sterilizers/autoclaves								●	○													
Equipment washing			○		○					●		●										○
Dust control										●		●										○
Container washing			●							●		○										
Washing of autos, vans or trucks	●	●									●	○		●	●	●			○			
Washing of sidewalks, driveway, or parking			●	○	●		●	○				○		○								

Table 4-6
Predominant Cooling/Heating End Uses by Water Use Sector

MAJOR AND MINOR END USES ● = presence of end use is almost certain ○ = possible presence but not certain ++ = high intensity water use + = moderate to low intensity water use	Single-Family	Multifamily	Restaurants (Full-Service, Fast Food)	Lodging: Hotels or Motels	Retail Stores	Office Buildings	Schools or Colleges	Healthcare (Hospitals, Nursing, Medical Services)	Retirement (Assisted Living Facilities)	Heavy/Light Manufacturing Plants	Governmental/Other Institutional	Warehouses	Commercial Laundries	Laundromats	Car Washes	Auto Service Facilities	Religious Buildings	City Park or Recreation Area	Golf Courses	Landscape Irrigation Only	Other Commercial	Other Industrial
COOLING/HEATING		++	++	++	++	++	++	++	++	++	++	++	+									++
Cooling tower		○		○	○	●	○	●	○	●		○										○
Boilers and steam systems		○	○	○				○	○	●												○
Chillers		○						○		●												○
Refrigeration systems			●					○	○			●										
Once-through cooling:																						
Air conditioners								○					●									○
Air compressors										●												○
Hydraulic equipment										●		●										○
Degreasers										●												○
Rectifiers										●												○
Vacuum pumps										●												○
Motor bearings										●												○

4.1.1 Mechanical Efficiency

Mechanical efficiency refers to the effective flow rate (e.g. gallons per flush) of an end use device. Several levels of mechanical efficiency corresponding to different flow rates exist for each end use technology. End use technologies can generally be categorized according to three levels of mechanical efficiency defined as follows:

- Non-conserving (conventional)
- Conserving (standard)
- Ultra-conserving (high-efficiency)

Conventional technologies are the least water efficient and commonly found in older homes and businesses. With respect to domestic end use fixtures including toilets, faucets and showerheads, conventional technologies are most often associated with homes built prior to 1994. Standard and high-efficiency fixtures provide the same technology based result as conventional fixtures but at lower water usage rates per event (i.e. with higher efficiency).

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The U.S. Energy Policy Act of 1992 (EPAct), effective in 1994, was responsible for mandating maximum flow standards for many fixtures including toilets, faucets and showerheads. Since that time, manufacturers have introduced and marketed fixtures and appliances, which meet or exceed EPAct standards, leading to programs such as the EPA WaterSense and Energy Star (ES) programs. These programs certify products performing at rates that are more efficient than the current national efficiency standards while meeting consumer expectations and influence the market by encouraging consumers to purchase ultra-water conserving, high-efficiency (HE) water products. WaterSense labeled products require independent third-party certification of performance and product durability, insuring product use is consistent with labeling over a defined life.

4.1.2 Product Life Expectancy

Most water technologies are typically replaced within a certain period of use. This period is defined as the products life expectancy (years) or the durability which translates to an annual rate of decay or natural replacement rate (nrr). A technology's nrr is calculated as the inverse of its expected life in years using equation 4-1.

Equation 4-1:

$$nrr = \frac{1}{Expected\ Life\ in\ Years}$$

Passive water efficiency is the process of replacing old fixtures with new, more efficient fixtures as they wear out or become effectively obsolete or installing efficient water-using fixtures in new construction due to codes or other market driven factors. As older fixtures are replaced with newer more efficient products, the distribution of product market penetration rates and associated rates of mechanical efficiency change. For example, if the target market for high efficiency toilets (HETs) is all single-family homes, but only 5 percent of households actually have HETs, the 5 percent could be described as the market penetration of the target market for HETs.

4.1.3 Frequency of Use

The amount of water used by a given technology depends on mechanical efficiency (rated or design flow) and frequency of use. Frequency indicates the duration or number of end use events in a day, and is typically expressed in per capita terms (events/minutes/loads per person per day). Frequency of use assumptions, used to produce baseline end use estimates for the DMP, are provided in Table 4-7.

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Table 4-7
Frequency of Residential End Use Events

End Use	Event	SF Event Frequencies	MF Event Frequencies
Toilet	flushes/person/day	5.05	5.05
Shower	minutes/person/day	6.1	6.1
Faucet	minutes/person/day	8.1	8.1
Clothes Washer	loads/person/day	0.37	0.38
Dishwasher	loads/person/day	0.23	0.31

Note: SF/MF clothes washer and dishwasher event frequencies assume 2.62 and 1.90 persons per household respectively

The single-family and multifamily toilet, shower and faucet frequencies provided in Table 4-7 are based on the Residential End Uses of Water Study (REUWS)[1] measurements. Similar studies such as the Analysis of Water Use in New Homes (Aquacraft, 2011) and EPA Water and Energy Savings from High Efficiency Fixtures and Appliances in Single Family Homes Study (Aquacraft, 2005) indicate similar findings. While the single-family clothes washer frequencies are also based on REUWS data, sector-specific research performed by the Multi-housing Laundry Association indicates the average multifamily household washes approximately 0.73 loads per household day.[2] Although the REUWS also provides estimates for dishwasher use, a more recent 2005 Energy Star estimate indicating the average number of cycles of dishwasher use at 215 per year or 0.59 loads per day (McNary, 2005) was used.[3]

Programmatic savings and costs included in the WEPL provide a range of potential savings and costs estimates for converting a conventional fixture or appliance to a standard or high efficiency model identified through implementation of utility sponsored conservation programs and other industry research. Additional information taken from literature includes participant savings on gas and electricity, durability, plumbing code.

A complete itemization of single-family, multifamily and nonresidential technologies is provided by source in the WEPL (Appendix B). The range of water use intensities, water savings, associated costs of retrofit, and frequency of use measures for non-residential end use technologies identified in the literature review is also provided. Section 4.3 and 4.4 examine the baseline water use and potential water savings associated with various end use technologies by sector.

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[1] *Mayer et al, (1999). Residential End Uses of Water Study, AWWARF.*
[2] *Multi-housing Laundry Association (2002 rev). Multifamily Housing In-Apartment Washers vs. Common Area Laundry Water Energy Survey.*
[3] *CUWCC, (2007). A Report on Potential Best Management Practices, Annual Report Year 3.*

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4.2 Estimation of Baseline Fixtures and Appliances by Age and Efficiency

Evaluation of baseline water efficiency requires use of parcel information, assumptions related to passive efficiency and market penetration of high efficiency products to estimate baseline average end use flow rates. The current (2008) distribution of end use technologies by age and efficiency supports estimation of baseline end use water demand and it serves as the basis for examining remaining active and passive water efficiency potential over the agency's long-term water demand horizon (through 2035).

End use fixture estimates provide a basis for measuring product saturation (market penetration) in existing residential (single-family/multifamily) homes and businesses according to varied levels of technological efficiency. The fixture estimation methodology employs a two-step process that includes:

- Estimation of existing fixtures and appliance stock by age and efficiency cohorts
- Conversion of non-conserving fixtures and appliances to standard or HE products

Passive water efficiency has been most widely documented with respect to toilets, clothes washers, dishwashers, and urinals. Estimation of these fixtures relies on the 1) correlation of fixture efficiency (rate of use) with structure age and 2) assumptions relating to the expected life of a technology.

Parcel data provide initial distributions of fixture efficiency by sector of water use based on the age of home. Toilets for example have a variety of efficiency mandates allowing age v. type of technology portrayal. Prior to estimation of passive replacement, fixture stock is categorized according to various levels of technological efficiency (mechanical rates of use) v. year of construction. These assumptions are provided for toilets, showerheads, faucets, and urinals in Table 4-8 and clothes washers in Table 4-9.

Flow rates provided in Table 4-8 for toilets and urinals manufactured after 1994 are consistent with EPAct standards flush volumes of 1.6 gpf and 1.0 gpf respectively. Conventional fixtures, those installed before EPAct standards went into effect in 1994, typically operate at flow rates much higher than conserving standard and high-efficiency counterparts. As shown in Table 4-8, flush volumes for conventional toilets and urinals installed prior to 1994 are assumed to operate at ranging between 3.5 and 7 gpf and 2.5 gpf and 3.0 gpf, while WaterSense labeled products are required to flush at maximum flow rate of 1.28 gpf and 0.5 gpf respectively.

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The faucet and showerhead flow rates for the 1995-2008 housing age group are lower than the current EPAct standard. These rates are assumed based on end use research indicating average household bathroom faucet and showerhead water use is less than the current standard and close to or less than WaterSense HE criteria. For example, an

EPA high efficiency fixture and appliance study indicates the average flow rate of showers in Tampa was 2.08 gpm just slightly above the current WaterSense standard of 2.0 gpm.[4] A 2004 Tampa study indicated similar findings with respect to faucets, citing a typical baseline faucet flow rate of 1.0 gpm and 2.6 gpm peak flow, and signifying a flow utilization rate of 38 percent.[5] Many of the homes in the Tampa studies were found to either have fixtures of a higher mechanical efficiency or users simply throttle the fixtures below the federally established low-flow rates.

Table 4-8
Fixture Flow Rates Based on Distribution of Housing Age

End Uses	Unit	Pre-1983	1983-1994	1995-2008	Actual HE	Adjusted HE
		Unit Flow Rate				
Toilets	gpf	5.0	3.5	1.6	1.28	1.28
Showerheads	gpm	3.3	2.5	2.0	2.0	2.0
Faucets	gpm	1.2	1.1	1.0	1.5	0.8
Urinals	gpf	3.0	2.5	1.0	0.5	0.5

Table 4-9
Clothes Washer Flow Rates Based on Distribution of Housing Age

End Use	Unit	Pre-1997	1997-2000	2001-2007	2008
Clothes Washers	Water Factor	15.0	11.0	9.5	8.0
	Gallons/Load	40.5	29.7	25.7	21.6

According to a US Department of Energy[6] publication, showerheads manufactured before 1995 use 50% more water than new models. For the purpose of this research, showerhead flow rates for 1995 to 2008 are consistent with the current WaterSense specification and prior Tampa research, while showerheads manufactured between 1983 and 1994 and prior to 1983 are assumed to use 20 and 50 percent more water respectively, than the post-1994 flow rate (2.0 gpm). Given the finding of the 2004 Tampa research, a baseline faucet flow rate of 1.0 gpm is assumed for all products manufactured after 1994. Pre-1983 and 1983-1994 faucet flow rates also reflect the 38 percent flow utilization rate, under 2.75 and 3.0 gpm peak flow assumptions. The adjusted HE faucet flow rate assumes the current WaterSense specification minimum flow rate.

Using assumptions regarding (1) expected product life, (2) EPAct standards and (3) market share of high efficiency products, initial fixture estimates are adjusted to reflect passive water efficiency already embedded in prevailing average flow rates. The initial

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[4] *Aquacraft (2005) EPA Water and Energy Savings from High Efficiency Fixtures and Appliances in Single Family Homes*

[5] *Mayer (2004). Tampa Water Department Residential Water Conservation Study*

[6] *Department of Energy, (October, 2010). Guide to Home Water Efficiency, EE-0343. Prior to 1995, showerheads use up to 50% more water than the current standard.*

fixture estimates provide a base year distribution of fixture stock according to multiple levels of technological efficiency. Historically, products installed in new homes and businesses are assumed to correspond with standards prevailing when new homes or businesses are constructed.

As previously discussed, a product's natural replacement rate (nrr) is directly influenced by the expected life (years) or durability of the end use fixture. The nrr factor estimates the annual conversion of existing parcel housing stock to Ultra-low Flow (ULF) or HE products. Table 4-10 shows the expected life assumed for each end use fixture and the associated nrr factors calculated using Equation 4-1.

Subsection 4.3.1 details the methodology and assumptions used to estimate number of residential toilets, washing machines and dishwashers as well as non-residential toilets and urinals according to various level of mechanical efficiency. These estimates support the assessment of average end use flow rates used to evaluate passive and active efficiency potential.

Table 4-10
Natural Replacement Rate Assumptions

	Expected Life (Years)			Natural Replacement Rate (nrr)		
End Use Fixtures	**SF**	**MF**	**NR**	**SF**	**MF**	**NR**
Toilets	25	25	30	4.0%	4.0%	3.3%
Clothes Washers	12	12	n/a	8.3%	8.3%	n/a
Showerheads	8	8	n/a	12.5%	12.5%	n/a
Faucets	8	8	n/a	12.5%	12.5%	n/a
Dishwashers	8	8	n/a	12.5%	12.5%	n/a
Urinals	n/a	n/a	30	n/a	n/a	3.3%

4.2.1 Residential Toilets, Showers and Faucets

As described earlier, parcel data provides the basis for estimation of the number of toilets, showers and faucets according to housing age distribution and facilitate the estimation of passive replacement over time. Relevant parcel information includes full-baths, half-baths[7] and year of construction. While single-family data is generally complete, considerable amounts of multifamily bathroom data is missing. American Housing Survey (AHS, 2007) per unit estimates in Table 4-11 are used to estimate full- and half baths in multifamily units by construction year.

[7] *Hillsborough and Pasco County's parcel bathroom quantities are presented as decimal numbers, where the whole number represents number of full-baths and the decimal point represents the presence of a half-bath. However, in Pinellas County, decimal points are presented as either 0.66 or 0.33. A decimal point of 0.66 is assumed to imply a full-bath while a decimal point of 0.33 implies a one half-bath.*

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Table 4-11
Multifamily Full/Half-Bathroom per Unit Estimates (AHS, 2007)

WDPA	Full-baths per Unit	Half-baths per Unit
PAS	1.51	0.14
NPR	1.51	0.14
NWH	1.38	0.08
SCH	1.38	0.08
COT	1.38	0.08
PIN	1.45	0.11
STP	1.45	0.11

The total quantity of fixtures is related directly to the number of bathrooms in each housing unit and is defined as follows.

- Number of Toilets = number of full-baths + number of half-baths
- Number of Showers = number of full-baths
- Number of Faucets: number of full-baths + number of half-baths+ 1 (kitchen)

The technological efficiency of plumbing fixtures is assumed to depend on household age. Total fixture stock is quantified for each year of construction provided in the parcel data. Prior to estimation of passive replacement, total fixture stock is categorized into three housing age groups by year of construction.

- Housing units built prior to 1983 (G1)
- Housing units built between 1983 and 1994 (G2)
- Housing units built between 1995 and 2008 (G3)

The total quantity of toilets in each housing age group is the sum of full-baths and half-baths in households built during the specified construction period.

Initial levels of technological efficiency (rate of use) as previously provided in Table 4-8 are assumed for each housing age group prior to natural replacement. Table 4-12 further categorizes fixtures for each housing age group based on technological efficiencies after natural replacement. *F*1, *F*2 and *F*3 fixture categories correspond to four levels of technological efficiency assumed to exist in 2008. Fixtures installed at the time of construction in homes built prior to 1983 (*G1*) are assumed to correspond with *F1* levels and be the least water efficient. Fixtures installed in homes built between 1983 and 1994 (*G2*) are assumed to be more efficient and correspond with *F2* flow rates, while EPAct standard flow rates apply to all fixtures installed after 1994 (*G3*). Given the previously discussed end use research indicating average household bathroom faucet and shower-

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head water use is less than the current standard and close to or less than WaterSense HE criteria, *F4* efficiency levels reflect the adjusted HE flow rates in Table 4-8.

Table 4-12
Technological Efficiency Fixture Categories By Housing Age

	G1 (Pre-83)				**G2 (83-94)**			**G3 (95-08)**	
	Technological Efficiency Categories								
End Use	**F1**	**F2**	**F3**	**F4**	**F2**	**F3**	**F4**	**F3**	**F4**
Toilets	5	3.5	1.6	1.28	3.5	1.6	1.28	1.6	1.28
Showerheads	3.3	2.5	2.0	2.0	2.5	2	2.0	2	2.0
Faucets	1.2	1.1	1.0	0.8	1.2	1	0.8	1	0.8

Fixture decay occurs according to the nrr's provided in Table 4-10, beginning in 1983 for *G1* homes and1995 for *G2* homes. *F1, F2* and *F3* represent the initial technological efficiency levels in *G1, G2* and *G3* age groups respectively. As natural replacement occurs, older fixtures are converted to newer more efficient technologies and the number of fixtures in each housing age group changes, resulting in several levels of technological efficiency in a single age group. For example, natural replacement of fixtures in homes built prior to 1983 (G1) has occurred during time periods when all four technological efficiency levels were available for purchase, thus resulting in multiple levels of technological efficiency in this housing age group. However, homes built after 1994 were required to have EPACT compliant fixtures (1.6 gpf or less), thus resulting in only two levels of technological efficiency in this housing age group. Because *G1* decay initiates in 1983 and 1.6 gpf toilets are not yet a significant part of the market, *G1* toilets converted prior to 1994 are assumed to be replaced with 3.5 gpf toilets (*F2*), adding to the total number of 3.5 gpf toilets assumed to exist in 1994, and still eligible for a standard or HE retrofit.

The annual market share estimate data used to estimate the proportion of HETs installed between 2001 and 2008 is provided in Table 4-13. These estimates were generated for the WaterSense Program Methodology for National Water Savings Analysis Model for Indoor Residential Water Use (2007) and are based on historical toilet shipment data through 2006 and forecasted values for 2007-2030. According to these estimates, HE products accounted for nearly 5 percent of the total market share of fixtures available in the market in 2008. High efficiency toilets are estimated for each year by multiplying the annual market shares provided in Table 4-13 by the number of toilets installed in newly constructed housing units and replaced in existing homes. The equations used to estimate passive replacement for each housing age group (G1, G2 and G3), and quantify the number of fixtures in each technological efficiency category (F1, F2, F3 and HE) existing in 2008 are provided in Appendix G.

Table 4-13
High-Efficiency Toilet Market Share

Year	% Market Share
2001	1%
2002	1%
2003	1%
2004	2%
2005	3%
2006	3%
2007	5%
2008	5%

Table 4-14 and Table 4-15 provide estimates of regional market saturation for the various toilet, showerhead and faucet technological efficiency levels categorized by single-family household age with the distributions across all household ages illustrated in Figure 4.1. These estimates reflect the total number of toilets remaining after rebates issued by Tampa Bay Water member government conservation programs (see Table 4-16). Regionally, approximately 13 percent (137,247) of all toilets (1,060,251) were rebated through member government rebate programs through 2008.

Estimated saturation rates after rebates suggest 69 percent (731,868) of single-family toilets use 1.6 gpf or less. Similar to single-family customer class, nearly two-thirds of toilets (61%, 331,974) in the multifamily customer class are estimated to use 1.6 gpf or less. However, the majority of toilet fixtures remaining in single-family and multifamily units built prior to 1994 still use more than 3.5 gpf. For example, it is estimated 56.5% of toilet fixtures for single-family housing units built between 1983 and 1994 use at least 3.5 gpf with the remainder (43.5%) using between 1.28 and 1.6 gpf.

Showerheads and faucets display even greater levels of estimated efficiency in both classes, due largely to the assumed shorter life expectancy (see table 4.5). More than 80% of showerheads and faucets are estimated to operate at flow rates at or above WaterSense product specifications, thus minimizing the savings potential for these fixtures. Only 39% of faucets and showerheads in units built before 1995 are estimated to operate at lower efficiency levels.

These results imply that the majority of the toilets, showerheads and faucets installed in the Tampa Bay region can be considered efficient according to EPAct standards. However, with more than 30 percent of toilets estimated to use more than 3.5 gpf and the low saturation of HE products, additional water savings potential is still expected to exist. The estimated 2008 baseline distribution of single-family and multifamily toilets, showerheads and faucets are provided by WDPA in Table 4-17 and Table 4-18.

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Table 4-14
Regional Distribution of Single-Family Fixture Estimates by Housing Age and Technological Efficiency Level (2008)

End Uses	Flow Rate	Fixtures by Housing Age						All TBW Housing Ages	
		Pre-1983		1983-1994		1995-2008			
		Fixtures	Percent	Fixtures	Percent	Fixtures	Percent	Fixtures	Percent
Toilets	1.28 gpf	2,004	0.5%	792	0.5%	4,913	1.0%	7,709	0.7%
	1.6 gpf	179,420	43.1%	70,946	43.1%	473,793	99.0%	724,159	68.3%
	3.5 gpf	91,141	21.9%	93,053	56.5%	0	0.0%	184,194	17.4%
	5 gpf	144,189	34.6%	0	0.0%	0	0.0%	144,189	13.6%
	Total	**416,754**	**100%**	**164,791**	**100%**	**478,706**	**100%**	**1,060,251**	**100%**
Showers	2.0 gpm	374,828	77.1%	141,282	77.1%	316,574	100.0%	832,684	84.5%
	2.5 gpm	79,782	16.4%	41,908	22.9%	0	0.0%	121,690	12.3%
	3.3 gpm	31,402	6.5%	0	0.0%	0	0.0%	31,402	3.2%
	Total	**486,012**	**100%**	**183,190**	**100%**	**316,574**	**100%**	**985,776**	**100%**
Faucets	1.0 gpm	628,297	77.1%	216,460	77.1%	469,936	100.0%	1,314,693	84.0%
	1.1 gpm	133,733	16.4%	64,208	22.9%	0	0.0%	197,941	12.6%
	1.2 gpm	52,636	6.5%	0	0.0%	0	0.0%	52,636	3.4%
	Total	**814,666**	**100%**	**280,668**	**100%**	**469,936**	**100%**	**1,565,270**	**100%**

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Table 4-15
Regional Distribution of Multifamily Fixture Estimates by Housing Age and Technological Efficiency Level (2008)

End Uses	Flow Rate	Fixtures by Housing Age: Pre-1983 Fixtures	Pre-1983 Percent	1983-1994 Fixtures	1983-1994 Percent	1995-2008 Fixtures	1995-2008 Percent	All TBW Housing Ages Fixtures	All TBW Housing Ages Percent
Toilets	1.28 gpf	1,163	0.5%	616	0.5%	1,769	1.0%	3,547	0.7%
	1.6 gpf	104,115	43.1%	55,120	43.1%	169,193	99.0%	328,427	60.7%
	3.5 gpf	52,888	21.9%	72,296	56.5%	0	0.0%	125,183	23.1%
	5 gpf	83,670	34.6%	0	0.0%	0	0.0%	83,670	15.5%
	Total	**241,835**	**100%**	**128,031**	**100%**	**170,961**	**100%**	**540,827**	**100%**
Showers	2.0 gpm	192,966	77.1%	103,125	77.1%	122,042	100%	418,133	82.6%
	2.5 gpm	41,073	16.4%	30,590	22.9%	0	0.0%	71,662	14.2%
	3.3 gpm	**16,166**	6.5%	**0**	0.0%	**0**	0.0%	**16,166**	3.2%
	Total	**250,205**	**100.0%**	**133,714**	**100.0%**	**122,042**	**100%**	**505,961**	**100.0%**
Faucets	1.0 gpm	271,718	61.2%	183,350	77.1%	217,752	100%	672,820	74.8%
	1.1 gpm	143,555	32.3%	54,387	22.9%	0	0.0%	197,941	22.0%
	1.2 gpm	**28,684**	6.5%	**0**	0.0%	**0**	0.0%	**28,684**	3.2%
	Total	**443,958**	**100.0%**	**237,737**	**100.0%**	**217,752**	**100%**	**899,446**	**100.0%**

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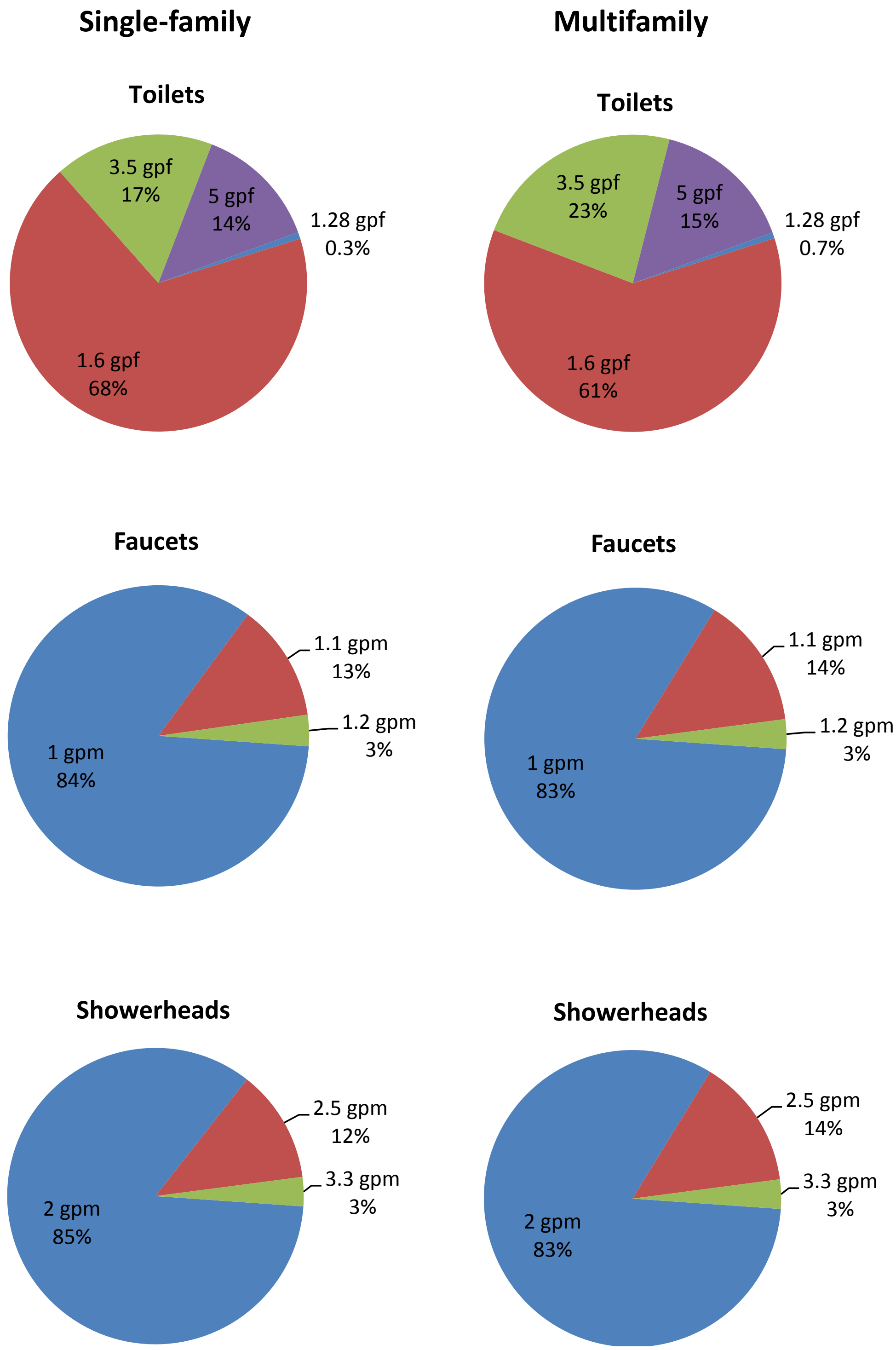

Figure 4.1: Distribution of Single-Family and Multifamily Toilets, Faucets & Showerheads (2008)

Table 4-16
Member Government Toilets and Rebated Toilets (Issued Through 2008)

WDPA	Age Cohort	Total Toilets	Toilet Rebates	% of Total Rebates	Toilets Remaining After Rebates
PAS	Pre 1983	52,375	144	0.10%	52,231
	1983-1994	28,481	288	0.21%	28,193
	1995-2008	104,676	0	0.00%	105,108
	Total	**185,532**	**432**	**0.31%**	**185,532**
NPR	Pre 1983	9,317	4	0.00%	9,313
	1983-1994	2,179	0	0.00%	2,179
	1995-2008	800	0	0.00%	804
	Total	**12,296**	**4**	**0.00%**	**12,296**
NWH	Pre 1983	34,695	9,609	7.00%	25,086
	1983-1994	39,464	8,965	6.53%	30,499
	1995-2008	41,838		0.00%	60,412
	Total	**115,997**	**18,574**	**13.53%**	**115,997**
SCH	Pre 1983	52,741	14,666	10.69%	38,075
	1983-1994	47,167	11,244	8.19%	35,923
	1995-2008	103,574		0.00%	129,485
	Total	**203,482**	**25,911**	**18.88%**	**203,482**
COT	Pre 1983	136,543	13,305	9.69%	123,238
	1983-1994	22,562	1,033	0.75%	21,529
	1995-2008	53,451		0.00%	67,790
	Total	**212,556**	**14,339**	**10.45%**	**212,556**
PIN	Pre 1983	120,139	46,671	34.00%	73,468
	1983-1994	51,524	11,425	8.32%	40,099
	1995-2008	29,050		0.00%	87,146
	Total	**200,713**	**58,096**	**42.33%**	**200,713**
STP	Pre 1983	114,847	19,504	14.21%	95,343
	1983-1994	6,758	388	0.28%	6,370
	1995-2008	8,070		0.00%	27,962
	Total	**129,675**	**19,892**	**14.49%**	**129,675**
TBW	Pre 1983	520,657	103,903	75.71%	416,754
	1983-1994	198,135	33,344	24.29%	164,791
	1995-2008	341,459		0.00%	478,706
	Total	**1,060,251**	**137,247**	**100%**	**1,060,251**

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Table 4-17
Distribution of Single-Family End Use Fixture Estimates by Technological Efficiency Level and WPDA (2008)

End Uses	Flow Rate	Unit Flow Rate	Fixture Estimates by WDPA															
			TBW		PAS		NPR		NWH		SCH		COT		PIN		STP	
			#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total
Toilets	1.28	gpf	7,709	0.70%	2,248	1.20%	65	0.50%	540	0.50%	1,989	1.00%	1,489	0.70%	759	0.40%	619	0.50%
	1.6	gpf	724,159	68.30%	137,870	75.20%	5,741	46.90%	84,069	72.80%	159,708	79.30%	129,322	61.30%	135,826	67.90%	71,622	55.50%
	3.5	gpf	184,194	17.40%	27,342	14.90%	3,267	26.70%	22,708	19.70%	28,611	14.20%	39,108	18.50%	38,710	19.40%	24,448	18.90%
	5	gpf	144,189	13.60%	18,071	9.90%	3,222	26.30%	8,679	7.50%	13,173	6.50%	42,638	20.20%	25,419	12.70%	32,987	25.60%
	Total	**gpf**	**1,060,251**	**100%**	**185,532**	**100%**	**12,296**	**100%**	**115,997**	**100%**	**203,482**	**100%**	**212,556**	**100%**	**200,713**	**100%**	**129,675**	**100%**
Showers	2	gpm	832,684	84.50%	154,791	90.30%	8,727	78.70%	91,800	85.30%	170,566	88.70%	164,447	82.80%	147,010	80.20%	95,343	78.50%
	2.5	gpm	121,690	12.30%	13,775	8.00%	1,829	16.50%	13,683	12.70%	18,518	9.60%	25,827	13.00%	28,934	15.80%	19,126	15.80%
	3.3	gpm	31,402	3.20%	2,930	1.70%	528	4.80%	2,089	1.90%	3,280	1.70%	8,334	4.20%	7,282	4.00%	6,959	5.70%
	Total	**gpm**	**985,776**	**100%**	**171,496**	**100%**	**11,083**	**100%**	**107,572**	**100%**	**192,363**	**100%**	**198,608**	**100%**	**183,226**	**100%**	**121,428**	**100%**
Faucets	1	gpm	1,314,693	84.00%	242,195	89.60%	15,190	78.50%	139,453	85.00%	259,785	88.40%	268,626	82.20%	229,406	80.10%	160,038	78.40%
	1.1	gpm	197,941	12.60%	22,862	8.50%	3,195	16.50%	21,261	13.00%	28,965	9.90%	43,829	13.40%	45,492	15.90%	32,336	15.80%
	1.2	gpm	52,636	3.40%	5,228	1.90%	964	5.00%	3,296	2.00%	5,256	1.80%	14,391	4.40%	11,639	4.10%	11,863	5.80%
	Total	**gpm**	**1,565,270**	**100%**	**270,285**	**100%**	**19,349**	**100%**	**164,010**	**100%**	**294,006**	**100%**	**326,847**	**100%**	**286,536**	**100%**	**204,237**	**100%**
Clothes Washers	8	WF	12,514	2.60%	2,036	2.50%	131	1.70%	1,015	2.20%	2,295	2.70%	2,556	2.40%	2,333	2.70%	2,149	2.80%
	9.5	WF	73,346	15.00%	12,762	15.80%	1,192	15.60%	6,593	14.50%	12,561	14.80%	16,012	15.30%	12,755	14.60%	11,471	15.00%
	11	WF	130,822	26.80%	29,052	35.90%	1,680	21.90%	12,456	27.50%	30,164	35.60%	25,083	24.00%	17,684	20.20%	14,703	19.20%
	15	WF	270,717	55.50%	37,063	45.80%	4,659	60.80%	25,270	55.70%	39,764	46.90%	60,984	58.30%	54,686	62.50%	48,290	63.00%
	Total	**WF**	**487,400**	**100%**	**80,913**	**100%**	**7,661**	**100%**	**45,335**	**100%**	**84,785**	**100%**	**104,636**	**100%**	**87,458**	**100%**	**76,612**	**100%**
Dishwashers	8.7	gpl	352,401	100%	59,140	100%	4,922	100%	33,503	100%	63,167	100%	79,752	100%	59,887	100%	52,029	100%
	Total	**gpl**	**352,401**	**100%**	**59,140**	**100%**	**4,922**	**100%**	**33,503**	**100%**	**63,167**	**100%**	**79,752**	**100%**	**59,887**	**100%**	**52,029**	**100%**
Housing Units			**505,019**		**84,753**		**7,053**		**48,013**		**90,524**		**114,291**		**85,823**		**74,562**	

Table 4-18
Distribution of Multifamily End Use Fixture Estimates by Technological Efficiency Level and WDPA (2008)

End Uses	Flow Rate	Unit Flow Rate	Fixture Estimates by WDPA															
			TBW		PAS		NPR		NWH		SCH		COT		PIN		STP	
			#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total
Toilets	1.28	gpf	3,547	0.7%	292	0.8%	42	0.6%	214	0.5%	640	1.1%	1,111	0.7%	761	0.5%	487	0.6%
	1.6	gpf	328,427	60.7%	22,315	58.3%	3,443	45.6%	32,090	75.2%	44,372	76.3%	99,156	64.0%	80,616	54.0%	46,434	53.9%
	3.5	gpf	125,183	23.1%	10,570	27.6%	2,692	35.6%	8,283	19.4%	9,713	16.7%	34,832	22.5%	39,755	26.6%	19,338	22.4%
	5	gpf	83,670	15.5%	5,391	14.1%	1,423	18.8%	2,306	5.4%	4,089	7.0%	21,047	13.6%	28,973	19.4%	20,443	23.7%
	Total	**gpf**	**540,827**	**100%**	**38,568**	**100%**	**7,600**	**100%**	**42,893**	**100%**	**58,814**	**100%**	**156,145**	**100%**	**150,105**	**100%**	**86,702**	**100%**
Showers	2	gpm	418,133	82.6%	29,309	83.2%	5,422	78.1%	35,253	87.0%	49,696	89.4%	123,047	83.5%	111,520	79.9%	63,886	79.2%
	2.5	gpm	71,662	14.2%	4,985	14.2%	1,280	18.4%	4,786	11.8%	5,071	9.1%	20,173	13.7%	22,610	16.2%	12,757	15.8%
	3.3	gpm	16,166	3.2%	919	2.6%	243	3.5%	474	1.2%	793	1.4%	4,226	2.9%	5,499	3.9%	4,013	5.0%
	Total	**gpm**	**505,961**	**100%**	**35,213**	**100%**	**6,945**	**100%**	**40,512**	**100%**	**55,560**	**100%**	**147,446**	**100%**	**139,630**	**100%**	**80,655**	**100%**
Faucets	1	gpm	743,496	82.7%	51,533	83.2%	9,525	78.1%	63,189	87.1%	89,099	89.5%	220,366	83.4%	196,959	79.9%	160,038	84.4%
	1.1	gpm	127,265	14.1%	8,764	14.2%	2,250	18.4%	8,551	11.8%	9,077	9.1%	36,160	13.7%	39,933	16.2%	22,529	11.9%
	1.2	gpm	28,684	3.2%	1,616	2.6%	427	3.5%	846	1.2%	1,421	1.4%	7,576	2.9%	9,713	3.9%	7,086	3.7%
	Total	**gpm**	**899,446**	**100%**	**61,914**	**100%**	**12,202**	**100%**	**72,587**	**100%**	**99,598**	**100%**	**264,102**	**100%**	**246,604**	**100%**	**189,654**	**100%**
Clothes Washers MF Owner	8	WF	4,053	2.7%	376	2.7%	46	2.4%	298	2.7%	344	2.8%	823	2.7%	1,647	2.7%	519	2.8%
	9.5	WF	22,154	14.8%	2,120	15.4%	293	15.0%	1,595	14.5%	1,796	14.4%	4,552	14.8%	9,004	14.6%	2,793	15.0%
	11	WF	33,428	22.3%	3,502	25.4%	410	20.9%	3,150	28.6%	3,898	31.2%	7,254	23.7%	11,909	19.4%	3,305	17.8%
	15	WF	90,318	60.2%	7,793	56.5%	1,209	61.7%	5,967	5`4.2%	6,442	51.6%	18,031	58.8%	38,904	63.3%	11,973	64.4%
	Total	**WF**	**149,953**	**100%**	**13,790**	**100%**	**1,958**	**100%**	**11,010**	**100%**	**12,480**	**100%**	**30,660**	**100%**	**61,464**	**100%**	**18,591**	**100%**
Clothes Washers MF Renter	8	WF	2,129	2.7%	91	2.7%	25	2.4%	207	2.7%	189	2.8%	880	2.7%	306	2.7%	432	2.8%
	9.5	WF	11,632	14.8%	512	15.4%	158	15.0%	1,111	14.5%	985	14.4%	4,869	14.8%	1,672	14.6%	2,326	15.0%
	11	WF	18,118	23.1%	845	25.4%	221	20.9%	2,193	28.6%	2,138	31.2%	7,758	23.7%	2,211	19.4%	2,752	17.8%
	15	WF	46,695	59.4%	1,881	56.5%	652	61.7%	4,154	54.2%	3,534	51.6%	19,283	58.8%	7,223	63.3%	9,968	64.4%
	Total	**WF**	**78,574**	**100%**	**3,328**	**100%**	**1,055**	**100%**	**7,665**	**100%**	**6,846**	**100%**	**32,789**	**100%**	**11,412**	**100%**	**15,478**	**100%**
Clothes Washers Total	8	WF	6,183	2.7%	467	2.7%	71	2.4%	505	2.7%	533	2.8%	1,702	2.7%	1,953	2.7%	951	2.8%
	9.5	WF	33,786	14.8%	2,631	15.4%	451	15.0%	2,706	14.5%	2,781	14.4%	9,421	14.8%	10,676	14.6%	5,119	15.0%
	11	WF	51,546	22.6%	4,347	25.4%	630	20.9%	5,342	28.6%	6,037	31.2%	15,012	23.7%	14,120	19.4%	6,057	17.8%
	15	WF	137,013	60.0%	9,673	56.5%	1,861	61.7%	10,121	54.2%	9,975	51.6%	37,314	58.8%	46,127	63.3%	21,941	64.4%
	Total	**WF**	**228,527**	**100%**	**17,118**	**100%**	**3,014**	**100%**	**18,674**	**100%**	**19,326**	**100%**	**63,449**	**100%**	**72,877**	**100%**	**34,069**	**100%**
Dishwashers	8.7	gpl	170,406	100%	11,093	100%	2,187	100%	14,110	100%	19,379	100%	51,298	100%	45,854	100%	26,485	100%
	Total	**gpl**	**170,406**	**100%**	**11,093**	**100%**	**2,187**	**100%**	**14,110**	**100%**	**19,379**	**100%**	**51,298**	**100%**	**45,854**	**100%**	**26,485**	**100%**
Housing Units			**358,619**		**23,346**		**4,602**		**29,694**		**40,784**		**107,957**		**96,499**		**55,738**	

4.2.2 Residential Clothes Washers

A wide range of mechanical efficiency levels exist in the clothes washers market. Although WaterSense labels do not currently exist for residential clothes washers, many Energy Star (ES) products have both substantial water and energy benefits. Products earn the ES label by meeting the efficiency requirements set forth in ES product specifications. ES specifications are comprised of two parts:

- MEF (Modified Energy Factor): Measurement of energy consumption for the total laundry cycle (washing and drying) indicating how many cubic feet of laundry can be washed with one kWh of electricity. ***The higher the number the greater the energy efficiency.***
- WF (Water Factor): Measurement of water consumption for the laundry wash cycle indicating how many gallons of water is needed to wash one cubic foot of clothing. ***The lower the number the greater the water use efficiency.***

The ES clothes washer labeling program initially began in May, 1997. In 2004, the DOE developed its first specification which considered the amount of water used as a critical determinant of clothes washer performance in ES, however, a minimum federal standard for clothes washer water efficiency was not established until 2011.

Even without a federal standard, appliance sales data indicates clothes washer WFs have continually decreased while wash load capacities have increased. Although market trend towards voluntary technological efficiency improvements and product development have naturally occurred, programs such as ES and the Consortium for Energy Efficiency's (CEE) Residential Clothes Washer Initiative and Super Efficient Home Appliances Initiative have likely helped accelerate the development of the water efficient clothes washer market.[8] These programs promote the manufacture and sales of efficient products and provide guidance on what constitutes highly water efficient clothes washing performance. Similar to ES, the CEE considers both the MEF and WF in its specification.

Through its initiatives, the CEE has developed several high efficiency clothes washer specifications and qualifying products lists to define and promote energy and water efficiency. CEE specifications provided advanced levels of energy and water performance, higher than is normal in a market and are meant to achieve superior energy efficiency without trade-offs in performance or quality. Key CEE specification milestones occurred in 1995, 2004 and then again in 2007 as provided in Table 4-19.

In 1995, the CEE released its first two-tier specification. Tier 1 represented the characteristics of the most efficient models available in the U.S. market between 1993 and

[8] *CEE, (2001). The Residential Clothes Washer Initiative: A Case Study of the Contributions of a Collaborative Effort to Transform a Market.*

1994, while Tier 2 was set at targets identified as technically feasible for a reasonable increment in manufacturing costs according to studies. In 2004, the specification was expanded to three Tiers with the most efficient products listed in the higher tiers.

Table 4-19
Qualifying CEE and Energy Star Clothes Washer Specifications for 1995, 2004 and 2007

	1995	2004	2007
CEE Tier 1	11	9.5	7.5
CEE Tier 2	9.5	8.5	6.0
CEE Tier 3	n/a	7.5	4.5
ENERGY STAR®	n/a	9.5	8
ES Market Share	0%	25%	44%

According to the CEE, ES qualifying clothes washers with a WF rating of 11 were widely available in 1995 as reflected by the first Tier 1. The CEE Tier 1 WF was lowered to 9.5 in 2004, and then again to 7.5 in 2007. While the timing of historical modifications to ES designations are consistent with the adoption of CEE specifications, ES specifications are generally in-line with the CEE's Tier 1 even though the CEE research suggests a considerable market for more efficient products existed. The first ES WF rating for clothes washers was released in 2004. HE market share information for South/Southeast Region and Florida indicate the HE market share for clothes washers increased by approximately 44% between 1997 and 2008.[9]

As water factors decline and units are replaced, the overall demand for water is expected to decline. Similar to the other plumbing fixtures, the baseline distribution of clothes washer estimates are based on housing units and building age from parcel data, as well as assumptions relating to natural replacement, frequency of use, changes in technological efficiency, and an increasing market share for HE products.

According to the AHS (2007) and National Residential Energy Consumption Survey (RECS, 2009), 97 percent of single-family units have clothes washers. This estimate is also consistent with Tampa Bay Water's single-family survey results. Further investigations revealed ownership plays a large role in whether multifamily units have in-unit clothes washers. While 86 percent of multifamily owner units (e.g., condominium, townhome, and mobile home) have in-unit laundry, only 45 percent of rental units have in-unit appliances. For the purpose of estimating clothes washers, multifamily unit estimates were therefore categorized as either owner or rental units based on the following FDOR property use designations:

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[9] *ENERGY STAR, (1998-2009). Qualified Appliance Retail Sales Data. Data was provided by ENERGY STAR retail partners and represents approximately 60% of the appliance retail market.*

- ***Multifamily owner units*** include condominium, townhome, and 50 percent of mobile homes.
- ***Multifamily rental units*** include multifamily properties with more than 10 units, multifamily properties with less than 10 units, retirement homes and non-profit low income housing and the remaining and 50 percent of mobile homes.

Table 4-20 provides the 2008 parcel unit and clothes washer estimates for single-family and multifamily customer classes. Units without in-unit clothes washers are assumed to use common area or offsite laundry facilities.

Table 4-20
Estimates of Owner and Renter Occupied Units with In-Unit Clothes Washers (2008)

	SF Total	MF Total	MF Owner	MF Renter
Total Units	502,474	365,396	179,186	186,211
% of Units w/In-Unit CW	97%	65%	86%	45%
Units w/CW	487,400	238,804	154,459	84,345
% of Units w/Common/Offsite CW	3%	35%	14%	55%
Units w/Common/Offsite CW	15,074	126,592	24,727	101,866

Assessment of changes in technological efficiency and water use rely on historical water factor and wash load capacity information from various sources, including the CEE, Multi-housing Laundry Association (MLA) and Census AHS (Tampa, 2007) and Annual Sales and Market Share of Energy Star Products. The WEPL classifies water factors as either conventional, standard or HE. Any single water factor may have multiple designations over time as new more efficient models are introduced into the market. Market share based Water factor ratings have improved very quickly since 1997.

Table 4-21 provides annual HE market share and water factor assumptions assumed between 1997 and 2008 and used to assess the current saturation of technological efficiencies existing in homes.[10] Single-family survey results indicate 22 percent of respondents had frontloading clothes washers in 2008. Accordingly, the historical market share assumptions are adjusted to reflect market conditions consistent with the survey estimates. A typical clothes washer installed prior to 1997 used more than 40 gallons of water per load (gpl) (Mayer et al, 1999), while today newer more efficient models use less than 15 gallons per load.[11] To compare apples to apples, its necessary to translate WF into a quantity of water, so wash load capacity must be considered.

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[10] ENERGY STAR, (1998-2009). Qualified Appliance Retail Sales Data.
[11] US Department of Energy, (January 12, 2001). Federal Register, Vol. 66, No. 9. DOE estimate consistent w/REUWS of 40.9 gpl.

Table 4-21
Market Share and Water Factors for Clothes Washers

Year	Adjusted ES Market Share	ES Market Share	Conventional		Standard		High Efficiency	
			WF	GPL	WF	GPL	WF	GPL
1997	1%	1%	15.0	40.5	15.0	40.5	11.0	29.7
1998	4%	4%	15.0	40.5	15.0	40.5	11.0	29.7
1999	7%	6%	15.0	40.5	15.0	40.5	11.0	29.7
2000	10%	7%	15.0	40.5	15.0	40.5	11.0	29.7
2001	13%	9%	15.0	40.5	11.0	29.7	9.5	25.7
2002	15%	13%	15.0	40.5	11.0	29.7	9.5	25.7
2003	18%	20%	15.0	40.5	11.0	29.7	9.5	25.7
2004	21%	25%	15.0	40.5	11.0	29.7	9.5	25.7
2005	24%	34%	15.0	40.5	11.0	29.7	9.5	25.7
2006	27%	36%	15.0	40.5	11.0	29.7	9.5	25.7
2007	30%	40%	15.0	40.5	11.0	29.7	9.5	25.7
2008	33%	44%	15.0	40.5	11.0	29.7	8.0	21.6

However, research indicates consumer laundry habits vary greatly. While some users fill the front-loading machines to less than full capacity (A&N 1999), others fill their washers to maximum capacity, reducing the overall numbers of loads.[12] Although research indicates tub sizes are increasing, consumers are assumed to wash the same number of cubic feet of laundry overtime on average per day. To control for variation in behavior, the total daily quantity and frequency of household wash loads is assumed to remain constant over time. Households are assumed to wash 2.7 cubic feet per load[13] and .96 loads per day on average (Mayor et al, 1999). Research performed by the MLA indicates multifamily households wash fewer loads at 0.73 laundry loads per household per day.

Due to the limited availability of high efficiency products, clothes washers with a WF of 15 (ENERGY STAR, 2004) are assumed to characterize the conventional market and standard market until 2001.[14] However, South/Southeast sales data indicate that a small ES clothes washer market share (1%) existed in 1997. Although the first ES WF of 9.5 was not officially introduced until 2004, the 1995 CEE Tier 1 specification[15] (11 WF), consistent with water use intensities as low as 30 gpl, is used as the high efficiency benchmark through 2001.

In 2001, the DOE revised its clothes washer energy standards. The DOE considered water savings as a factor in determining the economic justification of the clothes washer standard level, however, determined it did not have the authority to prescribe a minimum water factor standard. Nonetheless, 2001 appliance sales data indicate a 9% market

[12] *Pacific Institute, (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California.*
[13] *ENERGY STAR, (2004). Market Impact Analysis of Potential Changes to the ENERGY STAR Criteria for Clothes Washers, (2004).*
[14] *Assumes WF 15 and 2.7 cubic feet per load.*
[15] *Consortium for Energy Efficiency, (1994), Residential Clothes Washer Initiative. Specifies Tier 1 at WF 11.*

share for ES qualified product. In accordance with this market trend, a shift in ES product market share is assumed to have occurred between 1997 and 2001, providing for the implementation of a lower high efficiency benchmark consistent with the 1995 CEE Tier 2 (9.5 WF, 26 gpl). Given the absence of a federal clothes washer standard until 2011, CEE specifications are used to infer a standard WF, resulting in the lowering the assumption for the standard from 15 WF to 11 WF in 2001.

Based on the introduction of the ENERGY STAR water factor criteria in 2004, ENERGY STAR specifications after that date are used to set the HE water benchmark. In 2007, the ES WF was lowered to 7.5. The market share for Energy Star products was already up to 40%. Given this, it was assumed products with 2004 rating were still available on the market and penetration into homes was delayed one year to 2008.

Table 4-17 and Table 4-18 provide the 2008 baseline distribution of single-family and multifamily clothes washers by WDPA. The 2008 baseline estimates assume average useful life of 12-years or nrr of 8.3 percent per year (Table 4-10).[16] Appendix G provides the equations used to estimate passive replacement and quantify the number of clothes washers in each technological efficiency category existing in 2008.

The regional distribution of single-family and multifamily clothes washer efficiency is illustrated by Figure 4.2. As shown, more than 80% of single-family clothes washers have a WF of 11 or higher. Less than 20 percent of households have clothe washers operating at or below the current federal standard of a 9.5 WF implying opportunities to reduce clothes washer water use still exist in both the single-family and multifamily classes.

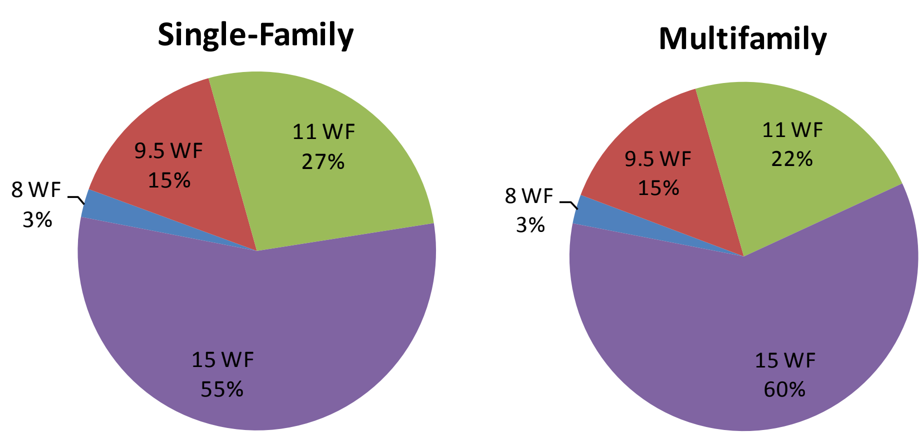

Figure 4.2: Distribution of Single-Family and Multifamily Clothes Washers (2008)

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[16] *Pacific Institute, (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Alliance for Water Efficiency Tracking Tool, version 2, default.*

4.2.3 Residential Dishwashers

Water savings potential for residential dishwashers exist primarily through reductions in water factors (water use per load) and in number of cycles of dishwasher use per year. In 1997, the Energy Star program was expanded to include residential dishwashers. Prior to 2001, the average water use intensity of dishwashers is estimated to range between 7 and 12 gallons per cycle.[17] An Energy Star market analysis conducted in 2005 shows the ENERGY STAR market share for 2002 below 40 percent. By 2005, 86% of dishwashers were ENERGY STAR qualified indicating a 36 percent growth in approximately three years, of the models available, the most inefficient non-qualified dishwashers used 10 gallons per cycle on average. [18] The newer units (installations from 2000 through 2005) are functioning at an estimated 7.5 gallons per cycle.

As technologies become more efficient, some research also suggests fewer wash loads attributable to a trend to dine outside the home and a downward trend in household size. In accordance with this trend, the DOE test method for ENERGY STAR qualifications lowered the number of dishwasher cycle per year in 2002, from 322 to 264. This estimate was lowered even further to 215 cycles per year in February 2004. [19]

In 1985, only 42 percent of households were estimated to use automatic dishwashers, however, this end use has steadily grown since this time (CUWCC, 2007).[20] The 2005 National AHS estimates of new and existing single-family and multifamily housing units with dishwashers are provided in Table 4-22. New construction refers to those units built within 4-years of the survey. According to the AHS, a vast majority of new single-family (95%) and multi-family (82%) households constructed now have builder-installed dishwashers. A lower overall proportion of existing households surveyed had dishwashers with 70 percent of single-family and only 48% homes equipped with automatic-dishwashers. The relative proportion of AHS single-family and multifamily households with dishwashers applied to parcel unit estimates are used to estimate dishwasher presence in new and existing households as presented Table 4-17 and Table 4-18.

Table 4-22
Proportion of New and Existing Households with Dishwashers (AHS, 2005)

Class	Existing			New Construction		
	Total Units	Units w/DW	% of Units w/DW	Total Units	Units w/DW	% of Units w/DW
SF	53,140,000	76,154,000	70%	4,919,000	4,666,000	95%
MF	12,249,000	25,778,000	48%	1,025,000	838,000	82%

[17] *Vickers, Amy, (2001). Handbook of Water Use and Conservation, WaterPlow Press, p131.*
[18] *Market Impact Analysis on the Potential Revision of the ENERGY STAR Criteria for Dishwashers, (2005).*
[19] *CUWCC, (2007). A Report on Potential Best Management Practices, Annual Report Year 3.*
[20] *American Housing Survey for the United States (Multiple reports: 1985 through 2003).*

Baseline dishwasher efficiency is based on the Alliance for Water Efficiency (AWE) Water Conservation Tracking Tool methodology which estimates a weighted average water factor between 2005 and 2010. The approach assumes a 13 year useful life (7.7 nrr)[21] to estimate natural replacement of dishwashers during this period. The 2008 weighted average 8.9 water factor is calculated based on the Californian Urban Water Conservation Council's (CUWCC's) Potential Best Management Practices Annual Report Year 3 assumptions.[22] The assumed water factors and housing estimates used to estimate the weighted water factor are presented in Table 4-23. Although many possible mechanical efficiency levels exist for dishwashers, the method used to estimate the distribution of dishwashers in the base-year does not provide estimates of varied levels of market penetration. Instead, the mix of flow rates is reflected through the single weighted average.

Table 4-23
2005-2010 Estimates of Dishwasher Market Penetration and Water Factors

Unit Type	Class	2005	2006	2007	2008	2009	2010
Total Housing Units	SF	482,108	492,197	497,573	502,474	499,777	499,680
	MF	344,517	345,562	345,334	347,427	349,601	348,936
	Total	**826,626**	**837,760**	**842,907**	**849,900**	**849,379**	**848,616**
New Housing Units	SF	-	10,089	5,375	4,901	-	-
	MF	-	1,045	-	2,092	2,175	-
	Total	**-**	**11,134**	**5,375**	**6,994**	**2,175**	**-**
Total DW	SF	336,414	345,984	351,082	355,732	355,732	355,732
	MF	163,705	164,560	164,560	166,270	168,048	168,048
	Total	**500,119**	**510,543**	**515,642**	**522,002**	**523,779**	**523,779**
New Unit DW	SF	-	9,570	5,099	4,649	-	-
	MF	-	854	-	1,711	1,778	-
	Total	**-**	**10,424**	**4,838**	**6,294**	**1,957**	**-**
Natural Replacement	SF	-	25,878	23,887	22,050	20,354	18,788
	MF	-	12,593	11,624	10,730	9,905	9,143
	Total	**-**	**38,471**	**35,511**	**32,780**	**30,258**	**27,931**
New Installed DW	SF	-	35,448	28,986	26,699	20,354	18,788
	MF	-	13,447	11,624	12,441	11,682	9,143
	Total	**-**	**48,895**	**40,610**	**39,139**	**32,036**	**27,931**
Existing DW	SF	-	310,536	322,096	329,033	335,378	336,943
	MF	-	151,112	152,936	153,830	156,366	158,905
	Total	**-**	**461,648**	**475,032**	**482,862**	**491,743**	**495,849**
Marginal WF		**7.5**	**7.0**	**7.0**	**7.0**	**7.0**	**7.0**
Weighted Average WF		**9.5**	**9.3**	**9.1**	**8.9**	**8.8**	**8.7**

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[21] *National Family Opinion, Inc., (2006). Average Useful Life of Major Home Appliances Survey.*
[22] *AWE Water Conservation Tracking Tool assumes dishwashers installed prior to 2005 operate at 9.5 gpl on average, while dishwashers installed between 2006 and 2010 operate at 7 gpl on average.*

4.2.4 Nonresidential Fixtures and Employment

Similar to the residential customer classes, baseline estimates of nonresidential fixtures (toilets and urinals) are based on a building age distribution and used to estimate baseline average end use flow rates for assessing passive savings through the demand forecast horizon (2035). Evaluation of nonresidential passive savings occurs through development of water use intensity metrics defined as gallons per employee per day and therefore also requires employment estimates.

Unlike the residential classes, parcel data does not provide nonresidential fixture estimates, nor does it provide estimates of employment. Alternatively, baseline estimates of nonresidential fixtures and preliminary employment are based on 1) parcel area (square feet) and 2) fixture/employee per square foot coefficients for FDOR property use designations obtained from University of Florida (UF) research.[23] The UF fixture and employment coefficients provided in Appendix H for commercial, institutional and industrial FDOR property use designations are based on minimum construction code requirements and are applied at a parcel level. Coefficients for total toilets, male use toilets, female use toilets, urinals and employment are provided for each FDOR property use designation. Fixtures and employment are estimated by multiplying a parcels building area by its corresponding FDOR coefficients and then aggregating to distinct locations.[24]

Sectoral disaggregation of nonresidential water end uses requires sectoral correspondence of required data elements. Although initial fixture estimates are generated at a FDOR level, frequency of use assumptions (e.g. flushes/employee/visitor per day) obtained through literature review for estimating average daily water use are limited to nine key nonresidential sector types inclusive of the high-priority sectors identified in Section 3.4. Furthermore, Tampa Bay Water's existing LTDFS demand forecast is based on water use per employee estimates according to total nonresidential employment and the relative proportion of service, industrial and commercial (S/I/C) employment categories.

In addition to sectoral discrepancies between data sources containing the required data elements (FDOR, nine key nonresidential sectors, and LTDFS), employment estimates derived using parcel data and property use coefficients are substantially lower than LTDFS employment. To ensure end-use estimates correlated with LTDFS employment, FDOR parcel employment estimates were used to disaggregate LTDFS S/I/C employment into the nine key nonresidential sectors with frequency of use assumptions. To facilitate sectoral disaggregation of LTDFS employment FDOR property use designations corresponding were corresponded with the key nonresidential sectors and three LTDFS S/I/C employment categories as provided in Table 4-24.

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[23] *Morales et al., (2011). Estimating Water End-Use Devices in the Commercial and Institutional Sectors.*
[24] *Functional employment population coefficients normalized on heated area. Fixture coefficients generally limited to first 10,000 sq. ft. of building area, employee coefficients are limited to the first 50,000 sq. ft.*

Table 4-24
Mapping of LTDFS S/I/C Employment Categories to Key Sectors and FDOR Designations

S/I/C Employment Category	NR Key Sectors	FDOR Property Use Code	FDOR Property Use Description
Service	Hotels	39	Hotels, motels
	Health	06	Nursing Homes
		19	Medical Services
		73	Hospitals
		74	Independent/Assisted Living
		78	Rest Homes
		85	Public Hospitals
	Offices	17	Office Buildings, 1 story
		18	Office Buildings, multistory
		23	Office Buildings, Finance
		24	Office Buildings, Insurance
	Churches	71	Churches
	Government	81	Military
		86	County
		87	State
		88	Federal
		89	Municipal
	Education	72	Private Schools
		83	Public Schools
		84	Public Colleges
	Others	20	Airport/Bus Passenger Terminal
		25	Electrical, Laundry & Dry Cleaner
		26	Service (Gas) Station
		27	Vehicle Wash Full Service
		31	Theater - Drive in
		32	Theater - Enclosed
		33	Night Clubs
		34	Bowling Alley/Skating Rink/Arena
		35	Attraction/Exhibit
		37	Race Tracks
		38	Golf Regulation
		76	Mortuaries, cemeteries, crematoriums
		77	Fitness Center
		79	Cultural
		90	Professional Sports Facilities
		91	Miscellaneous
Industrial	Industrial	41	Small equipment manufacturing
		42	Heavy equipment manufacturing
		43	Lumber Yards
		44	Packing Plants
		45	Bottler/Cannery
		46	Food Processing
		47	Mineral Processing
		48	Warehouse
		49	Open Storage
Commercial	Restaurants	21	Full Service
		22	Fast Food
	Retail	11	Retail Stores
		13	Department Stores
		15	Shopping Centers
		16	Shopping Centers
	Others	12	Store and office or residential combination
		14	Grocer/Food Store
		29	Florist, Greenhouses, Wholesale
		30	Florist Retail
		69	Greenhouses, Retail

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The mapping provided in Table 4-24 is used to aggregate FDOR fixture and employment estimates to the nine nonresidential key sectors and permits and scaling of parcel-based FDOR employment to LTDFS S/I/C base-year employment. FDOR codes not falling within the nine nonresidential key sectors are designated as service and commercial other.[25] The relevant parcel and LTFDS attributes supporting this methodology include:

- Parcel Identifiers (PINs)
- Unique Identifiers (UIDs)
- FDOR property use codes
- Year built / Building area
- LTDFS Total/Fraction S/I/C employment
- LTDFS employees per nonresidential account

The following subsections describe the methodology used to estimate and scale parcel level FDOR estimates to LTDFS employment according to nonresidential key sectors of water use provided in Table 4-24.

4.2.4.1 Nonresidential Toilets and Urinals

As previously mentioned, fixtures (total and male-female specific) are estimated by multiplying FDOR fixture coefficients by parcel building area, and then aggregating up to distinct water use locations, and across the FDOR property use, nonresidential key sectors and LTDFS S/I/C categories as shown in Table 4-24. Parcel fixture counts are rounded to the nearest integer ensuring locations have at least one toilet for male and one for female use. Male urinals are substituted for 50 percent of male toilets (67% for assembly or educational establishments), consistent with Florida plumbing code provisions, while locations with fewer than two male toilets are not assumed to have any urinals.

Passive measures are generally assumed to be associated with current plumbing standards and increased efficiency due to an evolving HE market for water efficient products. Similar to residential fixture estimates, nonresidential toilet and urinal estimates are assigned to the three building age and corresponding technological efficiency cohorts provided in Table 4-8. Prior to implementing natural replacement calculations, the fixture estimates are aggregated to FDOR property use designations. Annual conversion rates obtained from literature are then calculated based on an expected product life of 30 years (3.3% nrr), slightly longer than the rate assumed for residential fixtures.

Although HETs are suitable for use in residential applications, issues related to flushing performance and drainline transport of waste with valve-type HETs in commercial appli-

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[25] *Service Other and Commercial Other key sectors are associated with FDOR designations lacking specific estimates of water use intensity. Criteria used to estimate water use is discussed in Section 5.0.*

cations were identified as high priority research projects by the Plumbing Efficiency Research Coalition (PERC). As a result of ongoing research, HET conversions are only applicable to tank-type toilets in select key sectors for the purpose of this evaluation.

Since presence of valve-type and tank-type toilets within an establishment cannot be determined without field verification, assumptions regarding flush mechanisms were made for each key sector as shown in Table 4-25. Establishments with high traffic volumes were generally assumed to have a flush-valve mechanism. These assumptions were necessary to establish the cost and benefits of tank and flush valve programs, but do not affect water savings calculations. Additionally, these assumptions recognize the existence and permit conservative estimation of HETs in nonresidential establishments. Tank-type HETs are estimated in applicable sectors by assuming the HE market share factors for the residential sector provided in Table 4-13.

Table 4-25
Nonresidential Key Sectors for Fixture Estimates

Key Sector	Flush Mechanism
Churches	Tank
Education	Valve
Government	Valve
Health	Valve
Hotels	Tank
Industrial	Tank
Office	Valve
Restaurants	Valve
Retail	Tank/Valve
Others	Valve

Table 4-26 provides WDPA baseline estimates of toilets and urinals for the nonresidential key sectors and LTDFS S/I/C categories. The fixture estimates in Table 4-26 suggest that more than half (56.0%) of the nonresidential toilets in the Tampa Bay region are rated at 1.6 gpf, while the remaining 24.4 percent (51,560) and 19.5 percent (41,211) are rated at 3.5 gpf and 5.0 gpf respectively. Urinals reflect a similar distribution with an estimated 56 percent of urinals are rated at less than 1.0 gpf, 24.7 percent are rated at 2.5 gpf and 19.1 percent using 3.5 gpf.

Table 4-27 provides regional baseline toilet and urinal estimates, as well as the average weighted flow rates for the LTDFS S/I/C categories and nonresidential key sectors (see Appendix I for WDPA estimates). Overall, the S/I/C service category accounts for the largest proportion of toilets at 82 percent, followed by commercial and industrial at 13 and 5 percent. Across the nine key sectors (excluding other), hotels represent 26 percent of total toilets followed by health at 13 percent and office establishments at 11 percent. These three sectors were also identified as high priority sectors in Section 3.4.

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Table 4-26
Baseline Estimates of Nonresidential Fixtures by Technological Efficiency Level and WDPA (2008)

End Uses	Flow Rate	Unit Flow Rate	Fixture Estimates by WDPA															
			TBW		PAS		NPR		NWH		SCH		COT		PIN		STP	
			#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total	#	% of Total
Toilets	1.28	gpf	393	0.2%	26	0.2%	8	0.2%	17	0.2%	33	0.2%	178	0.2%	75	0.2%	56	0.2%
	1.6	gpf	118,382	56.0%	8,957	64.0%	2,026	46.1%	6,373	69.7%	11,525	64.5%	52,259	54.8%	22,215	55.4%	15,028	49.7%
	3.5	gpf	51,560	24.4%	3,295	23.5%	1,178	26.8%	1,959	21.4%	4,046	22.7%	23,743	24.9%	10,515	26.2%	6,825	22.6%
	5.0	gpf	41,211	19.5%	1,738	12.4%	1,190	27.1%	806	8.8%	2,289	12.8%	19,414	20.3%	7,390	18.4%	8,385	27.7%
	Total	**gpf**	**211,546**	**100%**	**14,016**	**100%**	**4,402**	**100%**	**9,154**	**100%**	**17,892**	**100%**	**95,594**	**100%**	**40,194**	**100%**	**30,294**	**100%**
NR Locations w/Toilets			**28,810**		**2,780**		**779**		**1,491**		**2,992**		**11,571**		**4,647**		**4,550**	
Urinals	1.0	gpf	20,598	56.2%	1,373	63.3%	357	46.4%	1,288	71.1%	1,980	66.9%	9,742	54.4%	3,196	55.0%	2,662	50.7%
	3.0	gpf	16,071	43.8%	794	36.7%	413	53.6%	524	28.9%	979	33.1%	8,156	45.6%	2,618	45.0%	2,587	49.3%
	Total	**gpf**	**36,669**	**100%**	**2,167**	**100%**	**770**	**100%**	**1,812**	**100%**	**2,959**	**100%**	**17,898**	**100%**	**5,814**	**100%**	**5,249**	**100%**
NR Locations w/Urinals			**5,775**		**472**		**135**		**324**		**596**		**2,113**		**1,104**		**958**	

Table 4-27
Baseline Estimates of Regional Nonresidential Toilets and Urinals by Technological Efficiency Level and Key Sectors (2008)

S/I/C Category	Key Sectors	Toilets											Urinals								
		1.28 gpf	% of Total	1.6 gpf	% of Total	3.5 gpf	% of Total	5 gpf	% of Total	Total	% of Total	Weighted Average GPF	1.0 gpf	% of Total	2.5 gpf	% of Total	3.0 gpf	% of Total	Total	% of Total	Weighted Average GPF
Service	**Hotels**	211	54%	32,548	27%	12,952	25%	9,417	23%	55,128	26%	2.63	4,360	21%	1,765	19%	1,233	18%	7,358	20%	1.69
	Churches	55	14%	7,053	6%	3,496	7%	3,771	9%	14,375	7%	2.95	1,253	6%	622	7%	647	9%	2,522	7%	1.88
	Health	0	0%	15,175	13%	7,649	15%	5,196	13%	28,021	13%	2.75	2,861	14%	1,339	15%	1,262	18%	5,463	15%	1.83
	Office	0	0%	13,785	12%	6,129	12%	3,635	9%	23,549	11%	2.62	1,740	8%	865	10%	312	4%	2,917	8%	1.66
	Government	0	0%	4,616	4%	2,006	4%	1,873	5%	8,494	4%	2.80	1,032	5%	476	5%	448	6%	1,957	5%	1.82
	Education	0	0%	7,188	6%	2,457	5%	2,342	6%	11,987	6%	2.65	3,102	15%	1,029	11%	972	14%	5,103	14%	1.68
	Others	0	0%	16,101	14%	7,514	15%	7,420	18%	31,035	15%	2.87	3,814	19%	2,071	23%	1,559	22%	7,444	20%	1.84
Industrial	**Industrial**	44	11%	6,276	5%	2,925	6%	2,311	6%	11,556	5%	2.76	57	0%	27	0%	26	0%	110	0%	1.83
Commercial	**Retail**	53	13%	7,963	7%	3,346	6%	2,479	6%	13,841	7%	2.67	901	4%	360	4%	172	2%	1,433	4%	1.62
	Restaurants	30	8%	4,714	4%	1,693	3%	1,342	3%	7,779	4%	2.60	1,367	7%	473	5%	362	5%	2,201	6%	1.65
	Others	0	0%	2,964	3%	1,392	3%	1,425	3%	5,781	3%	2.90	110	1%	36	0%	15	0%	161	0%	1.52
Service Total		**266**	**68%**	**96,465**	**81%**	**42,203**	**82%**	**33,655**	**82%**	**172,589**	**82%**	**2.73**	**18,163**	**88%**	**8,168**	**90%**	**6,433**	**92%**	**32,764**	**89%**	**1.77**
Industrial Total		**44**	**11%**	**6,276**	**5%**	**2,925**	**6%**	**2,311**	**6%**	**11,556**	**5%**	**2.76**	**57**	**0%**	**27**	**0%**	**26**	**0%**	**110**	**0%**	**1.83**
Commercial Total		**83**	**21%**	**15,641**	**13%**	**6,432**	**12%**	**5,245**	**13%**	**27,401**	**13%**	**2.70**	**2,378**	**12%**	**869**	**10%**	**548**	**8%**	**3,795**	**10%**	**1.63**
Nonresidential Total		**393**	**100%**	**118,382**	**100%**	**51,560**	**100%**	**41,211**	**100%**	**211,546**	**100%**	**2.72**	**20,598**	**100%**	**9,064**	**100%**	**7,007**	**100%**	**36,669**	**100%**	**1.75**

Locations without an explicit key sector and categorized as "service other" account for the second highest proportion of nonresidential toilets at 15 percent. "Service other" locations consist primarily of travel and entertainment related facilities and may provide significant opportunities given the potential for high occupancy and water use.

As previously mentioned, locations with fewer than two male toilets are assumed to not have urinals, therefore the number of locations estimated to have toilets and urinals within each key sector varies as shown in Table 4-28 and Table 4-29. This is an important distinction as future estimates of toilets and urinals (discussed in Section 5.0) rely on base-year estimates and assumptions for toilets-per-location and urinals-per-location.

4.2.4.2 Employment

Similar to fixtures, parcel-based FDOR employment is estimated by multiplying the corresponding FDOR employment coefficients by each parcel's total building area, and then aggregating to distinct water use locations and the various sectoral designations (FDOR, LTDFS, key nonresidential sectors) provided in Table 4-24. The distribution of key sector parcel employment resulting from the initial estimation process provides the basis for disaggregating base-year (2008) LTDFS employment estimates across the nonresidential key sectors. Base-year LTDFS employment is derived using the WY 2007 WPDA employee-per-account factors provided in Table 4-30.[26]

Distribution of the existing LTDFS employment estimates into the key sectors, required a process of rescaling and reallocation of the LTDFS data relative to the available parcel employment. To keep the LTDFS distribution across the S/I/C categories consistent the following three steps were employed:

- Assign key sector employment from parcel data to S/I/C classification
- Calculate distribution of key industries within parcel S/I/C
- Apply parcel distributions to LTDFS S/I/C employment

The results and steps are shown in Table 4-31 (WDPA estimates are provided in Appendix J).

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[26] WY 2007 WPDA employee-per-account factors were derived for the LTDFS model prepared in 2008 and are inherently linked to the LTDFS forecast coefficients used to forecast nonresidential demand.

Table 4-28
Estimates of Fixtures per Location for Nonresidential Locations with Toilets by WDPA (2008)

S/I/C Category	10 Key Sectors	Locations								Toilets								Fixtures per Location							
		TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Service	Hotels	527	16	7	4	17	158	227	98	55,128	1,396	753	620	1227	26,914	17,736	6,482	105	87	108	155	72	170	78	66
	Churches	1,792	95	27	109	294	781	185	301	14,375	866	174	928	2,503	5,179	2,067	2,658	8	9	6	9	9	7	11	9
	Health	2,299	444	120	121	272	656	278	408	28,021	3,092	1,377	1,303	3,628	11,223	2,901	4,497	12	7	11	11	13	17	10	11
	Office	5,422	225	95	470	540	2,139	1,011	942	23,549	764	271	1,467	1,593	11,169	4,599	3,686	4	3	3	3	3	5	5	4
	Government	908	89	26	49	111	361	150	122	8,494	435	123	258	365	5,185	1,013	1,115	9	5	5	5	3	14	7	9
	Education	795	57	19	70	142	304	97	106	11,987	1,144	269	1,022	2,048	4,293	1,441	1,770	15	20	14	15	14	14	15	17
	Others	4435	538	87	134	404	2097	586	589	31,035	2,288	367	1,237	2,217	17343	3,363	4,220	7	4	4	9	5	8	6	7
Industrial	Industrial	4,797	376	76	147	267	2,237	893	801	11,556	844	154	338	628	5,301	2,424	1,867	2	2	2	2	2	2	3	2
Commercial	Retail	3,948	445	137	195	394	1,398	693	686	13,841	1,700	372	1,223	1,907	4,267	2,256	2,116	4	4	3	6	5	3	3	3
	Restaurants	1,336	101	31	79	152	482	279	212	7,779	621	225	506	899	2,712	1,691	1,125	6	6	7	6	6	6	6	5
	Others	2,551	394	154	113	399	958	248	285	5,781	866	317	252	877	2,008	703	758	2	2	2	2	2	2	3	3
NR Total		**28,810**	**2,780**	**779**	**1,491**	**2,992**	**11,571**	**4,647**	**4,550**	**211,546**	**14,016**	**4,402**	**9,154**	**17,892**	**95,594**	**40,194**	**30,294**	**7**	**5**	**6**	**6**	**6**	**8**	**9**	**7**

Table 4-29
Estimates of Fixtures per Location for Nonresidential Locations with Urinals by WDPA (2008)

S/I/C Category	10 Key Sectors	Locations								Urinals								Fixtures per Location							
		TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Service	Hotels	504	16	7	4	17	157	206	97	7,358	197	108	91	170	3,972	1,953	867	15	12	15	23	10	25	9	9
	Churches	824	65	15	50	126	278	124	166	2,522	161	25	174	455	823	406	478	3	2	2	3	4	3	3	3
	Health	282	46	27	5	23	84	42	55	5,463	508	349	225	366	2,151	719	1,145	19	11	13	45	16	26	17	21
	Office	645	22	5	33	25	333	121	106	2,917	34	7	105	49	1,793	563	366	5	2	1	3	2	5	5	3
	Government	309	19	11	15	14	137	54	59	1,957	52	15	40	23	1,397	185	245	6	3	1	3	2	10	3	4
	Education	417	37	7	35	72	136	59	71	5,103	516	115	432	860	1,815	601	764	12	14	16	12	12	13	10	11
	Others	1,086	123	26	36	91	483	157	170	7,444	300	51	354	467	4763	663	846	7	2	2	10	5	10	4	5
Industrial	Industrial	71	0	0	0	5	50	8	8	110	0	0	0	8	75	16	11	2	0	0	0	2	2	2	1
Commercial	Retail	485	68	11	69	91	111	84	51	1,433	206	22	233	291	343	162	176	3	3	2	3	3	3	2	3
	Restaurants	1,063	94	28	70	126	350	233	162	2,201	183	77	152	255	744	491	299	2	2	3	2	2	2	2	2
	Others	89	7	1	5	10	17	27	22	161	10	1	6	15	22	55	52	2	1	1	1	2	1	2	2
NR Total		**5,775**	**497**	**138**	**322**	**600**	**2,136**	**1,115**	**967**	**36,669**	**2,167**	**770**	**1,812**	**2,959**	**17,898**	**5,814**	**5,249**	**6**	**4**	**6**	**6**	**5**	**8**	**5**	**5**

Table 4-30
Estimates of LTDFS Nonresidential Employment by WDPA for Base-Year 2008

WDPA	Employee-per-Account Factors (2007)	Accounts (2008)	Employees (2008)
PAS	26	3,379	87,523
NPR	16	779	12,553
NWH	50	1,423	70,578
SCH	35	2,783	97,746
COT	49	11,294	549,011
PIN	51	5,175	263,719
STP	25	6,602	164,415
TBW	**40**	**31,435**	**1,245,544**

Table 4-31
Nonresidential Key Sector, S/I/C Parcel and LTDFS Employment Estimates (2008)

S/I/C Category	Key Sector	Parcel-Based Employment	Distribution of Parcel-Based Employment in S/I/C Categories	LTDFS S/I/C Employment	Estimated LTDFS Employment
Service	Hotels	25,465	5.9%	757,739	47,949
	Churches	14,055	3.3%		25,279
	Health	40,734	9.5%		74,794
	Office	110,456	25.7%		197,981
	Government	71,247	16.6%		121,849
	Education	57,657	13.4%		102,936
	Others	110,186	25.6%		186,951
Industrial	Industrial	177,510	100.0%	250,754	250,754
Commercial	Retail	221,246	68.5%	237,051	159,836
	Restaurants	40,486	12.5%		31,165
	Others	61,033	18.9%		46,050
Total Nonresidential Employment		**930,075**	**100%**	**1,245,544**	**1,245,544**

Similar to fixtures, employment is also estimated separately for locations with toilets and locations with urinals. As previously shown, the number of locations estimated to have toilets and urinals within each key sector varies, and so do the employment estimates at these locations. Estimating employment separately ensures water use estimates consider only the applicable number of employees at locations with each fixture type. Table 4-32 and Table 4-33 provide regional baseline estimates of employment, as well as the average employee-per-location estimates for locations with toilets and urinals, according to LTDFS S/I/C and nonresidential key sector categories. Again similar to fixtures, distinguishing locations and base-year estimates of employees-per-location on the presence of fixture types (i.e. toilets and urinals) permits future estimation of employment specific to the location type (i.e. locations with toilets and locations with urinals) as discussed further in Section 5.0.

Table 4-32
Estimates of Employees per Location for Nonresidential Locations with Toilets by WDPA (2008)

S/I/C Category	10 Key Sectors	Locations								Employment								Employees per Location							
		TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Service	Hotels	527	16	7	4	17	158	227	98	47,949	1,249	548	505	929	19,492	19,543	5,687	91	78	78	126	55	123	86	58
	Churches	1,792	95	27	109	294	781	185	301	25,279	1,657	255	1,633	4,051	7,699	4,994	4,988	14	17	9	15	14	10	27	17
	Health	2,299	444	120	121	272	656	278	408	74,794	8,820	2,722	3,055	6,927	19,673	15,887	17,711	33	20	23	25	25	30	57	43
	Office	5,422	225	95	470	540	2,139	1,011	942	197,981	5,354	1,437	10,589	8,173	91,931	50,331	30,166	37	24	15	23	15	43	50	32
	Government	908	89	26	49	111	361	150	122	121,849	4,683	1,068	3,012	2,504	75,405	17,714	17,462	134	53	41	61	23	209	118	143
	Education	795	57	19	70	142	304	97	106	102,936	11,233	1,769	8,488	14,838	32,001	16,582	18,024	129	197	93	121	104	105	171	170
	Others	4435	538	87	134	404	2097	586	589	186,951	8,851	1,015	14,242	13,649	109,598	23,280	16,315	42	16	12	106	34	52	40	28
Industrial	Industrial	4,797	376	76	147	267	2,237	893	801	250,754	21,649	1,971	11,280	21,078	109,087	61,745	23,946	52	58	26	77	79	49	69	30
Commercial	Retail	3,948	445	137	195	394	1,398	693	686	159,836	19,076	1,228	14,553	18,187	53,704	33,904	19,184	40	43	9	75	46	38	49	28
	Restaurants	1,336	101	31	79	152	482	279	212	31,165	1,923	280	1,532	2,420	12,180	8,967	3,863	23	19	9	19	16	25	32	18
	Others	2,551	394	154	113	399	958	248	285	46,050	3,028	259	1,688	4,991	18,241	10,772	7,070	18	8	2	15	13	19	43	25
NR Total		**28,810**	**2,780**	**779**	**1,491**	**2,992**	**11,571**	**4,647**	**4,550**	**1,245,544**	**87,523**	**12,553**	**70,578**	**97,746**	**549,011**	**263,719**	**164,415**	**43**	**31**	**16**	**47**	**33**	**47**	**57**	**36**

Table 4-33
Estimates of Employees per Location for Nonresidential Locations with Urinals by WDPA (2008)

S/I/C Category	10 Key Sectors	Locations								Employment								Employees per Location							
		TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Service	Hotels	504	16	7	4	17	157	206	97	44,215	1,249	548	505	926	19,490	15,964	5,533	88	78	78	126	54	124	77	57
	Churches	824	65	15	50	126	278	124	166	21,286	1,496	206	1,383	3,394	5,988	4,535	4,284	26	23	14	28	27	22	37	26
	Health	282	46	27	5	23	84	42	55	45,559	3,742	1,846	1,371	2,781	11,694	11,405	12,721	162	81	68	274	121	139	272	231
	Office	645	22	5	33	25	333	121	106	139,145	2,207	460	5,268	2,630	73,036	36,086	19,458	216	100	92	160	105	219	298	184
	Government	309	19	11	15	14	137	54	59	112,456	3,629	814	2,493	1,326	72,673	15,450	16,070	364	191	74	166	95	530	286	272
	Education	417	37	7	35	72	136	59	71	97,291	10,998	1,654	7,809	13,672	30,134	15,560	17,464	233	297	236	223	190	222	264	246
	Others	1,086	123	26	36	91	483	157	170	167,740	6,383	774	13,706	11,979	104	17,966	13,144	154	52	30	381	132	0	114	77
Industrial	Industrial	71	0	0	0	5	50	8	8	42,590	0	0	0	4,729	25,632	8,652	3,578	600	0	0	0	946	513	1,082	447
Commercial	Retail	485	68	11	69	91	111	84	51	94,193	12,266	518	11,843	13,547	27,778	17,553	10,688	194	180	47	172	149	250	209	210
	Restaurants	1,063	94	28	70	126	350	233	162	29,012	1,898	275	1,473	2,279	11,062	8,505	3,520	27	20	10	21	18	32	37	22
	Others	89	7	1	5	10	17	27	22	19,032	868	41	553	1,440	3,319	7,921	4,888	214	124	41	111	144	195	293	222
NR Total		**5,775**	**497**	**138**	**322**	**600**	**2,136**	**1,115**	**967**	**812,518**	**44,736**	**7,135**	**46,405**	**58,703**	**384,594**	**159,596**	**111,348**	**141**	**90**	**52**	**144**	**98**	**180**	**143**	**115**

4.3 Estimation of Single-Family Customer Class Indoor Efficiency Potential

End use presence and saturation rates, used to quantify baseline end use average flow rates, are derived directly from estimates of fixture counts and distributions previously identified. Table 4-34 provides estimates of single-family end use flow rates by WDPA. These estimates reflect the weighted average flow rate for each end use event based on the product saturation rates previously provided in Table 4-17. Average rates of use establish the baseline which per unit savings are compared and measured to assess passive and active efficiency potential. The average rates of use also permit the development of per capita and total household estimates through application of per capita event frequency (intensities) and persons per household assumptions.

Table 4-34
Estimated Average Single-Family Flow Rates by End Use (2008)

	Toilet (gpf)	Shower (gpm)	Faucet (gpm)	Clothes Washer (gpl)	Dishwasher (gpl)
TBW	**2.39**	**2.10**	**1.01**	**33.49**	**8.90**
PAS	2.21	2.06	1.01	32.45	8.90
NPR	3.00	2.14	1.02	34.08	8.90
NWH	2.23	2.09	1.01	33.55	8.90
SCH	2.08	2.07	1.01	32.59	8.90
COT	2.63	2.12	1.01	33.77	8.90
PIN	2.40	2.13	1.02	34.22	8.90
STP	2.82	2.15	1.02	34.25	8.90
Standard	**1.60**	**2.50**	**2.20**	**24.62**	**6.50**
HE	**1.28**	**2.00**	**1.50**	**15.00**	**6.00**

Table 4-35 provides estimates of single-family end use water demands in gallons per capita day (gpcd) by WDPA for the fixtures discussed in previous sections. Showers, followed by clothes washers and toilets comprise the greatest proportion of daily use at 12.9, 12.4 and 12 gpcd, respectively. Faucets are estimated to account for the next largest increments of household use at 8.2 gpcd, followed by dishwasher use at 1.8 gpcd.

Table 4-35
Estimated Single-Family Average Daily per Capita Indoor Use (gpcd)

End Use	Tampa Bay Water	PAS	NPR	NWH	SCH	COT	PIN	STP
Toilet	11.95	11.04	14.98	11.13	10.42	13.15	11.98	14.11
Shower	12.92	12.68	13.17	12.84	12.73	13.02	13.09	13.22
Faucet	8.20	8.16	8.24	8.19	8.17	8.22	8.22	8.25
Clothes Washer	12.39	12.01	12.61	12.41	12.06	12.49	12.66	12.67
Dishwasher	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78
Total Indoor Use	47.25	45.67	50.78	46.35	45.16	48.67	47.74	50.04
Persons Per Household	2.61	2.40	2.60	2.80	2.79	2.70	2.46	2.47

Note: This does not include miscellaneous indoor uses and leaks.

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Potential demand reductions associated with reducing regional average single-family end use flow rates to standard and HE flow rates are provided in Table 4-36 for applicable end uses. Based on this assessment, end uses with the greatest efficiency potential appear to be toilets, clothes washers and dishwasher, with potential reductions in the 26-33 percent range under current federal standards and in the 33-55 percent range under high efficiency product benchmarks. Although most showerheads and faucet are likely operating at lower flow rates than the current standard, water savings may be achieved from switching to HE options provided behavioral changes impacting total water use (i.e. longer duration of fixture use) do not occur.

Table 4-36
Estimated Single-Family End Use Flow Rates (Gallons/Event) and Efficiency Potential (2008)

End Use	Tampa Bay Water	Current Standard	High Efficiency	Estimated % Reduction w/Standard Benchmark	Estimated % Reduction w/High Efficiency Benchmark
Toilet	2.39	1.60	1.28	-33%	-46%
Shower	2.10	2.50	2.00	19%	-5%
Faucet	1.01	2.20	1.50	117%	48%
Clothes Washer[1]	33.49	24.62	15.00	-26%	-55%
Dishwasher[2]	8.90	6.50	6.00	-27%	-33%

[1] Current standard based on 9.5 Water Factor, 2.7 cubic feet per load and .96 loads per day
[2] Current standard based on federal dishwasher standard effective January 2010.

Given all fixtures within a household are operating at the highest levels of efficiency it is assumed indoor use can be as low as 34 gpcd as shown in Table 4-37, if there are no allowances for miscellaneous uses or leaks. Comparison of the baseline per capita end use water estimates to the theoretical water savings benchmark, indicates significant indoor water savings still exist in the Tampa Bay region. Specifically, a 29 percent reduction in indoor demands across these five end uses is estimated to be achievable. Theoretically, this savings potential could be realized through both passive and active water efficiency.

Table 4-37
Estimated Single-Family Indoor Per Capita Water Savings Potential

End Use	Estimated % Reduction @ HE flow rate	Baseline Estimate (gpcd)	Theoretical Estimate (gpcd)	Reduction (gpcd)
Toilet	46%	11.95	6.40	5.55
Shower	5%	12.92	12.30	0.62
Faucet (Bath)	0%	8.20	8.20	0.00
Clothes Washer	55%	12.39	5.55	6.84
Dishwasher	33%	1.78	1.20	0.58
Total	**29%**	**47.25**	**33.65**	**13.60**

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It is important to note this estimate of indoor use does not include use associated with leaks, baths or other incidental household water use. Accounting for these uses, the estimated total indoor use would likely be between 50 and 60 gpcd. However, the results of a 2011 EPA study indicates that average indoor water use in new high efficiency homes is as low as 35.6 gpcd, a value consistent with the theoretical estimate for the Tampa Bay region.[27]

Baseline estimates of fixture efficiency support examination of remaining passive and program-based water efficiency potential over a long-term water demand horizon. The effects of passive efficiency (i.e. water savings observed from the natural replacement of fixtures with those meeting or exceeding national plumbing standards) should be expected to occur over time and effectively reduce long-term demands for water. Passive water savings are based on changing water use across time and technology in comparison to baseline efficiency. As described herein, the saturation of technological efficiencies is impacted by a variety of factors including natural replacement rates, current national standards and market increases in HE products. Using these various parameters, a base-year analysis was completed for 2008 to provide a starting-point for assessing future technology and program based savings. Remaining water efficiency potential associated with future standards and increased efficiency due to an evolving market for water efficient products is evaluated over the agency's long-term water demand horizon (2035) in Section 5.0.

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[27] *Aquacraft, (2011). Analysis of Water Use in New Single Family Homes.*

Section 5.0
Passive Water Efficiency Evaluation

Water savings can be realized from either passive or active water use efficiency measures.

- Passive water efficiency is achieved through a "natural" process of replacing old fixtures with new, more efficient fixtures or installing efficient water-using fixtures in new construction, which are required by code or driven by market changes. Passive water efficiency typically occurs indoors with the replacement of toilets, clothes washers, dishwashers and urinals.
- Active water efficiency measures include programs designed to expedite the passive replacement process. Such programs are often sponsored by water utilities to ensure a target installation rate and associated water savings.

Estimating passive water savings is essential in determining the water savings potential and efficacy of active water efficiency programs and for projecting long term water demands. Before the potential benefits of active water efficiency alternatives can be assessed, passive savings must be estimated.

As previously discussed in Section 4.1, the U.S. Energy Policy Act of 1992 (EPAct), effective in 1994, was responsible for mandating flow standards for many fixtures (e.g., toilets, faucets and showerheads) and since that time, manufacturers have introduced and marketed fixtures and appliances, which far exceed EPAct standards. As consumers decide to purchase and install High Efficiency (HE) water products, water use efficiency increases. While the current Tampa Bay Water baseline demand forecast reflects the water use of existing HE products within sectoral per account water use calculations, the penetration of high-efficiency products is expected to increase. By estimating the distribution of differing water use among different levels of mechanical efficiency that exist currently and that are expected to occur in the future, the baseline forecast can be adjusted to reflect passive demand reductions that are likely to occur.

The evaluation of passive water efficiency includes an assessment of the potential impacts of passive measures associated with plumbing standards and increased efficiency due to an evolving market (supply and demand) for water efficient products recognized or certified through the U.S. Environmental Protection Agency (EPA) WaterSense label and/or Energy Star programs. This approach estimates replacement of water-using fixtures by water customers through a natural process of replacing old fixtures with new more efficient fixtures, and installation of efficient water-using fixtures in new construction in accordance with revised building codes, standards and market changes.

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This section highlights the assumptions about efficiency standards, fixture life and market penetration of high efficiency products, which are then used to estimate the water-using characteristics of water fixtures for each year contained in the long-term demand forecast. These estimates are used to assess passive water savings and help define applicability and timing of active (utility-sponsored) programs. Passive water savings are estimated based on changing water use across time and technology in comparison to baseline efficiency.

5.1 Approach for Estimating Passive Replacement of Fixtures and Appliances

Assumptions for efficiency standards and replacement related to limited fixture life, along with increasing market penetration of high efficiency products, were used to estimate the distribution and water use of fixtures for each year in the demand forecast.

Passive savings were estimated for residential toilets, washing machines and dishwashers as well as nonresidential toilets and urinals. Calculation of savings for these fixtures and appliances involves three general steps to estimate:

- Remaining fixtures and appliances by age and efficiency (Section 4)
- Conversion of existing stock to current water efficiency standard or HE products
- Savings from the replacement of existing stock to EPAct standard or HE products

Using expected product life and existing standards or market share of a more efficient product, the market saturation of fixture stock can be estimated in the base year and for each forecast year. Accordingly, average household fixture water use can be estimated for each year in the forecast horizon with estimated savings occurring from change in the distribution of fixtures. The following formulae were used to generate the fixture and passive savings estimates.

5.1.1 Natural Replacement Rate

All fixtures have an expected life, and are translated into an annual rate of decay or natural replacement rate (nrr). The nrr for each technology is calculated using equation 5-1.

Equation 5-1:

$$nrr = \frac{1}{Expected\ Life\ in\ Years}$$

5.1.2 Estimation of Fixture and Appliance Change by Age and Efficiency

The 2008 property appraiser-based technology estimates of the number of existing fixture and appliance types for given mechanical efficiency levels in the region were extrapolated to the baseline water demand forecast base year of 2010 and each forecast year through 2035 according to equation 5-2.

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Equation 5-2:

$$F_m^y = (\, FE_{y_1} - \, R \,) \times (1 - nrr)^{(y - y_1)}$$

Where:

F	=	Remaining fixtures in mechanical efficiency level m for year y
FE	=	Fixtures existing in mechanical efficiency level m for year y_1
R	=	Rebates provided by member governments through y_1
m	=	Mechanical efficiency level
y	=	Forecast year
y_1	=	Initial year of analysis (or product decay)
nrr	=	Natural replacement rate

EXAMPLE 1: Estimation of Remaining Fixtures According to Equation 5-2

Estimation of remaining fixtures (F) where 1,000 fixtures of a specified mechanical efficiency level m exist in 2011, 100 rebates (R) are issued prior the initial year of analysis (y_1) and a nrr of 4 percent is calculated as follows:

$$864 = (\, 1000 - \, 100 \,) \times (1 - .04)^{(2011 - 2010)}$$

Therefore, 864 fixtures of the specified efficiency level $\boldsymbol{m}$ still exist in 2011 after natural replacement occurred.

5.1.3 Conversion of Older Fixtures and Appliances to Existing Standard or HE Models

Replacement of older technologies with higher efficiency models (e.g. existing EPAct standard or HE products) is estimated for each year of the forecast period. Estimates of the number of converted fixtures or appliances are determined using equation 5-3.

Equation 5-3:

$$FC_m^y = (\, FE_{y_1} - \, R \,) \times (1 - (1 - nrr)^{(y - y_1)})$$

Where:

FC	=	Fixtures in mechanical efficiency level m converted in year y
FE	=	Fixtures existing in mechanical efficiency level m for year y_1
R	=	Rebates provided by member governments
y	=	Forecast year
y_1	=	Initial year of analysis (or product decay)
nrr	=	Natural replacement rate

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EXAMPLE 2: Estimation of Existing Fixture Conversion According to Equation 5-3

Estimation of converted fixtures (FC) where 1,000 existing fixtures (FI) of a specified mechanical efficiency level (m) exist in forecast year 2011 (y), 100 rebates (R) are issued prior the initial year of analysis (y_1) and a nrr of 4 percent is calculated as follows:

$$36 = (\ 1000 - \ 100\ ) \times (1 - (1 - .04)^{(2011-2010)})$$

Accordingly, 36 fixtures of the specified efficiency level m are replaced in 2011.

Conversion to HE products is estimated by multiplying the total number of converted fixtures or appliances (FC) by product market share estimates obtained from WaterSense, Energy Star, Department of Energy (DOE) and Tampa Bay Water's single-family survey results. Any remaining fixtures not converted to HE models are assumed to operate at the EPAct standard (or technological efficiency reflecting the lowest level assumed to exist in the current market from appliances not affected by EPAct). With respect to new housing, new products are assumed to realize the same market share proportion as converted products, while rebated fixtures in existing households are assumed to operate at standard mechanical efficiency levels.

EXAMPLE 3: Estimation of Fixtures Operating at Existing Standard and HE Levels

Estimation of converted fixtures across the standard efficiency and HE mechanical efficiency categories given a 5 percent HE market share is calculated as follows:

$$HE\ Fixtures = 1.8 = 36 * .05$$

$$Standard\ Fixtures = 34.2 = 36 - 1.8$$

Given a total of 36 converted fixtures and a 5 percent HE market share, 2 fixtures are converted to HE models while the remaining 34 fixtures are replaced with the existing standard mechanical efficiency models.

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5.1.4 Estimation of Savings from Fixture or Appliance Conversion

Water savings resulting from conversion of fixtures and appliances to higher levels mechanical efficiencies, described in section 5.1.3, rely on estimates of average weighted water use (q^y), calculated according to Equation 5-4. Weighted average water savings (S^y) is estimated by subtracting the average weighted use of each fixture or appliance type in each forecast year (q^y) from the average weighted use of all fixtures in the forecast base year (q_{y1}) using Equation 5-5.

Equation 5-4

$$q^y = \frac{\sum_{m=1}^{M} F_m \times E_m}{FT_y}$$

Where:

q^y	=	Weighted average water use per event for a given end use
FT_y	=	Total fixtures
F_m	=	Fixtures installed of a given mechanical efficiency level
E_m	=	Water use per end use event for given mechanical efficiency level
y	=	Forecast year

Equation 5-5

$$S^y = q_{y1-}\, q_y$$

Where:

S^y	=	Weighted average water savings per event for a given end use
q_{y1}	=	Average water use per end use event for forecast base year (2010)
q_y	=	Average water use per end use event for forecast year

EXAMPLE 4: Average Weighted Fixture Water Use and Savings According to Equations 5-4 & 5-5

Estimates of weighted average water use (q^y) for the forecast base year (q_{y1}) and forecast year 2035 (q_y) given fixture (F_m) and end use (E_m) estimates for the three levels of mechanical efficiency can be calculated as follows:

$$2010\ Weighted\ Average\ End\ Use = 2.59 = \frac{(150x5.0gpf) + (250x3.5gpf) + (600x1.6gpf)}{1000}$$

$$2035\ Weighted\ Average\ End\ Use = 1.83 = \frac{(25x5.0gpf) + (75x3.5gpf) + (900x1.6gpf)}{1000}$$

Water savings is calculated as the difference between weighted average water use:

$$Weighted\ Average\ End\ Use\ Savings = 0.76 = 2.59 - 1.83$$

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5.2 Distribution of Fixture and Appliance Water Use Intensity vs. Time

Residential toilets, clothes washers, dishwashers and nonresidential toilets and urinals are estimated for each year in the demand forecast using:

- property appraiser-based technology estimates for 2008,
- natural replacement assumptions,
- projections of HE products market share
- projected unit growth rates

Changes related to passive efficiency are based on the introduction of more efficient products in new development and continued natural replacement of existing products in accordance with expected product life assumptions (Table 5-1) and HE market share estimates as projected for WaterSense and Energy Star products (Table 5-2).

Table 5-1
Natural Replacement Rates

Fixture	Expected Life (Years)			Natural Replacement Rate		
	SF	MF	NR	SF	MF	NR
Toilets	25	25	30	4.0%	4.0%	3.3%
Washing Machines	12	12	NA	8.3%	8.3%	NA
Dishwashers	13	13	NA	7.7%	7.7%	NA
Urinals	NA	NA	30	NA	NA	3.3%

As described in Section 4, base-year (2008) fixtures and appliances are estimated using property appraiser unit data and assumptions regarding expected product life and HE product penetration rates. To estimate the passive replacement of fixtures and appliances through the 2035 forecast horizon, 2008 property appraiser units and fixture estimates are extrapolated and calibrated to 2010 LTDFS single-family and multifamily unit estimates and then further changes according to the annual rate of unit growth in the forecast.

Occupied owner and renter multifamily units are projected by multiplying the total number multifamily units in each forecast year by the 2008 percent distribution of owner and renter multifamily units provided in Table 5-3. Table 5-4 provides the 2010-2035 single-family and multifamily (renter and owner) unit forecasts used to estimate change in the distribution of technology efficiency related to new development and natural replacement in existing development. The following sections discuss the expected product life and HE market share assumptions, as well as the predicted changes in the market saturation of fixture efficiency by end use.

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Table 5-2
Market Penetration of High-Efficiency Products

Year	Toilets	Clothes Washers	Urinals
2008	5%	33%	5%
2009	5%	36%	5%
2010	5%	38%	5%
2011	8%	41%	8%
2012	9%	44%	9%
2013	10%	47%	10%
2014	11%	50%	11%
2015	13%	53%	13%
2016	15%	56%	15%
2017	19%	59%	19%
2018	21%	61%	21%
2019	24%	64%	24%
2020	28%	67%	28%
2021	32%	70%	32%
2022	36%	70%	36%
2023	39%	70%	39%
2024	43%	70%	43%
2025	47%	70%	47%
2026	51%	70%	51%
2027	54%	70%	54%
2028	58%	70%	58%
2029	62%	70%	62%
2030	66%	70%	66%
2031	66%	70%	66%
2032	66%	70%	66%
2033	66%	70%	66%
2034	66%	70%	66%
2035	66%	70%	66%

Table 5-3
Multifamily Owner, Rental, and Total Units for 2008

WDPA	MF Units (Owner)	MF Units (Renter)	Total MF	% Owner MF	% Renter MF
PAS	15,998	7,348	23,346	68.5%	31.5%
NPR	2,272	2,330	4,602	49.4%	50.6%
NWH	12,772	16,922	29,694	43.0%	57.0%
SCH	19,954	20,830	40,784	48.9%	51.1%
COT	35,568	72,389	107,957	32.9%	67.1%
PIN	71,304	25,195	96,499	73.9%	26.1%
STP	21,567	34,171	55,738	38.7%	61.3%
TBW	**179,435**	**179,184**	**358,619**	**50.0%**	**50.0%**

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Table 5-4
Summary of Single-Family and Multifamily (Total, Owner and Rental) Units Projections by WDPA

Sector	WDPA	2010	2015			2020			2025			2030			2035			Absolute Change	% Change	Annual Average Percent Change
		Total	New	Existing	Total	New	Existing	Total	New	Existing	Total	New	Existing	Total	New	Existing	Total			
Single-Family Total	PAS	83,793	9,162	83,793	92,955	11,485	92,955	104,440	7,797	104,440	112,237	6,480	112,237	118,717	6,891	118,717	125,608	41,815	49.90%	1.60%
	NPR	7,675	-278	7,675	7,397	25	7,397	7,422	-144	7,422	7,278	-130	7,278	7,148	-24	7,148	7,124	-551	-7.20%	-0.30%
	NWH	47,552	3,024	47,552	50,576	4,054	50,576	54,630	3,723	54,630	58,353	3,604	58,353	61,957	4,299	61,957	66,256	18,704	39.30%	1.30%
	SCH	86,658	11,443	86,658	98,101	12,145	98,101	110,246	10,161	110,246	120,407	8,519	120,407	128,926	8,528	128,926	137,454	50,796	58.60%	1.90%
	COT	106,628	9,763	106,628	116,391	11,429	116,391	127,820	9,935	127,820	137,755	8,899	137,755	146,654	9,761	146,654	156,415	49,787	46.70%	1.50%
	PIN	89,772	1,380	89,772	91,152	708	91,152	91,860	-1,775	91,860	90,085	-2,426	90,085	87,659	-1,881	87,659	85,778	-3,994	-4.40%	-0.20%
	STP	77,602	411	77,602	78,013	53	78,013	78,066	-1,836	78,066	76,230	-2,176	76,230	74,054	-1,524	74,054	72,530	-5,073	-6.50%	-0.30%
	TBW	**499,680**	**34,905**	**499,680**	**534,585**	**39,899**	**534,585**	**574,484**	**27,860**	**574,484**	**602,344**	**22,771**	**602,344**	**625,115**	**26,049**	**625,115**	**651,164**	**151,485**	**30.30%**	**1.10%**
Multifamily Total	PAS	23,387	1,974	23,387	25,361	3,300	25,361	28,661	3,019	28,661	31,680	2,566	31,680	34,246	1,934	34,246	36,180	12,793	54.70%	1.80%
	NPR	4,462	-258	4,462	4,204	39	4,204	4,243	36	4,243	4,279	16	4,279	4,295	-21	4,295	4,274	-188	-4.20%	-0.20%
	NWH	28,245	114	28,245	28,359	1,113	28,359	29,472	1,003	29,472	30,475	1,037	30,475	31,512	632	31,512	32,144	3,900	13.80%	0.50%
	SCH	31,797	2,183	31,797	33,980	2,761	33,980	36,741	2,104	36,741	38,845	1,662	38,845	40,507	689	40,507	41,196	9,398	29.60%	1.00%
	COT	107,892	3,285	107,892	111,177	6,294	111,177	117,471	5,086	117,471	122,557	4,508	122,557	127,065	2,209	127,065	129,274	21,382	19.80%	0.70%
	PIN	98,661	1,767	98,661	100,428	2,398	100,428	102,826	1,164	102,826	103,990	668	103,990	104,658	-1,434	104,658	103,224	4,563	4.60%	0.20%
	STP	54,492	425	54,492	54,917	916	54,917	55,833	390	55,833	56,223	267	56,223	56,490	-724	56,490	55,766	1,275	2.30%	0.10%
	TBW	**348,936**	**9,490**	**348,936**	**358,426**	**16,822**	**358,426**	**375,248**	**12,801**	**375,248**	**388,049**	**10,725**	**388,049**	**398,774**	**3,285**	**398,774**	**402,059**	**53,123**	**15.20%**	**0.60%**
Multifamily Owner	PAS	16,026	1,353	16,026	17,379	2,262	17,379	19,641	2,068	19,641	21,709	1,759	21,709	23,468	1,325	23,468	24,793	8,766	54.70%	1.80%
	NPR	2,203	-127	2,203	2,076	19	2,076	2,095	18	2,095	2,113	8	2,113	2,121	-11	2,121	2,110	-93	-4.20%	-0.20%
	NWH	12,149	49	12,149	12,198	479	12,198	12,677	431	12,677	13,108	446	13,108	13,554	272	13,554	13,826	1,677	13.80%	0.50%
	SCH	15,557	1,068	15,557	16,625	1,351	16,625	17,976	1,030	17,976	19,006	813	19,006	19,819	337	19,819	20,156	4,598	29.60%	1.00%
	COT	35,547	1,082	35,547	36,629	2,073	36,629	38,702	1,676	38,702	40,378	1,485	40,378	41,863	728	41,863	42,591	7,045	19.80%	0.70%
	PIN	72,901	1,306	72,901	74,207	1,772	74,207	75,979	860	75,979	76,839	494	76,839	77,333	-1,060	77,333	76,273	3,372	4.60%	0.20%
	STP	21,085	164	21,085	21,249	355	21,249	21,604	151	21,604	21,755	103	21,755	21,858	-280	21,858	21,578	493	2.30%	0.10%
	TBW	**175,468**	**4,895**	**175,468**	**180,363**	**8,310**	**180,363**	**188,673**	**6,234**	**188,673**	**194,907**	**5,108**	**194,907**	**200,015**	**1,312**	**200,015**	**201,327**	**25,859**	**14.70%**	**0.60%**
Multifamily Rental	PAS	7,361	621	7,361	7,982	1,039	7,982	9,021	950	9,021	9,971	808	9,971	10,779	608	10,779	11,387	4,026	54.70%	1.80%
	NPR	2,259	-130	2,259	2,129	19	2,129	2,148	19	2,148	2,167	8	2,167	2,175	-11	2,175	2,164	-95	-4.20%	-0.20%
	NWH	16,096	65	16,096	16,161	635	16,161	16,796	571	16,796	17,367	591	17,367	17,958	360	17,958	18,318	2,222	13.80%	0.50%
	SCH	16,240	1,115	16,240	17,355	1,410	17,355	18,765	1,075	18,765	19,840	848	19,840	20,688	352	20,688	21,040	4,800	29.60%	1.00%
	COT	72,345	2,203	72,345	74,548	4,220	74,548	78,768	3,411	78,768	82,179	3,022	82,179	85,201	1,482	85,201	86,683	14,337	19.80%	0.70%
	PIN	25,759	462	25,759	26,221	626	26,221	26,847	304	26,847	27,151	174	27,151	27,325	-374	27,325	26,951	1,191	4.60%	0.20%
	STP	33,407	261	33,407	33,668	561	33,668	34,229	239	34,229	34,468	164	34,468	34,632	-444	34,632	34,188	781	2.30%	0.10%
	TBW	**173,468**	**4,595**	**173,468**	**178,063**	**8,511**	**178,063**	**186,574**	**6,568**	**186,574**	**193,142**	**5,617**	**193,142**	**198,759**	**1,973**	**198,759**	**200,732**	**27,264**	**15.70%**	**0.60%**

5.2.1 Estimation of Residential Toilet Market Saturation for 2010-2035

Change in the distribution of toilet efficiency in new and existing single-family and multi-family housing units is estimated annually for each year of the demand forecast. This process considers the installation of fixtures in newly constructed housing units and replacements of older toilets in existing homes through the process of natural replacement. This process considers:

- Existing 3.5 and 5.0 gpf toilets replaced with higher efficiency models according to a natural annual replacement rate of 4 percent, or an assumed 25 year life expectancy.
- New toilets estimated by assuming the average number of toilets per single-family and multifamily household for 2010 remains constant over the forecast.
- HETs estimated by multiplying the total number of existing toilet conversions and toilets installed in new construction by the HET market shares in Table 5-2.
- Table 5-5 and Table 5-6 provide WDPA distributions of single-family and multifamily toilets by efficiency level through the 2035 forecast horizon excluding additional active (utility sponsored) conservation programs.

Key table findings include:

- HET saturation (1.28 gpf) is estimated to increase at an average annual rate of 12 percent in the single-family customer class and 11 percent in the multifamily customer class, accounting for about 15 and 12 percent of toilets within each class by 2035, respectively.
- ULFTs (1.6 gpf) account for the majority of toilets throughout the forecast. Saturation is estimated to increase from 70 to 77.5 percent by 2035 in the single-family customer class and from 63 to 77 percent in the multifamily customer class, increasing at an annual average rate of 1.4 and 1.2 percent, respectively.
- Low-efficiency toilets (3.5 and 5.0 gpf) are projected to decrease in both the single-family and multifamily customer classes by 64% at an average annual rate of 3.7%. Region-wide low-efficiency toilets will comprise less than 8 percent of single-family toilets and 11 percent of multifamily toilets by 2035.

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Table 5-5
Distribution of Single-Family Toilet Efficiency by WDPA

WDPA	Flow (gpf)	2010 Units	2010 %	2015 Units	2015 %	2020 Units	2020 %	2025 Units	2025 %	2030 Units	2030 %	2035 Units	2035 %	Absolute Change	Percent Change	Annual Average Percent Change
PAS	1.28	2,429	0.2%	5,301	0.5%	12,013	1.0%	20,633	1.6%	31,286	2.4%	43,461	3.2%	41,032	1689.0%	11.3%
	1.6	139,808	13.3%	164,599	14.6%	189,229	15.6%	202,734	16.0%	210,389	16.0%	216,661	15.8%	76,852	55.0%	1.6%
	3.5	24,801	2.4%	20,222	1.8%	16,489	1.4%	13,444	1.1%	10,962	0.8%	8,938	0.7%	(15,863)	-64.0%	-3.7%
	5	16,391	1.6%	13,365	1.2%	10,898	0.9%	8,886	0.7%	7,245	0.5%	5,907	0.4%	(10,484)	-64.0%	-3.7%
	Total	**183,430**	**17.5%**	**203,487**	**18.1%**	**228,629**	**18.9%**	**245,697**	**19.4%**	**259,882**	**19.7%**	**274,968**	**20.0%**	**91,538**	**49.9%**	**1.5%**
NPR	1.28	102	0.0%	226	0.0%	454	0.0%	776	0.1%	1,164	0.1%	1,524	0.1%	1,423	1400.6%	10.6%
	1.6	6,581	0.6%	7,209	0.6%	8,033	0.7%	8,282	0.7%	8,337	0.6%	8,481	0.6%	1,900	28.9%	0.9%
	3.5	3,372	0.3%	2,749	0.2%	2,242	0.2%	1,828	0.1%	1,490	0.1%	1,215	0.1%	(2,157)	-64.0%	-3.7%
	5	3,325	0.3%	2,711	0.2%	2,211	0.2%	1,803	0.1%	1,470	0.1%	1,198	0.1%	(2,127)	-64.0%	-3.7%
	Total	**13,380**	**1.3%**	**12,896**	**1.1%**	**12,939**	**1.1%**	**12,688**	**1.0%**	**12,461**	**0.9%**	**12,419**	**0.9%**	**(961)**	**-7.2%**	**-0.3%**
NWH	1.28	744	0.1%	2,075	0.2%	5,027	0.4%	9,907	0.8%	16,631	1.3%	25,001	1.8%	24,257	3259.4%	13.9%
	1.6	85,981	8.2%	97,155	8.6%	108,238	8.9%	115,806	9.1%	120,609	9.1%	124,921	9.1%	38,940	45.3%	1.4%
	3.5	20,371	1.9%	16,610	1.5%	13,544	1.1%	11,043	0.9%	9,004	0.7%	7,342	0.5%	(13,030)	-64.0%	-3.7%
	5	7,786	0.7%	6,349	0.6%	5,177	0.4%	4,221	0.3%	3,442	0.3%	2,806	0.2%	(4,980)	-64.0%	-3.7%
	Total	**114,883**	**10.9%**	**122,189**	**10.9%**	**131,984**	**10.9%**	**140,977**	**11.1%**	**149,685**	**11.4%**	**160,070**	**11.6%**	**45,187**	**39.3%**	**1.2%**
SCH	1.28	2,079	0.2%	5,488	0.5%	12,403	1.0%	23,115	1.8%	36,412	2.8%	51,067	3.7%	48,988	2356.4%	12.6%
	1.6	155,531	14.8%	184,709	16.4%	210,689	17.4%	227,382	17.9%	236,957	18.0%	244,506	17.8%	88,975	57.2%	1.7%
	3.5	25,460	2.4%	20,760	1.8%	16,927	1.4%	13,802	1.1%	11,253	0.9%	9,176	0.7%	(16,284)	-64.0%	-3.7%
	5	11,722	1.1%	9,558	0.9%	7,793	0.6%	6,355	0.5%	5,181	0.4%	4,225	0.3%	(7,498)	-64.0%	-3.7%
	Total	**194,793**	**18.6%**	**220,514**	**19.6%**	**247,813**	**20.5%**	**270,653**	**21.3%**	**289,803**	**22.0%**	**308,973**	**22.5%**	**114,181**	**58.6%**	**1.7%**
COT	1.28	1,708	0.2%	4,986	0.4%	11,709	1.0%	22,356	1.8%	36,128	2.7%	51,940	3.8%	50,232	2941.6%	13.5%
	1.6	125,491	12.0%	153,499	13.7%	178,735	14.8%	195,294	15.4%	205,187	15.6%	213,332	15.5%	87,840	70.0%	2.0%
	3.5	34,017	3.2%	27,737	2.5%	22,616	1.9%	18,440	1.5%	15,036	1.1%	12,260	0.9%	(21,758)	-64.0%	-3.7%
	5	37,088	3.5%	30,241	2.7%	24,657	2.0%	20,105	1.6%	16,393	1.2%	13,366	1.0%	(23,722)	-64.0%	-3.7%
	Total	**198,305**	**18.9%**	**216,462**	**19.3%**	**237,717**	**19.7%**	**256,195**	**20.2%**	**272,744**	**20.7%**	**290,898**	**21.2%**	**92,593**	**46.7%**	**1.4%**
PIN	1.28	1,061	0.1%	2,524	0.2%	4,932	0.4%	7,911	0.6%	11,509	0.9%	14,853	1.1%	13,791	1299.3%	10.3%
	1.6	146,797	14.0%	160,025	14.2%	168,621	13.9%	169,112	13.3%	166,056	12.6%	163,378	11.9%	16,581	11.3%	0.4%
	3.5	37,479	3.6%	30,559	2.7%	24,917	2.1%	20,317	1.6%	16,566	1.3%	13,507	1.0%	(23,971)	-64.0%	-3.7%
	5	24,610	2.3%	20,067	1.8%	16,362	1.4%	13,341	1.1%	10,878	0.8%	8,869	0.6%	(15,741)	-64.0%	-3.7%
	Total	209,947	20.0%	213,175	19.0%	214,831	17.8%	210,681	16.6%	205,008	15.6%	200,607	14.6%	(9,340)	-4.4%	-0.2%
STP	1.28	894	0.1%	2,006	0.2%	3,909	0.3%	6,600	0.5%	9,849	0.7%	12,869	0.9%	11,975	1339.9%	10.4%
	1.6	77,999	7.4%	87,952	7.8%	94,583	7.8%	95,581	7.5%	94,161	7.1%	93,064	6.8%	15,065	19.3%	0.7%
	3.5	23,867	2.3%	19,460	1.7%	15,867	1.3%	12,938	1.0%	10,549	0.8%	8,602	0.6%	(15,265)	-64.0%	-3.7%
	5	32,203	3.1%	26,257	2.3%	21,409	1.8%	17,457	1.4%	14,234	1.1%	11,606	0.8%	(20,597)	-64.0%	-3.7%
	Total	**134,962**	**12.9%**	**135,676**	**12.1%**	**135,769**	**11.2%**	**132,576**	**10.4%**	**128,792**	**9.8%**	**126,140**	**9.2%**	**(8,822)**	**-6.5%**	**-0.3%**
TBW	1.28	9,017	0.9%	22,607	2.0%	50,446	4.2%	91,298	7.2%	142,978	10.8%	200,714	14.6%	191,698	2126.0%	12.2%
	1.6	738,190	70.3%	855,147	76.1%	958,128	79.2%	1,014,190	79.9%	1,041,695	79.0%	1,064,344	77.5%	326,154	44.2%	1.4%
	3.5	169,367	16.1%	138,097	12.3%	112,601	9.3%	91,812	7.2%	74,861	5.7%	61,039	4.4%	(108,328)	-64.0%	-3.7%
	5	133,126	12.7%	108,548	9.7%	88,507	7.3%	72,166	5.7%	58,842	4.5%	47,978	3.5%	(85,148)	-64.0%	-3.7%
	Total	**1,049,700**	**100%**	**1,124,399**	**100%**	**1,209,682**	**100%**	**1,269,466**	**100%**	**1,318,375**	**100%**	**1,374,076**	**100%**	**324,375**	**30.9%**	**1.0%**

Table 5-6
Distribution of Multifamily Toilet Efficiency by WDPA

		2010		2015		2020		2025		2030		2035				
WDPA	Flow (gpf)	Units	%	Units	%	Units	%	Units	%	Units	%	Units	%	Absolute Change	Percent Change	Annual Average Percent Change
PAS	1.28	358	0.1%	979	0.2%	2,643	0.5%	5,292	0.9%	8,608	1.4%	11,508	1.9%	11,150	3111.7%	13.7%
	1.6	23,569	4.5%	28,926	5.3%	34,928	6.2%	39,071	6.7%	41,468	6.9%	42,962	7.1%	19,393	82.3%	2.2%
	3.5	9,741	1.8%	7,943	1.5%	6,476	1.1%	5,281	0.9%	4,306	0.7%	3,511	0.6%	(6,231)	-64.0%	-3.7%
	5	4,968	0.9%	4,051	0.7%	3,303	0.6%	2,693	0.5%	2,196	0.4%	1,791	0.3%	(3,178)	-64.0%	-3.7%
	Total	**38,637**	**7.3%**	**41,898**	**7.7%**	**47,350**	**8.4%**	**52,337**	**8.9%**	**56,577**	**9.4%**	**59,772**	**9.8%**	**21,134**	**54.7%**	**1.6%**
NPR	1.28	58	0.0%	129	0.0%	275	0.0%	478	0.1%	714	0.1%	925	0.2%	866	1490.8%	10.8%
	1.6	3,520	0.7%	3,723	0.7%	4,212	0.7%	4,534	0.8%	4,704	0.8%	4,769	0.8%	1,249	35.5%	1.1%
	3.5	2,481	0.5%	2,023	0.4%	1,649	0.3%	1,345	0.2%	1,097	0.2%	894	0.1%	(1,587)	-64.0%	-3.7%
	5	1,311	0.2%	1,069	0.2%	872	0.2%	711	0.1%	580	0.1%	473	0.1%	(839)	-64.0%	-3.7%
	Total	**7,370**	**1.4%**	**6,944**	**1.3%**	**7,008**	**1.2%**	**7,068**	**1.2%**	**7,094**	**1.2%**	**7,060**	**1.2%**	**(310)**	**-4.2%**	**-0.2%**
NWH	1.28	255	0.0%	473	0.1%	1,145	0.2%	2,178	0.4%	3,615	0.6%	4,744	0.8%	4,489	1759.6%	11.4%
	1.6	30,786	5.8%	32,534	6.0%	34,940	6.2%	36,552	6.2%	37,590	6.2%	38,172	6.3%	7,386	24.0%	0.8%
	3.5	7,634	1.4%	6,225	1.2%	5,075	0.9%	4,138	0.7%	3,374	0.6%	2,751	0.5%	(4,883)	-64.0%	-3.7%
	5	2,125	0.4%	1,733	0.3%	1,413	0.2%	1,152	0.2%	939	0.2%	766	0.1%	(1,359)	-64.0%	-3.7%
	Total	**40,799**	**7.7%**	**40,964**	**7.6%**	**42,573**	**7.5%**	**44,021**	**7.5%**	**45,519**	**7.6%**	**46,433**	**7.7%**	**5,633**	**13.8%**	**0.5%**
SCH	1.28	663	0.1%	1,159	0.2%	2,316	0.4%	3,937	0.7%	5,856	1.0%	7,008	1.2%	6,345	957.3%	9.1%
	1.6	35,963	6.8%	40,319	7.4%	44,533	7.9%	47,079	8.0%	48,480	8.1%	49,074	8.1%	13,111	36.5%	1.2%
	3.5	6,495	1.2%	5,296	1.0%	4,318	0.8%	3,521	0.6%	2,871	0.5%	2,341	0.4%	(4,154)	-64.0%	-3.7%
	5	2,734	0.5%	2,229	0.4%	1,818	0.3%	1,482	0.3%	1,209	0.2%	985	0.2%	(1,749)	-64.0%	-3.7%
	Total	**45,855**	**8.7%**	**49,003**	**9.1%**	**52,984**	**9.4%**	**56,019**	**9.6%**	**58,415**	**9.7%**	**59,408**	**9.8%**	**13,554**	**29.6%**	**1.0%**
COT	1.28	1,330	0.3%	2,794	0.5%	6,433	1.1%	11,767	2.0%	18,529	3.1%	23,411	3.9%	22,081	1660.7%	11.2%
	1.6	103,224	19.6%	116,018	21.4%	129,235	22.8%	137,578	23.5%	142,491	23.7%	145,007	23.9%	41,783	40.5%	1.3%
	3.5	32,101	6.1%	26,174	4.8%	21,342	3.8%	17,402	3.0%	14,189	2.4%	11,569	1.9%	(20,532)	-64.0%	-3.7%
	5	19,396	3.7%	15,815	2.9%	12,895	2.3%	10,515	1.8%	8,573	1.4%	6,990	1.2%	(12,406)	-64.0%	-3.7%
	Total	**156,051**	**29.6%**	**160,802**	**29.7%**	**169,906**	**30.0%**	**177,262**	**30.3%**	**183,782**	**30.5%**	**186,977**	**30.8%**	**30,926**	**19.8%**	**0.7%**
PIN	1.28	1,199	0.2%	2,648	0.5%	5,503	1.0%	9,222	1.6%	13,494	2.2%	16,957	2.8%	15,758	1314.6%	10.3%
	1.6	88,930	16.9%	101,923	18.8%	112,333	19.8%	118,200	20.2%	121,306	20.1%	120,782	19.9%	31,852	35.8%	1.1%
	3.5	36,638	7.0%	29,874	5.5%	24,358	4.3%	19,861	3.4%	16,194	2.7%	13,204	2.2%	(23,434)	-64.0%	-3.7%
	5	26,701	5.1%	21,771	4.0%	17,752	3.1%	14,474	2.5%	11,802	2.0%	9,623	1.6%	(17,078)	-64.0%	-3.7%
	Total	**153,468**	**29.1%**	**156,216**	**28.9%**	**159,946**	**28.2%**	**161,757**	**27.6%**	**162,796**	**27.0%**	**160,566**	**26.5%**	**7,098**	**4.6%**	**0.2%**
STP	1.28	643	0.1%	1,388	0.3%	2,885	0.5%	4,868	0.8%	7,237	1.2%	9,238	1.5%	8,595	1337.0%	10.4%
	1.6	47,458	9.0%	54,143	10.0%	59,590	10.5%	62,714	10.7%	64,430	10.7%	64,295	10.6%	16,837	35.5%	1.1%
	3.5	17,822	3.4%	14,532	2.7%	11,849	2.1%	9,661	1.6%	7,877	1.3%	6,423	1.1%	(11,399)	-64.0%	-3.7%
	5	18,840	3.6%	15,362	2.8%	12,526	2.2%	10,213	1.7%	8,327	1.4%	6,790	1.1%	(12,050)	-64.0%	-3.7%
	Total	**84,763**	**16.1%**	**85,424**	**15.8%**	**86,850**	**15.3%**	**87,456**	**14.9%**	**87,872**	**14.6%**	**86,746**	**14.3%**	**1,983**	**2.3%**	**0.1%**
TBW	1.28	4,506	0.9%	9,571	1.8%	21,200	3.7%	37,743	6.4%	58,052	9.6%	73,791	12.2%	69,285	1537.7%	10.9%
	1.6	333,449	63.3%	377,585	69.8%	419,771	74.1%	445,728	76.1%	460,470	76.5%	465,060	76.6%	131,611	39.5%	1.2%
	3.5	112,912	21.4%	92,066	17.0%	75,068	13.2%	61,208	10.4%	49,908	8.3%	40,693	6.7%	(72,219)	-64.0%	-3.7%
	5	76,077	14.4%	62,031	11.5%	50,578	8.9%	41,240	7.0%	33,626	5.6%	27,418	4.5%	(48,659)	-64.0%	-3.7%
	Total	**526,943**	**100%**	**541,252**	**100%**	**566,617**	**100%**	**585,920**	**100%**	**602,056**	**100%**	**606,962**	**100%**	**80,018**	**15.2%**	**0.5%**

5.2.2 Estimation of Residential Clothes Washer Market Saturation for 2010-2035

Assessment of changes in technological efficiency of clothes washers rely on future regulatory changes expected to occur through 2015. Table 5-7 provides the market share and water factor (WF) assumptions used to estimate passive replacement and average water use per load overtime. Three levels of efficiency are used to reflect the range of mechanical efficiencies being sold in the market at any given time.

- Low-efficiency models are those installed prior to 2001
- Medium efficiency models are assumed to have the highest WF available after 2001
- High-efficiency models adhere to WFs consistent with historical, existing and proposed Energy Star specifications.

Effective January 1, 2011, the first federal standard for residential clothes washers requires a maximum WF rating of 9.5.[1] On May 31, 2012 the DOE published a direct final rule regarding energy conservation standards for residential clothes washers. The amended standards, effective March 12, 2015, reduce the water factors for both top-loading and front loading machines to 8.4 and 4.7, respectively. Machines *manufactured* after this date will be required to comply with the new updated DOE standard in 2015. The market impact of this new legislation is assumed to be fully realized in 2016 and if enacted will result in even further efficiency than assumed herein. However, the forecast estimates generated do not distinguish top loading and front loading clothes washers like the existing legislation. Instead, the assumed water factors for medium efficiency and high efficiency clothes washers throughout the remainder of the forecast horizon are conservative estimates of future market conditions for 2015-2035. Water factors for medium efficiency clothes washers are generally consistent with the top loading standard, while the high efficiency WF is close to the front loading standard.

The estimation process considers the installation of clothes washers in newly constructed housing units and replacements in existing homes through the process of natural replacement. Assumptions used to estimate future efficiency potential include:

- 97% of single-family homes have clothes washers[2]
- 86% of multifamily owner units and 45% of rental units have clothes washers[3]
- A natural life expectancy of 12 years ($nrr = 8.3$) as shown in Table 5-1

41068-025

[1] *US Department of Energy, (March 23, 2009). Federal Register, Vol. 74, No. 54.*
[2] *Estimate based on Tampa Bay Water single-family survey.*
[3] *American Housing Survey (2007) and National Residential Energy Consumption Survey average (2009).*

Table 5-7
Clothes Washer Market Share and Assumed Water Factors (2010-2035)

Year	Energy Star Market Share: % of Market Share (Adjusted)	Energy Star Market Share: % Change in Market Share	Water Factors: Low Efficiency (Existing)	Water Factors: Medium Efficiency (Standard)	Water Factors: High Efficiency (Energy Star)
2008	33%	2.88%	15[1]	11[2]	8.0
2009	36%	2.88%			
2010	39%	2.88%			
2011	42%	2.88%			
2012	45%	2.88%	15	9.5	6.0
2013	48%	2.88%			
2014	50%	2.88%			
2015	53%	2.88%			
2016	56%	2.88%	15	8.0	4.5
2017	59%	2.88%			
2018	62%	2.88%			
2019	65%	2.88%			
2020	67%	2.88%			
2021	70%	2.88%			
2022	70%	0.00%			
2023	70%	0.00%			
2024	70%	0.00%			
2025	70%	0.00%			
2026	70%	0.00%			
2027	70%	0.00%			
2028	70%	0.00%			
2029	70%	0.00%			
2030	70%	0.00%			
2031	70%	0.00%			
2032	70%	0.00%			
2033	70%	0.00%			
2034	70%	0.00%			
2035	70%	0.00%			

[1]Assumed lowest efficiency level available prior to 2001
[1]Assumed lowest efficiency level available 2002-2011

Annual market share for sale of Energy Star clothes washers (as provided in Table 5-7) is estimated to increase from 1% in 1997 to 70% of the sales market in 2021. The annualized rate of 2.88% is calculated as an annualized rate change between market share of 1% in 1997 and adjusted[4] Energy Star market share of 33% in 2008. The proportion of single-family HE clothes washers is calculated for each year by multiplying total number of clothes washers installed in new homes or replaced in existing homes by the HE clothes washers market share for that year.

[4] *Methodology for National Water Savings Analysis Model Indoor Residential Water Use. EPA (2008). The historical market share assumptions through 2008 are adjusted to reflect market conditions consistent with the survey estimates as discussed in Section 4.3.2.*

Table 5-8 and Table 5-9 provide WDPA distributions of single-family and multifamily toilets by efficiency level through the 2035 forecast horizon.

Key table findings include:

- Low-efficiency (WF 15)
  - WF 15 clothes washers are estimated to have the highest saturation rates in 2010, accounting for 47 and 50 percent of single-family and multifamily machines respectively. An 89 percent reduction (7.7% annually) in the relative presence of WF 15 models is estimated for both the single-family and multifamily customer classes and over forecast horizon (2035), at which time WF 15 clothes washers are assumed to account for less than 5 percent of washers in each class.
- Medium-efficiency (WF 11 / WF 9.5 / WF 8.0)
  - WF 11 clothes washers are estimated to have the second highest saturation rates in 2010, accounting for 32 and 30 percent of single-family and multifamily clothes washers, respectively. By 2035, WF 11 models are estimated to account for 13 and 15 percent of single-family and multifamily clothes washers, reflecting an estimated decrease of 47 and 42 percent by 2035, respectively.
  - WF 9.5 clothes washers are assumed to characterize the high efficiency market between 2001 and 2007 (Table 4-15), and these are then shifted over to the medium efficiency market category in 2012 in accordance with the federal standard. Although WF 9.5 models are assumed to be quickly replaced in the medium efficiency category with WF 8.0 models in 2015, by 2035 they are still estimated to account for about 12 percent of single-family and multifamily total clothes washers in 2035.
  - WF 8.0 clothes washers are assumed to have the highest WF rating available for sale between 2016 and 2035 (slightly more efficient than DOE's amended federal standard, effective March 2015). By 2035, WF 8.0 models are estimated to account for 25 percent of single-family and multifamily clothes washers, increasing at an annual average rate of 5 percent between 2010 and 2035.
- High-efficiency (WF 6.0 / WF 4.5)
  - WF 6 clothes washers are assumed to reflect the lowest WF rating available on the market for a short period of time between 2012 and 2015. During this time the market saturation of WF 6 models is assumed to increase to 13 and 12 percent in the single-family and multifamily classes, respectively. However, because additional passive replacement to a higher efficiency level (i.e. WF 4.5) is not assumed to occur, the estimated number of WF 6 clothes washers remains unchanged throughout the forecast horizon.

Table 5-8
Distribution of Single-Family Clothes Washer Efficiency by WDPA

		2010		2015		2020		2025		2030		2035				
WDPA	**Flow (WF)**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Absolute Change**	**Percent Change**	**Annual Average Percent Change**
PAS	4.5	0	0.0%	0	0.0%	16,322	2.9%	28,668	4.9%	37,634	6.2%	45,272	7.2%	45,272		
	6.0	0	0.0%	12,478	2.4%	12,478	2.2%	12,478	2.1%	12,478	2.1%	12,478	2.0%	12,478		
	8.0	6,622	1.4%	8,956	1.7%	18,908	3.4%	23,919	4.1%	27,577	4.5%	30,728	4.9%	24,106	364.1%	5.8%
	9.5	10,724	2.2%	20,223	3.9%	17,775	3.2%	16,190	2.8%	15,165	2.5%	14,501	2.3%	3,777	35.2%	1.1%
	11.0	32,790	6.8%	28,352	5.5%	22,778	4.1%	19,171	3.3%	16,836	2.8%	15,324	2.4%	(17,466)	-53.3%	-2.8%
	15.0	31,143	6.4%	20,157	3.9%	13,046	2.3%	8,444	1.4%	5,465	0.9%	3,537	0.6%	(27,606)	-88.6%	-7.7%
	Total	**81,279**	**16.8%**	**90,166**	**17.4%**	**101,307**	**18.2%**	**108,870**	**18.6%**	**115,155**	**19.0%**	**121,840**	**19.3%**	**40,561**	**49.9%**	**1.5%**
NPR	4.5	0	0.0%	0	0.0%	913	0.2%	1,482	0.3%	1,825	0.3%	2,088	0.3%	2,088		
	6.0	0	0.0%	756	0.1%	756	0.1%	756	0.1%	756	0.1%	756	0.1%	756		
	8.0	482	0.1%	625	0.1%	1,181	0.2%	1,408	0.2%	1,544	0.3%	1,649	0.3%	1,167	242.0%	4.7%
	9.5	1,001	0.2%	1,454	0.3%	1,225	0.2%	1,077	0.2%	981	0.2%	919	0.1%	(82)	-8.2%	-0.3%
	11.0	2,047	0.4%	1,807	0.3%	1,484	0.3%	1,276	0.2%	1,141	0.2%	1,053	0.2%	(993)	-48.5%	-2.4%
	15.0	3,915	0.8%	2,534	0.5%	1,640	0.3%	1,061	0.2%	687	0.1%	445	0.1%	(3,470)	-88.6%	-7.7%
	Total	**7,445**	**1.5%**	**7,175**	**1.4%**	**7,199**	**1.3%**	**7,060**	**1.2%**	**6,933**	**1.1%**	**6,910**	**1.1%**	**(535)**	**-7.2%**	**-0.3%**
NWH	4.5	0	0.0%	0	0.0%	7,704	1.4%	14,182	2.4%	19,188	3.2%	23,765	3.8%	23,765		
	6.0	0	0.0%	6,297	1.2%	6,297	1.1%	6,297	1.1%	6,297	1.0%	6,297	1.0%	6,297		
	8.0	3,840	0.8%	4,941	1.0%	9,673	1.7%	12,308	2.1%	14,361	2.4%	16,259	2.6%	12,419	323.4%	5.5%
	9.5	5,540	1.1%	10,266	2.0%	9,001	1.6%	8,183	1.4%	7,653	1.3%	7,310	1.2%	1,770	32.0%	1.0%
	11.0	15,512	3.2%	13,811	2.7%	11,421	2.0%	9,875	1.7%	8,873	1.5%	8,226	1.3%	(7,286)	-47.0%	-2.3%
	15.0	21,234	4.4%	13,743	2.7%	8,895	1.6%	5,757	1.0%	3,726	0.6%	2,412	0.4%	(18,822)	-88.6%	-7.7%
	Total	**46,125**	**9.5%**	**49,059**	**9.5%**	**52,992**	**9.5%**	**56,602**	**9.7%**	**60,098**	**9.9%**	**64,268**	**10.2%**	**18,142**	**39.3%**	**1.2%**
SCH	4.5	0	0.0%	0	0.0%	17,113	3.1%	31,404	5.4%	41,976	6.9%	50,867	8.1%	50,867		
	6.0	0	0.0%	13,894	2.7%	13,894	2.5%	13,894	2.4%	13,894	2.3%	13,894	2.2%	13,894		
	8.0	6,644	1.4%	9,097	1.8%	19,590	3.5%	25,398	4.3%	29,720	4.9%	33,392	5.3%	26,748	402.6%	6.2%
	9.5	10,555	2.2%	21,586	4.2%	19,176	3.4%	17,616	3.0%	16,607	2.7%	15,953	2.5%	5,398	51.1%	1.5%
	11.0	33,446	6.9%	28,955	5.6%	23,168	4.2%	19,423	3.3%	16,998	2.8%	15,429	2.4%	(18,017)	-53.9%	-2.8%
	15.0	33,413	6.9%	21,626	4.2%	13,997	2.5%	9,059	1.6%	5,863	1.0%	3,795	0.6%	(29,618)	-88.6%	-7.7%
	Total	**84,059**	**17.3%**	**95,158**	**18.4%**	**106,938**	**19.2%**	**116,794**	**20.0%**	**125,058**	**20.6%**	**133,331**	**21.1%**	**49,272**	**58.6%**	**1.7%**
COT	4.5	0	0.0%	0	0.0%	19,009	3.4%	34,875	6.0%	46,823	7.7%	57,277	9.1%	57,277		
	6.0	0	0.0%	15,540	3.0%	15,540	2.8%	15,540	2.7%	15,540	2.6%	15,540	2.5%	15,540		
	8.0	7,888	1.6%	10,621	2.0%	22,283	4.0%	28,730	4.9%	33,618	5.5%	37,942	6.0%	30,054	381.0%	6.0%
	9.5	13,455	2.8%	25,206	4.9%	22,134	4.0%	20,145	3.4%	18,858	3.1%	18,026	2.9%	4,571	34.0%	1.1%
	11.0	30,843	6.4%	28,366	5.5%	23,554	4.2%	20,439	3.5%	18,423	3.0%	17,119	2.7%	(13,724)	-44.5%	-2.2%
	15.0	51,244	10.6%	33,166	6.4%	21,466	3.9%	13,894	2.4%	8,992	1.5%	5,820	0.9%	(45,424)	-88.6%	-7.7%
	Total	**103,429**	**21.3%**	**112,900**	**21.8%**	**123,985**	**22.2%**	**133,623**	**22.9%**	**142,254**	**23.5%**	**151,723**	**24.0%**	**48,293**	**46.7%**	**1.4%**
PIN	4.5	0	0.0%	0	0.0%	10,624	1.9%	17,031	2.9%	20,309	3.3%	22,219	3.5%	22,219		
	6.0	0	0.0%	9,911	1.9%	9,911	1.8%	9,911	1.7%	9,911	1.6%	9,911	1.6%	9,911		
	8.0	6,986	1.4%	9,061	1.7%	15,455	2.8%	17,897	3.1%	19,107	3.2%	19,800	3.1%	12,814	183.4%	3.9%
	9.5	10,717	2.2%	17,593	3.4%	15,146	2.7%	13,562	2.3%	12,537	2.1%	11,873	1.9%	1,156	10.8%	0.4%
	11.0	23,424	4.8%	22,111	4.3%	18,719	3.4%	16,523	2.8%	15,102	2.5%	14,182	2.2%	(9,242)	-39.5%	-1.8%
	15.0	45,952	9.5%	29,741	5.7%	19,249	3.5%	12,459	2.1%	8,064	1.3%	5,219	0.8%	(40,733)	-88.6%	-7.7%
	Total	**87,078**	**18.0%**	**88,417**	**17.1%**	**89,104**	**16.0%**	**87,382**	**15.0%**	**85,030**	**14.0%**	**83,204**	**13.2%**	**(3,874)**	**-4.4%**	**-0.2%**
STP	4.5	0	0.0%	0	0.0%	8,972	1.6%	14,393	2.5%	17,230	2.8%	18,987	3.0%	18,987		
	6.0	0	0.0%	8,393	1.6%	8,393	1.5%	8,393	1.4%	8,393	1.4%	8,393	1.3%	8,393		
	8.0	5,839	1.2%	7,553	1.5%	12,919	2.3%	14,963	2.6%	16,000	2.6%	16,638	2.6%	10,799	184.9%	4.0%
	9.5	9,639	2.0%	15,264	2.9%	13,063	2.3%	11,638	2.0%	10,716	1.8%	10,120	1.6%	481	5.0%	0.2%
	11.0	19,220	4.0%	18,200	3.5%	15,379	2.8%	13,554	2.3%	12,372	2.0%	11,607	1.8%	(7,612)	-39.6%	-1.9%
	15.0	40,577	8.4%	26,262	5.1%	16,998	3.1%	11,001	1.9%	7,120	1.2%	4,609	0.7%	(35,968)	-88.6%	-7.7%
	Total	**75,274**	**15.5%**	**75,672**	**14.6%**	**75,724**	**13.6%**	**73,943**	**12.7%**	**71,833**	**11.8%**	**70,354**	**11.1%**	**(4,920)**	**-6.5%**	**-0.3%**
TBW	4.5	0	0.0%	0	0.0%	80,657	14.5%	142,036	24.3%	184,985	30.5%	220,475	34.9%	220,475		
	6.0	0	0.0%	67,270	13.0%	67,270	12.1%	67,270	11.5%	67,270	11.1%	67,270	10.7%	67,270		
	8.0	38,300	7.9%	50,854	9.8%	100,009	17.9%	124,623	21.3%	141,928	23.4%	156,407	24.8%	118,107	308.4%	5.3%
	9.5	61,631	12.7%	111,591	21.5%	97,519	17.5%	88,412	15.1%	82,517	13.6%	78,702	12.5%	17,071	27.7%	0.9%
	11.0	157,281	32.4%	141,603	27.3%	116,504	20.9%	100,259	17.2%	89,745	14.8%	82,940	13.1%	(74,341)	-47.3%	-2.3%
	15.0	227,478	46.9%	147,230	28.4%	95,291	17.1%	61,675	10.6%	39,918	6.6%	25,836	4.1%	(201,642)	-88.6%	-7.7%
	Total	**484,689**	**100%**	**518,547**	**100%**	**557,249**	**100%**	**584,274**	**100%**	**606,362**	**100%**	**631,630**	**100%**	**146,940**	**30.3%**	**1.0%**

Table 5-9
Distribution of Multifamily Clothes Washer Efficiency by WDPA

		2010		2015		2020		2025		2030		2035				
WDPA	**Flow (WF)**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Unit**	**%**	**Absolute Change**	**Percent Change**	**Annual Average Percent Change**
PAS	4.5	0	0.0%	0	0.0%	3,503	1.4%	6,545	2.6%	8,829	3.4%	10,447	4.0%	10,447		
	6.0	0	0.0%	2,477	1.0%	2,477	1.0%	2,477	1.0%	2,477	0.9%	2,477	0.9%	2,477		
	8.0	1,414	0.6%	1,858	0.8%	3,970	1.6%	5,209	2.0%	6,145	2.3%	6,811	2.6%	5,397	381.8%	6.0%
	9.5	2,211	1.0%	4,067	1.7%	3,562	1.4%	3,235	1.3%	3,024	1.2%	2,887	1.1%	676	30.6%	1.0%
	11.0	5,396	2.3%	4,934	2.1%	4,100	1.7%	3,561	1.4%	3,211	1.2%	2,985	1.1%	(2,411)	-44.7%	-2.2%
	15.0	8,128	3.5%	5,261	2.2%	3,405	1.4%	2,204	0.9%	1,426	0.5%	923	0.3%	(7,205)	-88.6%	-7.7%
	Total	**17,149**	**7.5%**	**18,596**	**7.9%**	**21,016**	**8.5%**	**23,230**	**9.1%**	**25,112**	**9.6%**	**26,530**	**10.0%**	**9,381**	**54.7%**	**1.6%**
NPR	4.5	0	0.0%	0	0.0%	370	0.1%	649	0.3%	826	0.3%	927	0.4%	927		
	6.0	0	0.0%	275	0.1%	275	0.1%	275	0.1%	275	0.1%	275	0.1%	275		
	8.0	203	0.1%	247	0.1%	467	0.2%	577	0.2%	647	0.2%	686	0.3%	483	237.6%	4.6%
	9.5	379	0.2%	538	0.2%	451	0.2%	395	0.2%	359	0.1%	335	0.1%	(44)	-11.6%	-0.5%
	11.0	776	0.3%	682	0.3%	561	0.2%	483	0.2%	432	0.2%	399	0.2%	(377)	-48.6%	-2.4%
	15.0	1,564	0.7%	1,012	0.4%	655	0.3%	424	0.2%	274	0.1%	178	0.1%	(1,386)	-88.6%	-7.7%
	Total	**2,922**	**1.3%**	**2,753**	**1.2%**	**2,779**	**1.1%**	**2,803**	**1.1%**	**2,813**	**1.1%**	**2,799**	**1.1%**	**(123)**	**-4.2%**	**-0.2%**
NWH	4.5	0	0.0%	0	0.0%	2,622	1.1%	4,690	1.8%	6,199	2.4%	7,159	2.7%	7,159		
	6.0	0	0.0%	2,086	0.9%	2,086	0.8%	2,086	0.8%	2,086	0.8%	2,086	0.8%	2,086		
	8.0	1,175	0.5%	1,559	0.7%	3,123	1.3%	3,942	1.5%	4,545	1.7%	4,928	1.9%	3,753	319.3%	5.5%
	9.5	2,274	1.0%	3,702	1.6%	3,183	1.3%	2,847	1.1%	2,630	1.0%	2,489	0.9%	215	9.5%	0.3%
	11.0	5,810	2.5%	4,984	2.1%	3,959	1.6%	3,295	1.3%	2,866	1.1%	2,588	1.0%	(3,222)	-55.5%	-3.0%
	15.0	8,504	3.7%	5,504	2.3%	3,563	1.4%	2,306	0.9%	1,492	0.6%	966	0.4%	(7,538)	-88.6%	-7.7%
	Total	**17,763**	**7.7%**	**17,835**	**7.6%**	**18,535**	**7.5%**	**19,165**	**7.5%**	**19,818**	**7.6%**	**20,216**	**7.6%**	**2,453**	**13.8%**	**0.5%**
SCH	4.5	0	0.0%	0	0.0%	3,374	1.4%	6,020	2.4%	7,870	3.0%	8,890	3.4%	8,890		
	6.0	0	0.0%	2,665	1.1%	2,665	1.1%	2,665	1.0%	2,665	1.0%	2,665	1.0%	2,665		
	8.0	2,123	0.9%	2,643	1.1%	4,677	1.9%	5,739	2.2%	6,485	2.5%	6,892	2.6%	4,769	224.6%	4.5%
	9.5	2,337	1.0%	4,362	1.8%	3,829	1.5%	3,483	1.4%	3,260	1.2%	3,115	1.2%	778	33.3%	1.1%
	11.0	7,924	3.4%	7,097	3.0%	5,939	2.4%	5,190	2.0%	4,704	1.8%	4,390	1.7%	(3,534)	-44.6%	-2.2%
	15.0	8,382	3.6%	5,425	2.3%	3,511	1.4%	2,273	0.9%	1,471	0.6%	952	0.4%	(7,430)	-88.6%	-7.7%
	Total	**20,766**	**9.0%**	**22,192**	**9.4%**	**23,995**	**9.7%**	**25,369**	**9.9%**	**26,455**	**10.1%**	**26,904**	**10.2%**	**6,138**	**29.6%**	**1.0%**
COT	4.5	0	0.0%	0	0.0%	9,716	3.9%	17,335	6.8%	22,768	8.7%	25,992	9.8%	25,992		
	6.0	0	0.0%	7,718	3.3%	7,718	3.1%	7,718	3.0%	7,718	2.9%	7,718	2.9%	7,718		
	8.0	5,169	2.2%	6,634	2.8%	12,464	5.0%	15,501	6.1%	17,680	6.7%	18,966	7.2%	13,797	266.9%	4.9%
	9.5	7,916	3.4%	13,377	5.7%	11,570	4.7%	10,400	4.1%	9,643	3.7%	9,153	3.5%	1,236	15.6%	0.5%
	11.0	18,971	8.3%	17,319	7.3%	14,439	5.8%	12,575	4.9%	11,368	4.3%	10,588	4.0%	(8,384)	-44.2%	-2.1%
	15.0	31,354	13.6%	20,293	8.6%	13,134	5.3%	8,501	3.3%	5,502	2.1%	3,561	1.3%	(27,793)	-88.6%	-7.7%
	Total	**63,411**	**27.6%**	**65,341**	**27.7%**	**69,040**	**27.9%**	**72,030**	**28.2%**	**74,679**	**28.5%**	**75,977**	**28.7%**	**12,567**	**19.8%**	**0.7%**
PIN	4.5	0	0.0%	0	0.0%	9,657	3.9%	16,618	6.5%	21,078	8.0%	22,977	8.7%	22,977		
	6.0	0	0.0%	8,399	3.6%	8,399	3.4%	8,399	3.3%	8,399	3.2%	8,399	3.2%	8,399		
	8.0	6,513	2.8%	8,210	3.5%	13,971	5.7%	16,696	6.5%	18,440	7.0%	19,148	7.2%	12,635	194.0%	4.1%
	9.5	8,971	3.9%	14,836	6.3%	12,788	5.2%	11,462	4.5%	10,604	4.0%	10,049	3.8%	1,078	12.0%	0.4%
	11.0	20,266	8.8%	19,313	8.2%	16,604	6.7%	14,850	5.8%	13,716	5.2%	12,981	4.9%	(7,285)	-35.9%	-1.6%
	15.0	38,760	16.9%	25,086	10.6%	16,237	6.6%	10,509	4.1%	6,802	2.6%	4,402	1.7%	(34,358)	-88.6%	-7.7%
	Total	**74,509**	**32.4%**	**75,844**	**32.1%**	**77,655**	**31.4%**	**78,534**	**30.7%**	**79,038**	**30.1%**	**77,956**	**29.5%**	**3,446**	**4.6%**	**0.2%**
STP	4.5	0	0.0%	0	0.0%	4,339	1.8%	7,472	2.9%	9,506	3.6%	10,438	3.9%	10,438		
	6.0	0	0.0%	3,791	1.6%	3,791	1.5%	3,791	1.5%	3,791	1.4%	3,791	1.4%	3,791		
	8.0	2,528	1.1%	3,276	1.4%	5,851	2.4%	7,068	2.8%	7,859	3.0%	8,207	3.1%	5,679	224.6%	4.5%
	9.5	4,302	1.9%	6,860	2.9%	5,878	2.4%	5,242	2.1%	4,831	1.8%	4,565	1.7%	263	6.1%	0.2%
	11.0	8,041	3.5%	7,708	3.3%	6,545	2.6%	5,793	2.3%	5,307	2.0%	4,991	1.9%	(3,049)	-37.9%	-1.8%
	15.0	18,437	8.0%	11,933	5.1%	7,723	3.1%	4,999	2.0%	3,235	1.2%	2,094	0.8%	(16,343)	-88.6%	-7.7%
	Total	**33,307**	**14.5%**	**33,567**	**14.2%**	**34,127**	**13.8%**	**34,365**	**13.5%**	**34,529**	**13.2%**	**34,086**	**12.9%**	**779**	**2.3%**	**0.1%**
TBW	4.5	0	0.0%	0	0.0%	33,580	13.6%	59,328	23.2%	77,076	29.4%	86,830	32.8%	86,830		
	6.0	0	0.0%	27,409	11.6%	27,409	11.1%	27,409	10.7%	27,409	10.4%	27,409	10.4%	27,409		
	8.0	19,125	8.3%	24,425	10.3%	44,522	18.0%	54,732	21.4%	61,801	23.5%	65,638	24.8%	46,513	243.2%	4.7%
	9.5	28,390	12.4%	47,743	20.2%	41,261	16.7%	37,066	14.5%	34,350	13.1%	32,593	12.3%	4,203	14.8%	0.5%
	11.0	67,184	29.2%	62,037	26.3%	52,147	21.1%	45,747	17.9%	41,604	15.9%	38,923	14.7%	(28,261)	-42.1%	-2.0%
	15.0	115,129	50.1%	74,515	31.6%	48,228	19.5%	31,214	12.2%	20,203	7.7%	13,076	4.9%	(102,053)	-88.6%	-7.7%
	Total	**229,828**	**100%**	**236,129**	**100%**	**247,148**	**100%**	**255,496**	**100%**	**262,443**	**100%**	**264,468**	**100%**	**34,640**	**15.1%**	**0.5%**

- WF 4.5 clothes washers are assumed to reflect the HE market between 2016 and 2035. By 2035, WF 4.5 models are estimated to account for the largest proportion of single-family and multifamily clothes washer with saturation rates at 35 and 33 percent, respectively.
- Collectively, HE models are estimated to account for 46 and 43 percent of single-family and multifamily clothes washers region wide by 2035.

5.2.3 Estimation of Residential Dishwasher Market Saturation for 2010-2035

Like toilets and clothes washers, change in the distribution of dishwasher efficiency in new and existing single-family and multifamily housing units is estimated annually for each year of the demand forecast. The estimation process considers the installation of dishwashers in newly constructed housing units and replacements of older toilets in existing homes through the process of natural replacement. Assumptions used to estimate future efficiency potential include:

- A natural life expectancy of 13 years (nrr=7.7) as shown in Table 5-1[5]
- 95% of new single-family and 82% of new multifamily units have dishwashers
- 70% of existing single-family and 48% of existing multifamily units have dishwashers

Effective January 1, 2010, the first federal water standard for dishwashers was established at 6.5 gallons per load. This level of water use is assumed to be the lowest level of efficiency available until the average dishwasher rating is reduced to 6.25 gpl in 2016 and 6.0 gpl in 2021.[6] All dishwashers are assumed to comply with the highest mechanical efficiency rating available at the time of installation.

Table 5-10 and Table 5-11 provide WDPA distributions of single-family and multifamily dishwasher efficiency in 5-year increments through the 2035 forecast horizon.

Key table findings include:

- Approximately 87 percent dishwashers existing in single-family and multifamily households in 2010, which are assumed to use 8.7 gpl on average, are estimated to be replaced with more efficient models by 2035.
- In 2035, approximately 60 percent of single-family and multifamily dishwashers are estimated to operate at less than 6.25 gpl.

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[5] *National Family Opinion, Inc., (2006). Average Useful Life of Major Home Appliances Survey*
[6] *Alliance for Water Efficiency Water Conservation Tracking Tool default assumptions.*

Table 5-10
Distribution of Single-Family Dishwasher Efficiency by WDPA

WDPA	Flow (gpl)	2010		2015		2020		2025		2030		2035		Absolute Change	Percent Change	Annual Average Percent Change
		Unit	%	Unit	%	Unit	%	Unit	%	Unit	%	Unit	%			
PAS	6.0	-	0.0%	-	0.0%	-	0.0%	16,458	3.7%	28,743	6.1%	39,525	8.0%	39,525		
	6.25	-	0.0%	-	0.0%	24,409	5.8%	24,409	5.5%	24,409	5.2%	24,409	5.0%	24,409		
	6.5	-	0.0%	28,447	7.5%	28,447	6.8%	28,447	6.4%	28,447	6.1%	28,447	5.8%	28,447		
	8.7	58,470	16.8%	39,185	10.3%	26,261	6.3%	17,600	3.9%	11,795	2.5%	7,905	1.6%	(50,566)	-86.5%	-7.1%
	Total	**58,470**	**16.8%**	**67,632**	**17.7%**	**79,117**	**18.8%**	**86,914**	**19.5%**	**93,394**	**20.0%**	**100,286**	**20.4%**	**41,815**	**71.5%**	**2.0%**
NPR	6.0	-	0.0%	-	0.0%	-	0.0%	649	0.1%	1,051	0.2%	1,383	0.3%	1,383		
	6.25	-	0.0%	-	0.0%	1,209	0.3%	1,209	0.3%	1,209	0.3%	1,209	0.2%	1,209		
	6.5	-	0.0%	1,489	0.4%	1,489	0.4%	1,489	0.3%	1,489	0.3%	1,489	0.3%	1,489		
	8.7	5,355	1.5%	3,589	0.9%	2,405	0.6%	1,612	0.4%	1,080	0.2%	724	0.1%	(4,631)	-86.5%	-7.1%
	Total	**5,355**	**1.5%**	**5,078**	**1.3%**	**5,103**	**1.2%**	**4,959**	**1.1%**	**4,828**	**1.0%**	**4,804**	**1.0%**	**(551)**	**-10.3%**	**-0.4%**
NWH	6.0	-	0.0%	-	0.0%	-	0.0%	8,638	1.9%	15,536	3.3%	22,042	4.5%	22,042		
	6.25	-	0.0%	-	0.0%	11,389	2.7%	11,389	2.6%	11,389	2.4%	11,389	2.3%	11,389		
	6.5	-	0.0%	13,968	3.7%	13,968	3.3%	13,968	3.1%	13,968	3.0%	13,968	2.8%	13,968		
	8.7	33,182	9.5%	22,238	5.8%	14,903	3.6%	9,988	2.2%	6,694	1.4%	4,486	0.9%	(28,696)	-86.5%	-7.1%
	Total	**33,182**	**9.5%**	**36,206**	**9.5%**	**40,260**	**9.6%**	**43,982**	**9.9%**	**47,587**	**10.2%**	**51,885**	**10.5%**	**18,704**	**56.4%**	**1.7%**
SCH	6.0	-	0.0%	-	0.0%	-	0.0%	19,119	4.3%	33,642	7.2%	46,193	9.4%	46,193		
	6.25	-	0.0%	-	0.0%	25,511	6.1%	25,511	5.7%	25,511	5.5%	25,511	5.2%	25,511		
	6.5	-	0.0%	31,387	8.2%	31,387	7.5%	31,387	7.0%	31,387	6.7%	31,387	6.4%	31,387		
	8.7	60,470	17.3%	40,526	10.6%	27,159	6.5%	18,202	4.1%	12,198	2.6%	8,175	1.7%	(52,295)	-86.5%	-7.1%
	Total	**60,470**	**17.3%**	**71,913**	**18.8%**	**84,057**	**20.0%**	**94,218**	**21.1%**	**102,738**	**22.0%**	**111,266**	**22.6%**	**50,796**	**84.0%**	**2.3%**
COT	6.0	-	0.0%	-	0.0%	-	0.0%	20,957	4.7%	37,242	8.0%	51,954	10.5%	51,954		
	6.25	-	0.0%	-	0.0%	27,875	6.6%	27,875	6.2%	27,875	6.0%	27,875	5.7%	27,875		
	6.5	-	0.0%	34,304	9.0%	34,304	8.2%	34,304	7.7%	34,304	7.3%	34,304	7.0%	34,304		
	8.7	74,405	21.3%	49,864	13.1%	33,418	8.0%	22,396	5.0%	15,009	3.2%	10,059	2.0%	(64,346)	-86.5%	-7.1%
	Total	**74,405**	**21.3%**	**84,168**	**22.0%**	**95,597**	**22.8%**	**105,532**	**23.7%**	**114,430**	**24.5%**	**124,192**	**25.2%**	**49,787**	**66.9%**	**1.9%**
PIN	6.0	-	0.0%	-	0.0%	-	0.0%	7,505	1.7%	11,298	2.4%	13,584	2.8%	13,584		
	6.25	-	0.0%	-	0.0%	14,554	3.5%	14,554	3.3%	14,554	3.1%	14,554	3.0%	14,554		
	6.5	-	0.0%	22,041	5.8%	22,041	5.3%	22,041	4.9%	22,041	4.7%	22,041	4.5%	22,041		
	8.7	62,642	18.0%	41,981	11.0%	28,135	6.7%	18,855	4.2%	12,636	2.7%	8,469	1.7%	(54,174)	-86.5%	-7.1%
	Total	**62,642**	**18.0%**	**64,023**	**16.8%**	**64,731**	**15.4%**	**62,956**	**14.1%**	**60,530**	**12.9%**	**58,649**	**11.9%**	**(3,994)**	**-6.4%**	**-0.2%**
STP	6.0	-	0.0%	-	0.0%	-	0.0%	6,185	1.4%	9,386	2.0%	11,464	2.3%	11,464		
	6.25	-	0.0%	-	0.0%	12,023	2.9%	12,023	2.7%	12,023	2.6%	12,023	2.4%	12,023		
	6.5	-	0.0%	18,271	4.8%	18,271	4.4%	18,271	4.1%	18,271	3.9%	18,271	3.7%	18,271		
	8.7	54,151	15.5%	36,290	9.5%	24,321	5.8%	16,299	3.7%	10,923	2.3%	7,321	1.5%	(46,830)	-86.5%	-7.1%
	Total	**54,151**	**15.5%**	**54,561**	**14.3%**	**54,614**	**13.0%**	**52,778**	**11.8%**	**50,603**	**10.8%**	**49,078**	**10.0%**	**(5,073)**	**-9.4%**	**-0.4%**
TBW	6.0	-	0.0%	-	0.0%	-	0.0%	78,119	17.5%	134,366	28.7%	182,312	37.0%	182,312		
	6.25	-	0.0%	-	0.0%	114,975	27.4%	114,975	25.8%	114,975	24.6%	114,975	23.3%	114,975		
	6.5	-	0.0%	148,161	38.8%	148,161	35.3%	148,161	33.2%	148,161	31.7%	148,161	30.1%	148,161		
	8.7	348,675	100%	233,674	61.2%	156,603	37.3%	104,952	23.5%	70,336	15.0%	47,138	9.6%	(301,537)	-86.5%	-7.1%
	Total	**348,675**	**100%**	**381,835**	**100%**	**419,739**	**100%**	**446,206**	**100%**	**467,839**	**100%**	**492,585**	**100%**	**143,910**	**41.3%**	**1.3%**

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Table 5-11
Distribution of Multifamily Dishwasher Efficiency by WDPA

WDPA	Flow (gpl)	2010 Unit	2010 %	2015 Unit	2015 %	2020 Unit	2020 %	2025 Unit	2025 %	2030 Unit	2030 %	2035 Unit	2035 %	Absolute Change	Percent Change	Annual Average Percent Change
PAS	6.0	-	0.0%	-	0.0%	-	0.0%	4,122	2.1%	7,329	3.5%	9,654	4.6%	9,654		
	6.25	-	0.0%	-	0.0%	5,162	2.8%	5,162	2.6%	5,162	2.5%	5,162	2.5%	5,162		
	6.5	-	0.0%	5,284	3.0%	5,284	2.8%	5,284	2.7%	5,284	2.6%	5,284	2.5%	5,284		
	8.7	11,113	6.7%	7,803	4.5%	5,941	3.2%	4,838	2.4%	4,196	2.0%	3,805	1.8%	(7,308)	-65.8%	-3.9%
	Total	**11,113**	**6.7%**	**13,087**	**7.5%**	**16,387**	**8.7%**	**19,406**	**9.8%**	**21,972**	**10.6%**	**23,906**	**11.4%**	**12,793**	**115.1%**	**2.9%**
NPR	6.0	-	0.0%	-	0.0%	-	0.0%	344	0.2%	567	0.3%	691	0.3%	691		
	6.25	-	0.0%	-	0.0%	501	0.3%	501	0.3%	501	0.2%	501	0.2%	501		
	6.5	-	0.0%	488	0.3%	488	0.3%	488	0.2%	488	0.2%	488	0.2%	488		
	8.7	2,120	1.3%	1,375	0.8%	913	0.5%	605	0.3%	398	0.2%	253	0.1%	(1,868)	-88.1%	-7.6%
	Total	**2,120**	**1.3%**	**1,862**	**1.1%**	**1,901**	**1.0%**	**1,937**	**1.0%**	**1,953**	**0.9%**	**1,933**	**0.9%**	**(188)**	**-8.9%**	**-0.3%**
NWH	6.0	-	0.0%	-	0.0%	-	0.0%	2,810	1.4%	4,993	2.4%	6,405	3.1%	6,405		
	6.25	-	0.0%	-	0.0%	3,880	2.1%	3,880	2.0%	3,880	1.9%	3,880	1.9%	3,880		
	6.5	-	0.0%	4,520	2.6%	4,520	2.4%	4,520	2.3%	4,520	2.2%	4,520	2.2%	4,520		
	8.7	13,421	8.1%	9,015	5.2%	6,249	3.3%	4,441	2.2%	3,295	1.6%	2,516	1.2%	(10,905)	-81.3%	-6.0%
	Total	**13,421**	**8.1%**	**13,535**	**7.8%**	**14,649**	**7.8%**	**15,651**	**7.9%**	**16,688**	**8.1%**	**17,321**	**8.3%**	**3,900**	**29.1%**	**0.9%**
SCH	6.0	-	0.0%	-	0.0%	-	0.0%	3,964	2.0%	6,826	3.3%	8,396	4.0%	8,396		
	6.25	-	0.0%	-	0.0%	5,604	3.0%	5,604	2.8%	5,604	2.7%	5,604	2.7%	5,604		
	6.5	-	0.0%	6,774	3.9%	6,774	3.6%	6,774	3.4%	6,774	3.3%	6,774	3.2%	6,774		
	8.7	15,109	9.1%	10,519	6.1%	7,676	4.1%	5,817	2.9%	4,616	2.2%	3,734	1.8%	(11,375)	-75.3%	-5.0%
	Total	**15,109**	**9.1%**	**17,292**	**10.0%**	**20,053**	**10.7%**	**22,157**	**11.2%**	**23,819**	**11.5%**	**24,508**	**11.7%**	**9,398**	**62.2%**	**1.8%**
COT	6.0	-	0.0%	-	0.0%	-	0.0%	11,765	5.9%	20,551	9.9%	25,774	12.3%	25,774		
	6.25	-	0.0%	-	0.0%	16,493	8.8%	16,493	8.3%	16,493	8.0%	16,493	7.9%	16,493		
	6.5	-	0.0%	19,603	11.3%	19,603	10.5%	19,603	9.9%	19,603	9.5%	19,603	9.4%	19,603		
	8.7	51,267	30.9%	34,949	20.1%	24,750	13.2%	18,071	9.1%	13,793	6.7%	10,780	5.1%	(40,488)	-79.0%	-5.6%
	Total	**51,267**	**30.9%**	**54,552**	**31.4%**	**60,846**	**32.5%**	**65,932**	**33.3%**	**70,440**	**34.1%**	**72,649**	**34.7%**	**21,382**	**41.7%**	**1.3%**
PIN	6.0	-	0.0%	-	0.0%	-	0.0%	7,899	4.0%	13,101	6.3%	15,045	7.2%	15,045		
	6.25	-	0.0%	-	0.0%	12,329	6.6%	12,329	6.2%	12,329	6.0%	12,329	5.9%	12,329		
	6.5	-	0.0%	16,911	9.7%	16,911	9.0%	16,911	8.5%	16,911	8.2%	16,911	8.1%	16,911		
	8.7	46,881	28.3%	31,737	18.3%	21,806	11.6%	15,070	7.6%	10,536	5.1%	7,159	3.4%	(39,722)	-84.7%	-6.7%
	Total	**46,881**	**28.3%**	**48,648**	**28.0%**	**51,046**	**27.2%**	**52,210**	**26.4%**	**52,878**	**25.6%**	**51,444**	**24.6%**	**4,563**	**9.7%**	**0.3%**
STP	6.0	-	0.0%	-	0.0%	-	0.0%	4,156	2.1%	6,945	3.4%	8,074	3.9%	8,074		
	6.25	-	0.0%	-	0.0%	6,475	3.5%	6,475	3.3%	6,475	3.1%	6,475	3.1%	6,475		
	6.5	-	0.0%	8,889	5.1%	8,889	4.7%	8,889	4.5%	8,889	4.3%	8,889	4.2%	8,889		
	8.7	25,893	15.6%	17,429	10.0%	11,871	6.3%	8,105	4.1%	5,583	2.7%	3,730	1.8%	(22,163)	-85.6%	-6.9%
	Total	**25,893**	**15.6%**	**26,318**	**15.2%**	**27,234**	**14.5%**	**27,624**	**14.0%**	**27,892**	**13.5%**	**27,168**	**13.0%**	**1,275**	**4.9%**	**0.2%**
TBW	6.0	-	0.0%	-	0.0%	-	0.0%	35,059	17.7%	60,314	29.2%	74,039	35.4%	74,039		
	6.25	-	0.0%	-	0.0%	50,443	26.9%	50,443	25.5%	50,443	24.4%	50,443	24.1%	50,443		
	6.5	-	0.0%	62,468	36.0%	62,468	33.3%	62,468	31.6%	62,468	30.2%	62,468	29.8%	62,468		
	8.7	165,805	100%	111,119	64.0%	74,469	39.7%	49,907	25.2%	33,447	16.2%	22,415	10.7%	(143,390)	-86.5%	-7.1%
	Total	**165,805**	**100%**	**173,586**	**100%**	**187,380**	**100%**	**197,877**	**100%**	**206,672**	**100%**	**209,366**	**100%**	**43,561**	**26.3%**	**0.9%**

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5.2.4 Estimation of Nonresidential Toilet and Urinal Market Saturation for 2010-2035

Active and passive water savings rely on future estimates of nonresidential employment, locations and fixtures. Figure 5.1 summarizes the projection process, which is based on annual projections of LTDFS total employment and fraction of S/I/C employment and base-year 2008 fixture, employment and location estimates presented in Section 4.3.4.

- Nonresidential employment is projected for key sectors by growing the 2008 LTDFS employment according to ***LTDFS S/I/C employment growth rates***.
- Nonresidential locations are projected throughout the forecast horizon by assuming a constant average number of ***employees per location***.
- Nonresidential fixtures are projected throughout the forecast horizon by assuming a constant average number of ***fixtures per location***.

As previously discussed in Section 4.3.4, the nonresidential customer class is defined by three LTDFS service, industrial and commercial (S/I/C) employment categories and nine nonresidential key sector types inclusive of the high-priority sectors identified in Section 3.4. Employment projections are derived by growing WDPA LTDFS key sector employment estimates by corresponding WPDA S/I/C employment annual growth rates provided in Appendix K.[7] Table 5-12 provides the distribution of LTDFS S/I/C employment by WDPA, defined as the product of total employment and the fractions of S/I/C employment. Regional key sector employment reflects the sum of WDPA estimates.

Table 5-13 provides the regional key sector employment projections in five-year increments for the estimated locations with toilets and urinals (annual WDPA estimates are provided in Appendix L). Because all customer locations are assumed to have toilets, employment for locations with toilets reflects total key sector employment, while employment for locations with urinals reflects locations estimated to have more than one male toilet.

Location projections are calculated for each forecast year by assuming the number of employees per location estimated for 2008 remains constant.[8] Table 5-14 provides the projected number of nonresidential locations with toilets and urinals in 5-year increments between 2010 and 2035 (annual WDPA estimates are provided in Appendix M).

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[7] The S/I/C employment growth rates provided in Appendix I are calculated for each forecast year by dividing the current S/I/C employment estimates by the prior S/I/C employment estimate.
[8] Employees per location previously provided in Section 4.3.2.4, Tables 4-23 and 4-24.

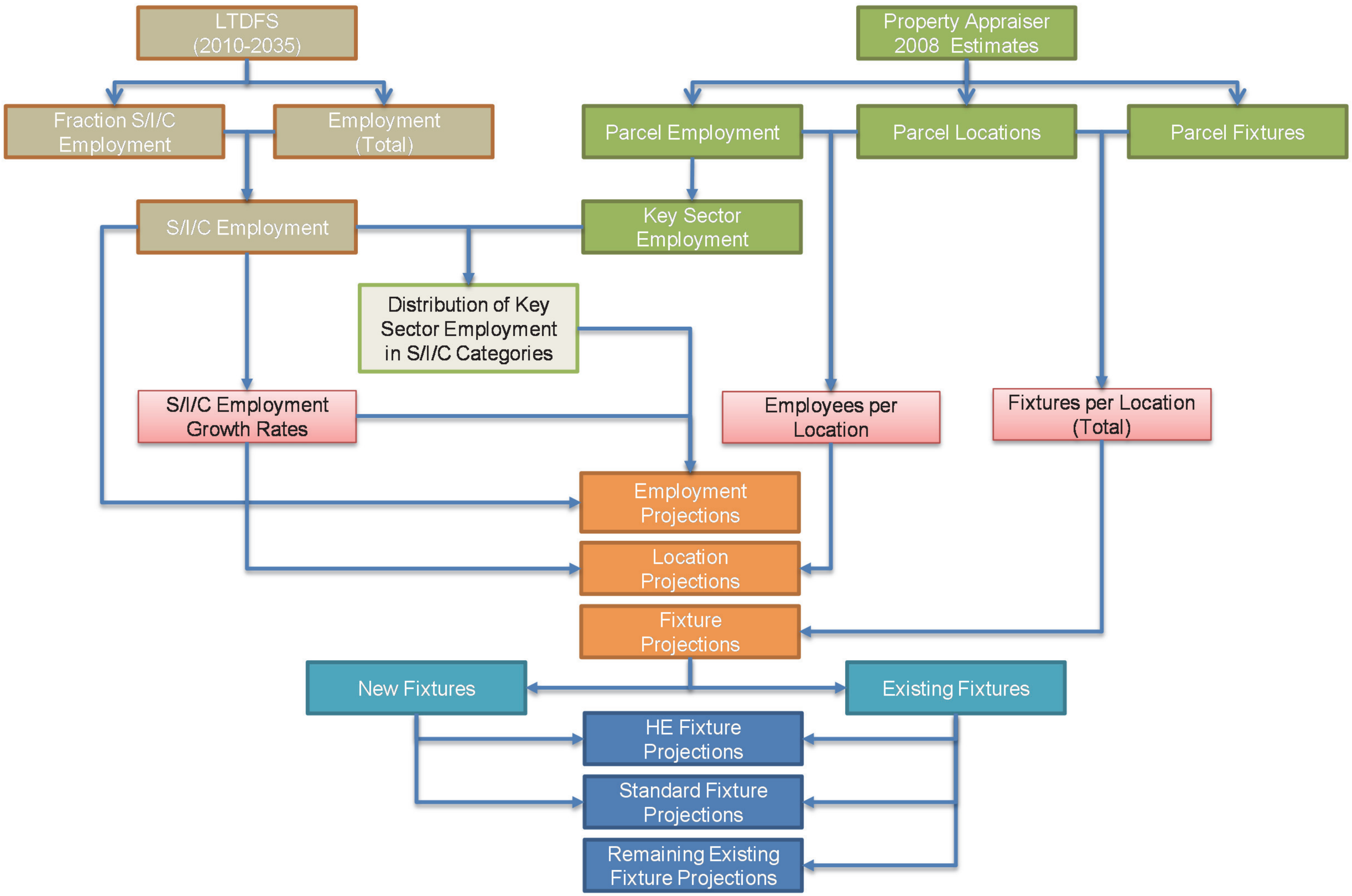

Figure 5.1: 2010-2035 Fixtures, Locations and Employment Projection Overview

Table 5-12
Distribution of Regional Service, Industrial and Commercial Employment by WDPA

WDPA	SIC Sector	2010 Employees	2010 % of WDPA Total	2015 Employees	2015 % of WDPA Total	2020 Employees	2020 % of WDPA Total	2025 Employees	2025 % of WDPA Total	2030 Employees	2030 % of WDPA Total	2035 Employees	2035 % of WDPA Total
PAS	Service	40,063	48.7%	51,041	50.5%	60,418	51.9%	70,076	53.1%	80,559	54.1%	92,117	55.0%
	Commercial	22,269	27.1%	26,647	26.3%	30,170	25.9%	33,872	25.7%	38,002	25.5%	42,657	25.5%
	Industrial	19,990	24.3%	23,478	23.2%	25,853	22.2%	28,064	21.3%	30,326	20.4%	32,702	19.5%
	Total	**82,322**	**100%**	**101,165**	**100%**	**116,441**	**100%**	**132,012**	**100%**	**148,887**	**100%**	**167,476**	**100%**
NPR	Service	8,392	70.2%	8,562	70.1%	8,374	70.0%	8,213	70.0%	8,128	70.0%	8,115	70.0%
	Commercial	1,681	14.1%	1,710	14.0%	1,667	13.9%	1,630	13.9%	1,608	13.8%	1,599	13.8%
	Industrial	1,885	15.8%	1,943	15.9%	1,916	16.0%	1,890	16.1%	1,877	16.2%	1,877	16.2%
	Total	**11,957**	**100%**	**12,214**	**100%**	**11,957**	**100%**	**11,733**	**100%**	**11,612**	**100%**	**11,591**	**100%**
NWH	Service	37,105	60.3%	44,233	62.6%	48,647	63.2%	51,940	62.7%	54,412	61.1%	55,999	58.7%
	Commercial	15,441	25.1%	17,865	25.3%	19,875	25.8%	22,141	26.7%	24,849	27.9%	28,105	29.4%
	Industrial	8,955	14.6%	8,595	12.2%	8,419	10.9%	8,771	10.6%	9,722	10.9%	11,342	11.9%
	Total	**61,502**	**100%**	**70,693**	**100%**	**76,941**	**100%**	**82,852**	**100%**	**88,984**	**100%**	**95,446**	**100%**
SCH	Service	44,412	52.6%	54,688	53.2%	61,003	53.7%	65,300	54.2%	67,938	54.8%	68,766	55.6%
	Commercial	21,215	25.1%	24,597	23.9%	27,385	24.1%	30,497	25.3%	34,190	27.6%	38,606	31.2%
	Industrial	18,884	22.3%	23,580	22.9%	25,225	22.2%	24,612	20.4%	21,740	17.6%	16,255	13.1%
	Total	**84,510**	**100%**	**102,865**	**100%**	**113,613**	**100%**	**120,409**	**100%**	**123,868**	**100%**	**123,626**	**100%**
COT	Service	350,759	64.9%	380,428	65.1%	408,496	65.3%	449,587	65.3%	507,598	65.2%	585,432	65.1%
	Commercial	87,650	16.2%	105,507	18.1%	120,830	19.3%	137,539	20.0%	156,885	20.2%	179,623	20.0%
	Industrial	101,849	18.9%	98,065	16.8%	96,684	15.4%	101,648	14.8%	113,802	14.6%	134,027	14.9%
	Total	**540,258**	**100%**	**584,000**	**100%**	**626,010**	**100%**	**688,775**	**100%**	**778,284**	**100%**	**899,082**	**100%**
PIN	Service	147,882	56.3%	153,531	56.5%	153,230	56.7%	153,171	56.8%	154,265	56.8%	156,616	56.9%
	Commercial	53,484	20.4%	55,621	20.5%	55,715	20.6%	55,999	20.8%	56,799	20.9%	58,156	21.1%
	Industrial	61,145	23.3%	62,490	23.0%	61,483	22.7%	60,673	22.5%	60,403	22.3%	60,694	22.0%
	Total	**262,511**	**100%**	**271,642**	**100%**	**270,428**	**100%**	**269,842**	**100%**	**271,467**	**100%**	**275,466**	**100%**
STP	Service	108,562	67.0%	113,021	66.9%	112,939	66.7%	112,880	66.5%	113,526	66.3%	114,961	66.1%
	Commercial	29,873	18.4%	31,751	18.8%	32,395	19.1%	33,061	19.5%	33,956	19.8%	35,118	20.2%
	Industrial	23,481	14.5%	24,255	14.3%	24,053	14.2%	23,862	14.1%	23,824	13.9%	23,952	13.8%
	Total	**161,916**	**100%**	**169,027**	**100%**	**169,387**	**100%**	**169,803**	**100%**	**171,307**	**100%**	**174,032**	**100%**
TBW	Service	737,175	61.2%	805,505	61.4%	853,108	61.6%	911,167	61.8%	986,426	61.9%	1,082,005	61.9%
	Commercial	231,613	19.2%	263,697	20.1%	288,037	20.8%	314,739	21.3%	346,288	21.7%	383,865	22.0%
	Industrial	236,189	19.6%	242,405	18.5%	243,633	17.6%	249,520	16.9%	261,695	16.4%	280,849	16.1%
	Total	**1,204,977**	**100%**	**1,311,606**	**100%**	**1,384,777**	**100%**	**1,475,427**	**100%**	**1,594,409**	**100%**	**1,746,719**	**100%**

Table 5-13
Regional Estimates of LTFDS Employment for Nonresidential Locations with Toilets and Urinals by Key Sector

SIC Category	10 Key Sectors	Employees for NR Locations w/Toilets						Employees for NR Locations w/Urinals						Total NR Employment				
		2010	2015	2020	2025	2030	2035	2010	2015	2020	2025	2030	2035	% of Total (2010)	% of Total (2035)	Absolute Change	Percent Change	Annual Average Percent Change
Service	Hotels	47,267	50,478	52,408	55,044	58,785	63,811	43,547	46,615	48,552	51,190	54,903	59,870	3.9%	3.7%	16,544	35.0%	1.2%
	Churches	24,289	26,858	28,491	30,224	32,264	34,678	20,455	22,617	23,974	25,398	27,063	29,022	2.0%	2.0%	10,389	42.8%	1.4%
	Health	72,445	79,691	84,297	89,364	95,515	102,962	44,396	48,131	50,310	52,822	56,032	60,065	6.0%	5.9%	30,517	42.1%	1.4%
	Office	193,547	209,244	219,676	232,994	250,911	274,225	136,666	146,938	153,982	163,532	176,819	194,474	16.1%	15.7%	80,678	41.7%	1.4%
	Government	119,546	129,484	137,040	147,243	161,242	179,693	110,486	119,447	126,361	135,871	149,046	166,516	9.9%	10.3%	60,147	50.3%	1.6%
	Education	98,738	110,190	117,885	126,046	135,560	146,723	93,372	104,192	111,475	119,217	128,257	138,878	8.2%	8.4%	47,984	48.6%	1.6%
	Others	181,342	199,560	213,310	230,251	252,148	279,914	162,672	178,995	191,488	207,014	227,171	252,811	15.0%	16.0%	98,571	54.4%	1.8%
Industrial	Industrial	236,189	242,405	243,633	249,520	261,695	280,849	40,244	40,712	40,586	41,473	43,641	47,222	19.6%	16.1%	44,660	18.9%	0.7%
Commercial	Retail	155,351	177,180	193,825	212,076	233,606	259,214	90,422	103,331	113,251	124,134	136,962	152,207	12.9%	14.8%	103,863	66.9%	2.1%
	Restaurants	30,848	34,915	37,944	41,276	45,235	49,973	28,686	32,445	35,236	38,308	41,959	46,330	2.6%	2.9%	19,125	62.0%	1.9%
	Others	45,415	51,602	56,267	61,387	67,447	74,679	18,723	20,473	21,541	22,729	24,197	26,001	3.8%	4.3%	29,264	64.4%	2.0%
NR Total		**1,204,977**	**1,311,606**	**1,384,777**	**1,475,427**	**1,594,409**	**1,746,719**	**789,668**	**863,895**	**916,757**	**981,688**	**1,066,050**	**1,173,395**	**100%**	**100%**	**541,742**	**45.0%**	**1.5%**

Table 5-14
Regional Estimates of Nonresidential Locations with Toilets and Urinals by Key Sector and WDPA (2010-2035)

SIC Category	10 Key Sectors	Employees for NR Locations w/Toilets						Employees for NR Locations w/Urinals						Total NR Employment				
		2010	2015	2020	2025	2030	2035	2010	2015	2020	2025	2030	2035	% of Total (2010)	% of Total (2035)	Absolute Change	Percent Change	Annual Average Percent Change
Service	Hotels	519	553	571	594	627	672	496	529	547	570	603	647	1.9%	1.6%	153	29.5%	1.0%
	Churches	1,720	1,908	2,038	2,182	2,358	2,571	792	878	934	996	1,068	1,155	6.2%	6.2%	851	49.4%	1.6%
	Health	2,209	2,485	2,680	2,888	3,131	3,415	273	302	322	344	371	404	7.9%	8.2%	1,206	54.6%	1.8%
	Office	5,239	5,744	6,075	6,454	6,927	7,512	630	683	721	769	833	917	18.8%	18.1%	2,273	43.4%	1.5%
	Government	876	971	1,037	1,112	1,204	1,315	301	328	346	368	397	435	3.2%	3.2%	439	50.1%	1.6%
	Education	759	849	910	975	1,052	1,142	399	446	477	510	548	592	2.7%	2.8%	382	50.3%	1.6%
	Others	4,300	4,768	5,115	5,524	6,036	6,672	1,054	1,164	1,244	1,338	1,456	1,603	15.5%	16.1%	2,372	55.2%	1.8%
Industrial	Industrial	4,534	4,619	4,629	4,747	5,005	5,422	67	67	66	68	73	81	16.3%	13.1%	887	19.6%	0.7%
Commercial	Retail	3,867	4,396	4,793	5,228	5,742	6,353	459	523	572	626	689	765	13.9%	15.3%	2,486	64.3%	2.0%
	Restaurants	1,308	1,485	1,617	1,762	1,935	2,140	1,037	1,174	1,276	1,389	1,522	1,682	4.7%	5.2%	832	63.6%	2.0%
	Others	2,469	2,842	3,133	3,452	3,825	4,266	87	96	102	109	117	128	8.9%	10.3%	1,797	72.8%	2.2%
NR Total		**27,800**	**30,620**	**32,597**	**34,918**	**37,841**	**41,479**	**5,594**	**6,189**	**6,607**	**7,086**	**7,679**	**8,408**	**100%**	**100%**	**13,679**	**49.2%**	**1.6%**

The number of locations estimated to have toilets and urinals within each key sector varies as shown in Table 5-14. Similar to employment, locations with toilets reflects the total number of key sector locations, while locations with urinals are locations estimated to have more than one male toilet.

Toilets and urinals are estimated at a WDPA level by multiplying the location estimates in Table 5-14 by the 2008 fixture location factors provided in Table 5-15 and Table 5-16. This approach assumes a constant number of fixtures per location through the forecast horizon. The total regional estimates reflect the aggregate member government values.

Table 5-17 and Table 5-18 provide WDPA distributions of nonresidential toilet and urinal efficiency in 5-year increments through the 2035 forecast horizon. The natural replacement rates provided in Table 5-1 are used to decay baseline estimates of 5.0 and 3.5 gpf toilets and 3.0 gpf urinals to EPAct and HE models. HE fixtures are estimated for any given year by multiplying the HE market share estimates provided in Table 5-2 by the number of passive replacements and fixtures installations in new construction units.9 Standard fixtures (i.e., 1.6 gpf toilets) are estimated by subtracting the sum of remaining 5.0 and 3.5 gpf toilets (after natural replacement) and HE fixtures from total fixture estimates for each year.

Key table findings include:

- HET (1.28 gpf) and HEU (0.5 gpf) saturation is estimated to increase at an average annual rate of 21 percent in the nonresidential class. By 2035, HETs and HEU's are estimated to accounting for about 20 and 14 percent of toilets and urinals, respectively.
- ULF toilets (1.6 gpf) and urinals (1.0 gpf) account for the majority of each fixture type throughout the forecast horizon. Saturation of ULF fixtures is estimated to increase from about 58 to 70 percent by 2035, increasing at an annual average rate of 2 percent.
- Low-efficiency toilets and urinals (3.5 and 5.0 gpf) are projected to decrease by 64% at an average annual rate of 2 percent. Region wide low-efficiency toilets and urinals will comprise about 14 percent of nonresidential fixtures by 2035.

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[9] *Calculated as the difference between total toilets in any given year and total toilets from the previous year.*

Table 5-15
Fixtures per Location Factors for Toilets and Urinals by WDPA (2008)

SIC Category	Sector	PAS		NPR		NWH		SCH		COT		PIN		STP	
		Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals
Service	Hotels	87.3	12.3	107.6	15.4	155.0	22.8	72.2	10.0	170.3	25.3	78.1	9.5	66.1	8.9
	Churches	9.1	2.5	6.4	1.7	8.5	3.5	8.5	3.6	6.6	3.0	11.2	3.3	8.8	2.9
	Health	7.0	11.0	11.5	12.9	10.8	45.0	13.3	15.9	17.1	25.6	10.4	17.1	11.0	20.8
	Office	3.4	1.5	2.9	1.4	3.1	3.2	3.0	2.0	5.2	5.4	4.5	4.7	3.9	3.5
	Government	4.9	2.7	4.7	1.4	5.3	2.7	3.3	1.6	14.4	10.2	6.8	3.4	9.1	4.2
	Education	20.1	13.9	14.2	16.4	14.6	12.3	14.4	11.9	14.1	13.3	14.9	10.2	16.7	10.8
	Others	4.3	2.4	4.2	2.0	9.2	9.8	5.5	5.1	8.3	9.9	5.7	4.2	7.2	5.0
Industrial	Industrial	2.2	NA	2.0	NA	2.3	NA	2.4	1.6	2.4	1.5	2.7	2.0	2.3	1.4
Commercial	Retail	3.8	3.0	2.7	2.0	6.3	3.4	4.8	3.2	3.1	3.1	3.3	1.9	3.1	3.5
	Restaurants	6.1	1.9	7.3	2.8	6.4	2.2	5.9	2.0	5.6	2.1	6.1	2.1	5.3	1.8
	Others	2.2	1.4	2.1	1.0	2.2	1.2	2.2	1.5	2.1	1.3	2.8	2.0	2.7	2.4
NR Total		5.0	4.4	5.7	5.6	6.1	5.6	6.0	4.9	8.3	8.4	8.6	5.2	6.7	5.4

Table 5-16
Employees per Location Factors for Locations with Toilets and Urinals by WDPA (2008)

SIC Category	Sector	PAS		NPR		NWH		SCH		COT		PIN		STP	
		Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals	Toilets	Urinals
Service	Hotels	78.0	78.0	78.2	78.2	126.3	126.3	54.5	54.5	123.4	124.1	86.1	77.5	58.0	57.0
	Churches	17.4	23.0	9.5	13.7	15.0	27.7	13.8	26.9	9.9	21.5	27.0	36.6	16.6	25.8
	Health	19.9	81.4	22.7	68.4	25.2	274.1	25.5	120.9	30.0	139.2	57.1	271.5	43.4	231.3
	Office	23.8	100.3	15.1	92.0	22.5	159.6	15.1	105.2	43.0	219.3	49.8	298.2	32.0	183.6
	Government	52.6	191.0	41.1	74.0	61.5	166.2	22.6	94.7	208.9	530.5	118.1	286.1	143.1	272.4
	Education	197.1	297.2	93.1	236.3	121.3	223.1	104.5	189.9	105.3	221.6	170.9	263.7	170.0	246.0
	Others	16.5	51.9	11.7	29.8	106.3	380.7	33.8	131.6	52.3	214.9	39.7	114.4	27.7	77.3
Industrial	Industrial	57.6	NA	25.9	NA	76.7	NA	78.9	945.8	48.8	512.6	69.1	1081.5	29.9	447.2
Commercial	Retail	42.9	180.4	9.0	47.1	74.6	171.6	46.2	148.9	38.4	250.3	48.9	209.0	28.0	209.6
	Restaurants	19.0	20.2	9.0	9.8	19.4	21.0	15.9	18.1	25.3	31.6	32.1	36.5	18.2	21.7
	Others	7.7	124.1	1.7	41.1	14.9	110.6	12.5	144.0	19.0	195.3	43.4	293.4	24.8	222.2
NR Total		31.5	90.0	16.1	51.7	47.3	144.1	32.7	97.8	47.4	180.1	56.8	143.1	36.1	115.1

Table 5-17
Distribution of Nonresidential Toilets by Efficiency Level and WPDA

WDPA	Flow (gpf)	2010 Units	2010 %	2015 Units	2015 %	2020 Units	2020 %	2025 Units	2025 %	2030 Units	2030 %	2035 Units	2035 %	Absolute Change	Percent Change	Annual Average Percent Change
PAS	1.28	20	0.0%	448	0.2%	1,198	0.5%	2,556	1.0%	4,659	1.7%	7,197	2.4%	7,178	36380%	24.4%
	1.6	8,634	4.2%	12,398	5.5%	15,144	6.3%	17,237	6.8%	18,736	6.8%	20,044	6.6%	11,410	132%	3.2%
	3.5	3,036	1.5%	2,476	1.1%	2,019	0.8%	1,646	0.6%	1,342	0.5%	1,094	0.4%	-1,942	-64%	-3.7%
	5.0	1,602	0.8%	1,306	0.6%	1,065	0.4%	869	0.3%	708	0.3%	577	0.2%	-1,025	-64%	-3.7%
	Total	**13,293**	**6.5%**	**16,629**	**7.4%**	**19,426**	**8.1%**	**22,308**	**8.7%**	**25,445**	**9.2%**	**28,913**	**9.5%**	**15,620**	**118%**	**2.9%**
NPR	1.28	9	0.0%	62	0.0%	131	0.1%	236	0.1%	362	0.1%	480	0.2%	471	5073%	15.7%
	1.6	1,999	1.0%	2,433	1.1%	2,597	1.1%	2,678	1.0%	2,725	1.0%	2,776	0.9%	777	39%	1.2%
	3.5	1,086	0.5%	885	0.4%	722	0.3%	589	0.2%	480	0.2%	391	0.1%	-694	-64%	-3.7%
	5.0	1,096	0.5%	894	0.4%	729	0.3%	594	0.2%	485	0.2%	395	0.1%	-701	-64%	-3.7%
	Total	**4,190**	**2.0%**	**4,274**	**1.9%**	**4,179**	**1.8%**	**4,097**	**1.6%**	**4,052**	**1.5%**	**4,043**	**1.3%**	**-147**	**-4%**	**-0.1%**
NWH	1.28	11	0.0%	206	0.1%	490	0.2%	926	0.4%	1,504	0.5%	2,085	0.7%	2,074	19137%	21.5%
	1.6	5,538	2.7%	7,246	3.2%	8,291	3.5%	8,973	3.5%	9,388	3.4%	9,687	3.2%	4,149	75%	2.1%
	3.5	1,805	0.9%	1,472	0.7%	1,200	0.5%	979	0.4%	798	0.3%	651	0.2%	-1,155	-64%	-3.7%
	5.0	743	0.4%	605	0.3%	494	0.2%	403	0.2%	328	0.1%	268	0.1%	-475	-64%	-3.7%
	Total	**8,097**	**3.9%**	**9,530**	**4.2%**	**10,475**	**4.4%**	**11,280**	**4.4%**	**12,017**	**4.3%**	**12,690**	**4.2%**	**4,593**	**57%**	**1.7%**
SCH	1.28	25	0.0%	476	0.2%	1,113	0.5%	2,011	0.8%	3,065	1.1%	3,958	1.3%	3,933	15838%	20.7%
	1.6	9,563	4.7%	13,549	6.0%	15,921	6.7%	17,311	6.8%	17,989	6.5%	18,265	6.0%	8,701	91%	2.4%
	3.5	3,728	1.8%	3,040	1.4%	2,479	1.0%	2,021	0.8%	1,648	0.6%	1,344	0.4%	-2,385	-64%	-3.7%
	5.0	2,109	1.0%	1,720	0.8%	1,402	0.6%	1,143	0.4%	932	0.3%	760	0.3%	-1,349	-64%	-3.7%
	Total	**15,426**	**7.5%**	**18,785**	**8.4%**	**20,915**	**8.8%**	**22,487**	**8.8%**	**23,634**	**8.5%**	**24,326**	**8.0%**	**8,900**	**58%**	**1.7%**
COT	1.28	188	0.1%	1,844	0.8%	4,883	2.0%	11,334	4.4%	22,990	8.3%	39,123	12.9%	38,935	20710%	21.9%
	1.6	54,506	26.5%	68,697	30.5%	79,629	33.4%	89,477	35.1%	97,714	35.3%	106,025	34.9%	51,520	95%	2.5%
	3.5	21,881	10.7%	17,841	7.9%	14,547	6.1%	11,862	4.6%	9,672	3.5%	7,886	2.6%	-13,995	-64%	-3.7%
	5.0	17,892	8.7%	14,589	6.5%	11,895	5.0%	9,699	3.8%	7,908	2.9%	6,448	2.1%	-11,444	-64%	-3.7%
	Total	**94,467**	**46.0%**	**102,971**	**45.8%**	**110,955**	**46.5%**	**122,371**	**47.9%**	**138,284**	**50.0%**	**159,483**	**52.5%**	**65,016**	**69%**	**2.0%**
PIN	1.28	70	0.0%	562	0.2%	1,095	0.5%	1,903	0.7%	3,053	1.1%	4,373	1.4%	4,303	6131%	16.5%
	1.6	23,485	11.4%	27,540	12.2%	29,392	12.3%	30,589	12.0%	31,394	11.3%	32,074	10.6%	8,589	37%	1.2%
	3.5	9,690	4.7%	7,901	3.5%	6,443	2.7%	5,253	2.1%	4,283	1.5%	3,492	1.1%	-6,198	-64%	-3.7%
	5.0	6,811	3.3%	5,553	2.5%	4,528	1.9%	3,692	1.4%	3,010	1.1%	2,454	0.8%	-4,356	-64%	-3.7%
	Total	**40,056**	**19.5%**	**41,556**	**18.5%**	**41,457**	**17.4%**	**41,437**	**16.2%**	**41,740**	**15.1%**	**42,394**	**14.0%**	**2,337**	**6%**	**0.2%**
STP	1.28	60	0.0%	473	0.2%	943	0.4%	1,656	0.6%	2,629	1.0%	3,702	1.2%	3,643	6109%	16.5%
	1.6	15,752	7.7%	19,223	8.5%	20,915	8.8%	21,983	8.6%	22,672	8.2%	23,225	7.6%	7,473	47%	1.4%
	3.5	6,290	3.1%	5,129	2.3%	4,182	1.8%	3,410	1.3%	2,780	1.0%	2,267	0.7%	-4,023	-64%	-3.7%
	5.0	7,727	3.8%	6,301	2.8%	5,137	2.2%	4,189	1.6%	3,415	1.2%	2,785	0.9%	-4,942	-64%	-3.7%
	Total	**29,829**	**14.5%**	**31,126**	**13.8%**	**31,177**	**13.1%**	**31,238**	**12.2%**	**31,497**	**11.4%**	**31,979**	**10.5%**	**2,150**	**7%**	**0.3%**
TBW	1.28	382	0.2%	4,071	1.8%	9,852	4.1%	20,623	8.1%	38,261	13.8%	60,918	20.1%	60,536	15827%	20.7%
	1.6	119,478	58.2%	151,086	67.2%	171,890	72.0%	188,247	73.8%	200,618	72.5%	212,096	69.8%	92,618	78%	2.1%
	3.5	47,517	23.1%	38,744	17.2%	31,591	13.2%	25,759	10.1%	21,003	7.6%	17,125	5.6%	-30,392	-64%	-3.7%
	5.0	37,980	18.5%	30,968	13.8%	25,250	10.6%	20,589	8.1%	16,787	6.1%	13,688	4.5%	-24,292	-64%	-3.7%
	Total	**205,358**	**100%**	**224,869**	**100%**	**238,584**	**100%**	**255,217**	**100%**	**276,669**	**100%**	**303,827**	**100%**	**98,469**	**48%**	**1.5%**

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Table 5-18
Distribution of Nonresidential Urinals by Efficiency Level and WDPA

WDPA	Flow (gpf)	2010 Units	2010 %	2015 Units	2015 %	2020 Units	2020 %	2025 Units	2025 %	2030 Units	2030 %	2035 Units	2035 %	Absolute Change	Percent Change	Annual Average Percent Change
PAS	0.5	3	0.0%	72	0.2%	193	0.5%	413	0.9%	754	1.6%	1,167	2.2%	1,164	37381%	24.5%
	1.0	1,327	3.7%	1,930	4.9%	2,374	5.7%	2,713	6.1%	2,957	6.1%	3,169	5.9%	1,842	139%	3.3%
	3.0	732	2.1%	597	1.5%	487	1.2%	397	0.9%	324	0.7%	264	0.5%	-468	-64%	-3.7%
	Total	**2,062**	**5.8%**	**2,599**	**6.6%**	**3,054**	**7.3%**	**3,523**	**7.9%**	**4,035**	**8.3%**	**4,600**	**8.6%**	**2,538**	**123%**	**3.0%**
NPR	0.5	2	0.0%	11	0.0%	23	0.1%	41	0.1%	63	0.1%	84	0.2%	82	5073%	15.7%
	1.0	351	1.0%	427	1.1%	455	1.1%	469	1.1%	478	1.0%	487	0.9%	135	39%	1.2%
	3.0	380	1.1%	310	0.8%	253	0.6%	206	0.5%	168	0.3%	137	0.3%	-243	-64%	-3.7%
	Total	**733**	**2.1%**	**747**	**1.9%**	**731**	**1.8%**	**716**	**1.6%**	**709**	**1.5%**	**707**	**1.3%**	**-26**	**-4%**	**-0.1%**
NWH	0.5	2	0.0%	42	0.1%	98	0.2%	185	0.4%	297	0.6%	406	0.8%	404	19664%	21.6%
	1.0	1,124	3.2%	1,471	3.8%	1,682	4.0%	1,818	4.1%	1,898	3.9%	1,954	3.6%	830	74%	2.1%
	3.0	483	1.4%	394	1.0%	321	0.8%	262	0.6%	213	0.4%	174	0.3%	-309	-64%	-3.7%
	Total	**1,609**	**4.5%**	**1,907**	**4.9%**	**2,102**	**5.1%**	**2,264**	**5.1%**	**2,409**	**5.0%**	**2,535**	**4.7%**	**925**	**58%**	**1.7%**
SCH	0.5	4	0.0%	77	0.2%	182	0.4%	330	0.7%	500	1.0%	641	1.2%	637	16604%	20.9%
	1.0	1,645	4.6%	2,294	5.9%	2,683	6.4%	2,915	6.5%	3,038	6.3%	3,105	5.8%	1,460	89%	2.4%
	3.0	902	2.5%	735	1.9%	600	1.4%	489	1.1%	399	0.8%	325	0.6%	-577	-64%	-3.7%
	Total	**2,551**	**7.2%**	**3,107**	**7.9%**	**3,465**	**8.3%**	**3,734**	**8.4%**	**3,937**	**8.1%**	**4,070**	**7.6%**	**1,520**	**60%**	**1.7%**
COT	0.5	34	0.1%	346	0.9%	920	2.2%	2,138	4.8%	4,329	8.9%	7,354	13.7%	7,320	21345%	22.0%
	1.0.	10,152	28.5%	12,855	32.9%	14,932	35.9%	16,791	37.6%	18,340	37.7%	19,898	37.1%	9,746	96%	2.5%
	3.0	7,516	21.1%	6,128	15.7%	4,997	12.0%	4,074	9.1%	3,322	6.8%	2,709	5.1%	-4,807	-64%	-3.7%
	Total	**17,703**	**49.7%**	**19,329**	**49.4%**	**20,849**	**50.1%**	**23,003**	**51.5%**	**25,991**	**53.5%**	**29,961**	**55.9%**	**12,259**	**69%**	**2.0%**
PIN	0.5	10	0.0%	82	0.2%	160	0.4%	279	0.6%	448	0.9%	643	1.2%	633	6165%	16.6%
	1.0	3,373	9.5%	3,969	10.2%	4,245	10.2%	4,424	9.9%	4,544	9.4%	4,645	8.7%	1,272	38%	1.2%
	3.0	2,413	6.8%	1,967	5.0%	1,604	3.9%	1,308	2.9%	1,067	2.2%	870	1.6%	-1,543	-64%	-3.7%
	Total	**5,796**	**16.3%**	**6,019**	**15.4%**	**6,009**	**14.4%**	**6,011**	**13.5%**	**6,059**	**12.5%**	**6,158**	**11.5%**	**361**	**6%**	**0.2%**
STP	0.5	10	0.0%	81	0.2%	160	0.4%	280	0.6%	445	0.9%	627	1.2%	617	6084%	16.5%
	1.0	2,773	7.8%	3,366	8.6%	3,654	8.8%	3,835	8.6%	3,953	8.1%	4,047	7.6%	1,273	46%	1.4%
	3.0	2,385	6.7%	1,944	5.0%	1,585	3.8%	1,293	2.9%	1,054	2.2%	859	1.6%	-1,525	-64%	-3.7%
	Total	**5,168**	**14.5%**	**5,392**	**13.8%**	**5,399**	**13.0%**	**5,408**	**12.1%**	**5,452**	**11.2%**	**5,533**	**10.3%**	**365**	**7%**	**0.3%**
TBW	0.5	65	0.2%	711	1.8%	1,737	4.2%	3,666	8.2%	6,837	14.1%	10,922	20.4%	10,857	16621%	20.9%
	1.0	20,746	58.2%	26,313	67.3%	30,025	72.2%	32,966	73.8%	35,207	72.5%	37,304	69.6%	16,558	80%	2.2%
	3.0	14,811	41.6%	12,077	30.9%	9,847	23.7%	8,029	18.0%	6,547	13.5%	5,338	10.0%	-9,473	-64%	-3.7%
	Total	**35,623**	**100%**	**39,100**	**100%**	**41,609**	**100%**	**44,660**	**100%**	**48,591**	**100%**	**53,565**	**100%**	**17,942**	**50%**	**1.5%**

5.3 Determining Passive Water Savings by End Use

Annual water savings rely on reductions in fixture average flow rates occurring as a result of passive replacement. Weighted average flow rate estimates are derived for each forecast year (2010-2035) using Equation 5-4 previously provided in Section 5.1.4. Annual savings are estimated by subtracting the weighted average fixture use in each forecast year from the weighted average use for all fixtures in the forecast base year (2010). Assumptions regarding frequency of fixture events (Table 5-19) and regional persons per household (Table 5-20 and Table 5-21) are then multiplied by the average flow rate reduction in each year to generate annual estimates of total fixture savings. Sections 5.1.3.1 through 5.1.3.4 discuss the estimated reductions in weighted average fixture water use and passive savings by end use.

Table 5-19
Residential Frequency of Use Assumptions

End Use	Event	SF Event Frequencies	MF Event Frequencies
Toilet	flushes/person/day	5.05	5.05
Shower	minutes/person/day	6.10	6.10
Faucet	minutes/person/day	8.10	8.10
Clothes Washer[10,11,12]	events/person/day	0.37	0.38
Dishwasher[13]	events/person/day	0.23	0.31

Table 5-20
Single-Family Persons per Household

WDPA	Variable	Class	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	PPH	SF	2.60	2.72	2.76	2.80	2.84	2.86	0.27	10.3%	0.4%
NPR	PPH	SF	2.40	2.49	2.51	2.54	2.56	2.57	0.17	7.1%	0.3%
NWH	PPH	SF	2.80	2.76	2.73	2.69	2.65	2.62	(0.17)	-6.2%	-0.3%
SCH	PPH	SF	2.79	2.73	2.69	2.64	2.60	2.57	(0.21)	-7.7%	-0.3%
COT	PPH	SF	2.70	2.73	2.73	2.71	2.69	2.65	(0.05)	-1.8%	-0.1%
PIN	PPH	SF	2.46	2.39	2.36	2.34	2.32	2.31	(0.14)	-5.8%	-0.2%
STP	PPH	SF	2.47	2.40	2.37	2.35	2.33	2.32	(0.15)	-6.2%	-0.3%
TBW	**PPH**	**SF**	**2.62**	**2.62**	**2.62**	**2.61**	**2.60**	**2.59**	**(0.03)**	**-1.2%**	**-0.1%**

Table 5-21
Multifamily Persons per Household

WDPA	Variable	Class	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	PPH	MF	2.07	2.17	2.20	2.23	2.26	2.28	0.21	10.3%	0.4%
NPR	PPH	MF	1.60	1.66	1.67	1.69	1.71	1.71	0.11	7.1%	0.3%
NWH	PPH	MF	1.93	1.91	1.88	1.85	1.83	1.81	(0.12)	-6.2%	-0.3%
SCH	PPH	MF	2.37	2.32	2.28	2.24	2.21	2.19	(0.18)	-7.7%	-0.3%
COT	PPH	MF	2.05	2.07	2.08	2.06	2.04	2.02	(0.04)	-1.8%	-0.1%
PIN	PPH	MF	1.72	1.68	1.66	1.64	1.63	1.62	(0.10)	-5.8%	-0.2%
STP	PPH	MF	1.69	1.64	1.62	1.61	1.59	1.58	(0.11)	-6.2%	-0.3%
TBW	**PPH**	**MF**	**1.90**	**1.88**	**1.87**	**1.86**	**1.85**	**1.84**	**(0.06)**	**-3.2%**	**-0.1%**

5.3.1 Residential Toilets Passive Savings

Table 5-22 to Table 5-25 provide WDPA weighted average water use and passive savings estimates for single-family and multifamily toilets in 5-year increments through the 2035 forecast horizon.

[10] *Mayer et al, (1999). Residential End Uses of Water Study, AWWARF. Single-family units assumed to wash .96 loads per day.*
[11] *Multifamily units assumed to wash.73 loads per day.*
[12] *All homes assumed to wash 2.7 cubic feet per load. Market Impact Analysis of Potential Changes to the ENERGY STAR® Criteria for Clothes Washers, 2004.*
[13] *Equates to 215 loads per household per year.*

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- Single-family and multifamily toilet ***efficiency*** is projected to increase by approximately 25 percent or an average annual rate of 1 percent through 2035.
- Weighted average toilet ***water use*** per flush is estimated to decrease from 2.34 to 1.76 gpf in the single-family class and 2.50 to 1.84 gpf in the multifamily class.

Increased toilet efficiency is estimated to reduce total regional water demand by 7 MGD by 2035, with 4.8 MGD and 2.2 MGD of estimated savings in the single-family and multi-family classes, respectively.

5.3.2 Residential Clothes Washers Passive Savings

Table 5-26 to Table 5-29 provide WDPA weighted average water factors and passive savings estimates for single-family and multifamily clothes washers in 5-year increments through the 2035 forecast horizon.

- Single-family and multifamily clothes washer ***efficiency*** is projected to increase by about 40 percent or an average annual rate of 2 percent through 2035.
- Weighted average clothes washer ***water factors*** are estimated to decrease from about 12.5 to 7.5 in both the single-family and multifamily classes by 2035.

Increased clothes washer efficiency is estimated to reduce total regional water demand by more than 10 MGD by 2035, with estimated 8.2 and 2.4 MGD reductions in single-family and multifamily class demands, respectively.

5.3.3 Residential Dishwashers Passive Savings

Table 5-30 to Table 5-33 provide WDPA weighted average water use and passive savings estimates for single-family and multifamily dishwashers in 5-year increments through the 2035 forecast horizon.

- Single-family and multifamily dishwasher ***efficiency*** is projected to increase by approximately 25 percent or an average annual rate of 1 percent through 2035.
- Weighted average dishwasher ***water use*** is estimated to decrease from 8.7 gpl to about 6.5 gpl in both the single-family and multifamily classes by 2035.
- Increased dishwasher efficiency is estimated reduce total regional demands by 0.7 MGD by 2035, with an estimated savings of 0.5 MGD and 0.2 MGD in single-family and multifamily classes, respectively.

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Table 5-22
Single-Family Toilets Weighted Average Water Use by WDPA

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	SF	gpf	2.16	2.00	1.88	1.80	1.74	1.68	(0.47)	-21.9%	-1.0%
NPR	SF	gpf	2.92	2.71	2.50	2.34	2.20	2.07	(0.85)	-29.0%	-1.4%
NWH	SF	gpf	2.17	2.03	1.92	1.83	1.76	1.70	(0.47)	-21.6%	-1.0%
SCH	SF	gpf	2.05	1.92	1.82	1.75	1.69	1.65	(0.40)	-19.5%	-0.9%
COT	SF	gpf	2.56	2.31	2.12	1.98	1.87	1.78	(0.78)	-30.5%	-1.4%
PIN	SF	gpf	2.34	2.19	2.07	1.99	1.92	1.85	(0.48)	-20.6%	-0.9%
STP	SF	gpf	2.80	2.57	2.39	2.25	2.13	2.03	(0.77)	-27.6%	-1.3%
TBW	**SF**	**gpf**	**2.34**	**2.16**	**2.02**	**1.91**	**1.83**	**1.76**	**(0.58)**	**-24.9%**	**-1.1%**

Table 5-23
Single-Family Toilets Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	SF	Toilet	0.04	14.4%	0.19	14.8%	0.37	15.6%	0.52	15.7%	0.65	15.9%	0.77	16.0%
NPR	SF	Toilet	0.00	1.4%	0.02	1.6%	0.04	1.7%	0.06	1.7%	0.07	1.6%	0.08	1.6%
NWH	SF	Toilet	0.02	6.4%	0.09	7.2%	0.18	7.4%	0.26	7.7%	0.33	8.1%	0.40	8.4%
SCH	SF	Toilet	0.03	12.4%	0.17	13.4%	0.33	13.7%	0.47	14.2%	0.60	14.6%	0.71	14.8%
COT	SF	Toilet	0.07	27.4%	0.38	30.1%	0.74	30.7%	1.05	31.6%	1.32	32.3%	1.58	32.9%
PIN	SF	Toilet	0.04	16.2%	0.18	14.0%	0.32	13.2%	0.41	12.4%	0.48	11.7%	0.53	11.1%
STP	SF	Toilet	0.05	21.8%	0.24	18.8%	0.43	17.7%	0.55	16.6%	0.65	15.8%	0.73	15.1%
TBW	**SF**	**Toilet**	**0.25**	**100%**	**1.26**	**100%**	**2.40**	**100%**	**3.32**	**100%**	**4.09**	**100%**	**4.80**	**100%**

Table 5-24
Multifamily Toilets Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	MF	gpf	2.51	2.28	2.08	1.93	1.83	1.75	(0.76)	-30.3%	-1.4%
NPR	MF	gpf	2.84	2.67	2.46	2.28	2.14	2.03	(0.82)	-28.7%	-1.3%
NWH	MF	gpf	2.13	2.03	1.93	1.85	1.79	1.74	(0.39)	-18.5%	-0.8%
SCH	MF	gpf	2.07	1.95	1.86	1.79	1.73	1.69	(0.37)	-18.1%	-0.8%
COT	MF	gpf	2.41	2.24	2.08	1.97	1.87	1.80	(0.61)	-25.1%	-1.2%
PIN	MF	gpf	2.64	2.43	2.26	2.12	2.01	1.93	(0.72)	-27.1%	-1.3%
STP	MF	gpf	2.75	2.53	2.34	2.19	2.07	1.97	(0.78)	-28.3%	-1.3%
TBW	**MF**	**gpf**	**2.50**	**2.31**	**2.14**	**2.02**	**1.92**	**1.84**	**(0.65)**	**-26.2%**	**-1.2%**

Table 5-25
Multifamily Toilets Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	MF	Toilet	0.01	7.7%	0.05	8.5%	0.10	9.3%	0.15	9.8%	0.20	10.1%	0.23	10.4%
NPR	MF	Toilet	0.00	0.9%	0.01	1.2%	0.02	1.4%	0.02	1.4%	0.03	1.5%	0.03	1.5%
NWH	MF	Toilet	0.00	3.8%	0.02	4.0%	0.05	4.2%	0.07	4.3%	0.09	4.4%	0.10	4.5%
SCH	MF	Toilet	0.01	5.6%	0.03	5.7%	0.07	5.8%	0.09	5.8%	0.11	5.9%	0.13	5.8%
COT	MF	Toilet	0.03	26.1%	0.16	26.9%	0.31	27.5%	0.44	27.9%	0.55	28.2%	0.62	28.5%
PIN	MF	Toilet	0.04	30.9%	0.17	29.7%	0.32	28.6%	0.44	28.0%	0.53	27.4%	0.59	27.0%
STP	MF	Toilet	0.03	25.1%	0.14	24.1%	0.26	23.3%	0.36	22.8%	0.44	22.5%	0.49	22.2%
TBW	**MF**	**Toilet**	**0.13**	**100%**	**0.58**	**100%**	**1.13**	**100%**	**1.57**	**100%**	**1.94**	**100%**	**2.19**	**100%**

Table 5-26
Single-Family Clothes Washers Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	SF	WF	12.09	10.57	9.03	8.14	7.61	7.25	(4.84)	-40.0%	-2.0%
NPR	SF	WF	12.71	11.32	9.81	8.87	8.26	7.83	(4.88)	-38.4%	-1.9%
NWH	SF	WF	12.41	10.86	9.33	8.35	7.74	7.33	(5.08)	-41.0%	-2.1%
SCH	SF	WF	12.16	10.55	9.02	8.09	7.54	7.18	(4.98)	-41.0%	-2.1%
COT	SF	WF	12.56	10.87	9.26	8.27	7.66	7.26	(5.30)	-42.2%	-2.2%
PIN	SF	WF	12.69	11.18	9.76	8.89	8.35	7.99	(4.69)	-37.0%	-1.8%
STP	SF	WF	12.73	11.23	9.80	8.92	8.36	7.99	(4.75)	-37.3%	-1.8%
TBW	**SF**	**WF**	**12.45**	**10.87**	**9.34**	**8.40**	**7.82**	**7.43**	**(5.02)**	**-40.3%**	**-2.0%**

Table 5-27
Single-Family Clothes Washers Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	Class	Fixture	MGD	%	MGD	%	MGD	%	MGD	%	MGD	%	MGD	%
PAS	SF	Clothes Washer	0.05	15.7%	0.36	16.9%	0.80	18.0%	1.11	18.3%	1.34	18.5%	1.53	18.8%
NPR	SF	Clothes Washer	0.00	1.3%	0.03	1.2%	0.05	1.2%	0.07	1.2%	0.08	1.1%	0.09	1.1%
NWH	SF	Clothes Washer	0.03	8.8%	0.20	9.3%	0.42	9.5%	0.60	9.8%	0.73	10.1%	0.85	10.4%
SCH	SF	Clothes Washer	0.05	17.0%	0.40	18.9%	0.87	19.6%	1.23	20.3%	1.50	20.8%	1.72	21.1%
COT	SF	Clothes Washer	0.07	22.3%	0.49	23.4%	1.06	23.7%	1.49	24.4%	1.81	25.0%	2.08	25.6%
PIN	SF	Clothes Washer	0.06	18.8%	0.35	16.4%	0.68	15.1%	0.86	14.1%	0.96	13.2%	1.01	12.4%
STP	SF	Clothes Washer	0.05	16.1%	0.29	13.9%	0.57	12.9%	0.73	12.0%	0.81	11.3%	0.87	10.6%
TBW	**SF**	**Clothes Washer**	**0.31**	**100%**	**2.11**	**100%**	**4.46**	**100%**	**6.09**	**100%**	**7.22**	**100%**	**8.15**	**100%**

Table 5-28
Multifamily Clothes Washers Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	MF	WF	12.46	10.84	9.15	8.13	7.53	7.18	(5.28)	-42.4%	-2.2%
NPR	MF	WF	12.74	11.41	9.84	8.78	8.11	7.70	(5.04)	-39.6%	-2.0%
NWH	MF	WF	12.52	11.08	9.52	8.51	7.85	7.46	(5.07)	-40.5%	-2.1%
SCH	MF	WF	12.14	10.73	9.29	8.41	7.86	7.56	(4.58)	-37.8%	-1.9%
COT	MF	WF	12.55	11.04	9.49	8.51	7.89	7.53	(5.02)	-40.0%	-2.0%
PIN	MF	WF	12.64	11.15	9.70	8.77	8.18	7.84	(4.80)	-38.0%	-1.9%
STP	MF	WF	12.79	11.26	9.75	8.77	8.14	7.78	(5.02)	-39.2%	-2.0%
TBW	**MF**	**WF**	**12.57**	**11.07**	**9.55**	**8.58**	**7.97**	**7.62**	**(4.95)**	**-39.4%**	**-2.0%**

Table 5-29
Multifamily Clothes Washers Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	Class	Fixture	MGD	%	MGD	%	MGD	%	MGD	%	MGD	%	MGD	%
PAS	MF	Clothes Washer	0.01	7.5%	0.05	8.3%	0.12	9.1%	0.18	9.6%	0.22	10.0%	0.25	10.5%
NPR	MF	Clothes Washer	0.00	1.1%	0.01	1.1%	0.02	1.2%	0.02	1.2%	0.03	1.2%	0.03	1.2%
NWH	MF	Clothes Washer	0.01	6.5%	0.04	6.7%	0.09	6.9%	0.13	7.0%	0.15	7.1%	0.17	7.3%
SCH	MF	Clothes Washer	0.01	8.2%	0.06	8.7%	0.12	9.0%	0.17	9.1%	0.20	9.2%	0.22	9.3%
COT	MF	Clothes Washer	0.03	25.6%	0.17	26.1%	0.36	26.6%	0.50	26.9%	0.59	27.2%	0.65	27.5%
PIN	MF	Clothes Washer	0.03	31.1%	0.19	29.9%	0.39	28.8%	0.52	28.2%	0.60	27.6%	0.64	27.0%
STP	MF	Clothes Washer	0.02	20.1%	0.12	19.2%	0.25	18.4%	0.33	17.9%	0.38	17.6%	0.41	17.3%
TBW	**MF**	**Clothes Washer**	**0.10**	**100%**	**0.64**	**100%**	**1.35**	**100%**	**1.84**	**100%**	**2.18**	**100%**	**2.36**	**100%**

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Table 5-30
Single-Family Dishwashers Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	SF	gpl	8.71	7.78	7.16	6.78	6.56	6.42	(2.30)	-26.4%	-1.2%
NPR	SF	gpl	8.71	8.06	7.48	7.09	6.82	6.63	(2.09)	-23.9%	-1.1%
NWH	SF	gpl	8.71	7.86	7.25	6.84	6.59	6.42	(2.29)	-26.3%	-1.2%
SCH	SF	gpl	8.71	7.75	7.14	6.76	6.54	6.40	(2.31)	-26.6%	-1.2%
COT	SF	gpl	8.71	7.81	7.20	6.80	6.57	6.41	(2.30)	-26.4%	-1.2%
PIN	SF	gpl	8.71	7.95	7.41	7.05	6.81	6.64	(2.07)	-23.8%	-1.1%
STP	SF	gpl	8.71	7.97	7.43	7.07	6.83	6.65	(2.06)	-23.6%	-1.1%
TBW	**SF**	**gpl**	**8.71**	**7.85**	**7.25**	**6.86**	**6.62**	**6.46**	**(2.25)**	**-25.8%**	**-1.2%**

Table 5-31
Single-Family Dishwashers Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	SF	Dishwasher	0.01	18.6%	0.04	19.0%	0.07	19.9%	0.10	20.1%	0.12	20.3%	0.13	20.5%
NPR	SF	Dishwasher	0.00	1.0%	0.00	1.0%	0.00	1.0%	0.00	1.0%	0.01	0.9%	0.01	0.9%
NWH	SF	Dishwasher	0.00	8.6%	0.02	9.3%	0.03	9.5%	0.05	9.9%	0.06	10.2%	0.07	10.6%
SCH	SF	Dishwasher	0.01	19.7%	0.04	20.9%	0.08	21.3%	0.11	22.0%	0.13	22.6%	0.15	22.9%
COT	SF	Dishwasher	0.01	21.4%	0.04	22.9%	0.08	23.3%	0.12	24.1%	0.14	24.8%	0.17	25.4%
PIN	SF	Dishwasher	0.01	16.8%	0.03	14.7%	0.05	13.7%	0.06	12.6%	0.07	11.6%	0.07	10.8%
STP	SF	Dishwasher	0.01	14.0%	0.02	12.2%	0.04	11.3%	0.05	10.4%	0.06	9.6%	0.06	9.0%
TBW	**SF**	**Dishwasher**	**0.04**	**100%**	**0.19**	**100%**	**0.36**	**100%**	**0.49**	**100%**	**0.58**	**100%**	**0.66**	**100%**

Table 5-32
Multifamily Dishwashers Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	MF	gpl	8.71	7.82	7.23	6.88	6.70	6.60	(2.11)	-24.2%	-1.1%
NPR	MF	gpl	8.71	8.13	7.50	7.04	6.74	6.55	(2.17)	-24.9%	-1.1%
NWH	MF	gpl	8.71	7.97	7.38	6.98	6.73	6.58	(2.13)	-24.5%	-1.1%
SCH	MF	gpl	8.71	7.85	7.28	6.93	6.73	6.61	(2.10)	-24.1%	-1.1%
COT	MF	gpl	8.71	7.92	7.33	6.96	6.73	6.60	(2.12)	-24.3%	-1.1%
PIN	MF	gpl	8.71	7.94	7.39	7.00	6.76	6.60	(2.11)	-24.2%	-1.1%
STP	MF	gpl	8.71	7.97	7.41	7.02	6.76	6.60	(2.12)	-24.3%	-1.1%
TBW	MF	gpl	**8.71**	**7.92**	**7.35**	**6.97**	**6.74**	**6.60**	**(2.11)**	**-24.3%**	**-1.1%**

Table 5-33
Multifamily Dishwashers Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	MF	Dishwasher	0.00	7.4%	0.01	8.2%	0.01	9.1%	0.02	9.7%	0.02	10.2%	0.03	10.7%
NPR	MF	Dishwasher	0.00	0.7%	0.00	0.9%	0.00	1.0%	0.00	1.0%	0.00	1.0%	0.00	1.0%
NWH	MF	Dishwasher	0.00	6.5%	0.01	6.7%	0.01	6.9%	0.01	7.0%	0.02	7.2%	0.02	7.4%
SCH	MF	Dishwasher	0.00	10.4%	0.01	10.6%	0.02	10.8%	0.02	10.9%	0.03	10.9%	0.03	11.0%
COT	MF	Dishwasher	0.00	28.8%	0.02	29.4%	0.04	30.1%	0.06	30.5%	0.07	30.9%	0.08	31.4%
PIN	MF	Dishwasher	0.00	26.5%	0.02	25.4%	0.03	24.3%	0.05	23.5%	0.05	22.9%	0.06	22.2%
STP	MF	Dishwasher	0.00	19.6%	0.01	18.7%	0.03	17.9%	0.03	17.3%	0.04	16.9%	0.04	16.5%
TBW	**MF**	**Dishwasher**	**0.02**	**100%**	**0.08**	**100%**	**0.14**	**100%**	**0.19**	**100%**	**0.23**	**100%**	**0.25**	**100%**

5.3.4 Nonresidential Toilets and Urinals Passive Savings

Nonresidential passive savings estimates rely on the employee and visitor occupancy assumptions provided in Table 5-34 for each key class. The employee estimates reflect the data previously provided in Table 5-13. Due to a lack of sufficient data for estimating visitation, most key sectors assume 1 visitor per employee per day. Visitation for hotel and restaurants is based on DBPR estimates of rooms and seats, while visitation in the education sector reflects student estimates derived from DOE demographic data.[14] A large share of DBPR restaurant seating estimates are located on generic retail properties and therefore visitation estimates for this customer class reflect both the 1 visitor per employee (non-restaurant) per day and 1 visitor/seat/day assumptions.

Table 5-34
Valve-Type ULFT / Tank-Type HET / 1/2 Gallon HEU Employee / Visitor Assumptions

	Occupancy				Employee Intensity[15]			Visitor Intensity[16]		
Key Sector	2010 Employees	Visitation	Employee Days	Visitation Days	Female Toilet Flushes	Male Toilet Flushes	Male Urinal Flushes	Total Flushes	Toilet Flushes	Urinal Flushes
Hotels	47,267	20,286	250	365	2.5	1.0	1.5	5.0	4.83	0.17
Churches	24,289	24,289	250	0	2.5	1.0	1.5	0.5	0.33	0.17
Health	72,445	72,445	250	250	2.5	1.0	1.5	0.5	0.33	0.17
Office	193,547	193,547	250	250	2.5	1.0	1.5	0.5	0.33	0.17
Government	119,546	119,546	250	250	2.5	1.0	1.5	0.5	0.33	0.17
Education	98,738	783,819	180	180	1.875	0.75	1.125	1.17	0.86	0.31
Industrial	236,189	0	250	0	2.5	1.0	1.5	0.5	0.33	0.17
Retail	155,351	328,506	250	250	2.5	1.0	1.5	0.2	0.13	0.07
Restaurant	30,848	131,300	250	365	2.5	1.0	1.5	0.2	0.13	0.07
Other	226,757	226,757	250	250	2.5	1.0	1.5	0.2	0.13	0.07

Table 5-35 to Table 5-38 provide WDPA weighted average water use and passive savings estimates for nonresidential toilets and urinals in 5-year increments through 2035.

Key table findings include:

- Nonresidential toilet efficiency is projected to increase by approximately 33 percent or an average annual rate of 1.6 percent through 2035. Weighted average toilet water use per flush is estimated to decrease from 2.67 to 1.80 gpf by 2035.
- Nonresidential urinal efficiency is projected to increase by approximately 40 percent or an average annual rate of 2 percent through 2035. Weighted average urinal water use per flush is estimated to decrease from 1.8 to 1.1 gpf by 2035.

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14 Assumes 50% average daily occupancy with 1 visitor/room in hotels and 1 visitor/seat/day in restaurants.
15 Assumes 6 hrs day in education and 8 hrs day in other sectors; base assumption of 5.1 flushes/person/day (REUWS) during a 16 hr period. 60% of male flushes are assumed to be associated with urinals.
16 Pacific Institute, (2003), Waste Not Want Not: The Potential for Urban Water Conservation, Appendix D. Visitor intensity for Retail, Restaurant and Other is reduced to reflect 40 percent fixture use.

Table 5-35
Nonresidential Toilets Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	NR	gpf	2.44	2.14	1.96	1.84	1.74	1.66	(0.78)	-32.1%	-1.5%
NPR	NR	gpf	2.98	2.70	2.51	2.35	2.20	2.08	(0.90)	-30.3%	-1.4%
NWH	NR	gpf	2.33	2.10	1.96	1.86	1.78	1.72	(0.62)	-26.5%	-1.2%
SCH	NR	gpf	2.52	2.21	2.04	1.92	1.83	1.76	(0.76)	-30.3%	-1.4%
COT	NR	gpf	2.68	2.41	2.20	2.02	1.87	1.75	(0.93)	-34.7%	-1.7%
PIN	NR	gpf	2.64	2.41	2.26	2.13	2.02	1.92	(0.72)	-27.2%	-1.3%
STP	NR	gpf	2.88	2.60	2.41	2.25	2.11	1.99	(0.89)	-30.8%	-1.5%
TBW	**NR**	**gpf**	**2.67**	**2.39**	**2.20**	**2.04**	**1.91**	**1.80**	**(0.87)**	**-32.7%**	**-1.6%**

Table 5-36
Nonresidential Toilet Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	NR	Toilet	0.02	9.9%	0.11	8.8%	0.20	9.0%	0.29	9.1%	0.38	9.1%	0.47	9.0%
NPR	NR	Toilet	0.00	1.0%	0.01	1.0%	0.02	0.9%	0.03	0.9%	0.03	0.8%	0.04	0.7%
NWH	NR	Toilet	0.01	5.1%	0.06	4.7%	0.11	4.6%	0.14	4.5%	0.18	4.3%	0.21	4.1%
SCH	NR	Toilet	0.02	12.3%	0.13	10.5%	0.23	10.0%	0.30	9.2%	0.34	8.2%	0.37	7.1%
COT	NR	Toilet	0.08	42.5%	0.57	44.7%	1.06	46.9%	1.59	49.6%	2.18	52.5%	2.87	55.6%
PIN	NR	Toilet	0.03	16.4%	0.22	17.2%	0.36	16.1%	0.49	15.2%	0.59	14.3%	0.69	13.4%
STP	NR	Toilet	0.03	12.7%	0.17	13.1%	0.28	12.3%	0.37	11.6%	0.45	10.8%	0.52	10.1%
TBW	**NR**	**Toilet**	**0.20**	**100%**	**1.27**	**100%**	**2.26**	**100%**	**3.20**	**100%**	**4.16**	**100%**	**5.17**	**100%**

Table 5-37
Nonresidential Urinals Weighted Average Water Use

WDPA	Class	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
PAS	NR	gpf	1.71	1.45	1.29	1.17	1.07	0.99	(0.72)	-42.2%	-2.2%
NPR	NR	gpf	2.04	1.82	1.68	1.55	1.43	1.33	(0.71)	-34.8%	-1.7%
NWH	NR	gpf	1.60	1.40	1.28	1.19	1.12	1.06	(0.54)	-33.9%	-1.6%
SCH	NR	gpf	1.71	1.46	1.32	1.22	1.14	1.08	(0.63)	-36.7%	-1.8%
COT	NR	gpf	1.85	1.63	1.46	1.31	1.17	1.06	(0.79)	-42.7%	-2.2%
PIN	NR	gpf	1.83	1.65	1.52	1.41	1.32	1.23	(0.60)	-32.8%	-1.6%
STP	NR	gpf	1.92	1.71	1.57	1.45	1.35	1.25	(0.67)	-34.8%	-1.7%
TBW	**NR**	**gpf**	**1.83**	**1.61**	**1.45**	**1.32**	**1.20**	**1.10**	**(0.73)**	**-40.1%**	**-2.0%**

Table 5-38
Nonresidential Urinal Passive Savings by WDPA

			2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**Fixture**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	NR	Urinal	0.01	9.7%	0.04	8.7%	0.07	9.1%	0.10	9.3%	0.14	9.5%	0.18	9.6%
NPR	NR	Urinal	0.00	1.0%	0.00	1.0%	0.01	0.9%	0.01	0.9%	0.01	0.8%	0.01	0.7%
NWH	NR	Urinal	0.00	6.5%	0.03	5.9%	0.05	5.9%	0.06	5.7%	0.08	5.4%	0.10	5.1%
SCH	NR	Urinal	0.01	13.5%	0.05	11.8%	0.09	11.4%	0.12	10.7%	0.15	9.7%	0.16	8.6%
COT	NR	Urinal	0.03	41.6%	0.19	43.6%	0.35	45.7%	0.54	48.4%	0.77	51.4%	1.04	54.5%
PIN	NR	Urinal	0.01	15.7%	0.07	16.5%	0.12	15.4%	0.16	14.3%	0.20	13.3%	0.24	12.3%
STP	NR	Urinal	0.01	11.9%	0.05	12.4%	0.09	11.6%	0.12	10.8%	0.15	10.0%	0.18	9.2%
TBW	**NR**	**Urinal**	**0.07**	**100%**	**0.43**	**100%**	**0.77**	**100%**	**1.12**	**100%**	**1.50**	**100%**	**1.91**	**100%**

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Overall, increased nonresidential fixture efficiency is estimated to reduce regional 2035 demand by 5.6 MGD, with 3.2 MGD and 1.5 MGD in toilet and urinal water savings.

5.3.5 Total Regional Passive End Use Reductions

Table 5-39 and Table 5-40 summarize the projected reductions in weighted average water use rates and the resulting passive savings in five-year increments for each end use and customer class analyzed (annual WDPA estimates provided in Appendix N). By 2035, the estimated weighted average flow rates will be nearing the existing federal standards, however, they are still predicted to be well above current high-efficiency specifications. These results imply substantial opportunities with respect to active efficiency could still exist throughout the forecast horizon.

Single-family clothes washers are expected to result in the highest water savings among the end uses evaluated at 8.15 MGD (32% of passive savings), followed by nonresidential toilets at 5.2 MGD (20% of passive savings), and single-family toilets at 4.8 MGD (19% of passive savings). Collectively, total regional water demands are estimated to be reduced by 25.5 MGD from the baseline forecast through passive measures.

Table 5-39
Regional Weighted Average Fixture Water Use by Customer Class and End Use

Class	Fixture	Unit	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average Percent Change
SF	Toilets	gpf	2.34	2.16	2.02	1.91	1.83	1.76	(0.58)	-24.9%	-1.1%
MF	Toilets	gpf	2.50	2.31	2.14	2.02	1.92	1.84	(0.65)	-26.2%	-1.2%
NR	Toilets	gpf	2.67	2.39	2.20	2.04	1.91	1.80	(0.87)	-32.7%	-1.6%
NR	Urinals	gpf	1.83	1.61	1.45	1.32	1.20	1.10	(0.73)	-40.1%	-2.0%
SF	Clothes Washers	WF	12.45	10.87	9.34	8.40	7.82	7.43	(5.02)	-40.3%	-2.0%
MF	Clothes Washers	WF	12.57	11.07	9.55	8.58	7.97	7.62	(4.95)	-39.4%	-2.0%
SF	Dishwashers	gpl	8.71	7.85	7.25	6.86	6.62	6.46	(2.25)	-25.8%	-1.2%
MF	Dishwashers	gpl	8.71	7.92	7.35	6.97	6.74	6.60	(2.11)	-24.3%	-1.1%

Table 5-40
Regional Total Passive Fixture Savings by Customer Class and End Use

Class	Fixture	2011		2015		2020		2025		2030		2035	
		MGD	%	MGD	%	MGD	%	MGD	%	MGD	%	MGD	%
SF	Toilet	0.25	22.5%	1.26	19.1%	2.40	18.6%	3.32	18.6%	4.09	18.7%	4.80	18.8%
MF	Toilet	0.04	3.8%	0.20	3.0%	0.36	2.8%	0.49	2.8%	0.58	2.7%	0.66	2.6%
NR	Toilet	0.31	28.1%	2.11	32.1%	4.46	34.6%	6.09	34.2%	7.22	33.0%	8.15	32.0%
SF	Clothes Washer	0.13	11.3%	0.58	8.9%	1.13	8.8%	1.57	8.8%	1.94	8.9%	2.19	8.6%
MF	Clothes Washer	0.02	1.5%	0.08	1.1%	0.14	1.1%	0.19	1.1%	0.23	1.1%	0.25	1.0%
SF	Dishwasher	0.10	9.2%	0.64	9.8%	1.35	10.5%	1.84	10.3%	2.18	9.9%	2.36	9.3%
MF	Dishwasher	0.20	17.7%	1.27	19.4%	2.26	17.6%	3.20	18.0%	4.16	19.0%	5.17	20.3%
NR	Urinal	0.07	5.9%	0.43	6.5%	0.77	6.0%	1.12	6.3%	1.50	6.8%	1.91	7.5%
		1.12	**100%**	**6.56**	**100%**	**12.89**	**100%**	**17.83**	**100%**	**21.89**	**100%**	**25.49**	**100%**

5.3.6 Rationale for Products not Included in Passive Savings Forecast

Existing technology standards support the estimation of water use through the forecast horizon. Savings rates were not estimated for HE products in cases where end-use research indicates the average home uses currently less than the HE criteria or where technology increases have penetrated the market (e.g., showerheads and bathroom faucets). For example, the 1999 AWWA Residential End Uses Study and a 2007 EPA Water Efficiency Benchmarking Study indicated that on average existing showerhead water use was at or below 2.0 gallons per minute (gpm), the existing maximum flow rate for EPA WaterSense criteria. Additionally, where commercial end uses of water (e.g., dishwashers, clothes washers, ice-machines) were not readily identified or able to be determined, passive savings were not incorporated into the passive forecast scenario.

5.4 Reductions in Baseline Demand Due to Passive Replacement

Table 5-41 compares Tampa Bay Water's 2010-2035 baseline water demand projections in five-year increments to the demand projections produced when passive is considered, while WDPA projections are provided in Appendix N (Table N-9). Water savings associated with passive demand reductions are presented in both absolute and relative terms. Figure 5.2 illustrates the reduction in water demands due to passive replacement of fixtures relative to the baseline water demand forecast over the planning horizon.

Table 5-41
Comparison of Baseline and Passive Demand Projections (MGD)

Forecast Scenario (75th percentile)	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Average Annual Percent Change
Baseline Demand Forecast	222	249	263	278	290	302	79	35.7%	1.2%
Passive Demand Forecast	222	243	250	260	268	276	54	24.2%	0.9%
Passive Savings	0	6	13	18	22	26	26		
Percent Passive Savings	0	-3%	-5%	-6%	-8%	-8%			

As shown in Table 5-41, total 75th percentile baseline demands, taken as planning level demand forecasts for supply reliability planning, are projected to increase at an annualized average rate of 1.24 percent per year to about 302 MGD in 2035. This represents a 36 percent (79 MGD) increase in total 75th percentile baseline demands from the 2010 base year. However, given the expected impact of passive measures (i.e., existing and new plumbing codes), this projected increase is reduced to 25 percent (or 54 MGD), to 276 MGD. As shown in Table 5-41, this 26 MGD reduction corresponds to an 8.45 percent reduction in 75th percentile baseline production demands for 2035. Changes in water use resulting from passive fixture replacement are thus estimated to reduce long-term projected demand by 8% by the end of the forecast horizon (2035).

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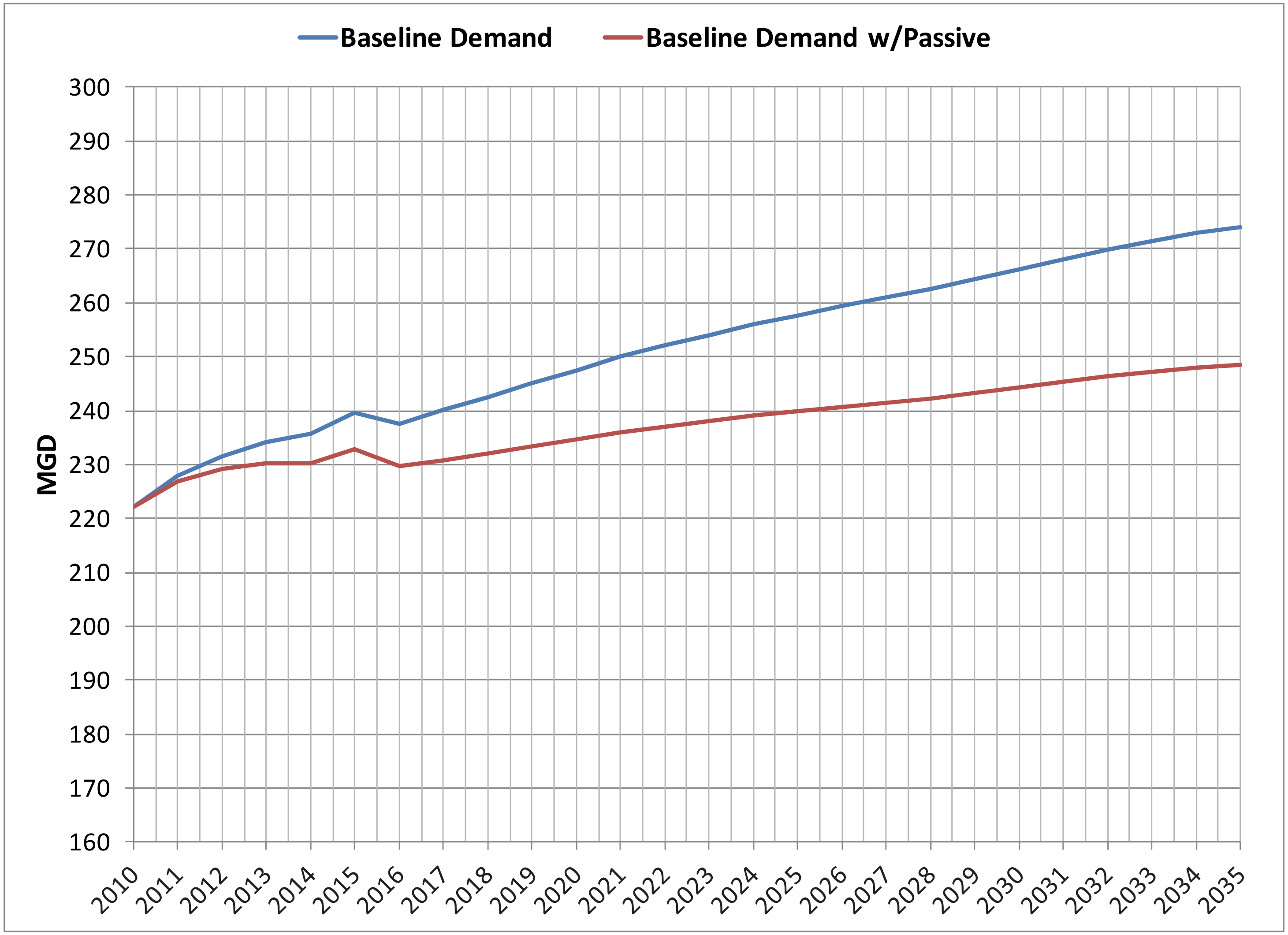

Figure 5.2: Demand Forecast with Passive Efficiency

Table 5-42 to Table 5-45 provide sectoral and regional estimates of baseline reductions due to passive savings associated with passive fixture and appliance replacement. Overall, the single-family residential customer class is projected to have the greatest reduction in water demand with 13.61 MGD saved by 2035, followed by nonresidential with 7.09 MGD of reduced water demand by 2035. Multifamily has the least amount of estimated passive water savings at 4.80 MGD by 2035.

Key table findings include:

- Passive replacement of single-family fixtures is projected to provide the greatest impact on water saved in Tampa with an estimated 3.83 MGD of water saved, followed by South Central Hillsborough (2.58 MGD) and Pasco (2.43 MGD).
- Tampa is also projected to have the greatest passive savings in the multifamily customer class at 1.35 MGD.
- Pinellas and St. Petersburg rank the second and the third with expected multifamily passive water savings of 1.28 MGD and 0.94 MGD, respectively.
- More than 50% of water saved through passive replacement of nonresidential fixtures is projected to be from the city of Tampa where 3.92 MGD of demand reductions occur, followed by Pinellas (0.93 MGD) and St. Petersburg (0.7 MGD).

Estimation of passive efficiency is a fundamental component of assessing water supply alternatives and the potential need, benefits, and timing of active water efficiency programs available to help meet future demands. The effects of passive efficiency should be expected to occur over time and effectively reduce long-term demands for water. The distributions of differing water use among different levels of mechanical efficiency that exist currently and that are expected to occur in the future, are key elements in adjusting the baseline forecast to reflect passive demand reductions likely to occur in the future. Additional savings potential associated with implementation of active water conservation efforts, such as programs sponsored by Tampa Bay Water member governments or other regional initiatives, is evaluated in Section 6.0.

Table 5-42
Single-Family Reductions in Baseline Use Due to Passive Savings

		2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	SF	0.09	15.3%	0.58	16.3%	1.25	17.3%	1.73	17.5%	2.10	17.7%	2.43	17.9%
NPR	SF	0.01	1.3%	0.05	1.3%	0.10	1.4%	0.13	1.3%	0.15	1.3%	0.17	1.3%
NWH	SF	0.05	7.8%	0.31	8.6%	0.64	8.8%	0.90	9.1%	1.12	9.4%	1.32	9.7%
SCH	SF	0.09	15.3%	0.61	17.1%	1.28	17.7%	1.81	18.3%	2.23	18.7%	2.58	19.0%
COT	SF	0.15	24.4%	0.92	25.8%	1.88	26.0%	2.65	26.8%	3.27	27.5%	3.83	28.2%
PIN	SF	0.11	17.6%	0.55	15.5%	1.04	14.4%	1.33	13.5%	1.50	12.6%	1.62	11.9%
STP	SF	0.11	18.3%	0.55	15.6%	1.04	14.4%	1.33	13.5%	1.52	12.8%	1.65	12.1%
TBW	**SF**	**0.61**	**100%**	**3.56**	**100%**	**7.23**	**100%**	**9.90**	**100%**	**11.89**	**100%**	**13.61**	**100%**

Table 5-43
Multifamily Reductions in Baseline Use Due to Passive Savings

		2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	MF	0.02	7.6%	0.11	8.4%	0.24	9.2%	0.35	9.7%	0.44	10.1%	0.50	10.5%
NPR	MF	0.00	1.0%	0.01	1.1%	0.03	1.3%	0.05	1.3%	0.06	1.3%	0.06	1.3%
NWH	MF	0.01	5.1%	0.07	5.5%	0.15	5.7%	0.21	5.8%	0.26	5.9%	0.29	6.0%
SCH	MF	0.02	7.0%	0.10	7.5%	0.20	7.7%	0.28	7.8%	0.34	7.8%	0.37	7.8%
COT	MF	0.06	26.0%	0.35	26.6%	0.71	27.2%	0.99	27.5%	1.21	27.9%	1.35	28.2%
PIN	MF	0.08	30.7%	0.38	29.6%	0.75	28.5%	1.00	27.8%	1.19	27.3%	1.28	26.7%
STP	MF	0.06	22.6%	0.28	21.3%	0.54	20.5%	0.72	20.0%	0.86	19.8%	0.94	19.5%
TBW	**MF**	**0.25**	**100%**	**1.30**	**100%**	**2.62**	**100%**	**3.61**	**100%**	**4.35**	**100%**	**4.80**	**100%**

Table 5-44
Nonresidential Reductions in Baseline Use Due to Passive Savings

		2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	NR	0.03	9.9%	0.15	8.8%	0.28	9.1%	0.40	9.2%	0.52	9.2%	0.65	9.1%
NPR	NR	0.00	1.0%	0.02	1.0%	0.03	0.9%	0.04	0.9%	0.04	0.8%	0.05	0.7%
NWH	NR	0.01	5.5%	0.09	5.0%	0.15	5.0%	0.21	4.8%	0.26	4.6%	0.31	4.4%
SCH	NR	0.03	12.6%	0.18	10.9%	0.32	10.4%	0.41	9.6%	0.49	8.6%	0.53	7.5%
COT	NR	0.11	42.3%	0.76	44.4%	1.42	46.6%	2.13	49.3%	2.95	52.2%	3.92	55.3%
PIN	NR	0.04	16.2%	0.29	17.0%	0.48	15.9%	0.65	15.0%	0.79	14.0%	0.93	13.1%
STP	NR	0.03	12.5%	0.22	12.9%	0.37	12.1%	0.49	11.4%	0.60	10.6%	0.70	9.9%
TBW	**NR**	**0.26**	**100%**	**1.70**	**100%**	**3.04**	**100%**	**4.32**	**100%**	**5.66**	**100%**	**7.09**	**100%**

Table 5-45
Regional Total Passive Savings Reductions in Baseline Use Due to Passive Savings

		2011		2015		2020		2025		2030		2035	
WDPA	**Class**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**	**MGD**	**%**
PAS	Total	0.14	12.3%	0.84	12.8%	1.77	13.7%	2.48	13.9%	3.06	14.0%	3.58	14.0%
NPR	Total	0.01	1.2%	0.08	1.2%	0.16	1.2%	0.21	1.2%	0.25	1.2%	0.29	1.1%
NWH	Total	0.07	6.7%	0.46	7.0%	0.94	7.3%	1.32	7.4%	1.63	7.5%	1.92	7.5%
SCH	Total	0.14	12.8%	0.89	13.5%	1.80	13.9%	2.51	14.1%	3.05	14.0%	3.49	13.7%
COT	Total	0.32	29.0%	2.02	30.8%	4.01	31.1%	5.78	32.4%	7.43	34.0%	9.10	35.7%
PIN	Total	0.23	20.1%	1.22	18.6%	2.27	17.6%	2.98	16.7%	3.48	15.9%	3.83	15.0%
STP	Total	0.20	17.9%	1.05	16.0%	1.95	15.1%	2.55	14.3%	2.98	13.6%	3.29	12.9%
TBW	**Total**	**1.12**	**100%**	**6.56**	**100%**	**12.89**	**100%**	**17.83**	**100%**	**21.89**	**100%**	**25.49**	**100%**

Section 6.0
Active Water Efficiency Alternatives Evaluation

As the cost of future Tampa Bay Water supply options increase, positive economic benefits may accrue regionally as a result of water saved from utility-sponsored water efficiency programs. Product technology information obtained from regional and national literature and other secondary sources, along with information gleaned from the analyses of detailed information in the preceding sections support development, screening, ranking and selection of active water efficiency measure for inclusion in the DMP. The passive savings and technology estimates previously discussed in Section 5.0 are used to help define the applicability of *active* (utility-sponsored) programs.

Potentially applicable water efficiency measures considered for program development include technologies and best practices that target:

- Indoor and outdoor water end uses
- Nonresidential establishments

The Alliance for Water Efficiency Water Conservation Tracking Tool (AWE Tool) was the primary instrument used to formulate and estimate cost-effectiveness of alternative demand management program measures and to conduct an "avoided supply cost" analysis. Estimates of the ***cost-effectiveness*** and ***net benefits*** quantify the viability of active water efficiency measures in terms of reducing operational costs of existing supply and deferring or eliminating the cost (capital and operating) to develop new water supply.

- Cost-effectiveness, the unit costs of water saved ($/1000 gallons), is defined by total water savings and total implementation costs over the useful life of a measure.
- Net benefits, the total benefit (avoided cost) minus the total cost of any active measure, is measured in terms of benefit-cost ratios. Benefit-cost ratios are calculated by dividing the net present benefits of a measure by the net present costs associated with a measure (in 2011 dollars).

Measures of cost-effectiveness and net benefits of fully formulated water efficiency programs are quantified in the AWE Tool and provide key criteria for screening, ranking and selection of water efficiency measures for program development. Remaining market potential (beyond what is likely to be accounted-for by passive activities) is used to define the applicability, timing and penetration rates for active (utility-sponsored) programs. The "avoided supply cost" analysis then considers increments of conserved water versus the operational and capital costs of future supply needs. Consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water

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supply alternatives. The following sections describe the methods used to fully formulate potentially viable water efficiency measures through estimation of market potential and savings rates, quantification of net benefits and cost-effectiveness, screening of measures, and selection of demand management alternatives.

6.1 Determination of Market Potential and Saving Rates for Alternative Programs

Of the potential measures identified in the WEPL, 24 are deemed viable for implementation in the Tampa Bay region. Table 6-1 identifies the 24 programs initially considered for program development and provides an indicator of whether the measure is included in the passive efficiency assessment discussed in Section 5.0.

Table 6-1
Estimated Annual Savings Rates for Selected Conservation Programs

Class	Passive Estimate	Activity Name
SF	Y	Residential HE Washers
	Y	Residential HE Toilets
	N	Landscape/Irrigation Modifications
	N	Irrigation Evaluations
	N	ET Irrigation Controller
	N	Alternative Irrigation Source
MF	Y	Residential HE Washer
	Y	Residential HE Toilets
NR	N	Under-Counter Dishwasher
	Y	Tank-Type HE Toilet
	Y	1/2 Gallon Urinal
	Y	Valve-Type Toilet (ULFT)
	Y	Valve-Type Toilet (HET)
	N	Door Dishwasher
	N	Pre-Rinse Spray Valve
	N	Commercial Clothes Washers
	N	Flight Dishwasher
	N	Conveyor Dishwasher
	N	Food Steamer
	N	Large Landscape Surveys
	N	Large Land. Irrigation Controller
	N	Large Landscape Water Budgets
	N	Cooling Tower
	N	Large Landscape/Irrigation Modifications

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Water efficiency measures subject to passive savings include the residential and nonresidential fixtures and appliances previously described in Section 5.1 (toilets, clothes washers, dishwashers and urinals). Since incentive based retrofit programs often retrofit multiple levels of technological efficiency, water savings for these programs reflect a weighted average rate of use over the forecast horizon based on the distribution of eligible remaining products after passive replacement.

Passive savings are not considered for outdoor efficiency programs and most nonresidential measures. Water savings for these measures are estimated using various methods dependent on the availability of data. Observed water use in conjunction with survey results is used to estimate water savings whenever possible and practical. However, several of the potentially applicable landscape programs are new to Tampa Bay Water member governments and thus pre- and post-implementation water use is unavailable to assist with estimation of savings rates. Since many of these new landscape programs are targeted at reducing inefficient water use, theoretical landscape water requirement estimates are used to reflect post-implementation water use where necessary. In cases where water use cannot be directly obtained from observed water use or theoretical requirements, literature-based assumptions, many based on Florida-based research, are employed to estimate program effects.

Of the potential 24 measures deemed viable for implementation, only 18 are judged to have information sufficient to estimate the presence of end uses and support a comprehensive assessment of efficiency potential and cost. Programs excluded from further assessment are specific to the nonresidential sector and include the four large landscape, commercial clothes washer and food steamer measures listed in Table 6-1.

The following sections describe the estimation of remaining market potential available after natural replacement for incentive based programs. Average annual water savings and program penetration rates over the forecast horizon are provided for each of the 18 programs assessed. These estimates provide key factors considered in screening, ranking and selection of active efficiency measures for inclusion in the DMP.

6.1.1 Residential HET Retrofits

Residential HET retrofit programs provide financial incentives to water customers to encourage conversion of 5.0 and 3.5 gpf toilets to High Efficiency Toilets (HETs). Table 6-2 and Table 6-3 provide the total number of single-family and multifamily rebate eligible toilets estimated throughout the forecast horizon in five year increments starting in 2015 (the initial year of the program), as well as the unit water savings and household assumptions used to derive annual savings estimates per rebate.

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Table 6-2
Single-Family Rebate Eligible Toilets and Unit Water Savings Estimates

Unit Flow Rate Assumptions		Unit Water Savings			Household Assumptions		Rebate Eligible Toilets				
Rebate Eligible Fixture Type	HE Retrofit (gpf)	Gallons / Flush	Gallons / Day	Gallons / Year	Flushes / Person /Day	PPH	2015	2020	2025	2030	2035
3.5 gpf	1.28	2.22	24	8,924	4.2	2.61	141,493	115,369	91,812	76,701	62,540
5.0 gpf	1.28	3.72	41	14,954	4.2	2.61	108,548	88,507	72,166	58,842	47,978
Weighted Average Savings / Eligible Fixtures		2.87	32	11,542	4.2	2.61	250,040	203,876	166,235	135,544	110,518
Total Single-family Toilets							1,124,399	1,209,682	1,269,466	1,318,375	1,374,076
Percent of Total Single-family Toilets Eligible for Rebate							22%	17%	13%	10%	8%

Table 6-3
Multifamily Rebate Eligible Toilets and Unit Water Savings Estimates

Unit Flow Rate Assumptions		Unit Water Savings			Household Assumptions		Rebate Eligible Toilets				
Rebate Eligible Fixture Type	HE Retrofit (gpf)	Gallons / Flush	Gallons / Day	Gallons / Year	Flushes / Person /Day	PPH	2015	2020	2025	2030	2035
3.5 gpf	1.28	2.22	17	6,377	4.2	1.87	92,066	75,068	61,208	49,908	40,693
5.0 gpf	1.28	3.72	29	10,686	4.2	1.87	62,031	50,578	41,240	33,626	27,418
Weighted Average Savings / Eligible Fixtures		2.82	22	8,111	4.2	1.87	154,096	125,646	102,448	83,534	68,111
Total Multifamily Toilets							541,252	566,617	585,920	602,056	606,962
Percent of Total Multifamily Toilets Eligible for Rebate							28%	22%	17%	14%	11%

Rebate-eligible toilets are estimated for each forecast year. As one would expect, the number of rebate eligible fixtures diminishes over the forecast horizon as the number of 5.0 and 3.5 gpf toilets remaining after passive replacement diminishes through time. In 2015, 22 percent of total single-family toilets are considered rebate eligible as shown in Table 6-2. However, due to natural replacement activity only 8 percent of total single-family toilets are estimated to have flush volumes greater than 1.6 gpf by 2035.

The water savings estimates provided in Table 6-2 and Table 6-3 are based on the weighted average flush volume reduction associated with converting remaining 5.0 and 3.5 gpf toilets to HETs. These estimates rely on:

- distributions of rebate eligible toilets after passive replacement and
- estimation of the number of daily flushes on rebated toilets

The relative proportion of 5.0 and 3.5 gpf toilets remaining after passive replacement remains constant throughout the forecast horizon due to EPAct requirements eliminating the availability of non-ULF toilets in 1994 and the assumed natural replacement rate (nrr) of 4 percent annually for each fixture type. Because fixtures are replaced at a constant annual rate over the entire forecast horizon, the proportion of remaining 3.5 and 5.0 gpf fixtures is constant over the forecast horizon. Therefore, the number of fixtures for any forecast year can be used to weight the average savings rates estimated at 2.87 gpf for the single-family sector and 2.82 gpf for the multifamily sector.

Table 6-4 provides estimates of the number of daily flushes on rebated toilets. The results of the toilet rebate regression analysis provided in Section 3.0 were used to estimate the number of flushes on retrofitted fixtures, which is assumed to be proportional to the estimated percent reduction in total water use. Because homes receiving multiple rebates achieved only 2 percent higher water savings than homes receiving one rebate, it is assumed households typically replace their most frequently used fixture. It is also assumed multiple rebate households would have achieved the same 10.8 percent reduction as other single rebate homes had they opted for only one rebate. Accordingly, 84 percent of the 12.8 percent total reduction in water use, and thus 84 percent of the average number of flushes per person per day is assumed to be associated with the first retrofitted toilet throughout the region.

Table 6-4
Estimation of Daily Flushes on Rebated Toilets

Toilets Rebated	Estimated Percent Reduction	Proportion of Total Savings/Flushes	Daily Flushes per Person
Single	10.8%	84.4%	4.22
Multiple	12.8%	15.6%	0.78
		Average Flushes per Person Per Day	**5.0**

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Only single retrofit flushes are considered in the toilet savings estimates provided in Table 6-2 and Table 6-3. Average daily water savings per single-family toilet are estimated by multiplying the weighted average water savings, assumed number of persons per household for each sector and the estimated intensity of single retrofit flushes (4.2 flushes per person per day).

- At 2.61 pph, single-family toilet savings are estimated at 32 gpd (11,578 GPY).
- At 1.9 pph multifamily average water savings per toilet is of 22 gpd (8,111 GPY).

Taking into account the substantial diminishing return of water savings associated with multiple rebates in past programs, only single rebate programs are recommended for implementation (unless further site specific research indicates otherwise) and therefore the estimated savings rates are analogous with the maximum expected savings per participating household.

Two implementation scenarios which assess regional savings potential over separate timeframes are considered for both the single-family and multifamily sectors. Table 6-5 summarizes the total number of available and planned interventions associated with each scenario. The first scenario is a 10-year program which assesses the savings potential associated with reducing the total number of eligible toilets by 50 percent prior to 2025, while the second scenario would reduce the total number of eligible toilets by 75 percent by 2035.

Table 6-5
Single-Family and Multifamily HET Market Potential and Intervention Scenarios

Program Length	Start Year	Final Year	Sector	Flow Rate	Penetration Rate	Interventions: Market Potential	Interventions: Total Planned	Interventions: Annual Planned
10-year	2015	2024	SF	3.5	50%	94,069	47,034	4703
				5.0	50%	72,166	36,083	3608
			MF	3.5	50%	61,208	30,604	3060
				5.0	50%	41,240	20,620	2062
21-year	2015	2035	SF	3.5	75%	62,540	49,250	2345
				5.0	75%	47,978	37,783	1799
			MF	3.5	75%	40,693	32,046	1526
				5.0	75%	27,418	21,591	1028

Table 6-6 provides the assumptions used to estimate average cost for HET interventions. At a unit cost of $100 per single-family intervention and $75 per multifamily intervention and a 25-year useful life, the estimated average cost of each program is $0.35 and $0.37 per 1000 gallons of water saved.

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Table 6-6
Single-family and Multifamily HET
Water Savings Estimates and Average Cost Assumptions

Variable	SF Estimate	MF Estimate
Water Savings (gpy)	11,542	8,111
Useful Life (years)	25	25
Savings Over Useful Life	288,549	202,782
Incentive ($/measure)	$100	$75
Average Cost ($/1000 gallons)	$0.35	$0.37

6.1.2 Residential HE Clothes Washers

Under a residential HE clothes washers incentive program, rebates are offered to encourage replacement of low-efficiency clothes washers with HE Water Factor (WF) 4.5 (gallons/cubic foot of laundry) models. Table 6-7 and Table 6-8 identify the number of single-family and multifamily rebate-eligible in-unit[1] clothes washers, categorized by four efficiency levels (WF 15, 11, 9.5 and 8), and in five year increments starting in 2015 (initial program year) throughout the forecast horizon. Unit savings rates and household assumptions used to derive annual savings estimates per rebate are also provided.

The weighted average water savings estimates provided for rebate eligible clothes washers in Table 6-7 and Table 6-8 are based on:

- distributions of rebate eligible clothes washers after passive replacement
- unit water savings associated with the water use reductions per cubic foot of laundry for each qualifying efficiency level

Rebate-eligible clothes washers are estimated after passive replacement for each forecast year as the number of appliances remaining in each of the four rebate-eligible efficiency levels. Although the total proportion of rebate-eligible clothes washers diminishes by more than 30 percent over the forecast horizon as a result of passive replacement, more than 50 percent of clothes washers are expected to exceed the target WF 4.5 efficiency threshold and are still considered rebate eligible in 2035. This high proportion of rebate eligible products relates in part to the regulatory policies set forth to occur in 2015. As previously discussed in Section 5.2.2, DOE's amended standards, effective March 12, 2015, reduce the water use requirements of both top-loading and front loading machines to WF 8.4 and WF 4.7, respectively. Although HE models are projected to account for more than half of clothes washer market share by 2015, the remaining market supply will consist of models using nearly two times that of their HE counterparts.

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[1] *Multi-Housing Laundry Association, (2001). A National Study of Water & Energy Consumption in Multifamily Housing, In-Apartment Washers vs. Common Area Laundry Rooms. Comparison of in-unit washers and common area laundry rooms indicates residents' w/in-unit washers use 3.3 times more water. Given this finding and other data constraints, common area laundries were not evaluated as part of the DMP.*

Table 6-7
Single-Family Rebate Eligible Clothes Washers and Unit Water Savings Estimates

Unit Flow Rate Assumptions		Unit Water Savings			Household Assumptions		Rebate Eligible Clothes Washers				
Rebate Eligible Fixture Type	**HE Retrofit WF**	**Gallons / Cubic Foot**	**Gallons / Day**	**Gallons / Year**	**Cubic Feet / Load**	**Loads / Day**	**2015**	**2020**	**2025**	**2030**	**2035**
15 WF	4.5	10.5	27	9,934	2.7	0.96	147,230	95,291	61,675	39,918	25,836
11 WF	4.5	6.5	17	6,150	2.7	0.96	141,603	116,504	100,259	89,745	82,940
9.5 WF	4.5	5.0	13	4,730	2.7	0.96	111,591	97,519	88,412	82,517	78,702
8 WF	4.5	3.5	9	3,311	2.7	0.96	50,854	100,009	124,623	141,928	156,407
Weighted Average Savings / Eligible Fixtures		5.91	15	5,588	2.7	0.96	451,278	409,323	374,969	354,108	343,885
Total Single-family Clothes Washers							518,547	557,249	584,274	606,362	631,630
Percent of Total Single-family Clothes Washers Eligible for Rebate							87%	73%	64%	58%	54%

Table 6-8
Multifamily Rebate Eligible In-Unit Clothes Washers and Unit Water Savings Estimates

Unit Flow Rate Assumptions		Unit Water Savings			Household Assumptions		Rebate Eligible Clothes Washers				
Rebate Eligible Fixture Type	**HE Retrofit WF**	**Gallons / Cubic Foot**	**Gallons / Day**	**Gallons / Year**	**Cubic Feet / Load**	**Loads / Day**	**2015**	**2020**	**2025**	**2030**	**2035**
15 WF	4.5	10.5	21	7,524	2.7	0.73	74,515	48,228	31,214	20,203	13,076
11 WF	4.5	6.5	13	4,658	2.7	0.73	62,037	52,147	45,747	41,604	38,923
9.5 WF	4.5	5	10	3,583	2.7	0.73	47,743	41,261	37,066	34,350	32,593
8 WF	4.5	3.5	7	2,508	2.7	0.73	24,425	44,522	54,732	61,801	65,638
Weighted Average Savings / Eligible Fixtures		6.04	12	4,326	2.7	0.73	208,720	186,158	168,759	157,958	150,230
Total Multifamily Clothes Washers							236,129	247,148	255,496	262,443	264,468
Percent of Total Multifamily Clothes Washers Eligible for Rebate							88%	75%	66%	60%	57%

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Unlike the distribution of rebate-eligible toilets which remains constant, the relative proportion of each clothes washer type varies annually over the forecast horizon. Although the nrr for clothes washers is held constant at 8 percent annually (a 12 year effective life), a changing distribution across qualifying levels results from the incremental timing of proposed DOE requirements eliminating the market share of high WF products not conforming to the new standard (e.g. 2011 federal standard for residential clothes washers requires a maximum WF rating of 9.5, thus eliminating the market share of WF 11 models).

Given the changing distribution previously discussed, the single-family and multifamily gallons per cubic foot (gpcf) savings estimates provided in Table 6-7 and Table 6-8 are weighted average reductions across the 2015 to 2035 time frame. Average daily household water savings for an HE conversion is then estimated by multiplying the clothes washer capacity assumption (2.7 cubic feet per load) by the frequency of use assumptions and applying the weighted average savings estimates for each sector.

- Single-family average daily water savings of 15 gpd (5,588 GPY) per HE conversion assumes 0.96 loads per day and a weighted average savings of 5.91 gpcf.
- Multifamily average daily water savings of 12 gpd (4,326 GPY) per HE conversion assumes 0.73 loads per day and a weighted average savings of 6.04 gpcf.

Similar to residential HET program, two implementation scenarios are considered for each sector. Table 6-9 summarizes the total number of available and planned interventions associated with clothes washers exceeding a WF 8.5. The first scenario reduces the total number of eligible clothes washers by 50 percent prior to 2025, while the second reduces the total number of eligible clothes washers by 75 percent by 2035.

Table 6-9
Residential Clothes Washers Market Potential and Intervention Scenarios

Program Length	Start Year	Final Year	Sector	Water Factor	Penetration Rate	Interventions		
						Market Potential	Total Planned	Annual Planned
10-Year	2015	2024	SF	> 6.0 WF	50%	374,969	187,484	18,748
			MF	> 6.0 WF	50%	168,759	84,379	8,438
21-Year	2015	2035	SF	> 6.0 WF	75%	343,885	257,914	12,896
			MF	> 6.0 WF	75%	150,230	112,672	5,634

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Table 6-10 provides the assumptions used to evaluate the average cost of the clothes washer program. At a unit cost of $125 per intervention and a 12-year useful life, the estimated average cost of the clothes washer program is $1.86 and $2.41 per 1000 gallons of water saved, for the single-family and multifamily sectors, respectively.

Table 6-10
Single-family and Multifamily Clothes Washers
Water Savings Estimates and Average Cost Assumptions

Variable	SF Estimate	MF Estimate
Water Savings (gpy)	5,588	4,326
Useful Life (years)	12	12
Savings Over Useful Life	67,058	51,914
Incentive ($/measure)	$125	$125
Average Cost ($/1000 gallons)	$1.86	$2.41

6.1.3 Nonresidential HETs, ULFTs and HEUs

Similar to the residential HET retrofit programs, a nonresidential fixture replacement program provides financial incentives to water customers to encourage conversion of higher flush volume toilets and urinals to HET and HEU models. Nonresidential incentives generally apply to three fixture types:

- Tank-Type HET
- Valve-Type ULFT
- 1/2 Gallon HEU

Although valve- and tank-type toilets exist to some degree in each nonresidential key sector, it is difficult to estimate the proportion of each type across any given sector. As previously discussed in Sections 4.0 and 5.0, key nonresidential sectors are defined by groupings of FDOR codes and represent the predominant nonresidential uses within Tampa Bay Water's service area. Since the existence of valve and tank-type toilets could not be determined at an establishment level, assumptions regarding the flush mechanisms (i.e., tank or valve) were made for each key sector as shown in Table 6-11. Establishments with high traffic volumes were generally assumed to have a flush-valve mechanism. These assumptions were necessary to establish the cost and benefits of tank and flush valve programs, but do not affect water savings calculations.

Table 6-11
Nonresidential Key Sectors for Fixture Estimates

Key Sector	Flush Mechanism
Churches	Tank
Education	Valve
Government	Valve
Health	Valve
Hotels	Tank
Industrial	Tank
Office	Valve
Restaurants	Valve
Retail	Tank/Valve
Others	Valve

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Annual estimates of the total number of nonresidential rebate-eligible fixtures and the potential water savings associated with HET, ULFT and HEU retrofits in the nonresidential key sectors are provided in five-year increments in Table 6-12 to Table 6-14. Estimates of rebate-eligible fixtures and retrofit water savings for each key sector take into account the predominant fixture type assignments provided in Table 6-11.

Nonresidential rebate-eligible fixtures are estimated for each forecast year as the number of 5.0 and 3.5 gpf toilets and 3.0 and 1.0 gpf urinals remaining after passive replacement has occurred. Retrofit water savings for each forecast year rely on the distribution of toilets across rebate eligible efficiency levels, which are used to estimate weighted average flush volumes as well as the number of flushes per employee and flushes per visitor assumed to occur each day (previously provided in Table 5-34). Weighted average savings estimates are derived by:

1. Subtracting weighted annual average flush volume from baseline flush volume to estimate **weighted average savings per flush**

2. Multiplying the weighted average savings per flush by the assumed number of employee/visitor flushes day to estimate ***savings per employee/visitor per day***

3. Dividing the estimated daily water savings by fixtures per employee/visitor to estimated ***water savings per retrofit per day***

4. Multiplying the assumed number of employee/visitor days per year by the water savings per retrofit per day to estimate ***annual water savings per toilet***

The total number of available retrofits and the weighted average savings for *each* key sector support the estimation of a weighted average savings rate for each of the three fixture types. Annual savings for each fixture type are weighted across the number of available retrofits available in each key sector. These annual water savings are then used to calculate average water savings rates between 2015 and 2035.

Table 6-15 summarizes the total number of available and planned interventions associated with the 10-year and 21-year scenarios evaluated for nonresidential HETs, ULFTs and HEUs. Similar to the residential programs previously discussed, the 10-year program assesses savings potential by reducing the eligible fixtures by 50 percent prior to 2025, while the second scenario reduces the eligible fixtures by 75 percent by 2035.

Table 6-16 provides the assumptions used to evaluate the average cost for the nonresidential fixture replacement programs. At a unit cost of $125 per measure and a 30-year useful life, the estimated average cost of the nonresidential fixture replacement programs ranges between $0.22 and $.032 per 1000 gallons of water saved.

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Table 6-12
Nonresidential Total Rebate Eligible Retrofits and Average Savings for Tank-Type HETs

Key Class		2015	2020	2025	2030	2035	Average (2015-2035)
Hotel	Total Eligible Retrofits	16,810	13,706	11,176	9,112	7,430	11,520
	Average Savings (GPY)	4,075	4,050	4,018	3,982	3,943	4,015
Industrial	Total Eligible Retrofits	3,935	3,208	2,616	2,133	1,739	2,697
	Average Savings (GPY)	54,889	55,108	55,101	54,872	54,443	54,940
Churches	Total Eligible Retrofits	5,461	4,453	3,631	2,960	2,414	3,743
	Average Savings (GPY)	5,042	5,020	4,995	4,968	4,938	4,993
Retail/ Restaurant	Total Eligible Retrofits	2,189	1,785	1,455	1,186	967	1,500
	Average Savings (GPY)	24,499	24,531	24,561	24,589	24,615	24,559
Total Tank-Type	**Total Eligible Retrofits**	**28,394**	**23,152**	**18,877**	**15,392**	**12,550**	**19,459**
	Weighted Average Savings (GPY)	**12,877**	**12,891**	**12,868**	**12,812**	**12,726**	**12,843**

Table 6-13
Nonresidential Average Savings for Toilets (Valve-Type ULFT Rebate)

Key Class		2015	2020	2025	2030	2035	Average (2015-2035)
Retail/ Restaurant	Total Eligible Retrofits	4,469	3,644	2,971	2,423	1,975	3,063
	Average Savings (GPY)	21,864	21,893	21,920	21,944	21,968	21,918
Health	Total Eligible Retrofits	9,653	7,871	6,418	5,233	4,267	6,615
	Average Savings (GPY)	6,378	6,300	6,216	6,128	6,038	6,213
Office	Total Eligible Retrofits	7,337	5,983	4,878	3,977	3,243	5,028
	Average Savings (GPY)	19,749	19,641	19,563	19,512	19,486	19,583
Government	Total Eligible Retrofits	2,914	2,376	1,937	1,580	1,288	1,997
	Average Savings (GPY)	35,951	35,781	35,675	35,627	35,629	35,717
Education	Total Eligible Retrofits	3,606	2,940	2,397	1,955	1,594	2,471
	Average Savings (GPY)	37,318	37,180	37,048	36,919	36,794	37,051
Others	Total Eligible Retrofits	13,339	10,876	8,868	7,231	5,896	9,142
	Average Savings (GPY)	15,240	15,243	15,238	15,229	15,216	15,235
Total Valve-Type	**Total Eligible Retrofits**	**41,318**	**33,690**	**27,470**	**22,398**	**18,263**	**28,317**
	Weighted Average Savings (GPY)	**18,074**	**18,017**	**17,966**	**17,921**	**17,883**	**17,971**

Table 6-14
Nonresidential Average Water Savings for Urinals

Key Class		2015	2020	2025	2030	2035	Average (2015-2035)
Hotel	Total Eligible Retrofits	7,658	7,866	8,046	8,186	8,367	8,027
	Average Savings (GPY)	6,703	6,235	5,853	5,540	5,274	5,903
Industrial	Total Eligible Retrofits	102	100	99	98	99	99
	Average Savings (GPY)	0	0	0	0	0	0
Churches	Total Eligible Retrofits	2,628	2,727	2,781	2,802	2,824	2,759
	Average Savings (GPY)	10,420	9,590	8,974	8,501	8,114	9,080
Retail/ Restaurant	Total Eligible Retrofits	2,384	2,525	2,630	2,699	2,771	2,608
	Average Savings (GPY)	15,950	14,891	14,123	13,551	13,096	14,269
Health	Total Eligible Retrofits	5,698	5,888	6,016	6,089	6,180	5,983
	Average Savings (GPY)	9,949	9,116	8,453	7,914	7,452	8,544
Office	Total Eligible Retrofits	3,038	3,132	3,216	3,283	3,368	3,208
	Average Savings (GPY)	54,184	50,483	47,468	45,014	42,932	47,873
Government	Total Eligible Retrofits	2,045	2,117	2,183	2,236	2,301	2,177
	Average Savings (GPY)	68,663	63,516	59,417	56,168	53,464	60,029
Education	Total Eligible Retrofits	5,363	5,623	5,795	5,896	5,996	5,748
	Average Savings (GPY)	26,120	24,299	22,959	21,941	21,121	23,199
Others	Total Eligible Retrofits	7,958	8,274	8,529	8,712	8,930	8,489
	Average Savings (GPY)	21,705	20,116	18,863	17,866	17,024	19,049
Total Urinals	**Total Eligible Retrofits**	**36,875**	**38,252**	**39,296**	**40,001**	**40,836**	**39,099**
	Weighted Average Savings (GPY)	**21,459**	**19,924**	**18,739**	**17,807**	**17,036**	**18,929**

Table 6-15
Nonresidential HET, ULFT, and HEU Market Potential and Intervention Scenarios

Program Length	Start Year	Final Year	Fixture Type	Flow Rate	Penetration Rate	Interventions		
						Market Potential	Total Planned	Annual Planned
10-year	2015	2024	HET	3.5	50%	10,515	5,257	526
				5.0	50%	8,363	4,181	418
			ULFT	3.5	50%	15,244	7,622	762
				5.0	50%	12,226	6,113	611
			HEU	1.0	50%	32,966	16,483	1,648
				3.0	50%	8,029	4,014	401
21-year	2015	2035	HET	3.5	75%	6,990	5,505	262
				5.0	75%	5,560	4,378	208
			ULFT	3.5	75%	10,135	7,981	380
				5.0	75%	8,128	6,401	305
			HEU	1.0	75%	37,304	29,377	1,399
				3.0	75%	5,338	4,204	200

Table 6-16
Nonresidential ULFT, HET, HEU
Water Savings Estimates and Average Cost Assumptions

Variable	ULFT	HET	HEU
Water Savings (gpy)	17,970	12,843	18,928
Useful Life (years)	30	30	30
Savings Over Useful Life	539,100	385,303	567,840
Incentive ($/measure)	$125	$125	$125
Average Cost ($/1000 gallons)	$0.23	$0.32	$0.22

6.1.4 Landscape Irrigation Programs

In general, outdoor conservation programs can offer substantial water savings when properly planned and implemented. However, the results of several DMP analyses discussed herein suggest unintended consequences, such as directing a customer to use more water than they did prior the intervention, can occur when programs are offered through non-targeted promotion. Consequently, it is imperative these programs are undertaken with specific focus on users or areas having opportunity to increase conservation efficiency.

Landscape irrigation programs offer financial incentives and behavioral guidance intended to reduce outdoor water use. The DMP considers four separate single-family landscape and irrigation programs:

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- Soil Moisture Sensor (SMS) and Evapotranspiration (ET) Irrigation Controllers
- Alternative Landscape Irrigation
- Irrigation Evaluations
- Landscape / Irrigation Modifications

As previously mentioned, multifamily and nonresidential landscape irrigation programs are not considered as part of the DMP due to difficulties associated with quantification of the potential number of measures available and water savings. Although potential landscape programs are likely tailorable for all sectors, water use practices of multifamily and nonresidential customers tend to be extremely heterogeneous. This makes it difficult to produce reliable estimates generally applicable to a broad segment of users.

As discussed in Section 3.1.1, irrigators are defined as customers using more than 177 gpd on average, while excessive irrigation is defined as any use exceeding estimated landscape water requirements (LWR). Through analysis of customer parcel data and water consumption records, theoretical LWR and irrigation water use is estimated for customers using more than the assumed 177 gpd threshold. The LWR is calculated using equation 6-1[2]:

EQUATION 6-1

$$LWR = RTM \times [(ET_o \times K_L) - R_e] \times A/C_u$$

Where

LWR	=	Landscape water requirement (gpy)
RTM	=	Run-time multiplier (inverse of irrigation efficiency)
ET_o	=	Reference evapotranspiration in inches per year
K_L	=	Landscape coefficient for the dominant plant type
R_e	=	Effective rainfall in inches per year
A	=	Area of the hydrozone in square feet
C_u	=	Conversion factor to express LWR in gpy (.6233)

Assumptions provided in Table 6-17 are taken from UF EDIS AE481[3] and AE 482[4] publications to support estimation of LWR per square foot of irrigated area. Annual precipitation and ET_o reflect IFAS AE481 (Tables 3 and 6) values for Tampa, while R_e is the sum of monthly effective rainfall taken from IFAS AE482 (Table 4).

[2] *US EPA WaterSense, (2009). Water Budget Approach, December.*
[3] *UF EDIS, (2011). Net Irrigation Requirements for Florida Turfgrass Lawns: Part 2 - Reference Evapotranspiration Calculation, AE481.*
[4] *UF, EDIS, (2011). Net Irrigation Requirements for Florida Turfgrass Lawns: Part 3 - Theoretical Irrigation Requirements, AE482.*

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The landscape coefficient (K_L) is calculated as the sum of monthly turf grass irrigation requirements (AE 482 Table 4) divided by ET_o. Because the entire water requirement of the landscape is consistent with that of turfgrass, and in order to compensate for the lack of separate K_L for non-turfgrass landscape areas with lower water requirements, irrigation efficiency (a value representing the amount of water beneficially applied divided by the total water applied) and thus the run-time multiplier (RTM) are estimated at 100 percent efficiency. Initial estimates associated with LWR are estimated in terms of water use per square foot of irrigated area and then converted using conversion factor C_u to gallons per year (gpy) and in turn gpd by dividing by 365 days.

Table 6-17
Landscape Water Requirement Assumptions

RTM	ET	K_L	R	e	R_e	C_u	LWR
Run time Multiplier	Reference Evapotranspiration (in/yr)	Landscape Coefficient	Annual Precipitation (in/yr)	Effective Rainfall Share	Effective Rainfall (in/yr)	Conversion factor	Net Irrigation Requirement (gpy)[1]
1.0	59.5	0.69	48.4	0.28	13.6	1.6043	17.1

[1] *LWR consistent with Net Irrigation requirement of 25.7 in/yr cited in University of Florida, EDIS, AE482.*

Table 6-18 provides LWR and irrigation water use estimates for a sample of single-family households having 12 complete months of water consumption and estimates of irrigable area generated using property appraiser data. This sample excludes customers with less than 12 months of consumption, incomplete parcel data, reclaimed or alternative water supplies. Of the 424,422 sample households, more than half (53%) are assumed to irrigate and of these, approximately 48 percent of average daily use is assumed to be used for irrigation purposes. By comparing LWR and irrigation water use estimates as provided in Table 6-18, households assumed to irrigate are categorized into two user groups:

- deficit irrigators, where estimated irrigation use is equal or less than theoretical LWR
- surplus irrigators, where estimated irrigation use exceeds theoretical LWR

Deficit irrigator landscapes tend to be larger, averaging 8,955 ft^2 of irrigate area. Average daily demand for deficit irrigators as a group is estimated at 339 gpd of which about 38 percent is estimated as irrigation use. It is important to note that as the size of a yard increases, uniformly achieving a LWR becomes increasingly difficult. However, that is not to say deficit irrigators are efficient in all irrigation practices. For example, deficit irrigators may be surplus irrigators for smaller areas cared most about (prominent gardens) while the theoretical needs of other more expansive areas (large lawns) are left unmet.

Surplus irrigators on the other hand tend to have smaller yards, averaging 6,026 ft^2 of irrigate area. Surplus irrigators use nearly two times the water as deficit households on average, of which approximately 70 percent of average daily demands is estimated to be associated with irrigation. Table 6-19 provides the number of estimated surplus and deficit irrigators in the sample of households by WDPA. As shown, the sample group represents 84 percent of total regional single-family households, with NWH having the lowest representation at 71 percent and COT having the highest at 94 percent. Of the sample homes assumed to irrigate, approximately 17 percent are estimated to water landscapes in excess of LWR, while the remaining 83 percent to use equal to or less than the LWR.

Table 6-18
Estimated Single-Family Landscape Water Requirements and Water Use for Sample Households (WY 2008)

Household Type	Count	% of Total	% of Irrigators	Irrigated Area	LWR (GPD)	Domestic Use (GPD)	Average Use (GPD)	Irrigation Use (GPD)	% Irrigation
Households	424,422	100%	NA	7,636	328	177	233	56	24%
Irrigators	223,866	53%	100%	8,445	361	177	339	162	48%
Deficit	184,841	44%	83%	8,955	383	177	286	109	38%
Surplus	39,025	9%	17%	6,026	257	177	589	412	70%

Table 6-19
Estimated Single-Family Surplus and Deficit Irrigators for Sample Households by WDPA (WY 2008)

WDPA	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Total Households	502,474	83,416	7,898	46,737	87,407	107,872	90,163	78,982
Households (*sample*)	424,422	72,961	6,326	33,006	78,728	100,969	75,493	56,939
Total Irrigators	223,866	33,311	2,651	22,882	50,853	59,609	36,632	17,928
Deficit	184,841	26,639	2,368	18,628	40,880	48,149	30,767	17,410
Surplus	39,025	6,672	283	4,254	9,973	11,460	5,865	518
% of Total Households	84%	87%	80%	71%	90%	94%	84%	72%
% of Total Irrigators	53%	46%	42%	69%	65%	59%	49%	31%
% Deficit	83%	80%	89%	81%	80%	81%	84%	97%
% Surplus	17%	20%	11%	19%	20%	19%	16%	3%

Two of the four landscape programs evaluated target surplus irrigators (SMS/ET Controllers and Irrigation Evaluations), while the remaining two (Alternative Irrigation Source, Landscape Modifications) provide opportunities for reducing potable water demand for deficit irrigators. Through analysis of single-family water use and program cost estimates, targeting of upper quartile (Q3), or top 25 percent, of irrigation users in both the surplus and deficit categories was determined to provide the greatest opportunities cost-effective savings for most programs considered.

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- ***SMS/ET Controllers and Irrigation Evaluations*** - While the overall proportion of Q3 surplus irrigators is low relative to the total number of households assumed to irrigate, potential savings for this class of users is high relative to program costs, producing low average program costs. In this analyses, deficit irrigators are completely excluded from programs aimed at achieving landscape water requirements to prevent likely increases in water use, reducing the practicality of the measure and the cost-effectiveness of the program. Consequently the average market potential and savings rates estimated for SMS/ET Controllers and Irrigation Evaluations generally apply to the top 25 percent of surplus users.

- ***Alternative Irrigation Source, Landscape Modifications*** - Although Surplus users are also desirable candidates for the Alternative Irrigation Source and Landscape Modifications programs, it is difficult to predict the number of surplus irrigators willing to participate in these types of alternative programs. Because these programs were found to have low average unit costs relative to future supply costs by focusing on Q3 deficit irrigator alone, the estimated market potential and savings rates presented for landscape programs exclude surplus irrigators.

Table 6-20 provides estimates of surplus upper quartile (SQ3) and deficit upper quartile (DQ3) irrigators estimated for each WDPA in WY 2008. The proportion of Q3 surplus and deficit irrigators within each WPDA is calculated by dividing the number of SQ3 and DQ3 sample households by the total number of 2008 single-family sample households. SQ3 irrigators are estimated to reflect 2.3 percent of total single-family households while DQ3 households comprise about 11 percent in WY 2008. These proportions are assumed to remain constant over the forecast horizon. Eligible surplus and deficit irrigators are estimated for each forecast year by applying the applicable 2008 WDPA Q3 percentages in Table 6-20 to annual estimates of WDPA total single-family households as provided in five-year increments in Table 6-21.

Table 6-20
Proportion of Surplus Q3 and Deficit Q3 Irrigators by WDPA (WY 2008)

WDPA	TBW	PAS	NPR	NWH	SCH	COT	PIN	STP
Total Households	424,422	72,961	6,326	33,006	78,728	100,969	75,493	56,939
Deficit Irrigators (Q3)	46,210	6,660	592	4,657	10,220	12,037	7,692	4,353
Surplus Irrigators (Q3)	9,756	1,668	71	1,064	2,493	2,865	1,466	130
% Deficit (Q3)	10.9%	9.1%	9.4%	14.1%	13.0%	11.9%	10.2%	7.6%
% Surplus (Q3)	2.3%	2.3%	1.1%	3.2%	3.2%	2.8%	1.9%	0.2%

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Table 6-21
Single-Family Households by WDPA (2010-2035)

WDPA	2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average % Change
PAS	83,793	92,955	104,440	112,237	118,717	125,608	41,815	49.9%	1.6%
NPR	7,675	7,397	7,422	7,278	7,148	7,124	(551)	-7.2%	-0.3%
NWH	47,552	50,576	54,630	58,353	61,957	66,256	18,704	39.3%	1.3%
SCH	86,658	98,101	110,246	120,407	128,926	137,454	50,796	58.6%	1.9%
COT	106,628	116,391	127,820	137,755	146,654	156,415	49,787	46.7%	1.5%
PIN	89,772	91,152	91,860	90,085	87,659	85,778	(3,994)	-4.4%	-0.2%
STP	77,602	78,013	78,066	76,230	74,054	72,530	(5,072)	-6.5%	-0.3%
TBW	**499,680**	**534,585**	**574,484**	**602,344**	**625,115**	**651,164**	**151,484**	**30.3%**	**1.1%**

Table 6-22 and Table 6-23 present the future WDPA estimates of total surplus and deficit irrigators, as well as SQ3, and DQ3 irrigators in five-year increments (assuming the WY 2008 proportion remains constant over the forecast horizon) used to estimate future market potential for the landscape and irrigation programs evaluated. The following sections describe the assessment of market and potential and savings for each of the four active landscape and irrigation programs.

6.1.4.1 Soil Moisture Sensor (SMS) and Evapotranspiration (ET) Irrigation Controllers

SMS and ET irrigation controllers eliminate excessive landscape water use by reducing irrigation rates towards theoretical landscape water requirements (LWR). Various research studies conducted by the University of Florida indicate ET controllers have the potential to produce water savings (without sacrificing landscape quality) when prior irrigation habits result in excess landscape water use.

The evaluation process for this program takes into account all users identified as surplus irrigators and considers two implementation scenarios, which assess regional savings potential over separate timeframes and penetration rates. Table 6-24 summarizes the total number of available and planned interventions associated with each scenario. The first scenario is an 8-year program designed to reduce the total number of surplus irrigators by 20 percent prior to 2025, while the second seeks to reduce the total number of surplus irrigators by 40 percent by 2035.

Table 6-25 provides the estimated water savings rates associated with SMS/ET irrigation controllers. Savings potential is estimated by subtracting the annual average irrigation requirement from annual average irrigation use of surplus users. As shown in Table 6-25, SMS or ET irrigation controllers are estimated to reduce household water demand by nearly 57,000 gpy (155 gpd). With utility costs estimated at $200 per intervention and a 10-year useful life of the technology, the average cost of the SMS/ET irrigation controller program is estimated at $0.35 per 1000 gallons of water saved.

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Table 6-22
Single-Family Total Deficit and Deficit Q3 Irrigators by WDPA (2010-2035)

WDPA	Total Deficit Irrigators 2010	2015	2020	2025	2030	2035	Absolute Change	Deficit Upper Quartile Irrigators (DQ3) 2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average % Change
PAS	30,594	33,939	38,132	40,979	43,345	45,861	15,267	7,648	8,485	9,533	10,245	10,836	11,465	3,817	49.9%	1.6%
NPR	2,873	2,769	2,778	2,724	2,676	2,667	(206)	718	692	695	681	669	667	(52)	-7.2%	-0.3%
NWH	26,838	28,544	30,832	32,933	34,968	37,393	10,556	6,709	7,136	7,708	8,233	8,742	9,348	2,639	39.3%	1.3%
SCH	44,998	50,940	57,246	62,522	66,946	71,374	26,376	11,249	12,735	14,311	15,630	16,736	17,844	6,594	58.6%	1.9%
COT	50,848	55,503	60,953	65,691	69,935	74,590	23,742	12,712	13,876	15,238	16,423	17,484	18,647	5,935	46.7%	1.5%
PIN	36,586	37,149	37,437	36,714	35,725	34,959	(1,628)	9,147	9,287	9,359	9,178	8,931	8,740	(407)	-4.4%	-0.2%
STP	23,728	23,854	23,870	23,308	22,643	22,177	(1,551)	5,932	5,963	5,967	5,827	5,661	5,544	(388)	-6.5%	-0.3%
TBW	**216,464**	**232,697**	**251,249**	**264,872**	**276,237**	**289,020**	**72,556**	**54,116**	**58,174**	**62,812**	**66,218**	**69,059**	**72,255**	**18,139**	**33.5%**	**1.2%**

Table 6-23
Single-Family Total Surplus and Surplus Q3 Irrigators by WDPA (2010-2035)

WDPA	Total Surplus Irrigators 2010	2015	2020	2025	2030	2035	Absolute Change	Surplus Upper Quartile Irrigators (SQ3) 2010	2015	2020	2025	2030	2035	Absolute Change	Percent Change	Annual Average % Change
PAS	7,663	8,500	9,551	10,264	10,856	11,486	3,824	1,916	2,125	2,388	2,566	2,714	2,872	956	49.9%	1.6%
NPR	343	331	332	326	320	319	(25)	86	83	83	81	80	80	(6)	-7.2%	-0.3%
NWH	6,129	6,519	7,041	7,521	7,985	8,539	2,411	1,532	1,630	1,760	1,880	1,996	2,135	603	39.3%	1.3%
SCH	10,978	12,427	13,966	15,253	16,332	17,412	6,435	2,744	3,107	3,491	3,813	4,083	4,353	1,609	58.6%	1.9%
COT	12,102	13,210	14,508	15,635	16,645	17,753	5,651	3,026	3,303	3,627	3,909	4,161	4,438	1,413	46.7%	1.5%
PIN	6,974	7,082	7,137	6,999	6,810	6,664	(310)	1,744	1,770	1,784	1,750	1,703	1,666	(78)	-4.4%	-0.2%
STP	706	710	710	693	674	660	(46)	176	177	178	173	168	165	(12)	-6.5%	-0.3%
TBW	**44,895**	**48,779**	**53,244**	**56,690**	**59,622**	**62,834**	**17,939**	**11,224**	**12,195**	**13,311**	**14,173**	**14,906**	**15,708**	**4,485**	**40.0%**	**1.4%**

Table 6-24
SMS/ET Irrigation Controller
Market Potential and Intervention Scenarios

Program	Program Start Year	Program Final Year	Penetration Rate	Interventions (Surplus) Market Potential	Total Planned	Annual Planned
8-year Program	2017	2025	20%	56,690	11,338	1,417
19-year Program	2017	2035	40%	62,834	25,133	1,323

Table 6-25
SMS/ET Irrigation Controller
Water Savings Estimates and Average Cost Assumptions for Surplus Irrigators

Variable	Surplus Irrigator Statistics
Average Green Space (sq ft)	6,026
Average Water Use (gpd)	589
Estimated Average Indoor Use (gpd)	177
Estimated Average Irrigation Use (gpd)	412
Average Theoretical	70%
% of Total Use as Irrigation	257
Average Surplus Use (gpd)	155
Deficit / Surplus % of Theoretical Req.	60.5%
Savings Potential (gpy)	**56,645**
Useful Life (years)	**10**
Savings Over Useful Life	**566,450**
Utility Costs ($)	**$200**
Average Cost ($/1000 gallons)	**$0.35**

6.1.4.2 Alternative Irrigation Sources Market Potential and Savings Rates

Alternative irrigation sources reduce or eliminate outdoor potable water use through non-descriptive but reliable outdoor source modification. Examples of alternative sources may include irrigation wells, reclaimed water or even harvested rainwater. Both irrigation wells and reclaimed water programs have been implemented successfully by Tampa Bay Water member governments. While alternative irrigation source programs present substantial savings opportunities for most regular users of automatic irrigation systems, it is assumed customers most likely to invest in such technology are those with water use equal to or greater than upper quartile deficit irrigators. Expanding an alternative incentive program to include irrigators using less than that of the 258 gpd DQ3 irrigation average was found to not be cost-effective. Thus, the market potential and savings estimates for this program are based on analysis of DQ3 irrigators.

Similar to the SMS/ET irrigation controllers, the evaluation process for this program considers two implementation scenarios, which assess regional savings potential over separate timeframes and penetration rates. Table 6-26 summarizes the total number of available and planned interventions associated with each implementation scenario along with assessing savings potential associated with reducing the number of DQ3 irrigators and their associated water use by 10 percent prior to 2025, and 20 percent by 2035.

Table 6-26
Alternative Irrigation Sources
Market Potential and Intervention Scenarios for Deficit Q3 Irrigators

				Interventions (DQ3)		
Program	**Start Year**	**Final Year**	**Penetration Rate**	**Market Potential**	**Total Planned**	**Annual Planned**
8-Year Program	2017	2025	10%	66,218	6,622	828
19-Year Program	2017	2035	20%	72,255	14,451	761

Table 6-27 provides water savings estimates for the Alternative Irrigation Sources program. Savings potential is assumed to equal the estimated irrigation use prior to the intervention (258 gpd) or 94,034 gallons annually. With utility costs estimated at $750 per intervention and a 25-year useful life of the technology, the average cost of the Alternative Irrigation Sources program is estimated at $0.32 per 1000 gallons of water saved.

Table 6-27
Alternative Irrigation Sources
Water Savings Estimates and Average Cost Assumptions for Deficit Q3 Irrigators

Variable	DQ3 Statistics
Average Green Space (sq ft)	12,604
Average Water Use (gpd)	435
Estimated Average Indoor Use (gpd)	177
Estimated Average Irrigation Use (gpd)	258
% of Total Use as Irrigation	59.3%
Average Theoretical LWR	537
Average Deficit Use (gpd)	-280
% of LWR (Deficit)	-52.0%
Savings Potential (gpy)	**94,034**
Useful Life (years)	**25**
Savings Over Useful Life	**2,350,850**
Utility Costs ($)	**$750**
Average Cost ($/1000 gallons)	**$0.32**

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6.1.4.3 Irrigation System Evaluations

Irrigation System Evaluation (ISE) programs provide landscape-specific irrigation schedules and recommendations to improve the performance and technological efficiency of automated irrigation. ISE's have been offered in the Northwest Hillsborough, South Central Hillsborough, City of Tampa, and St. Petersburg WDPAs. As part of the single-family demand profile discussed in Section 3, member government ISE programs were assessed for effectiveness in reducing water use at individual participating locations. The results of the profile analyses indicate that water savings from ISEs range from 6.9-7.4% in the year following the evaluation. However, in order to properly characterize ISE participants for use in market potential and savings rates estimation, it is important to understand the magnitude of water use both before and after the evaluation and relative to estimated watering requirements (i.e., LWR's).

Table 6-28 categorizes pre- and post-evaluation water use and LWR's of 400 ISE participants across the following four surplus and deficit irrigation categories:

- Surplus Before and After
- Surplus Before / Deficit After
- Deficit Before and After
- Deficit Before / Surplus After

Additional weighted average statistics are provided for the program as a whole, as well as for two aggregate surplus and deficit categories defined by pre-evaluation irrigation practices. Overall, the vast majority (68%) of ISE participants were estimated to be deficit irrigators prior to having an evaluation and this group on average used about 233 gpd (84,992 gpy) less than their estimated average LWR's. Much of this deficit use is likely attributable to the sizable average irrigated area (9,722 ft^2) of these properties and the involvedness associated with meeting LWR's, as compared to that of the surplus categories which tend to have about 3,000 ft^2 less of irrigable area. Of the 273 households using less than their LWR's prior to the evaluation, 248 remained deficit irrigators after the evaluation, and as a group saved 5,046 gpy on average. Of the 32 percent (127) of ISE participants identified as surplus irrigators prior to the evaluation, more than half (76 of 127) were still estimated to be surplus irrigating after the evaluation. However, as a group, surplus irrigators reduced water use by nearly 30 percent or 50,898 gpy from pre-program averages.

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Table 6-28
Irrigation System Evaluations
Evaluation of Pre-and and Post-Evaluation Water Use and Savings Potential for Surplus and Deficit Irrigators

Single-family Irrigation Evaluation Participant Type	Participants		Assumptions			Pre-Evaluation Water Use				Post-Evaluation Water Use			
	House-holds	% of Total	Irrigated Area	LWR (GPD)	Domestic Use (GPD)	Average Use (GPD)	Irrigation Use (GPD)	Surplus/ Deficit Use (GPD)	LWR Savings Potential (GPY)	Average Use (GPD)	Irrigation Use (GPD)	Change in Use (GPY)	% Change in Use
Total Participants	400	100%	8,593	365	177	477	300	-65	-23,849	436	261	-14,194	-13%
Surplus Before / After	76	19%	6,837	289	177	833	656	367	133,828	745	568	-31,997	-13%
Surplus Before / Deficit After	51	13%	6,661	282	177	575	398	115	42,147	358	181	-79,065	-54%
Deficit Before / After	248	62%	9,722	413	177	357	180	-233	-84,992	344	167	-5,046	-8%
Deficit Before / Surplus After	25	6%	6,683	283	177	375	198	-86	-31,274	565	388	69,531	96%
Program Summary (Weighted Average)	**400**	**100%**	**8,593**	**365**	**177**	**477**	**300**	**-65**	**-23,849**	**436**	**259**	**-14,943**	**-14%**
Surplus Summary (Weighted Average)	**127**	**32%**	**6,766**	**287**	**177**	**729**	**552**	**266**	**97,011**	**590**	**413**	**-50,898**	**-30%**
Deficit Summary (Weighted Average)	**273**	**68%**	**9,444**	**401**	**177**	**359**	**182**	**-219**	**-80,073**	**364**	**187**	**1,783**	**2%**

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The group identified as deficit irrigators both before and after the program reduced outdoor water demand by approximately 8 percent. However, some deficit participants actually increased their water use to the extent to be classified as surplus irrigators subsequent to the program. While the exact reason for this increase is unknown, this type of outcome is consistent with the basic design of ISE programs which tend to tailor watering schedules and side specific recommendations to LWR's, regardless of whether this results in a decrease in water use. Although ISE programs appear to save water overall, offering the program to deficit irrigators with limited savings potential would likely reduce the cost-effectiveness of the program because of unintended consequences. As such, the market potential and savings estimates for the ISE focus entirely on estimated impacts on surplus irrigators only.

Table 6-29 summarizes the number of available and proposed interventions associated with 10-year and 20-year implementation scenarios. The penetration rate for each program is 0.5 percent annually. It is anticipated ISE participants would also be candidates for the SMS/ET controller program, which estimates water savings across all surplus water users. Since it cannot be assumed future ISE participants will have the same characteristics as past ISE participants, the estimated savings rates assumes ISE savings are a proportion of the total savings estimated for the SMS/ET program which reduces surplus use to theoretical LWR's.

Table 6-29
Irrigation System Evaluations
Market Potential and Intervention Scenarios for Surplus Q3 Irrigators

Program	Start Year	Final Year	Penetration Rate (Annual)	Market Potential (SQ3)				Annual Planned			
				2015-2020	2021-2025	2026-2030	2031-2035	2015-2020	2021-2025	2026-2030	2031-2035
8-Year Program	2015	2024	0.5%	53,244	56,690	59,622	62,834	266	283	-	-
19-Year Program	2015	2035	0.5%	53,244	56,690	59,622	62,834	266	283	298	314

Table 6-30 provides water savings estimates of ISE programs directed at surplus irrigators. While the total surplus savings potential estimated for ISE surplus participants is 97,011 gpy, analysis of observed water use indicates member government programs achieved only 52 percent of this potential savings. As previously discussed in Section 0, the estimated average demand reduction associated with reducing surplus demand to theoretical LWR's is 56,645 gpy. By assuming an ISE would result in approximately 52 percent of this savings potential, the estimated program savings rate is 29,719 gpy. Given an assumed 5-year useful life of savings, the average cost of the ISE program is estimated at $1.35 per 1000 gallons of water saved.

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Table 6-30
Irrigation Evaluations Estimated Water Savings for Surplus Irrigators

Variable	GPY
Pre-Evaluation Irrigation Use	201,617
Post-Evaluation Irrigation Use	150,719
Irrigation System Evaluation Savings	50,898
Surplus (ET) Savings Potential for Irrigation Evaluation Participants	97,011
% of Surplus (ET) Savings Potential	52%
Regional ET/SMS Surplus Savings Potential	56,645
Estimated Irrigation Evaluations Savings Potential	**29,719**
Useful Life (years)	**5**
Utility Costs ($)	**$200**
Average Cost ($/1000 gallons)	**$1.35**

6.1.4.4 Landscape and Irrigation Modifications

Landscape and irrigation modification (LIM) programs provide financial incentives to encourage replacement of turf grass with alternative landscape materials that require little or no supplemental irrigation once established (e.g., Florida-Friendly landscaping and/or hardscape). LIM programs have been implemented quite successfully in the west; however, utilities in Florida have yet to incorporate extensive incentive based LIM programs into on-going water efficiency efforts. However, as part of the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) ongoing education efforts, the Florida-Friendly Landscaping (FFL) Program assists homeowners, builders and developers in creating and maintaining water efficient, low impact, sustainable landscapes.

The FFL program overarches a Florida Yards & Neighborhoods (FYN) program designed to assist and recognize single-family homeowners using FFL practices. FYN certifications (in previous years the program provided certifications but currently provides recognition) have been issued in Hillsborough, Pasco and Pinellas counties. As discussed in Section 3.2, the analysis of local FYN programs estimates total water use reductions ranging from 5 to 8.3 percent in the two years following certification/recognition.

In absence of sufficient information to support quantitative analysis specific to Florida landscapes, the true potential of local utility sponsored LIM programs remains unknown. Although FYN programs are demonstrated to result in demand reductions and ultimately share a common purpose with utility sponsored LIM programs, it is possible that the savings potential may vary substantially. For example, involvement in FYN programs is based solely on self-interest (e.g. aesthetics, sustainability, lower water bills) and likely attracts participants predisposed to landscape conservation. Although participants in utility sponsored programs receive the same benefits, incentive-based programs seek to

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maximize saving opportunities while expanding the use of FFL practices to a broader range of customers unlikely to independently modify irrigation practices.

The FYN potential water savings assessment is based on quantification of water savings associated with pre- and post-certification surplus/deficit water use behaviors. Table 6-31 summarizes the results of the FYN participant analysis.

Key findings include:

- 97 percent (113) deficit irrigate before certification
  - 35 percent (41) deficit irrigate before/after certification
  - 58 percent (68) do not irrigate before/after certification
  - 3 percent (4) deficit irrigate before, surplus irrigate after certification

Of the 41 participants determined to deficit irrigate before and after certification/recognition occurs, the estimated change in total average water use was 16 percent, or 16,611 gpd. As a whole, the deficit group reduced total average day demands by 9 percent or 5,885 gpd. Weighted average statistics provided for the program as whole, indicate FYN participants saved an average of 6,424 gpd, which reflects a 9 percent reduction in demands, or 17 gpd.

Although demand reductions did occur following certification, it is difficult to infer the cause of those changes without additional information. Because the majority of participants used less than the estimated non-seasonal water use estimate (reflective of indoor use)[5], of 177 gpd prior to participating in the FYN program, it was determined savings associated with past FYN programs this would not be an appropriate measurement for estimating future savings as the program would likely target customers with higher water use than that of past FYN participants and thus result in greater reductions. Alternatively, the number of DQ3 irrigators and the associated water use estimates for this group provide the basis for market potential and savings estimates derived for this program. Table 6-32 summarizes the total number of available and planned interventions associated reducing DQ3 irrigators by 10 percent prior to 2025, and 20 percent by 2035. These scenarios each include a 3-year pilot study meant to inform and help refine future cost and savings estimates.

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[5] *Analysis of seasonal water use as described in Section 3.2.5 indicates the non-seasonal estimate may inclusive of some weather-sensitive water uses, consistent with Tampa Bay regional climate patterns that generally support year-round growth of vegetation.*

Table 6-31
Landscape and Irrigation System Modifications
Evaluation of Pre-and and Post-Certification Water Use and Savings Potential for Surplus and Deficit Irrigators

Single-Family Florida-Friendly Landscape Participant Type	Participants		Assumptions			Pre-Certification Water Use				Post-Certification Water Use			
	House-holds	% of Total	Irrigated Area	LWR (GPD)	Domestic Use (GPD)	Average Use (GPD)	Irrigation Use (GPD)	Surplus /Deficit Use (GPD)	LWR Savings Potential (GPY)	Average Use (GPD)	Irrigation Use (GPD)	Change in Use (GPY)	% Change (Average Use)
Surplus Before / After	1	1%	8,606	366	177	813	636	270	98,623	990	813	64,371	28%
Surplus Before / Deficit After	3	3%	5,488	235	177	516	339	104	38,122	378	201	-50,342	-41%
Deficit Before / Surplus After	4	3%	6,968	296	177	422	245	-51	-18,768	536	359	41,558	46%
Deficit Before / After (>177 gpd)[1]	41	35%	10,777	469	177	292	115	-354	-129,146	246	69	-16,611	-40%
Deficit Before / After (<177 gpd)[2]	68	58%	7,613	336	177	104	-	-336	-122,799	98	-	-2,208	-0%
Program Summary (Weighted Average)	117	100%	8,654	379	177	197	63	-316	-115,448	180	49	-6,424	-22%
Surplus Summary (Weighted Average)	4	3%	6,268	268	177	590	413	146	53,248	531	354	-21,664	-14%
Deficit Summary (Weighted Average)	113	97%	8,738	383	177	184	50	-333	-121,419	167	38	-5,885	-25%

[1] *Pre-certification average water use is greater than 177 gpd.*
[2] *Pre-certification average water use is less than 177 gpd – assumed to be non-irrigators.*

Table 6-32
Landscape and Irrigation System Modifications
Market Potential and Intervention Scenarios for Deficit Q3 Irrigators

Program	Program Start Year	Program Final Year	Penetration Rate	Interventions (DQ3) Market Potential	Total Planned	Annual Planned Pilot (3-yr)		Annual Planned Program	
Landscape Modification 8-Year Program	2017	2025	10%	66,218	6,622	221	10%	1,192	90%
Landscape Modification 19-Year Program	2017	2035	20%	72,255	14,451	241	5%	858	95%

Table 6-33 provides water savings estimates for the LIM program. Savings potential assumes a 1,500 ft^2 conversion on average at .038 gpd per irrigated square foot converted, or 21,001 gpy. The water savings estimate is based solely on the reduction of irrigated area per square foot which is assumed to remain unchanged after the conversion is complete. With utility costs estimated at $750 per intervention or $0.50 per square foot of converted area, and a 25-year useful life of the measure, the average cost of the LIM program is estimated at $1.43 per 1000 gallons of water saved

Table 6-33
Landscape and Irrigation System Modifications
Estimated Water Savings for Deficit Q3 Irrigators

Variable	Before Modification	After Modification
Average Conversion (sq ft)	1,500	1,500
Irrigated Area (sq ft)*	6,716	5,216
Average Total Use (GPD)	435	377
Domestic Use Assumption	177	177
Irrigation Use (GPD)	258	200
gpd / irrigated sq ft	0.038	0.038
Irrigation Savings (gpd)		57.5
Irrigation Savings (gpy)		**21,001**
Useful Life (years)		**25**
Utility Costs ($)[1]		**$750**
Average Cost ($/1000 gallons)		**$1.43**

[1] Equivalent to $0.50 per square foot of converted turf grass

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6.1.4.5 Cooling Tower Market Potential and Savings Rates

Cooling towers remove heat from buildings generated by computers, lights, people, and other operations. However, many industrial processes also require chilled water to cool the equipment being used in the process itself. Heat is typically removed by a central refrigeration system and compressor, which may be either air cooled or water cooled. Water cooled, or chilled water systems are connected with a circulating loop to a cooling tower.

Cycles of concentration (COC) defines the accumulation of dissolved minerals (e.g. chlorides, total dissolved solids (TDS) or calcium) as number of times the tower water is concentrated over that of the makeup water. As water loss occurs through evaporation and drift, most contaminants are left behind thus increasing the dissolved mineral concentration of the tower water. Water use occurs as makeup water is added to compensate for water losses in a system, or as a result of cooling tower blowdown (i.e. discharge or bleedoff), a process which removes a portion of the concentrated water from the cooling tower and replaces it with makeup water. By increasing the COC, the amount of supplemental make-up water needed to operate the cooling tower efficiently is reduced. COC's can be optimized and increased based on tracking of pertinent water quality data, and through use of conductivity controllers. High-efficiency drift eliminators that reduce drift loss are available and may yield considerable savings.

Cooling tower market potential and savings rates are based on an estimation procedure which considers multifamily and nonresidential properties with buildings greater than four stories or having more than 25,000 ft^2 of heated area in 2008. Each property meeting the initial criteria underwent a virtual visual verification process which positively identified 569 cooling towers. While more are likely to exist, they could not be verified at this time through processes employed herein.

Given conversations with national experts and local nonresidential surveys conducted by member governments, all cooling towers in the region are assumed to operate at approximately 2.5 COC's at best, while 6 COC's or more may be possible. Taking these estimates into account, the average savings rates established for cooling towers is based on the estimated median water savings associated with moving identified cooling towers from 2.5 to 6 COC's. It is anticipated COC's will be optimized through use of conductivity controllers as well as a combination of other program requirements including increased metering and tracking of water quality data.

Water savings estimates reflect the difference in water use at 2.5 and 6.0 COC's. Estimation of cooling tower water use for each COC relied on property appraiser building area as well several operational assumptions taken from American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the California Urban Water

Conservation Council (CUWCC) Best Management Practices[6]. Cooling is typically measured in tons, and is thus the unit of weight typically applied in cooling calculations. Equations 6-2 to 6-4 provide the formulas required to generate the following estimates for each cooling tower location:

- Cooling Tons (Equation 6-1)
- Ton-Hours of Cooling (Equation 6-2)
- Total Cooling Tower Water Use (Equation 6-3)

These formulas utilize unit load (capacity) and equivalent full load hour (EFLH) assumptions obtained from various literature provided in Table 6-34. Unit load estimates provide the number of cooling tons required per square foot of building area and reflect the inverse of cooling capacity, or the number of square feet cooled per cooling ton. The literature provides unit loads for four general facility types, which further corresponded to DMP sector groupings derived from property appraiser data. EFLH reflects the total number of hours of operation at an assumed full-load capacity.

Equation 6-2 estimates the number of cooling tons (CT) required to cool the building area associated with each cooling tower location. Building area estimates come directly from property appraiser parcel data. Although ASHRAE provides capacity estimates from which unit load (L_t) can be estimated as provided in Table 6-34, more recent results from a local Tampa study were used in the final calculation.

Equation 6-2

$$CT = L_f * A$$

Where

CT = Cooling Tons
L_t = Unit Load (tons/ ft^2)
A = Building Area
f = Facility Type

Equation 6-3 estimates ton-hours of cooling, or the hours of operation per ton per year required to cool the building area for each cooling tower location. This estimate utilizes the CT estimate derived using Equation 6-2 as well as ASHRAE TRP-1120[7] equivalent full load hour (EFLH) estimates (E_f) provided in Table 6-34.

[6] Koeller, J. (2006). CUWCC Potential Best Management Practice for Commercial-Industrial Cooling Water Efficiency.
[7] Carlson, S. (2001). "Development of Equivalent Full Load Heating and Cooling Hours for GCHPs Applied in Various Building Types and Locations" ASHRAE TRP-1120, Final Report.

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Table 6-34
Cooling Tower Equivalent Full Load Hours and Unit Load and Assumptions

ASHRAE Report	Test City	ASHRAE EFLH Table	Occupancy Assumptions	Sectors	Equivalent Full Load Hours			Capacity (Ft^2/ Ton)			Unit Load ($Tons/Ft^2$)	
					MIN	MAX	Average	MIN	MAX	Average	ASHRAE	Tampa[1]
ASHRAE 1120-TRP	Tampa	Table 17. EFLH for Typical School	9 months, 8 am-4 pm	Education	1050	1100	1075	268	315	292	0.0032	0.0054
				Miscellaneous Seasonal								
		Table 18. EFLH for Typical Office	year-round, weekdays, 8 am-5 pm	Office <10 stories	1800	2000	1900	349	425	387	0.0024	0.0036
				Government								
				Medical Services								
		Table 19. EFLH Office Extended Retail Type Occupancy	year-round, weekdays, 8 am-10 pm	Office >10 stories	2170	2580	2375	349	425	387	0.0024	0.0036
				Nonprofits								
				Retail								
				Restaurants/Fast Food								
				Fitness/Leisure								
				Entertainment								
				Grocer/Food Store								
				Mixed Use Commercial								
		Table 20. EFLH for Typical Office with Continuous Occupancy	24 hrs, 7 days/wk, 365 days/year	Multifamily	2910	3710	3310	349	425	387	0.0024	0.0033
				Hotels/Motels								
				Retirement								
				Health Care								
				Warehousing								
				Transportation								
				Aviation								
				Heavy Manufacturing								
				Light Manufacturing								
				Miscellaneous								

[1] *CDM / Greeley and Hansen, (2008). City of Tampa Reclaimed Water System Expansion - Final Draft Basis of Design Report.*

Equation 6-3

$$H = CT * E_f$$

Where

H = Ton-Hours of Cooling (annual)
CT = Cooling Tons
E_f = Equivalent Full Load Hours per Year by Facility Type
f = Facility Type

Equation 6-4 estimates the total water use required to cool the building area of each cooling tower location. Water use estimates are specific to the number of ton-hours of Cooling (H) derived using equation 6-3, at a given level of water use per ton at a specified COC's (WU_c) as provided in Table 6-35 and illustrated in Figure 6-1. The percent reduction in water use estimates are taken from CUWCC Potential Best Management Practices[8], which provides the percent reduction in water use associated with incremental COC changes as shown in Table 6-36. These percent changes permit water use to be calculated for various increments of change and are generally provided in whole number increments. Because estimates are not provided for the 2.5 COC assumption, and the relationship between increases in COC's and water use is not linear, the gallons per ton estimate for 2.5 COC's is taken directly from Figure 6-1.

Equation 6-4

$$Q = H * WU_c$$

Where

Q = Total Cooling Water Use (gpy)
H = Ton-Hours of Cooling (annual)
WU_c = Water Use per TON at specified COC
f = Facility Type

Table 6-35
Water Use per Ton at Specified COC's

COC	Gallons/Ton	% Reduction in Water Use
1.5	5.40	
2.0	3.59	33%
2.5	3.15	na
3.0	2.70	25%
4.0	2.40	11%
5.0	2.26	6%
6.0	2.17	4%

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[8] *Koeller, J. (2006). CUWCC Potential Best Management Practice for Commercial-Industrial Cooling Water Efficiency.*

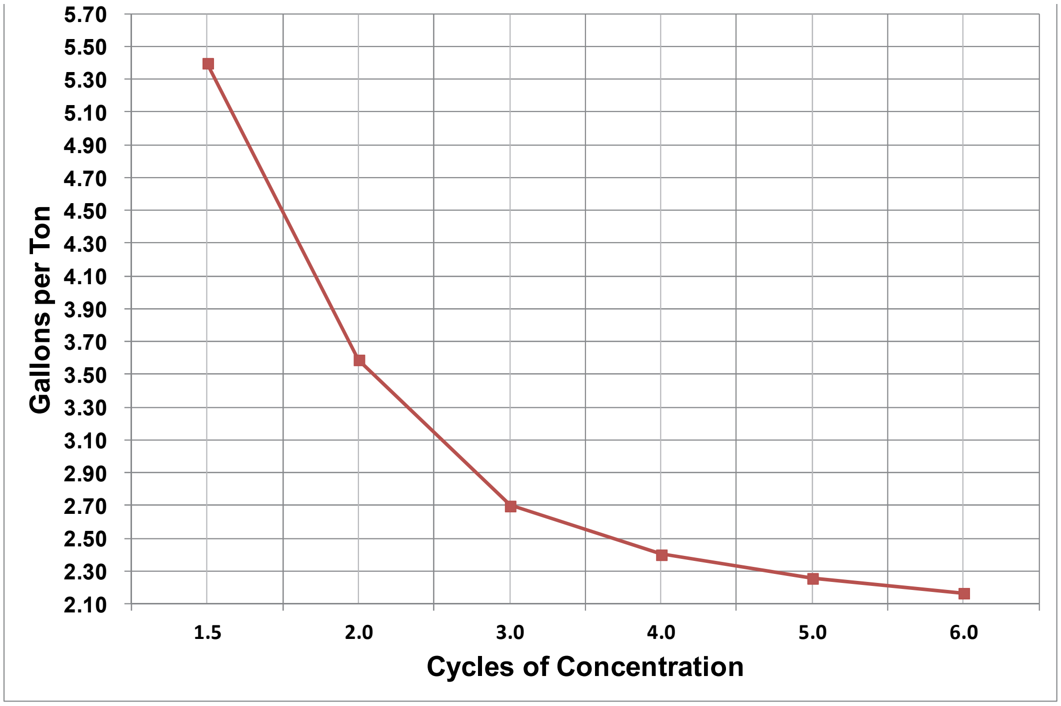

Figure 6-1 Cooling Tower Water Use per Cycle of Concentration

Table 6-36
Percent Reduction in Water Use vs. COC Change

COC's Before Increasing Cycles	COC's After Increasing Cycles											
	2	3	4	5	6	7	8	9	10	12	15	20
1.5	33%	50%	56%	58%	60%	61%	62%	63%	63%	64%	64%	65%
2		25%	33%	38%	40%	42%	43%	44%	44%	45%	46%	47%
3			11%	17%	20%	22%	24%	25%	26%	27%	29%	30%
4				6%	10%	13%	14%	16%	17%	18%	20%	21%
5					4%	7%	9%	10%	11%	13%	14%	16%
6						3%	5%	6%	7%	9%	11%	12%
7							2%	4%	5%	6%	8%	10%
8								2%	3%	5%	6%	8%
9									1%	3%	5%	6%
10										2%	4%	5%
11											2%	4%
12												2%

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Table 6-37 summarizes the total number of identified cooling towers identified for this analysis (considered a conservative number), as well as the estimated number of cumulative rebates associated with improving the operational efficiency of 25 percent of the number of cooling towers in the region prior to 2035. As previously mentioned, all cooling towers currently in use are assumed to be operating at 2.5 COC's and therefore are considered eligible for efficiency improvements. The number of eligible cooling towers is assumed to increase at the same rate as nonresidential accounts, resulting in 801 rebate eligible cooling towers by 2035. After 200 rebates, 601 eligible cooling towers are assumed to remain in 2035.

Table 6-37
Cooling Tower Intervention Market Potential

Variable	2015	2020	2025	2030	2035
Eligible Measures	610	638	676	730	801
Cumulative Planned Interventions	10	57	105	153	200
Eligible Measures After Planned Interventions	600	580	571	577	601

Table 6-38 provides the savings potential estimated across the 610 cooling towers identified for 2015. Program savings reflect the difference in median cooling tower water use across all 610 cooling towers at 2.5 and 6.0 COC's. This estimate is consistent with national estimates and considered conservative for Florida. Program costs are based on evaluation of national programs. With utility costs estimated at $1000 per intervention and a 10-year useful technology life, the average program costs is estimated at $0.07 per 1000 gallons of water saved, the most cost effective program identified.

Table 6-38
Cooling Tower Rebate Estimated Savings Potential

Variable	Total GPD	Median GPY
Water Use @ 2.5 COC	10,386,840	4,449,743
Water Use @ 6.0 COC	7,152,752	3,063,214
Savings Potential	3,234,089	1,386,530

6.1.5 Commercial Dishwashing

Dishwashing and scullery operations are water intensive end uses and often prime candidates for efficiency improvements in commercial kitchens. Examples of technologies that will provide for improved dishwashing water efficiency may include:

- Commercial-grade dishwasher replacements
- Pre-rinse spray valves for dish rinsing
- Strainer (scraper) baskets in place of garbage disposals

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The Consortium for Energy Efficiency (CEE) and U.S. EPA Energy Star have established specifications for dishwashing technologies that have significant water savings potential. The DMP considers technology improvements for two commercial dishwashing uses, dishwashers and pre-rinse spray valves (PRSV). Virtually all restaurants with dishwashing equipment will have one or more PRSV's, while strainer baskets tend to be less common. Although additional water conserving benefits are possible, nonresidential consumer preferences towards strainer baskets and the degree of market penetration are not well understood. Therefore, strainer baskets are not considered.

6.1.5.1 Dishwashers

Restaurant dishwashers are available in a variety of types, sizes, and flow rates. Dishwashers are normally selected and sized based on their ability to meet the service requirements of any given food establishment. The four main types of dishwashing machines and general capacity thresholds used to estimate presence in commercial facilities include:

- under-counter (less than 60 seats)
- door type (60 to 149 seats)
- conveyer (150 to 299 seats)
- flight (300+ seats)

Under the counter and door type dishwashers can be found in small restaurants while conveyor and flight type dishwashers are designed for higher dishwashing capacity and are more often found in larger restaurants or cafeterias.

The Florida Department of Business and Professional Regulation (DBPR) maintains a state database of restaurant information, which provides various types of geographic, service type and general occupancy data. The DBPR database separates restaurants into full service and fast-food service establishment and for the purpose of this analysis all full service establishments are assumed to have dishwashers.

Table 6-39 summarizes the number of dishwashers identified in 2008 DBPR data and literature based capacity assumptions, as well as provides water use estimates and savings potential by dishwasher type. DBPR data for 2008 identifies 2,401 full-service restaurants in the Tampa Bay Region. Restaurant seating capacity included in DBPR data and seat-turn over assumptions obtained from literature support the estimation of peak-hour operating capacity, which then can be used to assign a specific dishwasher type to each restaurant location. Based on seating capacity estimates, door-type and conveyor technologies account for the vast majority of commercial dishwashers in the region.

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Table 6-39
Water Savings Potential for Restaurant Dishwashers

	Dishwashers	Under-Counter	Door-Type	Conveyor	Flight
Seats per Location	Unit	Rack	Rack	Rack	Dish
	Locations	258	1,429	678	36
	Seats	7,276	111,622	142,483	25,636
	Avg. Seats/DW	28.2	78.1	210.2	712.1
Operational Assumptions	Customers/Hr/Seat[9]	1.0	1.0	1.0	1.0
	Hours of Operation[10]	5.5	5.5	5.5	5.5
	Dishes per Unit (rack)	14	14	14	na
	Meals per Unit (rack)	2.85	2.85	2.85	na
	Units (rack/dish) per Day	54	151	406	19,239
Water Use (gallons per unit)	CUWCC Median Baseline	1.20	1.18	0.86	0.02
	Energy Star Median	0.79	0.79	0.45	0.01
Potential Water Savings	Gallons per Unit	0.41	0.39	0.41	0.01
	Gallons per Dishwasher (GPY)	8,145	21,458	59,951	35,112

Table 6-40 summarizes the number of available and planned interventions associated with a 20-year implementation scenario in 5-year increments by dishwasher type. Eligible measures are calculated by assuming the nrr's provided in Table 6-41 and the achievement of 100 percent market penetration rate by 2035. According to the ENERGY STAR market penetration report data provided in Table 6-42, the average penetration rate for commercial dishwashers in 2009-2010 was 78 percent.[11] In accordance with these estimates, 78 percent of new dishwashers are assumed to be compliant with Energy Star standards.

Dishwasher use is typically assessed in terms of water use per rack or water use per dish. Racks serve as the unit of measurement for most machines with exception of flight-type machines that use moving pegs to hold dishes instead. Racks are typically 20 inches by 20 inches and in general can hold two to three place settings or 14 plates for a sit down restaurant. Roughly 35 racks of dishes are produced for every 100 meals that are served, which equates to 2.85, meals or seats per rack.[12]

[9] *Birchfield J. Design and Layout of Foodservice Facilities. http://higheredbcs.wiley.com/legacy/college/birchfield/0471292095/ppt/Chapter4Slides.ppt*
[10] *Koeller and Hoffman, (2010). CUWCC Potential Best Management Practice for Commercial Dishwashers.*
[11] *ENERGY STAR market penetrations for a given year are derived by dividing ENERGY STAR qualified product shipments by total U.S. shipments.*
[12] *http://www.jesrestaurantequipment.com/jesrestaurantequipmentblog/commercial-dishwasher-buying-guide/*

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Water use reduction can be achieved by converting older inefficient machines to an Energy Star product which typically uses 40% less water than a standard dishwasher. The water savings potential estimates provided in Table 6-39 are due to Energy Star dishwasher replacement and reflect the difference in a conventional dishwasher water use and an Energy Star dishwasher water use.[13]

Table 6-40
Commercial Dishwashers
Summary of Eligible Measures After Natural Replacement and Planned Interventions

Variable	Type	2015	2020	2025	2030	2035
Measures Available After Natural Replacement	Under-Counter	123	73	43	25	15
	Door	882	624	442	313	222
	Conveyor	473	366	283	219	170
	Flight	25	19	15	12	9
Natural Replacement w/ES Products (78%)	Under-Counter	105	144	168	181	190
	Door	427	628	770	870	942
	Conveyor	160	243	308	358	396
	Flight	8	13	16	19	21
Natural Replacement w/non-HE Products (22%)	Under-Counter	30	41	47	51	53
	Door	120	177	217	245	266
	Conveyor	45	69	87	101	112
	Flight	2	4	5	5	6
Eligible Measures	Under-Counter	153	114	90	77	68
	Door	1002	801	659	559	487
	Conveyor	518	435	370	320	282
	Flight	28	23	20	17	15
Cumulative Planned Interventions	Under-Counter	3	20	36	52	68
	Door	23	139	255	371	487
	Conveyor	13	80	147	215	282
	Flight	1	4	8	11	15
Eligible Measures After Planned Interventions	Under-Counter	150	94	54	24	0
	Door	979	662	404	187	0
	Conveyor	505	354	223	106	0
	Flight	27	19	12	6	0

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[13] *Koeller and Hoffman, (2010). CUWCC Potential Best Management Practice for Commercial Dishwashers.*

Table 6-41
Commercial Dishwasher Natural Replacement Rates

Machine Type	Product Life (years)	nrr
Under Counter	10	10%
Door Type	15	7%
Conveyor	20	5%

Table 6-42
ENERGY STAR Market Penetration Summary

Year	Market Penetration
2008	83%
2009	78%
2010	74%
Average	78%

The estimated unit costs estimated for dishwasher replacements by type are provided in Table 6-43.[14] Costs vary substantially depending on the type and desired options. Given incentives ranging from $250 to $1000, the average cost of these programs ranges from $0.21/gal for a $250 conveyor intervention to $12.28/gal for a $1000 under-counter intervention.

Table 6-43
Estimates Unit Costs and Average Cost

Type	Conventional Unit Cost Average	ES Unit Cost Average	Savings, Useful Life (yrs)	Savings, Per Unit (gpy)	Gallons Saved over Useful Life	Incentive ($/measure)			Average Cost ($/1000 gallons)		
						Low	Med	Hi	Low	Med	Hi
Under-Counter	$4,900	$5,900	10	8,145	81,446	$250	$500	$1,000	$3.07	$6.14	$12.28
Door	$6,700	$8,750	15	21,458	321,873	$250	$500	$1,000	$0.78	$1.55	$3.11
Conveyor	$15,500	$19,000	20	59,951	1,199,020	$250	$500	$1,000	$0.21	$0.42	$0.83
Flight	$60,000	$60,000	20	35,112	702,242	$250	$500	$1,000	$0.36	$0.71	$1.42

6.1.5.2 Pre-Rinse Spray Valve

Pre-rinse spray valves save water in restaurants by controlling water flow in sprayers that rinse food waste from utensils and dishware before they enter a dishwasher. All full service restaurant locations assumed to have dishwashers were also assumed to have a pre-rinse spray valve (PRSV). The projected number of PRSV for the base year (2010) through the end of the forecast year (2035) is estimated based on the number of existing dishwashers from 2,401 full service restaurants in 2008. Table 6-44 summarizes the number of available and planned interventions associated with a 21-year implementation scenario in 5-year increments. Eligible measures are calculated by assuming a 10 percent nrr (10-year)[15] and a 100 percent market penetration rate by 2035.

[14] *CEE Commercial Kitchens Initiative, (2008).*

[15] *AWE Tracking Tool v2, CII Kitchen Spray Rinse Valve Replacements default.*

Table 6-44
Pre-Rinse Spray Valves
Summary of Eligible Measures After Natural Replacement and Planned Interventions

Variable	2015	2020	2025	2030	2035
Measures Available After Natural Replacement	504	165	54	18	6
Natural Replacement of HE Products	949	1,118	1,173	1,192	1,198
Eligible Measures	1,452	1,283	1,228	1,209	1,203
Cumulative Planned Interventions	57	344	630	917	1,203
Eligible Measures After Planned Interventions	1,395	939	597	292	0

Under normal operating conditions, low-flow, pre-spray valves can reduce flow rates by 46 percent, from an average of 3 gpm to 1.6 gpm for existing spray valves.[16] Newer WaterSense labeled PRSV's use as little as 1.0 gpm, but are rated at 1.28 gpm or less. WaterSense research indicates participants are generally satisfied with HE PRSVs water use ranging between 1.0 and 1.25 gpm. Contrary to 2005 CUWCC[17] findings, a 2011 WaterSense field study found HE PRSVs did not require additional use time following replacement.[18] This is perhaps due to general improvements in the technology, similar to improvements made in toilet manufacturing to address the need for multiple flushes for many toilet models produced in years immediately following the EPAct mandate of ULFT's in 1994.

According to field studies that have measured the impact of PRSV replacement, water use and savings per location vary significantly as shown in Table 6-45. This variation is due to heterogeneity of restaurant water use practices. As such, the water savings potential for PRSV's is based on the weighted average across four studies as show in Table 6-45. Table 6-46 provides the assumptions used to estimate PRSV average cost. At a unit cost of $30 per measure and a 10-year useful life (AWE Tool v2 default), the estimated average cost of the PRSV program is $0.08 per 1000 gallons of water saved.[19]

[16] *Consortium for Energy Efficiency, (2008). Commercial Kitchens Initiative.*
[17] *Tso B., Koeller, J., (2005). Pre-Rinse Spray Valve Programs: How Are They Really Doing?*
[18] *WaterSense, (2011). Pre-Rinse Spray Valves Field Study Report.*
[19] *WaterSense, (2013). Specification for Commercial Pre-Rinse Spray Valves Supporting Statement. Useful life estimates released after completion of DMP analyses in support of the WaterSense Draft Commercial Pre-Rinse Spray Valves Specification indicate the useful life of a commercial pre-rinse spray valve may be as low as 5 years. At 5-years, the water savings over the useful life would be reduced to 187,128 gpy at an average cost of $0.16/1000 gallons.*

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Table 6-45
PRSV Water Savings Potential

Variable	PRSV's	GPY
CUWCC Phase 1	18	52,157
CUWCC Phase 2	8	28,778
Washington (Starbucks)	5	8,986
Region of Waterloo	5	26,669
Subtotal/Weighted Average	**36**	**37,426**

Table 6-46
PRSV Average Cost

Variable	Estimate
Water Savings (gpy)	37,426
Useful Life (years)	10
Savings Over Useful Life	374,260
Incentive ($/measure)	$ 30
Average Cost ($/1000 gallons)	0.08

6.2 Alternative Program Development

The AWE Tool was used as the primary instrument to formulate, screen and select alternative demand management program measures and to conduct an "avoided supply cost" analysis. The program savings and penetration rate assumptions discussed in the preceding sections support the formulation of alternative programs, while the final selection of alternative programs is based on a comprehensive assessment of the net benefits and costs of fully formulated water efficiency measures.

6.2.1 Determining Benefit Cost Ratios

Both the screening process and avoided costs analysis consider the present value (PV) of total costs and benefits (cost savings) of demand management alternatives. Nominal program costs for each water efficiency measure and forecast year reflect the expected implementation costs measured nominally when the costs are incurred. Future nominal costs are estimated by adjusting the average unit program costs in 2011 dollars to account for an annual average inflation rate of 3 percent.

However, in order to assess the future value of the proposed expenditures, cost to implement water efficiency measures must be assessed in terms of constant dollars to remove the effects of inflation over time and then discounted to the time value of money (e.g., the cost to borrow). Discounting renders benefits and costs that occur in different time periods comparable by expressing their values in present terms, indicating how much future benefits and costs are worth today. It is accomplished by multiplying annual

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program costs in constant dollars by an annual discount factor. The discount factor and annual discount rates are estimated according to Equation 5 and Equation 6.

Equation 5

$$df = \frac{r - i}{1 + i}$$

Where

df = factor discount
r = nominal interest rate
i = assumed inflation rate

Equation 5

$$d_n = \frac{1}{(1 + df)^{(n-y)}}$$

Where

d_n = annual discount rate
d = discount factor
r = nominal interest rate
i = assumed inflation rate
n = current year
y = analysis start year (2010)

An annual average inflation rate of 3 percent and nominal interest rate of 4 percent is assumed to estimate discounted PV's expressed in terms of in 2011 dollars. Net present value (NPV) is the PV benefits of avoided supply cost less the PV costs of alternative program implementation. The benefit cost ratio (BCR) is the PV benefits divide by the PV costs. A positive NPV (BCR greater than one) indicates the measures would benefit the regional utility and rate payers or rather, that is, the PV of future utility costs would be lower with conservation than without it. A negative NPV (BCR ratio less than one) indicates the utility and its rate payers would face higher costs with the conservation measure implemented (i.e., a measure with a negative NPV costs more to implement than the value of the water savings it would generate).

6.2.2 Screening and Ranking

The screening process considered 24 programs / technologies, which have been either applied through existing programs in the region or elsewhere, or developed based upon specific application of technologies vs. sectoral water use. However, as previously mentioned, only 18 were judged to have information sufficient to estimate the presence of end uses and support a comprehensive assessment of efficiency potential and cost as presented in Section 6.1. These estimates provide key factors considered in screening, ranking and selection of active efficiency measures for inclusion in the DMP. The pro-

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cess utilized regional and national literature and other secondary sources, along with information gleaned from survey and analysis of regional water use characteristics.

The criteria developed include:

- Ability to identify and match water uses and applicable water technology usage
- Water saving potential
- Public acceptability(survey results or communication with utility coordinators)
- Cost effectiveness
- Administrative feasibility
- Generally accepted program penetration rates

Programs were eliminated from further consideration if:

- Significant applicability or availability to sectors in region did not exist
- Insufficient data was available to assess market potential
- Savings rates were highly variable due to programs' nature and/or were not verifiable
- Program successes were not well defined
- Avoided benefit/cost ratio was less than 1

Table 6-47 lists the water efficiency measures not meeting screening criteria. Programs not meeting the aforementioned screening criteria were usually affected by a limited life of savings coupled with high unit costs (conservative literature-based cost-estimates used). As previously mentioned, six nonresidential measures thought to be applicable to the Tampa Bay Region are excluded from the DMP due to difficulties associated with estimating presence and water savings, and thus the savings rates and cost effectiveness remain unverified as indicated in Table 6-47. The utility costs and savings useful life stated for these measures are AWE Tool (v2) default assumptions.

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Table 6-47
Water Efficiency Measures Not Meeting Screening Criteria

Activity Name	Sector	Utility Costs ($/unit)	Savings, Useful Life (yrs)	Savings, Per Unit (gpy)	Gallons Saved over Useful Life	$ per 1000 gal	BCR
Irrigation Evaluations	SF	$200	5	29,719	148,595	$1.35	0.14
Landscape/Irrigation Modifications	SF	$750	25	20,001	500,025	$1.50	0.14
Residential HE Washer	SF	$125	12	5,588	67,058	$1.86	0.05
Residential HE Washer	MF	$125	12	4,326	51,914	$2.41	0.04
NR Valve-Type Toilet (HET)	NR	$150	30	19,680	590,414	$0.25	0.25
Dishwasher, Flight	NR	$1,000	20	35,112	702,242	$1.42	0.34
Dishwasher, Under-Counter	NR	$250	20	8,145	162,891	$1.53	0.32
Dishwasher, Door	NR	$500	20	21,458	429,164	$1.17	0.42
NR Food Steamer	NR	$485	10				
Large Landscape Surveys	NR	$571	5				
Large Landscape Water Budgets	NR	$2,952	10	Unverified Water Savings / Market Potential			
Large Landscape Irrigation Controller	NR	$2,071	10				
Large Landscape/Irrigation Modifications	NR	$19,602	10				
Commercial Clothes Washers	NR	$370	9				

Although, many eliminated measures appear to be cost-effective, intervention (utility) costs are typically greater than supply benefits (i.e., negative benefit cost ratio) over the planning period, thus resulting in elimination from the DMP. As previously discussed, the BCR is the NPV benefits divide by the NPV costs. Four of the nonresidential landscape programs with positive BCRs were excluded on the premise that savings rates for these programs are highly variable due to the nature of the program and or were not verifiable.

The 10 programs meeting the screening criteria and selected for inclusion in the DMP portfolio are shown in Table 6-48. Of the 10 programs, six programs are applicable to the nonresidential (NR) sector, three to the single-family (SF) sector and one to the multi-family (MF) sector. Indoor water efficiency still exists after passive efficiency in all sectors of water use, while outdoor opportunities exist primarily in the single-family sector. While the potential for outdoor efficiency is assumed to exist in the multifamily and nonresidential sectors, the potential savings rates for these programs are highly variable due to the diversity of nonresidential properties and establishment types.

The estimates of gallons saved reflect savings over the life of each measure, which varies depending on assumptions for the last year of measure implementation, unit savings rates, and useful life of the technology. The most cost-effective program at $0.07/1000 gallons is cooling tower retrofits. The least cost-effective program selected is the Conveyor Dishwasher program at $0.42/1000 gallons.

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Table 6-48
Water Efficiency Measures Meeting Screening Criteria

Activity Name	Class	Utility Costs ($/unit)	Savings, Useful Life (yrs)	Unit Savings, (gpy)	Gallons Saved over Useful Life	$/1000 gal	BCR
Cooling Tower	NR	$1,000	10	1,386,530	13,865,300	$0.07	8.15
PRSV	NR	$30	10	37,426	374,260	$0.08	5.93
HEU (1/2 Gallon)	NR	$125	30	18,928	567,853	$0.22	1.24
ULFT (Valve-Type)	NR	$125	30	17,970	539,100	$0.23	1.29
Alternative Irrigation Source	SF	$750	25	94,034	2,350,850	$0.32	1.17
HET (Tank-Type)	NR	$125	30	12,843	385,290	$0.32	0.88
Residential HET	SF	$100	25	11,542	288,550	$0.35	1.09
ET/SMS Irrigation Controller	SF	$200	10	56,645	566,450	$0.35	1.82
Residential HET	MF	$75	25	8,111	202,775	$0.37	1.01
Conveyor Dishwasher	NR	$500	20	59,951	1,199,020	$0.42	1.08

6.2.3 Planned Interventions

Table 6-49 summarizes the cumulative number of planned interventions for each active water efficiency measure and forecast year. Water efficiency measure interventions are planned over a 21-year implementation scenario with the exception of the Alternative Irrigation Source and ET/SMS Irrigation Controller measures which cover a 17-year implementation scenario. Appendix O (Tables O-1 to O-8) provide the cumulative number of remaining interventions available and planned interventions for each the water efficiency measures by WDPA.

6.2.4 Water Savings Potential

Program water savings are based on the number of planned interventions provided in Table 6-49 as well as the unit water savings rates and savings useful life estimates provided for each measure in Table 6-48. The cumulative water savings of planned program measures are summarized in

for each forecast year, while Figure 6-2 compares water savings estimates for 2035. Appendix O (Tables O-9 to O-16) provides the cumulative annual active water savings for planned interventions by WDPA.

As shown in Figure 6-2, savings potential for selected measures vary greatly from 0.04 to 3.72 MGD. The single-family alternative irrigation source measure has the highest expected water savings at 3.72 MGD, followed by single-family HET replacement at 2.64 MGD. Together these measures account for more half of the total 12.3 MGD of program water savings estimated for 2035. Nonresidential conveyor dishwashers and PRSV

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measures have the lowest potential savings estimates at 0.04 and 0.06 MGD of water saved, respectively, with each accounting for less than 1 percent of total program savings potential. Although PRSV's have the second lowest total savings potential estimate, this measures is ranked second in terms of its BCR, meaning the measure should result in high supply cost savings benefit for minimal cost when compared to other measures.

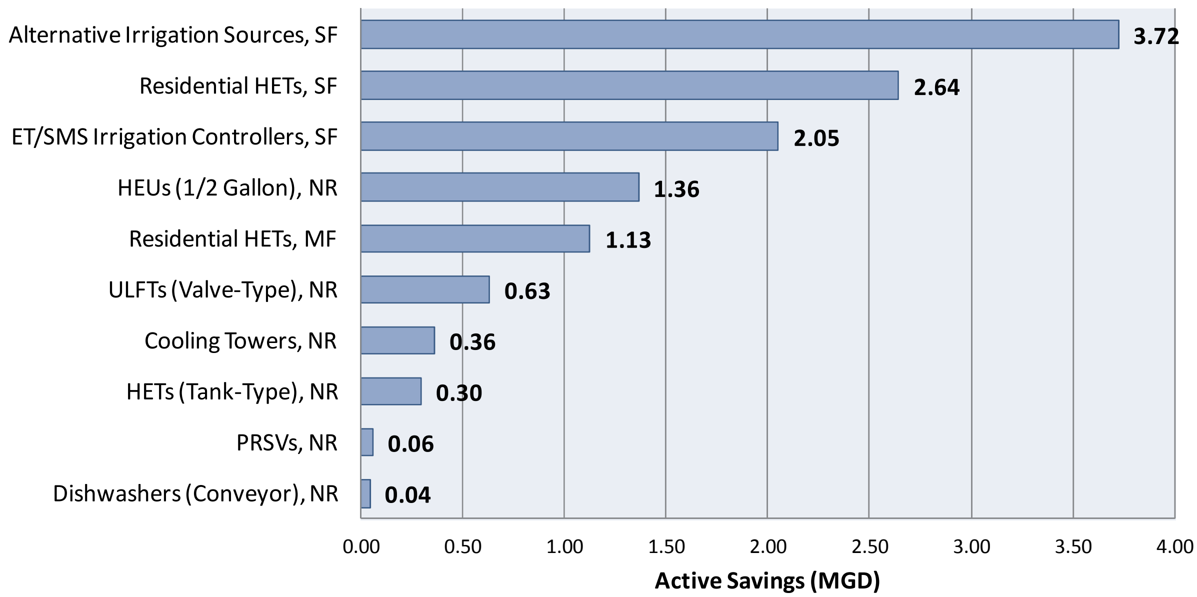

Figure 6-2: Alternative Program Total Water Savings (MGD)

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Table 6-49
Alternative Program Cumulative Planned Interventions

	SF			MF	NR					
Year	Alternative Irrigation Sources	Residential HETs	ET/SMS Irrigation Controllers	Residential HETs	ULFTs (Valve-Type)	HETs (Tank-Type)	HEUs (1/2 Gallon)	PRSVs	Dishwashers (Conveyor)	Cooling Towers
2015	0	4,144	0	2,554	686	472	1600	57	13	10
2016	0	8,289	0	5,108	1,370	941	3,199	115	27	19
2017	761	12,433	1,323	7,662	2,056	1,413	4,796	172	40	29
2018	1,521	16,578	2,646	10,217	2,740	1,883	6,396	229	54	38
2019	2,282	20,722	3,968	12,771	3,425	2,353	7,996	287	67	48
2020	3,042	24,867	5,291	15,325	4,110	2,823	9,595	344	80	57
2021	3,803	29,011	6,614	17,879	4,794	3,296	11,194	401	94	67
2022	4,563	33,156	7,937	20,433	5,478	3,765	12,793	458	107	76
2023	5,324	37,300	9,260	22,987	6,163	4,237	14,391	516	121	86
2024	6,085	41,444	10,583	25,542	6,848	4,706	15,991	573	134	95
2025	6,845	45,589	11,905	28,096	7,532	5,177	17,590	630	147	105
2026	7,606	49,733	13,228	30,650	8,218	5,647	19,190	688	161	114
2027	8,366	53,878	14,551	33,204	8,904	6,118	20,789	745	174	124
2028	9,127	58,022	15,874	35,758	9,588	6,587	22,387	802	188	134
2029	9,888	62,167	17,197	38,312	10,274	7,059	23,986	860	201	143
2030	10,648	66,311	18,519	40,867	10,958	7,528	25,586	917	215	153
2031	11,409	70,456	19,842	43,421	11,642	8,000	27,186	974	228	162
2032	12,169	74,600	21,165	45,975	12,328	8,470	28,784	1,031	241	172
2033	12,930	78,744	22,488	48,529	13,012	8,941	30,383	1,089	255	181
2034	13,690	82,889	23,811	51,083	13,697	9,413	31,981	1,146	268	191
2035	14,451	87,033	25,133	53,637	14,382	9,884	33,581	1,203	282	200

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Table 6-50
Alternative Program Cumulative Annual Water Savings (MGD)

	SF			MF	NR						
Year	**Alternative Irrigation Source**	**Residential HETs**	**ET/SMS Irrigation Controller**	**Residential HETs**	**HEU (1/2 Gallon)**	**ULFT (Valve-Type)**	**Cooling Tower**	**HET (Tank-Type)**	**PRSV**	**Dishwasher (Conveyor)**	**Total**
2015	0.00	0.13	0.00	0.06	0.08	0.03	0.00	0.02	0.00	0.00	0.32
2016	0.00	0.26	0.00	0.11	0.16	0.07	0.00	0.03	0.00	0.00	0.64
2017	0.20	0.39	0.21	0.17	0.25	0.10	0.00	0.05	0.00	0.00	1.36
2018	0.39	0.52	0.41	0.23	0.33	0.13	0.00	0.07	0.00	0.00	2.08
2019	0.59	0.65	0.62	0.28	0.40	0.17	0.00	0.08	0.00	0.00	2.79
2020	0.78	0.78	0.82	0.34	0.48	0.20	0.04	0.10	0.01	0.00	3.54
2021	0.98	0.91	1.03	0.39	0.56	0.23	0.08	0.11	0.01	0.00	4.30
2022	1.18	1.04	1.23	0.45	0.63	0.26	0.11	0.13	0.02	0.01	5.05
2023	1.37	1.17	1.44	0.50	0.70	0.29	0.15	0.14	0.02	0.01	5.79
2024	1.56	1.29	1.64	0.55	0.77	0.32	0.19	0.16	0.03	0.01	6.52
2025	1.76	1.42	1.85	0.61	0.83	0.35	0.23	0.17	0.04	0.01	7.27
2026	1.96	1.54	2.05	0.66	0.90	0.38	0.27	0.18	0.04	0.02	8.01
2027	2.16	1.67	2.05	0.72	0.96	0.41	0.30	0.20	0.05	0.02	8.53
2028	2.34	1.79	2.05	0.77	1.02	0.44	0.34	0.21	0.05	0.02	9.03
2029	2.55	1.92	2.05	0.82	1.08	0.47	0.38	0.22	0.06	0.02	9.57
2030	2.74	2.04	2.05	0.87	1.13	0.50	0.38	0.24	0.06	0.02	10.04
2031	2.94	2.16	2.05	0.92	1.18	0.53	0.38	0.25	0.06	0.03	10.50
2032	3.13	2.28	2.05	0.97	1.23	0.55	0.38	0.26	0.06	0.03	10.93
2033	3.33	2.40	2.05	1.03	1.28	0.58	0.38	0.27	0.06	0.03	11.41
2034	3.53	2.52	2.05	1.08	1.32	0.61	0.38	0.28	0.06	0.03	11.87
2035	3.72	2.64	2.05	1.13	1.36	0.63	0.38	0.30	0.06	0.04	12.31
% of 2035 Total	30.24%	21.47%	16.67%	9.15%	11.08%	5.13%	3.09%	2.40%	0.48%	0.29%	100%

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Figure 6-3 compares annual savings estimates for the residential and nonresidential sectors. Residential savings estimates includes three single-family and one multifamily residential measure as provided in Table 6-49, while the nonresidential sector savings are associated with the remaining six programs.

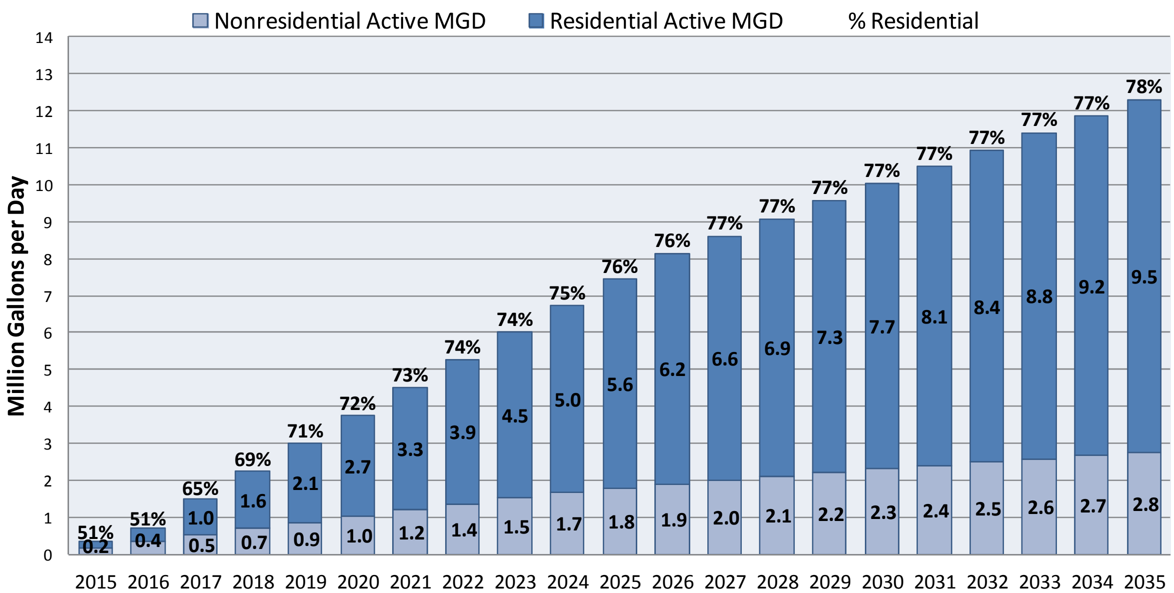

Figure 6-3: Residential and Nonresidential Active Savings (MGD)

Overall, residential water savings shown in Figure 6-3 increase at a much faster pace and account for a much greater proportion of the overall savings potential then the non-residential measures. Since all programs target a constant proportion of eligible measures over the forecast, the change in growth can be attributed to the introduction of residential landscape measures in 2017. By 2035, residential program savings are estimated to account for 78 percent (9.5 MGD) of program savings while, nonresidential programs account for the remaining 22 percent at 2.8 MGD.

6.2.5 Program Costs

Estimates of the total annual nominal costs to implement the planned interventions provided in Table 6-49 are provided in Table 6-51 for each forecast year. These costs reflect the constant annual variable utility costs provided in Table 6-48, measured nominally when cost are incurred (i.e. annual program budget). Table 6-52 and Table 6-53 provide annual and cumulative PV costs (discounted) of planned interventions, while Figure 6-2 provides a comparison of the total PV cost expenditures associated with each

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measure by 2035. The PV discounted cost estimates reflect the time value of money (e.g., the cost to borrow) adjusted for inflation, indicating how much future benefits and costs are worth today. Annual nominal, annual PV and cumulative PV costs for planned interventions are provided by WDPA in Appendix O (Tables O-17 to O-40).

The single-family alternative irrigation source and HET programs result in the highest cumulative PV costs at $9.3M and $7.6M, respectively. Similar to the savings estimates, these programs also account for more than half of the total program costs estimated PV at $31.3M. Although there are a variety of other programs which cost less in absolute terms, identification of programs with the greatest monetary benefits occurs through assessment of BCR's reflecting PV costs and benefits detailed in Section 5.3.

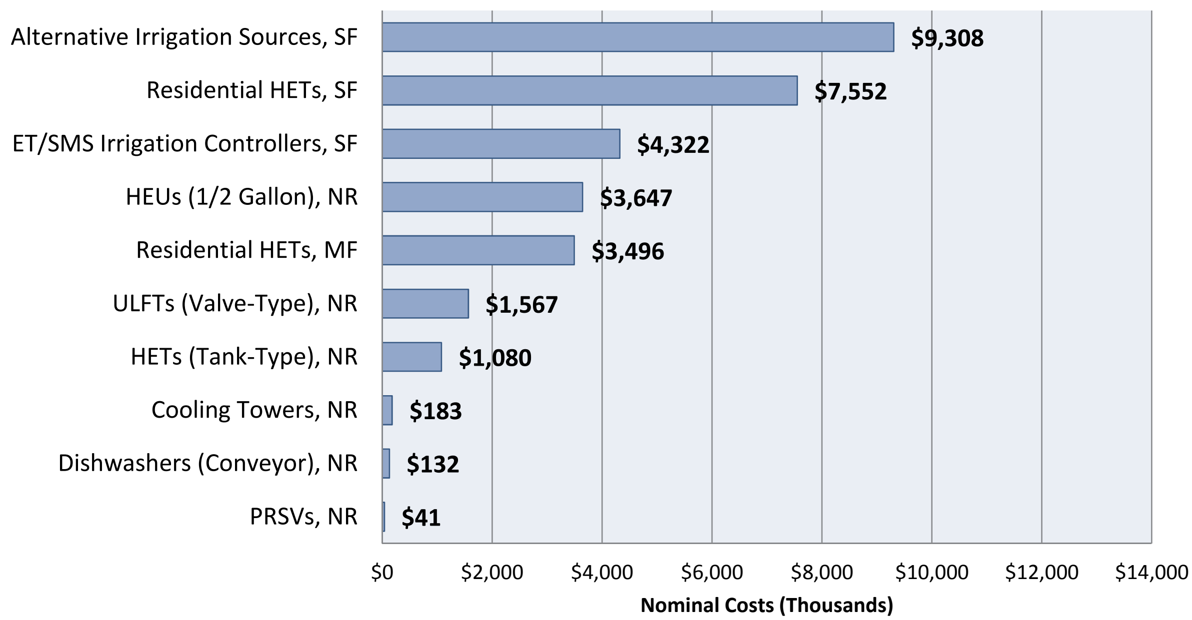

Figure 6-4: Alternative Program Cumulative Nominal Costs ($ Thousands)

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Table 6-51
Alternative Program Nominal Annual Costs

Year	Total Annual Program Budget ($/Yr)	Single-Family			Multifamily	Nonresidential					
		Alternative Irrigation Sources	Residential HETs	ET/SMS Irrigation Controllers	Residential HETs	HEUs (1/2 Gallon)	ULFTs (Valve-Type)	Cooling Towers	HETs (Tank-Type)	PRSVs	Dishwashers (Conveyor)
2015	$1,195,044	$-	$490,970	$-	$226,860	$236,229	$107,607	$23,920	$77,468	$13,190	$18,800
2016	$1,138,153	$-	$494,107	$-	$222,073	$231,723	$99,242	$13,045	$68,199	$1,993	$7,771
2017	$2,193,210	$693,070	$508,930	$327,843	$228,735	$238,674	$102,219	$13,437	$70,245	$2,053	$8,004
2018	$2,234,409	$701,563	$524,198	$325,379	$235,597	$245,835	$105,286	$13,840	$72,352	$2,114	$8,245
2019	$2,301,441	$722,610	$539,924	$335,141	$242,665	$253,210	$108,445	$14,255	$74,523	$2,178	$8,492
2020	$2,370,485	$744,288	$556,121	$345,195	$249,945	$260,806	$111,698	$14,683	$76,759	$2,243	$8,747
2021	$2,441,599	$766,617	$572,805	$355,551	$257,443	$268,630	$115,049	$15,123	$79,061	$2,310	$9,009
2022	$2,514,847	$789,616	$589,989	$366,217	$265,167	$276,689	$118,500	$15,577	$81,433	$2,380	$9,279
2023	$2,590,292	$813,304	$607,689	$377,204	$273,122	$284,990	$122,055	$16,044	$83,876	$2,451	$9,558
2024	$2,668,001	$837,703	$625,920	$388,520	$281,315	$293,539	$125,717	$16,525	$86,392	$2,525	$9,844
2025	$2,748,041	$862,834	$644,697	$400,175	$289,755	$302,346	$129,489	$17,021	$88,984	$2,600	$10,140
2026	$2,830,483	$888,719	$664,038	$412,181	$298,448	$311,416	$133,373	$17,532	$91,654	$2,678	$10,444
2027	$2,915,397	$915,381	$683,959	$424,546	$307,401	$320,758	$137,374	$18,058	$94,403	$2,759	$10,757
2028	$3,002,859	$942,842	$704,478	$437,282	$316,623	$330,381	$141,496	$18,599	$97,235	$2,841	$11,080
2029	$3,092,945	$971,128	$725,612	$450,401	$326,122	$340,293	$145,740	$19,157	$100,152	$2,927	$11,412
2030	$3,185,733	$1,000,262	$747,381	$463,913	$335,905	$350,501	$150,113	$19,732	$103,157	$3,015	$11,755
2031	$3,281,305	$1,030,269	$769,802	$477,830	$345,982	$361,016	$154,616	$20,324	$106,252	$3,105	$12,107
2032	$3,379,744	$1,061,177	$792,896	$492,165	$356,362	$371,847	$159,255	$20,934	$109,439	$3,198	$12,471
2033	$3,481,136	$1,093,013	$816,683	$506,930	$367,053	$383,002	$164,032	$21,562	$112,722	$3,294	$12,845
2034	$3,585,571	$1,125,803	$841,184	$522,138	$378,064	$394,492	$168,953	$22,209	$116,104	$3,393	$13,230
2035	$3,693,138	$1,159,577	$866,419	$537,802	$389,406	$406,327	$174,022	$22,875	$119,587	$3,495	$13,627
Total	$56,843,833	$17,119,778	$13,767,802	$7,946,414	$6,194,044	$6,462,703	$2,774,281	$374,452	$1,909,999	$66,742	$227,619
% of Total	100%	30.12%	24.22%	13.98%	10.90%	11.37%	4.88%	0.66%	3.36%	0.12%	0.40%

Note: Costs incurred during the first implementation year for each program include $10,000 in fixed initial costs.

Table 6-52
Alternative Program Present Value Annual Costs

Year	Total PV Costs	SF			MF	NR					
		Alternative Irrigation Sources	Residential HETs	ET/SMS Irrigation Controllers	Residential HETs	HEUs (1/2 Gallon)	ULFTs (Valve-Type)	Cooling Towers	HETs (Tank-Type)	PRSVs	Dishwashers (Conveyor)
2015	$1,011,706	$0	$415,648	$0	$192,056	$199,988	$91,098	$20,251	$65,583	$11,166	$15,916
2016	$926,484	$0	$402,215	$0	$180,773	$188,628	$80,786	$10,619	$55,516	$1,622	$6,326
2017	$1,716,659	$542,476	$398,347	$256,608	$179,035	$186,814	$80,009	$10,517	$54,982	$1,607	$6,265
2018	$1,681,641	$528,004	$394,517	$244,884	$177,313	$185,018	$79,239	$10,416	$54,453	$1,591	$6,205
2019	$1,665,471	$522,927	$390,724	$242,529	$175,608	$183,239	$78,477	$10,316	$53,930	$1,576	$6,145
2020	$1,649,457	$517,899	$386,967	$240,197	$173,920	$181,477	$77,723	$10,217	$53,411	$1,561	$6,086
2021	$1,633,597	$512,919	$383,246	$237,888	$172,247	$179,732	$76,976	$10,118	$52,897	$1,546	$6,028
2022	$1,617,889	$507,987	$379,561	$235,600	$170,591	$178,004	$76,235	$10,021	$52,389	$1,531	$5,970
2023	$1,602,332	$503,103	$375,911	$233,335	$168,951	$176,292	$75,502	$9,925	$51,885	$1,516	$5,912
2024	$1,586,925	$498,265	$372,297	$231,091	$167,326	$174,597	$74,776	$9,829	$51,386	$1,502	$5,855
2025	$1,571,666	$493,474	$368,717	$228,869	$165,717	$172,918	$74,057	$9,735	$50,892	$1,487	$5,799
2026	$1,556,554	$488,729	$365,171	$226,669	$164,124	$171,256	$73,345	$9,641	$50,403	$1,473	$5,743
2027	$1,541,587	$484,030	$361,660	$224,489	$162,546	$169,609	$72,640	$9,548	$49,918	$1,459	$5,688
2028	$1,526,764	$479,376	$358,183	$222,331	$160,983	$167,978	$71,942	$9,457	$49,438	$1,445	$5,634
2029	$1,512,084	$474,767	$354,739	$220,193	$159,435	$166,363	$71,250	$9,366	$48,963	$1,431	$5,579
2030	$1,497,545	$470,201	$351,328	$218,076	$157,902	$164,763	$70,565	$9,276	$48,492	$1,417	$5,526
2031	$1,483,145	$465,680	$347,949	$215,979	$156,384	$163,179	$69,886	$9,186	$48,026	$1,403	$5,473
2032	$1,468,884	$461,203	$344,604	$213,902	$154,880	$161,610	$69,214	$9,098	$47,564	$1,390	$5,420
2033	$1,454,760	$456,768	$341,290	$211,845	$153,391	$160,056	$68,549	$9,011	$47,107	$1,377	$5,368
2034	$1,440,772	$452,376	$338,009	$209,808	$151,916	$158,517	$67,890	$8,924	$46,654	$1,363	$5,316
2035	$1,426,919	$448,026	$334,759	$207,791	$150,455	$156,993	$67,237	$8,838	$46,205	$1,350	$5,265
Total PV Costs	$31,572,843	$9,308,213	$7,765,839	$4,322,083	$3,495,551	$3,647,028	$1,567,397	$214,308	$1,080,091	$40,813	$131,520
Distribution of Total PV Costs	100%	29.48%	24.60%	13.69%	11.07%	11.55%	4.96%	0.68%	3.42%	0.13%	0.42%

Note: Costs incurred during the first implementation year for each program include $10,000 in fixed initial costs.

Table 6-53
Alternative Program Present Value Cumulative Costs

Year	Total PV Costs	Single-Family			Multifamily	Nonresidential					
		Alternative Irrigation Sources	Residential HETs	ET/SMS Irrigation Controllers	Residential HETs	HEUs (1/2 Gallon)	ULFTs (Valve-Type)	Cooling Towers	HETs (Tank-Type)	PRSVs	Dishwashers (Conveyor)
2015	$ 1,011,706	$0	$415,648	$0	$192,056	$199,988	$91,098	$20,251	$65,583	$11,166	$15,916
2016	$1,938,190	$0	$817,863	$0	$372,829	$388,615	$171,884	$30,870	$121,099	$12,789	$22,242
2017	$3,654,849	$542,476	$1,216,210	$256,608	$551,863	$575,429	$251,892	$41,387	$176,080	$14,395	$28,507
2018	$5,336,490	$1,070,481	$1,610,727	$501,491	$729,176	$760,447	$331,132	$51,803	$230,533	$15,987	$34,712
2019	$7,001,961	$1,593,408	$2,001,450	$744,021	$904,785	$943,686	$409,609	$62,119	$284,463	$17,563	$40,857
2020	$8,651,417	$2,111,307	$2,388,417	$984,218	$1,078,704	$1,125,163	$487,332	$72,335	$337,874	$19,124	$46,944
2021	$10,285,014	$2,624,226	$2,771,663	$1,222,106	$1,250,951	$1,304,895	$564,308	$82,454	$390,771	$20,669	$52,971
2022	$11,902,903	$3,132,214	$3,151,223	$1,457,706	$1,421,542	$1,482,898	$640,543	$92,475	$443,160	$22,200	$58,941
2023	$13,505,236	$3,635,316	$3,527,135	$1,691,041	$1,590,493	$1,659,190	$716,046	$102,399	$495,045	$23,717	$64,853
2024	$15,092,161	$4,133,582	$3,899,431	$1,922,132	$1,757,819	$1,833,787	$790,822	$112,229	$546,431	$25,218	$70,709
2025	$16,663,827	$4,627,056	$4,268,148	$2,151,002	$1,923,537	$2,006,706	$864,879	$121,963	$597,323	$26,705	$76,508
2026	$18,220,382	$5,115,786	$4,633,319	$2,377,670	$2,087,661	$2,177,961	$938,225	$131,604	$647,726	$28,178	$82,252
2027	$19,761,969	$5,599,816	$4,994,979	$2,602,159	$2,250,206	$2,347,570	$1,010,865	$141,153	$697,644	$29,637	$87,940
2028	$21,288,734	$6,079,192	$5,353,162	$2,824,490	$2,411,189	$2,515,548	$1,082,806	$150,610	$747,082	$31,082	$93,573
2029	$22,800,818	$6,553,958	$5,707,901	$3,044,683	$2,570,624	$2,681,911	$1,154,056	$159,975	$796,045	$32,513	$99,153
2030	$24,298,362	$7,024,160	$6,059,228	$3,262,758	$2,728,526	$2,846,674	$1,224,621	$169,251	$844,537	$33,930	$104,678
2031	$25,781,508	$7,489,840	$6,407,178	$3,478,737	$2,884,909	$3,009,853	$1,294,507	$178,437	$892,562	$35,333	$110,151
2032	$27,250,392	$7,951,042	$6,751,782	$3,692,639	$3,039,789	$3,171,463	$1,363,722	$187,536	$940,126	$36,723	$115,571
2033	$28,705,152	$8,407,810	$7,093,072	$3,904,484	$3,193,180	$3,331,519	$1,432,270	$196,546	$987,233	$38,100	$120,939
2034	$30,145,925	$8,860,186	$7,431,081	$4,114,292	$3,345,096	$3,490,035	$1,500,160	$205,470	$1,033,886	$39,463	$126,255
2035	$31,572,843	$9,308,213	$7,765,839	$4,322,083	$3,495,551	$3,647,028	$1,567,397	$214,308	$1,080,091	$40,813	$131,520

Note: Costs incurred during the first implementation year for each program include $10,000 in fixed initial costs

6.3 Avoided Cost Analysis

Greater efficiency can lead to avoided or deferred variable costs of supplies (current and future) and capital costs (future). The "avoided supply cost" analysis compares the benefits of various increments of conserved water to the variable operating cost of existing water supplies and total cost of new supply development. Consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water supply alternatives. Additionally, decreased water consumption should also prolong the operating life of water and wastewater treatment facilities.

6.3.1 Supply Cost Assumptions

Tampa Bay Water planning and operational data used, Table 6-54, included 2011 actual O&M costs for the actual supply mix and planning level capital cost of new supply increments ($15-18M per MGD in 2008 dollars), if and when system expansion might be necessary.

Table 6-54
Tampa Bay Water Planning and Operation Water Supply Variable O&M Costs (2011$)

Variable	$/MG	Nominal Rate of Increase %/Yr
Water Purchase Cost	$26.23	3.30%
Energy for Transmission, Treatment, Distribution	$184.20	3.30%
Chemicals	$141.52	3.30%
Total Variable O&M	$351.95	3.30%

6.3.2 Supply Mix versus Time Assumptions

Tampa Bay Water's regional demand forecast indicates that future demand for water will increase. In response to increasing demands, the Agency will increase its use of more expensive O&M based supplies within the regional mix. Tampa Bay Water is currently evaluating the performance of its regional water supply system and has preliminary results on regional sustainable supplies. These results were assumed in the "avoided supply" cost analysis. The analysis considers ability to meet demands given some minimum desalination requirement. Any desalination use over this amount could be considered an "avoidable" operational cost for the "avoided cost" analysis (2011 variable O&M costs for the desalination facility is estimated at $1,857.05/MG). The supply threshold assumptions regarding the desalination plant average day and peak season average day demand used to estimate avoided O&M costs are shown in Appendix P.

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6.3.3 Active Water Savings Scenarios

Benefits for alternative programs are avoided or deferred variable costs of supplies (current and future) and capital costs (future). The PV benefit-cost comparisons (at present value, 2011 dollars) for active programs are provided in Table 6-55 and further illustrated in Figure 6-5.

All active programs in Table 6-55, with the exception of the nonresidential HET tank-type program, have positive BCRs and NPV's due to the PV supply benefits exceeding the PV implementation costs. As shown in Table 6-55, the BCRs for the selected programs vary from about 0.88 for nonresidential HETs to 8.15 for cooling tower interventions. Although the tank-type HET program has a negative BCR, it is assumed this is primarily due to restricting the existence of tank-type toilets to a limited number of sectors with lower rates of use as previously discussed in Section 5.1.3. As it is difficult to ascertain the demand for either type of intervention, the nonresidential HET and ULFT programs are considered one program from a CB perspective as show in Table 6-56, resulting in a positive BCR greater than that of the single-family HET program at 1.16.

Table 6-55
PV Benefits and Costs for Selected Active Measures (2011$)

Activity Name	Class	PV Cost	PV Benefit	Net PV	% of Total NPV	BCR
Cooling Towers	NR	$183,139	$1,491,811	$1,308,673	15%	8.15
PRSVs	NR	$40,813	$241,877	$201,064	2%	5.93
ET/SMS Irrigation Controllers	SF	$4,322,083	$7,854,281	$3,532,198	41%	1.82
ULFTs (Valve-Type)	NR	$1,567,397	$2,014,204	$446,807	5%	1.29
HEUs (1/2 Gallon)	NR	$3,647,028	$4,527,763	$880,734	10%	1.24
Alternative Irrigation Sources	SF	$9,308,213	$10,918,815	$1,610,602	19%	1.17
Residential HETs	SF	$7,551,533	$8,262,493	$710,960	8%	1.09
Dishwashers (Conveyor)	NR	$131,520	$141,523	$10,003	0%	1.08
Residential HETs	MF	$3,495,551	$3,536,948	$41,397	0%	1.01
HETs (Tank-Type)	NR	$1,080,091	$954,797	$(125,294)	-1%	0.88
	Total	$31,327,367	$39,944,511	$8,617,144	100%	1.28

Table 6-56
Present Value of Benefits and Costs with
Nonresidential ULFT and HET Measures Combined (2011$)

Activity Name	Sector	PV Cost	PV Benefit	NPV	BCR
ULFTs (Valve-Type)	NR	$1,567,397	$2,014,204	$446,807	1.29
HETs (Tank-Type)	NR	$1,080,091	$954,797	($125,294)	0.88
ULFTs and HETs	**NR**	**$2,647,488**	**$2,969,001**	**$321,513**	**1.16**

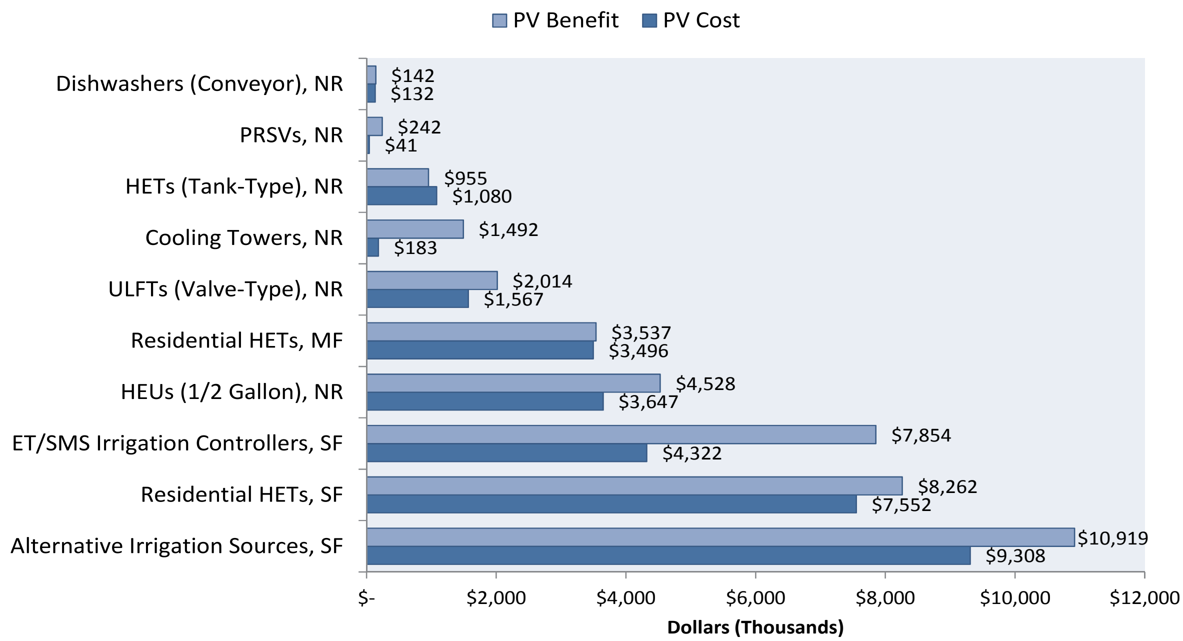

Figure 6-5: Present Value of Benefits and Costs (2011$)

Table 6-57 compares the BCR, NPV and water savings rankings across the selected measures. Following cooling towers, the PRSV and ET/SMS Irrigation Controller programs have the highest BCRs at 5.93 and 1.82, respectively. Although each program has significant benefits, the cooling tower and PRSV measures account for only 3.1 and 0.5 percent of total program savings, while the ET/SMS Irrigation Controller program ranks third at 16.7 percent of the total 12.3 MGD of program savings. Individually, nonresidential the ULFT and HET programs rank fourth and tenth in terms of BCR and sixth and eighth in terms of program water savings. Combined as weighted average, the nonresidential ULFT and HET BCR of 1.16 as previously provided in Table 6-56 reduces the nonresidential ULFT ranking from fourth to sixth as compared to the remaining eight measures shown in Table 6-58. With a NPV of $321K, this measure maintains the ULFT standing in sixth placed, and ranks second in terms of total water savings. Both the single-family and multifamily HET measures fall in the bottom three, along with nonresidential dishwashers.

It should be noted, however, measures with the highest BCR's do not necessarily correspond to the greatest total return, or NPV. For example, the Alternative Irrigation Sources measure ranks sixth in terms of BCR, but second in terms of total net benefits. Conversely, the PRSV program has the second highest BCR, but only offers $200K in total net benefits, ranking seventh. On the other hand, Cooling Towers and ET/SMS Irrigation Controllers both rank in the top three in terms of BCR and net benefits, accounting for more than half of the total net benefit across all programs. While all selected measures are deemed to have a positive NPV regardless of the level of capital outlay, implementation strategies should be tailored to consider key factors affecting long-term effects, including the level of return on investment and total savings potential.

Table 6-57
Comparison of BCR, NPV and Water Savings Ranks

Activity Name	Class	BCR	NPV	Savings MGD	% of Water Savings	BCR Rank	Net PV Rank	Water Savings Rank
Cooling Towers	NR	8.15	$1,308,673	0.38	3.1%	1	3	7
PRSVs	NR	5.93	$201,064	0.06	0.5%	2	7	9
ET/SMS Irrigation Controllers	SF	1.82	$3,532,198	2.05	16.7%	3	1	3
ULFTs (Valve-Type)	NR	1.29	$446,807	0.63	5.1%	4	6	6
HEUs (1/2 Gallon)	NR	1.24	$880,734	1.36	11.1%	5	4	4
Alternative Irrigation Sources	SF	1.17	$1,610,602	3.72	30.2%	6	2	1
Residential HETs	SF	1.09	$710,960	2.64	21.5%	7	5	2
Dishwashers (Conveyor)	NR	1.08	$10,003	0.04	0.3%	8	9	10
Residential HETs	MF	1.01	$41,397	1.13	9.2%	9	8	5
HETs (Tank-Type)	NR	0.88	($125,294)	0.3	2.4%	10	10	8
Total		**1.28**	**$8,617,144**	**12.31**	**100%**			

Table 6-58
Comparison of BCR, NPV and Water Savings Ranks
with Nonresidential ULFT and HET Measures Combined

Activity Name	Class	BCR	NPV	Savings MGD	% of Savings	BCR Rank	Net PV Rank	Savings Rank
Cooling Towers	NR	8.15	$1,308,673	0.38	3.1%	1	3	7
PRSVs	NR	5.93	$201,064	0.06	0.5%	2	7	8
ET/SMS Irrigation Controllers	SF	1.82	$3,532,198	2.05	16.7%	3	1	4
HEUs (1/2 Gallon)	NR	1.24	$880,734	1.36	11.0%	4	4	5
Alternative Irrigation Sources	SF	1.17	$1,610,602	3.72	30.2%	5	2	1
ULFTs and HETs	NR	1.16	$321,513	2.64	21.5%	6	6	2
Residential HETs	SF	1.09	$710,960	2.64	21.4%	7	5	3
Dishwashers (Conveyor)	NR	1.08	$10,003	0.04	0.3%	8	9	9
Residential HETs	MF	1.01	$41,397	1.13	9.2%	9	8	6
Total		**1.28**	**$8,617,144**	**12.31**	**100%**			

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As previously stated, an annual average inflation rate of 3 percent and nominal interest rate of 4 percent is assumed to estimate PV benefits and costs expressed in terms of in 2011 dollars. However, according to Tampa Bay Water's 2013 Annual Budget, Capital Improvement Program all-in true interest costs range between 4 and 5 percent. As such, the cost-benefit analysis considers a range of PV costs and benefits. Table 6-59, provides a comparison of the NPV at 4 and 5 percent nominal interest rates. Given a 1 percent increase in nominal interest, multifamily HET PV costs exceed PV benefits, thus resulting in negative NPV and BCR. While all other measures maintain positive NPV, including the combined nonresidential ULFT and HET measures as shown in Table 6-60, overall program net benefits are reduced by $2.9M.

Table 6-59
Comparison of Present Value Net Benefits at Alternative Nominal Interest Rates

		4% Nominal Interest Rate		5% Nominal Interest Rate		
Activity	**Class**	**PV Net Benefits**	**BCR**	**PV Net Benefits**	**BCR**	**PV Net Benefits Difference**
Alternative Irrigation Sources	SF	$1,610,602	1.17	$918,004	1.11	$(692,598)
Residential HETs	SF	$710,960	1.09	$219,671	1.03	$(491,289)
ET/SMS Irrigation Controllers	SF	$3,532,198	1.82	$2,772,269	1.74	$(759,929)
Residential HETs	MF	$41,397	1.01	$(134,797)	0.96	$(176,193)
HEUs (1/2 Gallon)	NR	$880,734	1.24	$557,485	1.18	$(323,249)
ULFTs (Valve-Type)	NR	$446,807	1.29	$292,593	1.21	$(154,214)
Cooling Towers	NR	$1,308,673	8.15	$1,081,807	7.75	$(226,866)
HETs (Tank-Type)	NR	$(125,294)	0.88	$(154,725)	0.84	$(29,430)
PRSVs	NR	$201,064	5.93	$165,059	5.54	$(36,005)
Dishwashers (Conveyor)	NR	$10,003	1.08	$1,092	1.01	$(8,911)
	Total	**$8,617,144**	**1.28**	**$5,718,460**	**1.21**	**$(2,898,684)**

Table 6-60
Comparison of Present Value Net Benefits at Alternative Nominal Interest Rates with Nonresidential ULFT and HET Measures Combined (2011$)

		4% Nominal Interest Rate		5% Nominal Interest Rate		
Activity	**Class**	**PV Net Benefits**	**B/C Ratio**	**PV Net Benefits**	**B/C Ratio**	**PV Net Benefits Difference**
ULFTs (Valve-Type)	NR	$446,807	1.29	$292,593	1.21	$(154,214)
HETs (Tank-Type)	NR	$(125,294)	0.88	$(154,725)	0.84	$(29,430)
ULFTs and HETs	NR	$321,513	1.12	$137,869	1.06	$(183,644)

6.3.4 Demand Forecast Scenarios with Passive and Active Water Savings

Using the AWE Tool, impacts of passive water savings and potential active demand management alternatives on Tampa Bay Water's reliability-based 75th percentile baseline demand forecast were quantified.[20] Water savings are compared to a reliability-based forecast as a means to evaluate the effect of conservation on supply reliability under the agencies unequivocal obligation to provide water to its members. Table 6-61 presents the 2010-2035 baseline water demand projections in five-year increments as compared to the demand projections produced when passive and active demand management programs are considered. Table 6-62 presents the water savings associated with passive and active demand management programs in both absolute and relative terms, while Figure 6-6 illustrates the magnitude of water demand reductions from both passive and active savings relative to the 75th percentile baseline demand forecast and current sustainable system capacity over the planning horizon.

Table 6-61
Comparison of Demand Projections Scenarios with Passive and Active Savings

Forecast Scenario (75th percentile)	Projected Water Demand (MGD)						Absolute Change	% Change 2008-2035	Average Annual % Change
	2010	2015	2020	2025	2030	2035			
Baseline Demand	222.2	249.3	263.3	277.8	289.7	301.5	79.3	35.7%	1.23%
Passive Savings	222.2	242.8	250.4	260.0	267.8	276.0	53.8	24.2%	0.87%
Passive/Active Savings	222.2	242.4	246.9	252.7	257.8	263.7	41.5	18.7%	0.69%

Table 6-62
Projected Water Savings from Passive and Active Water Conservation

Forecast Scenario (75th percentile)	Projected Water Savings (MGD) / Percent Reduction					
	2010	2015	2020	2025	2030	2035
Passive Savings	0/0	6.6/2.6	12.9/4.9	17.8/6.4	21.9/7.6	25.5/8.5
Active Savings	0/0	0.3/0.1	3.5/1.3	7.3/2.6	10.0/3.5	12.3/4.1
Passive and Active Savings	0/0	6.9/2.8	16.4/6.2	25.1/9.0	31.9/11	37.8/12.5

As shown in Table 6-61, total 75th percentile baseline demands are projected to increase at an annualized average rate of 1.23 percent per year to about 302 MGD in 2035. This represents a 36 percent (79 MGD) increase in total baseline demands from the 2010 base year. However, given the expected impact of passive programs (i.e., existing and new plumbing codes), this projected increase is reduced by 54 MGD (or 24

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[20] The primary function of the AWE Tracking Tool (v2) was to calculate and summarize the results of the avoided cost analysis. The AWE Tool was customized to accommodate use of product saturation rates, market penetration/potential and passive and active savings estimates tailored to Tampa Bay Water's long-term demand forecast and other region-specific conditions as previously described herein.

percent) from 302 MGD to 276 MGD. As shown in Table 6-62, this 26 MGD reduction corresponds to an 8.5 percent reduction in baseline production demands for 2035.

By 2035, approximately 38 MGD of water use reduction and savings potential associated with passive and active demand management programs is identified. Of this total, 25.5 MGD of water use reduction is associated solely with the impact of new plumbing codes, and the estimated additional savings from active programs is 12.3 MGD (Table 6-62). If the savings from passive and active conservation are fully realized, 2035 baseline demand would be reduced by 12.5 percent from 301.5 to 263.7 MGD.

The AWE Tool permits savings and costs to be evaluated over a 60-year planning horizon (2010-2069) allowing savings rates in this analysis to fully mature over the life of the technology installed (note that no active technology installed lasts more than 30 years). For example, if HET with a 25-year life is installed in 2035, the savings and avoided costs are realized through 2065.

The life of program savings associated with the demand management alternatives previously discussed exists in part through the end of 2064. Therefore, net avoided costs of viable demand management alternatives were evaluated over two separate timeframes shown in over the total life of all savings and over the 2035 forecast horizon.

When the cost and benefits of the collective portfolio of viable demand management alternatives are evaluated over the total life of the savings (through the end of 2064), a NPV of $25.8 million in benefits was identified as shown in Table 6-63. Given these benefits and costs, the collective portfolio of demand management alternatives has a B/C ratio (benefits / costs) of 1.82. As exemplified by the BCRs in Table 6-64, extending the life of the program savings also adds net benefits for individual measures.

Table 6-63
Net Present Value (NPV) of Avoided Costs

	PV Cost ($M)	PV Benefit ($M)	NPV ($M)	BCR
Life of Savings to 2065	$31.3	$57.1	$25.8	1.82
Life of Savings to 2035	$31.3	$39.9	$8.6	1.28

In terms of total net avoided cost, a NPV estimate of $25.8 million is likely a conservative estimate as avoided costs for supply increments beyond the 2035 forecast horizon were held constant as 2035 levels (since demand projections do not exist for periods beyond this point). When cost and benefits are evaluated though the forecast horizon only, the NPV of avoided costs remains positive but is reduced to $8.6 million, with PV costs remaining at $31.3 million, and PV benefits estimated at $39.9 million by 2035.

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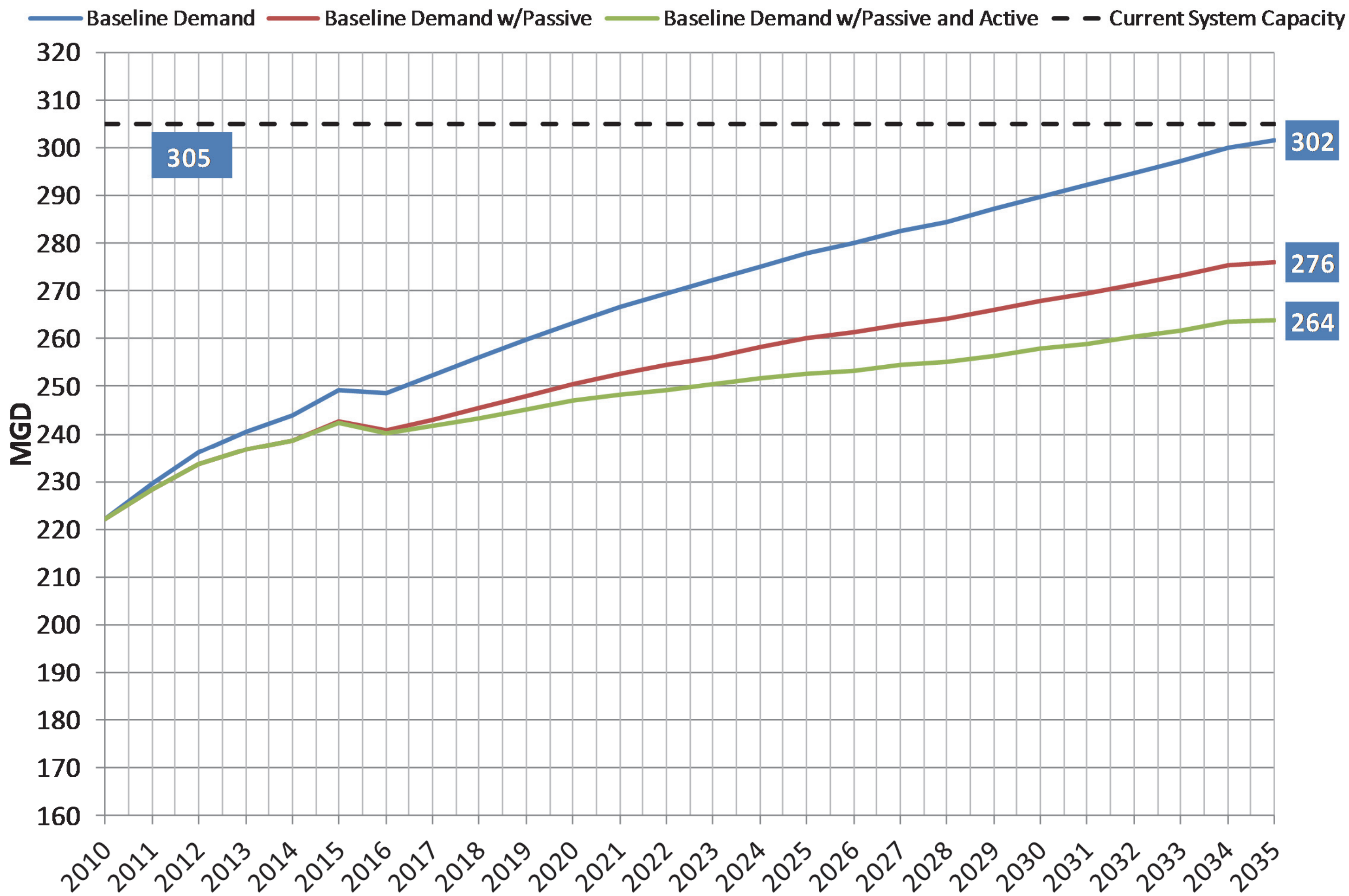

Figure 6-6: Demand Forecast with Passive and Active Efficiency

Table 6-64
Comparison of 2035 and 2065 PV Benefits and Costs for Selected Active Measures (2011$)

Activity Name	Sector	PV Cost	PV Benefit		BCR	
			2035	2065	2035	2065
Cooling Towers, NR	NR	$189,502	$1,491,811	$1,664,368	8.15	9.09
PRSVs, NR	NR	$42,054	$241,877	$269,855	5.93	6.61
ET/SMS Irrigation Controllers, SF	SF	$4,488,820	$7,854,281	$8,831,759	1.82	2.04
ULFTs (Valve-Type), NR	NR	$1,623,576	$2,014,204	$3,286,213	1.29	2.10
HEUs (1/2 Gallon), NR	NR	$3,778,048	$4,527,763	$7,444,875	1.24	2.04
Alternative Irrigation Sources, SF	SF	$9,667,537	$10,918,815	$16,624,847	1.17	1.79
Residential HETs, SF	SF	$7,823,066	$8,262,493	$12,083,624	1.09	1.60
Dishwashers (Conveyor), NR	NR	$136,025	$141,523	$184,837	1.08	1.41
Residential HETs, MF	MF	$3,621,119	$3,536,948	$5,171,982	1.01	1.48
HETs (Tank-Type), NR	NR	$1,118,733	$954,797	$1,562,827	0.88	1.45
	Total	**$32,488,481**	**$39,944,511**	**$57,125,187**	**1.28**	**1.82**

Although the need for supply development extends beyond the current demand forecast horizon, the avoided supply cost analysis indicates investment in active water efficiency would result in reduced operational and maintenance costs of existing supplies for Tampa Bay Water and its member governments. Should additional supply capacity be necessary prior to 2035, the net benefits associated with the selected portfolio of active measures would likely increase substantially, providing cost-effective opportunities for deferred or eliminated capital and operating costs of new water supply development.

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TAMPA BAY WATER
Supplying Water To The Region

Section 7.0
Summary and Recommendations

This Demand Management Plan (DMP) update has investigated and presented the benefits and costs of water demand management as a quantifiable, alternative to water supply source development. As a component of Tampa Bay Water's strategic goals to achieve reliability of its water supply and delivery system to its member governments, this DMP defined how water efficiency activities may fit into the agencies long-term water supply planning process and impact long-range demand projections.

The DMP assessed available water efficiency potential and articulates a long-term water demand management and planning strategy for Tampa Bay Water and its member governments by:

- Explicitly defining demand-side management (DSM) as a beneficial tool for long-term supply planning and its' relationship to Tampa Bay Water's long-term planning process, supply reliability and member government demand.
- Measuring the benefits and costs of integrated water demand management as a quantifiable, alternative water supply source.
- Defining how passive or active implementation of demand management activities fits into Tampa Bay Water's long-term water supply planning process.
- Quantifying water savings (past and future) related to improved water use efficiency.
- Comparing costs of conserved water to the cost to operate existing water supply sources and the total cost (capital and operating costs) to develop new water supply.

The demand management evaluation effort included an analysis of water savings (past and future) and an analysis of avoided supply costs related to improved water use efficiency. The "avoided supply cost" analysis considered increments of conserved water versus

- costs to operate existing water supply sources and
- total costs (capital and operating costs) to develop new water supply.

The DMP's consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water supply alternatives.

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7.1 Summary of Findings

7.1.1 Data Collection and Database Integration

The analyses undertaken as part of the DMP were based on extensive data collection and intensive data processing efforts. Datasets compiled include variables known to influence water use and provide increased levels of sectoral disaggregation. Member government customer billing records and parcel information obtained from Hillsborough, Pasco and Pinellas County Property Appraisers were the principal data sources used for water use profiling and assessment of efficiency potential. A single-family survey and various supplemental data from Florida government agencies and literature further supported characterization of water use and efficiency. Integration of geographic property features and other attribute data with water consumption data supported implementation of a diverse assortment of spatial, seasonal and sectoral demand analyses.

Distinct water use locations served as the geographic unit for detailed customer-level water profiling analyses. This approach relied on the development of a new level of aggregation that defines groups of parcels and water use accounts using grouping criteria. The groups defined by these criteria are termed distinct water use locations and the indices for these locations are termed unique identifiers. Definition of distinct locations ensured no water use and parcel data within any individual location are inadvertently duplicated or omitted. Consideration of one-to-many and many-to-many relationships provided a 20 percent increase (% change) in total parcels supporting DMP analyses.

7.1.2 Regional Baseline Water Demand Profile

As a study process, demand profiling provides a greater understanding of demand trends and how these trends relate to or can be affected by water use efficiency improvements. The regional baseline water demand profile undertaken as part of the DMP included several analyses of water use patterns among the major water using sectors in the Tampa Bay region, as well as an assessment of the market for water efficiency technologies and water savings estimates achieved from previously implemented conservation programs.

Weather-sensitive (seasonal) and weather-insensitive (non-seasonal) components of sectoral demand were estimated for the region as a whole and for each member government over WYs 2002-2008. Estimates were developed by performing minimum-month analyses on the time series of average monthly per-unit demand. Annual average single-family household demand over this period was estimated at 229 gpd and is estimated to include on, annual average basis, 52 gpd (23%) of weather-sensitive (outdoor use) and 177 gpd (77%) of weather-insensitive demand (indoor use). The multifamily customer class as a whole was found to exhibit lower and less variable weather-sensitive use than the single-family customer class. Long-term average multifamily per-unit consumption was estimated as 117 gpd. Weather-sensitive multifamily sector use, on an average annual basis,

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is estimated to be 7 gpd (6% of total average multifamily use). The nonresidential customer class as a whole, as well as many individual high-priority nonresidential sectors, were found to have significant weather-sensitive demands in the summer and spring seasons. This pattern differed from those of residential customer classes, where demands are typically high in the spring and low in the summer. In terms of seasonal variability, key factors contributing to nonresidential weather-sensitive use included cooling water and irrigation.

Statistical evaluations of single-family customer samples and survey groups were used to measure and verify impacts of existing conservation programs and develop a thorough understanding of the market for water efficiency technologies and water savings potential in the Tampa Bay Region. Important results include:

- On average, newer homes use more water and have higher variability in use. Assuming that this higher use arises from increased outdoor use, efficiency efforts aimed at reducing outdoor use for newer houses may be appropriate.
- The presence of either irrigation meters or active reclaimed service results in approximately 30% reduction in demand from the domestic (non-irrigation) water meter.
- Water use increases with the degree of irrigation automation, suggesting the possibility that customers who assert less direct control over irrigation may be less likely to be aware of inefficiencies. Irrigation efficiency measures can be facilitated by identifying irrigators with highly automated and/or separately metered irrigation.
- Single-family locations with a pool uses about 25% more water, on average, than a locations without a pool. Results also indicate that the use of solar covers for pools can be effective at reducing outdoor use.

Additional statistical evaluations were undertaken to measure and verify impacts of existing conservation programs implemented by member governments. Results of pre-and post-implementation evaluations indicate that:

- Households receiving one or more toilet rebate used nearly 12% less water on average after the change out of the toilet, while homes with only one rebate averaged a 10.8 % reduction.
- Homes recognized by the County Extension offices as having both water wise landscape design and efficient irrigation technology and practices, used about 3-5% less after one year of participation and from 5-9% after two years.
- A diminution of irrigation evaluation savings occur over time, with an estimated reduction in water use by about 7% after one year of participating and only 3% after two years.

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7.1.3 Analysis of Water Technologies and Baseline Water Efficiency

Baseline water efficiency profiles for residential toilets, washing machines and dishwashers, as well as nonresidential toilets and urinals, were based on estimates of the mix of water using technology existing in the base year. These estimates were designed to account for historical changes in fixture water efficiency occurring as a result of customers replacing old fixtures with new more efficient fixtures, and installation of efficient water-using fixtures in new construction in accordance with revised building codes, federal standards and market changes. Estimates of prevailing average rates of use by water end use for 2008 provided the baseline for examining water savings potential remaining over the agency's long-term water demand horizon (2035).

Assessment of technology and program based savings potential utilized base-year (2008) estimates of the distribution of fixture age and efficiency in region by sector of water use and market penetration of water efficient technologies. Parcel data provided current estimates of fixture age, while the regional single-family survey and literature review assisted with quantifying prevailing water end uses, consumer behaviors, natural replacement rates and the remaining market potential for efficient technology. According to the baseline efficiency assessment, the greatest efficiency potential appears to exist in toilet, clothes washer and dishwasher use. Future potential efficiency gains for these fixtures are estimated to be in the range of 26-33 percent under current federal standards and in the range of 33-55 percent under high efficiency product benchmarks.

7.1.4 Passive Water Efficiency Evaluation

Passive savings were estimated for residential toilets, washing machines and dishwashers, as well as nonresidential toilets and urinals. The evaluation incorporated estimates for natural replacement of water-using fixtures and the potential impacts of passive measures associated with changes in plumbing standards and increased efficiency due to an evolving market for water efficient products associated with the EPA WaterSense label and/or Energy Star programs. Incorporation of passive water use efficiency projections into the forecast were shown to reduce the forecasts demand by 26 MGD in 2035. Remaining efficiency potential after passive replacement was then used to help assess and define the applicability and timing of active (utility sponsored) programs.

7.1.5 Active Water Efficiency Alternatives Evaluation

Remaining market potential for water efficient technology (beyond what is likely accounted for by passive measures) was determined through the 2035 demand forecast planning horizon by screening the applicability of several active (utility-sponsored) programs. The screening process considered 24 programs / technologies, which have been either applied through existing programs in the region or elsewhere, or developed based upon specific application of technologies in given sectors. Ten programs were judged to be potentially

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viable for implementation. Six of these programs are applicable to the nonresidential sector, 3 are applicable to the single-family sector, and 1 program is applicable to the multi-family sector.

Impacts of these potential active demand management alternatives were estimated over the planning horizon. By 2035, the additional water savings potential from active efficiency programs is estimated at 9 MGD. Collectively, passive water savings and potential active demand management alternatives would be estimated to reduce long-term demands by 38 MGD over the planning horizon.

The DMP included an assessment of avoided supply costs related to improved water use efficiency, subjecting all demand management alternatives judged to be potentially viable for implementation to economic evaluation. Quantification of supply-side benefits were based on the accrual of avoided costs (or benefits) from water use efficiency generally resulting from:

- Capital deferral;
- Capital elimination; and
- Reduction in variable cost.

Savings and costs were determined over a 60-year planning horizon (2010-2069) allowing savings rates in this analysis to mature over the life of the technology installed. Net avoided costs of viable demand management alternatives were evaluated over two separate timeframes; the total life of all savings and through the 2035 forecast horizon. A net present value of $30 million in benefits was identified over the life of the potential programs with an estimated B/C ratio (benefits / costs) of 1.82. Net present value of avoided costs were estimated to be $8.6 million over the shorter 2035 planning horizon.

7.2 Recommendations

The DMP update results indicate demand management activities stemming from gains in water efficiency can effectively serve as a complementary component to traditional water supply planning processes in meeting current and future water demands. Through efficient use of available supplies and use of targeted implementation strategies, increases water use efficiency, whether they occur passively or are expedited by utility policies, can help manage peak and average day water demand in conjunction with reducing long-term future water supply requirements.

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Regular monitoring and routine updates of the passive efficiency forecast should be undertaken to reduce uncertainties over the water supply planning horizon, particularly with respect to Tampa Bay Water's long term demand forecasting, future need analysis, and long-term water supply plan updates. On-going monitoring and evaluation protocols should be revised to include periodic comprehensive assessments of passive efficiency and evaluation of potential active measures to thoroughly identify future planning, management, and policy options available to the Agency.

Cost-effective alternatives to new supply development and other valuable benefits can be realized through demand side management including optimization of existing facilities, deferred capital investment costs, improved public perception, support of future supply projects, and environmental stewardship and protection. It is recommended Tampa Bay Water continue to estimate and assess avoided operational and capital costs as a formal part of its water supply planning process. As part of this process, Tampa Bay Water should continue to refine and optimize the predicted schedule and need t of additional water supply and/or the optimization of existing facilities, by estimating the level of demand reductions possible or necessary to eliminate or defer meaningful amounts of capital and operational investments.

The Tampa Bay Water Board of Directors adopted Board Resolution No. 2013-006 in February 2013 (Appendix Q). This resolution incorporates water use efficiency evaluation efforts into the Agency long-term water supply planning process consistent and in concert with the recommendations of this DMP. This resolution directs the Agency to:

- Develop and implement data collection, management and analysis protocols and procedures for the continued assessment of passive water use efficiency within Tampa Bay Water's service area.
- Integrate passive water-use efficiency into the Agency's Long-term Demand Forecast and Future Need Analysis.
- Include the Water Use Efficiency Evaluation as an element of the Long-term Water Supply Plan and include an updated evaluation of potential active measures for implementing efficient water-use products as part of future options for the next Long-term Water Supply

Incorporation of the effects of increased water-use efficiency into the Agency's long-term planning process provides the Board of Directors with more supply policy options, affords Tampa Bay Water and its member governments a supply buffer (increased water use efficiency reduces demand) and allows Tampa Bay Water to prepare and plan for observed and anticipated changes in water use efficiency. These activities should continue to be supported by the types of analytical methods and strategies described in this DMP, and through deliberate integration of anticipated water savings into ongoing water demand forecasting and supply planning.

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Section 8.0
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