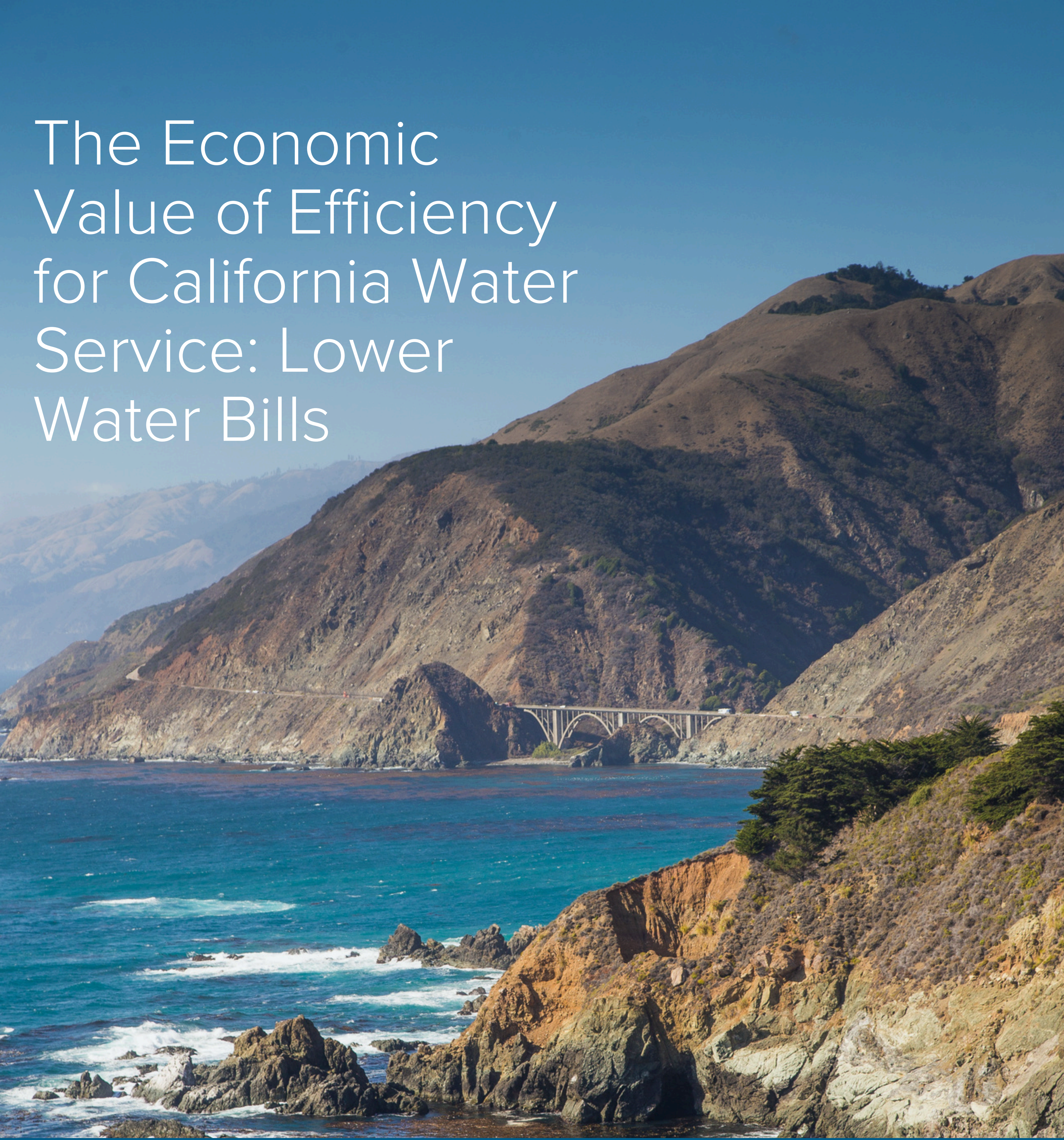
The Economic Value of Efficiency for California Water Service: Lower Water Bills



Prepared for Cal Water

Alliance for Water Efficiency

A&N Technical Services, Inc.

M.CUBED — Policy Analysis for the Public and Private Sectors

JUNE 2024

ABOUT THE PROJECT TEAM

Alliance for Water Efficiency

The Alliance for Water Efficiency (AWE) is a nonprofit dedicated to the efficient and sustainable use of water across North America. Based in Chicago, IL, AWE advocates for water-efficient products and programs and provides information and assistance on water conservation efforts. AWE works with more than 500-member organizations, providing benefit to water utilities, business and industry, governments, environmental and energy advocates, universities, and consumers.

Chicago, IL | www.allianceforwaterefficiency.org

A&N Technical Services

A & N Technical Services provides state-of-the-art financial expertise applied to water resources and water efficiency programs. The firm's team of professionals has broad experience in applications such as water reuse and recycling, and water supply and demand estimation and simulation. Members of the technical staff have worked for organizations such as the American Water Works Association Research Foundation, RAND, the U.S. Bureau of Reclamation, the US EPA, the California State Legislature, and numerous water agencies in the Western United States.

San Diego & Los Angeles, CA | www.antechserv.com

MCubed

M.Cubed provides economic and public policy consulting services to public and private sector clients. Practice areas include water and energy utility resource planning and ratemaking, resource use efficiency and conservation measures, project impact analysis, regional economic modeling, natural resource allocation policies, and environmental plan preparation and review. Clients include private industry; federal, state, and local government; and trade associations. M.Cubed has directly shaped many policies and technical resources guiding water use efficiency planning in California.

Davis, Oakland, & San Francisco, CA | www.mcubed-econ.com

Authors

Liesel Hans, PhD, Alliance for Water Efficiency of Programs
Andrew D. Morris, JD, Alliance for Water Efficiency
Thomas W. Chesnutt, Ph.D., P.Stat®, CAP® A & N Technical Services, Inc.
David M. Pekelney, PhD, A & N Technical Services, Inc.
David Mitchell, M.Cubed

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Prior to 2009, California Water Service Company (Cal Water) did not meter all its water customers, did not have conservation rates, and did not offer a robust set of conservation programs. Per capita water use had been flat or increasing prior to this period. In 2009, Cal Water adopted conservation rate designs (increasing block rates, IBRs), increased conservation program expenditures by more than three-fold and implemented an accelerated schedule to convert unmetered customers to metered water service. Per capita water demand has decreased steadily since 2009. These innovative strategies related to water efficiency, conservation, and rates over the years pose the questions:

- **WHAT WOULD THE ECONOMIC IMPACT ON BILLS HAVE BEEN IF NONE OF THESE ACTIVITIES OCCURRED?**
- **ARE BILL PAYING CUSTOMERS BETTER OR WORSE OFF?**

The relationship between conservation and water rates is not always well understood. Many water professionals and customers are perplexed by rate increases when system-wide water use has gone down and blame water conservation and efficiency for higher rates.

This Report provides evidence that this causality— efficiency causes higher customer bills via higher water rates — needs to be reversed. Our analysis conservatively estimates that, over the period from 2010 to 2022, customer bills in the service districts studied would have been 1.2 to 20.5 percent higher had Cal Water not implemented water efficiency and conservation.

Cal Water's strategies included the adoption of tiered rate structures that send an intentional price signal to customers about the cost consequences of consumptive choices. Water rates that communicate cost consequences to customers provide the basis for informed choices about efficient water use. Implementing tiered water rates, universal metering, efficient plumbing standards, and long-term conservation programs have lowered utility operating costs in the short and long term. This ultimately lowers the cost burden on water customers. This Report explores this dynamic by evaluating the costs that have been avoided by Cal Water's water efficiency activities, and the impact these have had on customer bills.

Specifically, this Report provides a technical estimation of the economic benefit of conservation activities over a more than a decade period by using the avoided marginal costs of water service as the way to value the savings. Historical roots of this analysis can be found in the benefit evaluation of public investments (Dupuit, 1844) and the institutionalist literature on avoided costs and efficient utility pricing (Boiteux, 1949).

This Report assesses the customer benefit of Cal Water's efficiency investments in all of its service areas, which span the spectrum in terms of geography, climate, supply sources, socio-demographics, and water supply costs. Our analysis compares a constant per capita water demand —that is, a world absent of demand reductions — to the actual per capita demand that embeds demand reductions. It quantifies the additional operating expenses and capital expenditures that would have been needed to meet the higher level of constant per capita demand. Thus, the analysis compared historical operating costs for the period 2010-2022 to what they would have been without the reductions in per capita water demand that began around 2008-2009. The results of the analysis are summarized in Table ES-1.

Table ES-1 Results: Estimated Percentage Reduction in Customer Bills

Service Area	Estimated 2010-2022 Cumulative Operating Costs w/o Conservation (Mil 2022 $)	Actual 2010-2022 Cumulative Operating Costs (Mil 2022 $)	Percent Bill Reduction due to Conservation, 2010-2022
Antelope Valley	$36.1	$32.8	9.1%
Bakersfield	$1,294.4	$1,164.9	10.0%
Bear Gulch	$779.9	$712.0	8.7%
Chico	$377.6	$361.9	4.1%
Dixon	$56.7	$55.4	2.2%
Dominguez	$1,163.9	$1,031.2	11.4%
East Los Angeles	$594.3	$535.7	9.9%
Hermosa-Redondo	$549.2	$465.4	15.3%
Kern River Valley	$101.7	$99.0	2.7%
King City	$51.1	$49.7	2.8%
Livermore	$378.5	$331.3	12.5%
Los Altos	$584.5	$487.6	16.6%
Marysville	$59.1	$57.5	2.8%
Mid-Peninsula	$904.6	$719.3	20.5%
Oroville	$81.0	$75.7	6.6%
Palos Verdes	$800.6	$724.1	9.6%
Redwood Valley	$45.1	$41.6	7.8%
Salinas	$485.1	$479.0	1.2%
Selma	$86.4	$81.4	5.8%
South San Francisco	$448.1	$369.5	17.6%
Stockton	$795.9	$683.9	14.1%
Visalia	$439.6	$430.1	2.2%
Westlake	$354.1	$287.9	18.7%
Willows	$41.8	$41.0	2.0%
All Cal Water Service Areas	**$10,509.3**	**$9,317.8**	**11.3%**

The analysis demonstrates that Cal Water's sustained activities to lower per capita water use over the last decade and a half has financially benefited its customers. Absent the reductions in per capita demand since 2008-2009, the conservative estimate is that bills in the study districts over the 2010-2022 period would have been 1.2 to 20.5 percent higher than what occurred. Instead, Cal Water spent money on conservation that was more than offset by lower water production costs, deferred capital spending, and other reduced costs. Avoided operating expenses and deferred capital expenditures (resulting from conservation investments, can yield a large economic benefit to today's customers. In short, Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs and, hence, lower water bills for its customers.

The largest cost reductions were in Hermosa-Redondo, Los Altos, Mid-Peninsula, South San Francisco, and Westlake. These service areas are dependent on high cost imported surface water. Reducing dependence on this expensive water provided a significant financial benefit to customers. Other service areas rely more on local groundwater, which has a much lower avoided cost. Consequently, the cost savings in these groundwater-dependent districts are significantly lower than in the districts reliant on imported surface water.

Investing in water conservation directly benefits customers by helping to slow the increase in water service costs over time. Economic investments in water efficiency are critical to help ensure that water utilities can continue to provide water service that is both affordable and sustainable.

INTRODUCTION

Cal Water provides water service to residents of 24 service districts across the state. Cal Water has invested substantially in water efficiency and conservation since the late 2000's. In addition to water conservation, water loss control programs, and universal metering programs, Cal Water has implemented tiered rate structures to communicate cost consequences to customers about efficient water use. These innovative strategies related to water efficiency, conservation, and rates over the years pose the questions:

- **WHAT WOULD THE ECONOMIC IMPACT ON BILLS HAVE BEEN IF NONE OF THESE ACTIVITIES OCCURRED?**
- **ARE RATE PAYERS BETTER OR WORSE OFF?**

The relationship between conservation and water rates is not always well understood. Many water professionals and customers are perplexed by rate increases when system-wide water use has gone down, blaming water conservation and efficiency as the culprit for higher rates.

This Report provides evidence that this causality — efficiency causes higher customer bills via higher water rates — needs to be reversed. Our analysis conservatively estimates that, over the 2010-2022 period, customer bills in the service districts studied would have been 1.2 to 20.5 percent higher had Cal Water not implemented water efficiency and conservation strategies.

Cal Water's strategies included adoption of tiered rate structures that send an intentional price signal to customers about the cost consequences of consumptive choices. Water rates that communicate cost consequences to customers provide the basis for informed choices about efficient water use. Implementing tiered water rates, universal metering, efficient plumbing standards, and long-term conservation programs have lowered utility operating costs in the short and long term. This ultimately lowers the cost burden on water customers. This Report explores this dynamic by evaluating the costs that have been avoided by Cal Water's water efficiency activities, and the impact this has had on customer bills.

Specifically, this Report provides a technical estimation of the economic benefit of conservation activities over a more than decade period by using avoided marginal costs of water service to value the savings. Historical roots of this analysis can be found in the benefit evaluation of public investments (Dupuit, 1844) and the institutionalist literature on avoided costs and efficient utility pricing (Boiteux, 1949).

We believe the estimates presented herein for Cal Water's districts are conservative. The most recent available estimates of avoided water supply costs occurred prior to implementation of the Sustainable Groundwater Management Act (SGMA); there were no identified long run supply costs for five of the districts that lie in critically over-drafted groundwater basins. A very different estimate of long run supply costs might be obtained today to account for the SGMA compliance — that is, the cost of sustainability.

Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs and, hence, lower water bills for its customers.

DISTRICTS IN THE ANALYSIS

All Cal Water districts were used in this analysis. Table 2 depicts how these districts vary in terms of current avoided supply costs (variable production costs from 2022 Water Loss Audits), population growth over the historical period 1997-2022), historical reductions in water use per capita, and proportion of supply from groundwater.

Table 2 District Characteristics

District	Code	Avoided Supply Costs[1]	Population Growth Since Historical Period[2]	GPCD Reduction Since Historical Period[3]	Proportion of Supply from Groundwater[4]
Antelope Valley	AV	Medium	Medium	High	Medium
Bakersfield	BK	Medium	High	High	Medium
Bear Gulch	BG	High	Medium	Medium	Low
Chico	CH	Low	High	Medium	High
Dixon	DIX	Low	Medium	Medium	High
Dominguez	DOM	High	Low	Medium	Low
East Los Angeles	ELA	High	Low	Medium	High
Hermosa-Redondo	HR	High	Low	Medium	Low

[1] Where Low is <=350 $/AF, Med. is >350, <800, and High is >=800 $/AF; Variable Production Costs are from the applicable 2022 Water Loss Audit.

[2] Where Low is <=10%, Med. is >10, <20, and High is >=20%; Historical period is 1997-2022 (except RDV starts in 2000).

[3] Where Low is <=20%, Med. is >20, <40, and High is >=40%; Historical period is 1997-2022 (except RDV starts in 2000).

[4] Where Low is <=20%, Med. is >20, <60, and High is >=60%.

Kern River Valley	KRV	Medium	Low	High	High
King City	KC	Low	High	High	High
Livermore	LIV	High	Medium	Medium	Low
Los Altos	LAS	High	High	High	Medium
Marysville	MRL	Low	Low	High	High
Mid-Peninsula	MPS	High	Medium	Medium	Low
Oroville	ORO	Low	Medium	High	Low
Palos Verdes	PV	High	Low	Medium	Low
Redwood Valley	RDV	Medium	Low	High	Medium
Salinas	SLN	Low	Low	Low	High
Selma	SEL	Low	High	High	High
South San Fran	SSF	High	Medium	High	Low
Stockton	STK	Medium	Low	Medium	Low
Visalia	VIS	Low	High	Medium	High
Westlake	WLK	High	Medium	High	Low
Willows	WIL	Low	Low	High	High

Since Cal Water developed Conservation Master Plans for each district, a short descriptive summary can be provided for each district:

- The Antelope Valley District serves unincorporated areas of the Western Mojave Desert and is located near the border of northeastern Los Angeles and southeastern Kern Counties. The district is characterized by medium avoidable supply costs ($398/AF variable production costs in 2022), medium population growth (approx. 12 percent from 1997-2022), high GPCD demand reduction, and medium groundwater (approx. 27) percent of supply.

- The Bakersfield District serves portions of the City of Bakersfield and segments of adjacent unincorporated Kern County. The district is characterized by medium avoidable supply costs ($355/AF variable production costs in 2022), high population growth (approx. 30 percent from 1997-2022), high GPCD demand reduction, and medium groundwater (approx. 52) percent of supply.
- The Bear Gulch District serves the communities of Atherton, Portola Valley, Woodside, portions of Menlo Park, and adjacent unincorporated portions of San Mateo County including West Menlo Park, Ladera, North Fair Oaks, and Menlo Oaks. The district is characterized by high avoidable supply costs ($2,211/AF variable production costs in 2022), medium population growth (approx. 13 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 0) percent of supply.
- The Chico-Hamilton City District serves the communities of Chico and Hamilton City. The district is characterized by low avoidable supply costs ($116/AF variable production costs in 2022), high population growth (approx. 32 percent from 1997-2022), medium GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The Dixon District serves a portion of the City of Dixon and is located south of Interstate 80 in northern Solano County, approximately 20 miles southwest of Sacramento and 65 miles northeast of San Francisco. The district is characterized by low avoidable supply costs ($165/AF variable production costs in 2022), medium population growth (approx. 17 percent from 1997-2022), medium GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The Dominguez District serves the majority of the City of Carson, a large section of the City of Torrance, small sections of the Cities of Compton, Long Beach and Los Angeles and a portion of Los Angeles County. The district is characterized by high avoidable supply costs ($1,470/AF variable production costs in 2022), low population growth (approx. 3 percent from 1997-2022), medium GPCD demand reduction, and a low share of groundwater (approx. 14 percent) of supply.
- The East Los Angeles District serves a large section of unincorporated Los Angeles County known as East Los Angeles, and portions of the cities of Montebello, Commerce, Vernon, and Monterey Park. The district is characterized by high avoidable supply costs ($818/AF variable production costs in 2022), low population growth (approx. 2 percent from 1997-2022), medium GPCD demand reduction, and high groundwater (approx. 67) percent of supply.
- The Hermosa-Redondo District serves the communities of Hermosa Beach, Redondo Beach and five percent of Torrance. The district is characterized by high avoidable supply costs ($1,470/AF variable production costs in 2022), low population growth (approx. 7 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 7) percent of supply.
- The Kern River Valley District serves the communities surrounding Lake Isabella, including Wofford Heights, Bodfish, Kernville, Lakeland, Mountain Shadows, Onyx, Squirrel Valley, and South Lake. The district is characterized by medium avoidable supply costs ($411/AF variable production costs in 2022), low population growth (approx. -8 percent from 1997-2022), high GPCD demand reduction, and high groundwater (approx. 82) percent of supply.
- The King City District serves the community of King City, which is in southern Monterey County approximately 45 miles southeast of the City of Salinas. The district is characterized by low avoidable supply costs ($74/AF variable production costs in 2022), high population growth (approx. 54 percent from 1997-2022), high GPCD demand reduction, and high groundwater (approx. 100) percent of supply.

- The Livermore District serves roughly half the incorporated area of the City of Livermore and serves about two-thirds of its population. The district is characterized by high avoidable supply costs ($1,414/AF variable production costs in 2022), medium population growth (approx. 19 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 20) percent of supply.
- The Los Altos Suburban District serves the entire city of Los Altos, sections of the cities of Cupertino, Los Altos Hills, Mountain View, Sunnyvale and adjacent unincorporated areas of Santa Clara County. The district is characterized by high avoidable supply costs ($1,719/AF variable production costs in 2022), high population growth (approx. 26 percent from 1997-2022), high GPCD demand reduction, and medium groundwater (approx. 28) percent of supply.
- The Marysville District serves the City of Marysville within its protective levee system. The district is characterized by low avoidable supply costs ($91/AF variable production costs in 2022), low population growth (approx. 1 percent from 1997-2022), high GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The Mid-Peninsula District serves the communities of San Carlos and San Mateo and adjacent unincorporated portions of San Mateo County, including The Highlands and Palomar Park. The district is characterized by high avoidable supply costs ($2,074/AF variable production costs in 2022), medium population growth (approx. 13 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 0) percent of supply.
- The Oroville District serves a major portion of the City of Oroville and unincorporated areas within Butte County. The district is characterized by low avoidable supply costs ($168/AF variable production costs in 2022), medium population growth (approx. 13 percent from 1997-2022), high GPCD demand reduction, and low groundwater (approx. 6) percent of supply.
- The Palos Verdes District serves all the area incorporated by the Cities of Palos Verdes Estates, Rancho Palos Verdes, Rolling Hills Estates, and Rolling Hills. The district is characterized by high avoidable supply costs ($1,760/AF variable production costs in 2022), low population growth (approx. 4 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 0) percent of supply.
- The Redwood Valley District is a collection of six individual water systems spread throughout northern California in Marin, Sonoma, and Lake Counties. The district is characterized by medium avoidable supply costs ($656/AF variable production costs in 2022), low population growth (approx. 1 percent from 1997-2022), high GPCD demand reduction, and medium groundwater (approx. 30) percent of supply.
- The Salinas District serves 70 percent of the residents of the City of Salinas and the residents of the unincorporated communities of Country Meadows, Bolsa Knolls, Las Lomas, Oak Hills, and Salinas Hills. The district is characterized by low avoidable supply costs ($140/AF variable production costs in 2022), low population growth (approx. 4 percent from 1997-2022), low GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The Selma District serves the City of Selma. The district is characterized by low avoidable supply costs ($124/AF variable production costs in 2022), high population growth (approx. 30 percent from 1997-2022), high GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The South San Francisco District serves the communities of South San Francisco, Colma, a small portion of Daly City, and an unincorporated area of San Mateo County known as Broadmoor. The district is characterized by high avoidable supply costs ($1,837/AF variable production costs in 2022), medium population growth (approx. 17 percent from 1997-2022), high GPCD demand reduction, and low groundwater (approx. 2) percent of supply.

- The Stockton District serves portions of the City of Stockton and adjacent unincorporated San Joaquin County. The district is characterized by medium avoidable supply costs ($783/AF variable production costs in 2022), low population growth (approx. 8 percent from 1997-2022), medium GPCD demand reduction, and low groundwater (approx. 10) percent of supply.
- The Visalia District serves the City of Visalia and segments of unincorporated Tulare County including the communities of Goshen, Mullen, and Tulco. The district is characterized by low avoidable supply costs ($97/AF variable production costs in 2022), high population growth (approx. 52 percent from 1997-2022), medium GPCD demand reduction, and high groundwater (approx. 100) percent of supply.
- The Westlake District serves a portion of the City of Thousand Oaks. The district is characterized by high avoidable supply costs ($1,820/AF variable production costs in 2022), medium population growth (approx. 15 percent from 1997-2022), high GPCD demand reduction, and low groundwater (approx. 0) percent of supply.
- The Willows District serves the City of Willows and adjacent unincorporated territory in Glenn County. The district is characterized by low avoidable supply costs ($82/AF variable production costs in 2022), low population growth (approx. 4 percent from 1997-2022), high GPCD demand reduction, and high groundwater (approx. 100) percent of supply.

Figures 1 to 3 summarize population trends in the 24 districts. Figure 1 displays the Cal Water Large Districts having a 2022 population of 100,000 or more, Figure 2 displays Cal Water Medium Districts having 2022 population between 20,000 and 100,000, and Figure 3 displays Cal Water Smaller Districts having a 2022 population of 20,000 or less. Note that Bakersfield, Chico, and Los Altos exhibit significant population growth over the period of analysis.

Figure 1 Cal Water Large Districts: Trends in Population Served

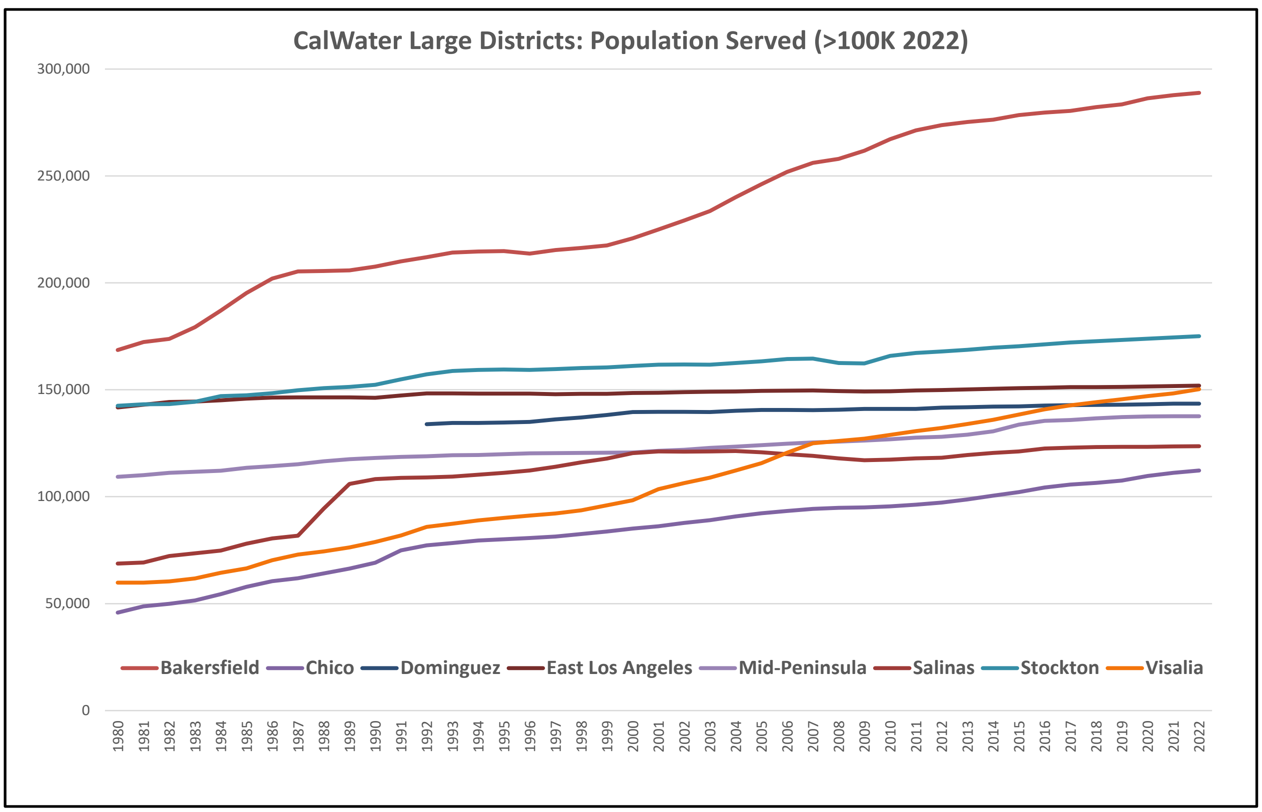


Figure 2 Cal Water Medium Districts: Trends in Population Served

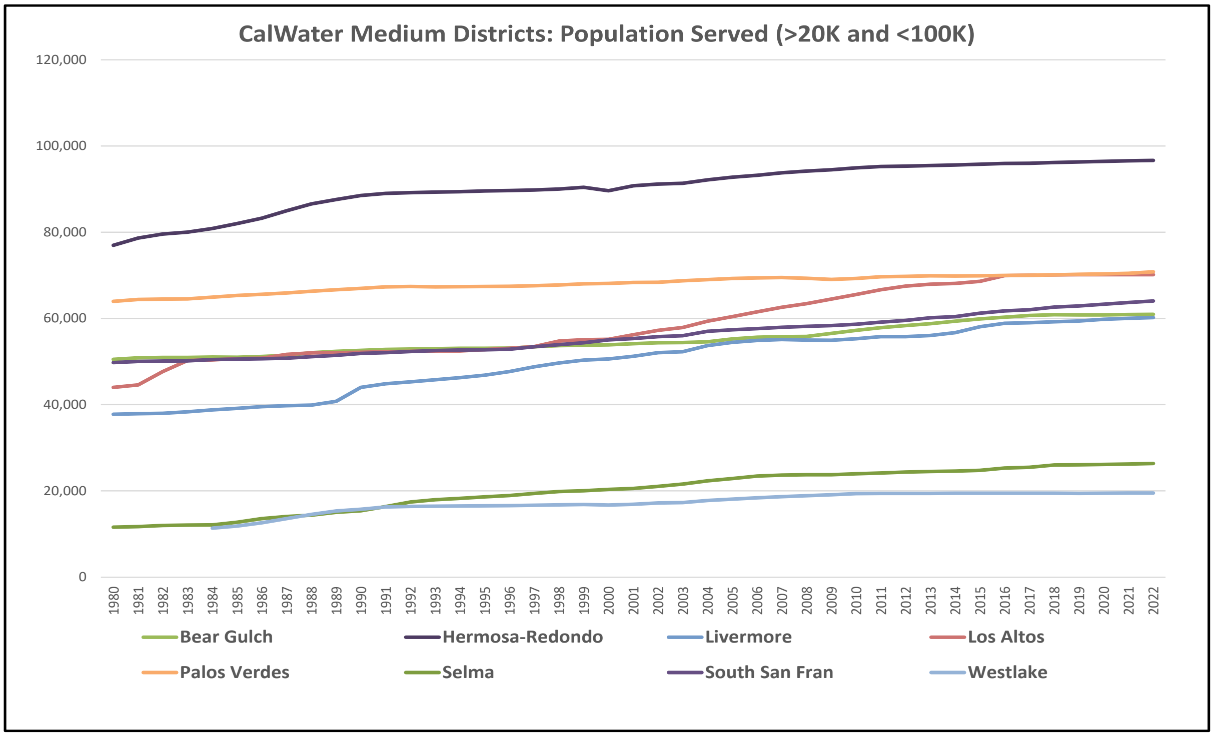
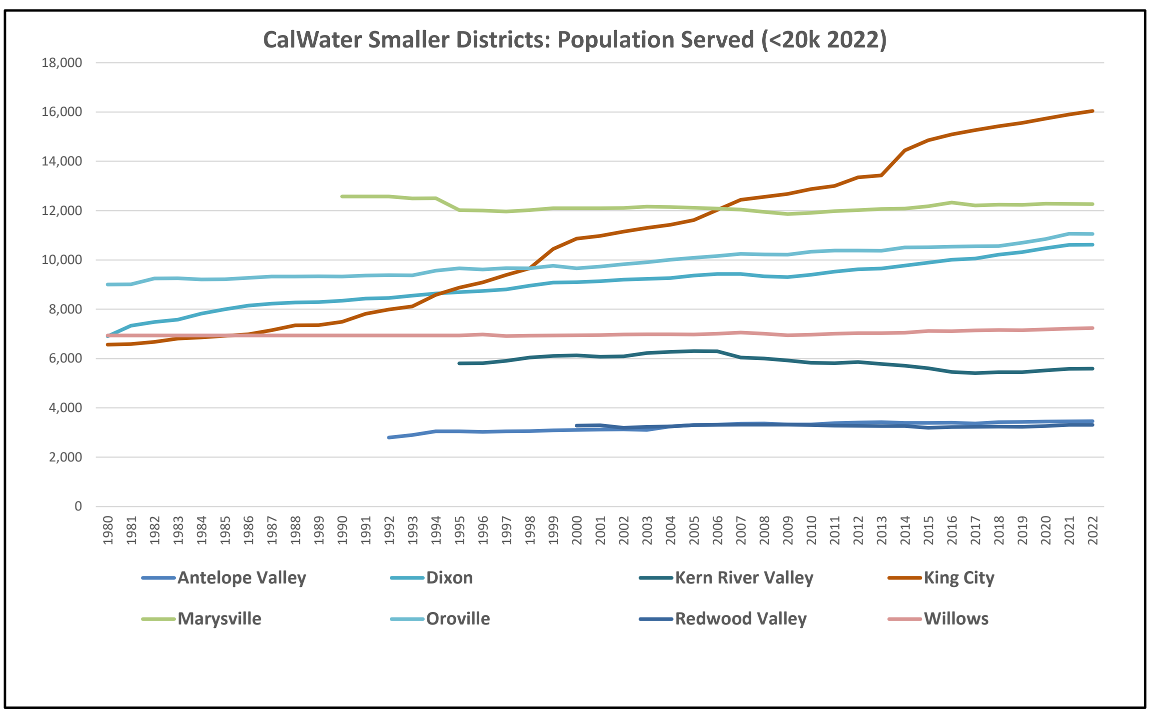


Figure 3 Cal Water Smaller Districts: Trends in Population Served



HISTORICAL CONSUMPTION

The historic assumption was that water demands would increase as population increases, but we have started to see population growth with little or no demand growth due to conservation and efficiency. And we also expect there to be differential conservation savings for a range of reasons:

- Rate increases. In general, the cost per unit volume of water faced by consumers was flat in real dollar terms (inflation-adjusted) from 1990 to about 2007. Since 2007 the real price of water has been rising, more in some areas than others.
- Drought restrictions. A five-year drought ended in the early 1990s. Water shortages requiring voluntary calls for customer water restriction occurred at various times thereafter. In response to severe drought, the state mandated urban water conservation in 2015 and 2016.
- Passive conservation. Since national water efficiency standards were set for low flow shower heads and 1.6 gallon per flush toilets in the National Energy Protection Act of 1992, there have been continuing federal and state improvements in plumbing fixture efficiency on an ongoing basis. Department of Energy efficiency standards for residential clothes washers and other water-using appliances have also had a big impact.
- Active conservation. Cal Water is a long-standing member of the California Urban Water Conservation Council (CUWCC) and its successor organization, the California Water Efficiency Partnership (CalWEP). It is also a member of the North American-wide Alliance for Water Efficiency (AWE). CalWEP is a state chapter of AWE. In conformance with the guiding principles and policies of these organizations, Cal Water has implemented a wide range of water conservation best management practices and programs to help its customers use water efficiently.

Figures 4 to 6 summarize volumetric demand trends over the period of analysis in order of 2022 population size. As expected, due to population growth, Bakersfield, Chico, and Los Altos volumetric demand grows through 2007. After 2007, volumetric demand declines for all districts, including those with continued population growth.

Figure 4 Cal Water Large Districts: Customer Water Demand (AFY)

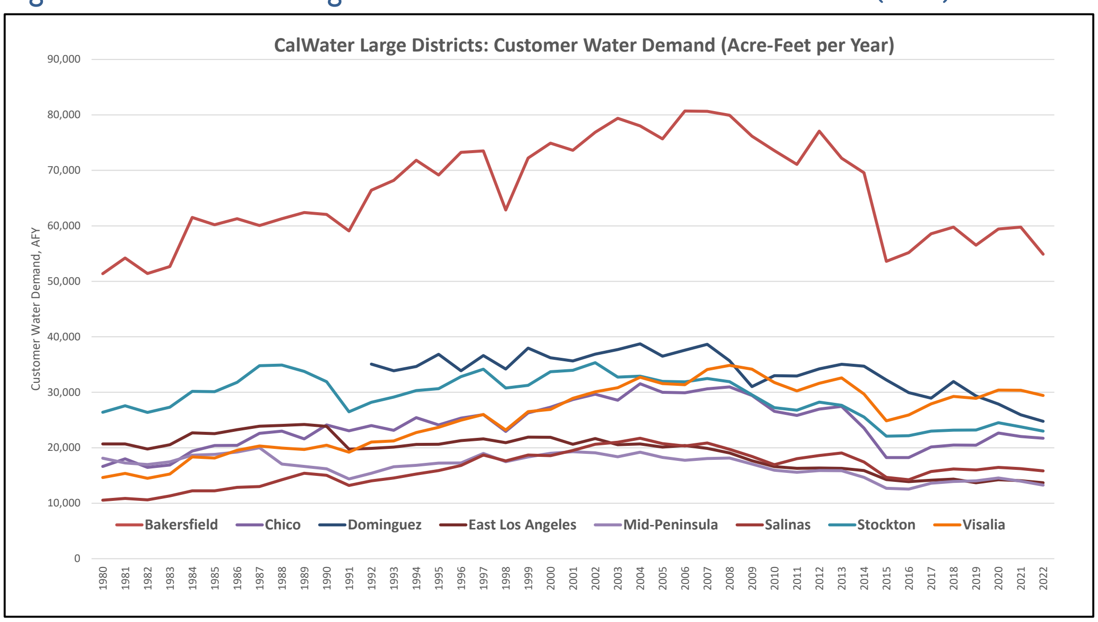


Figure 5 Cal Water Medium Districts: Customer Water Demand (AFY)

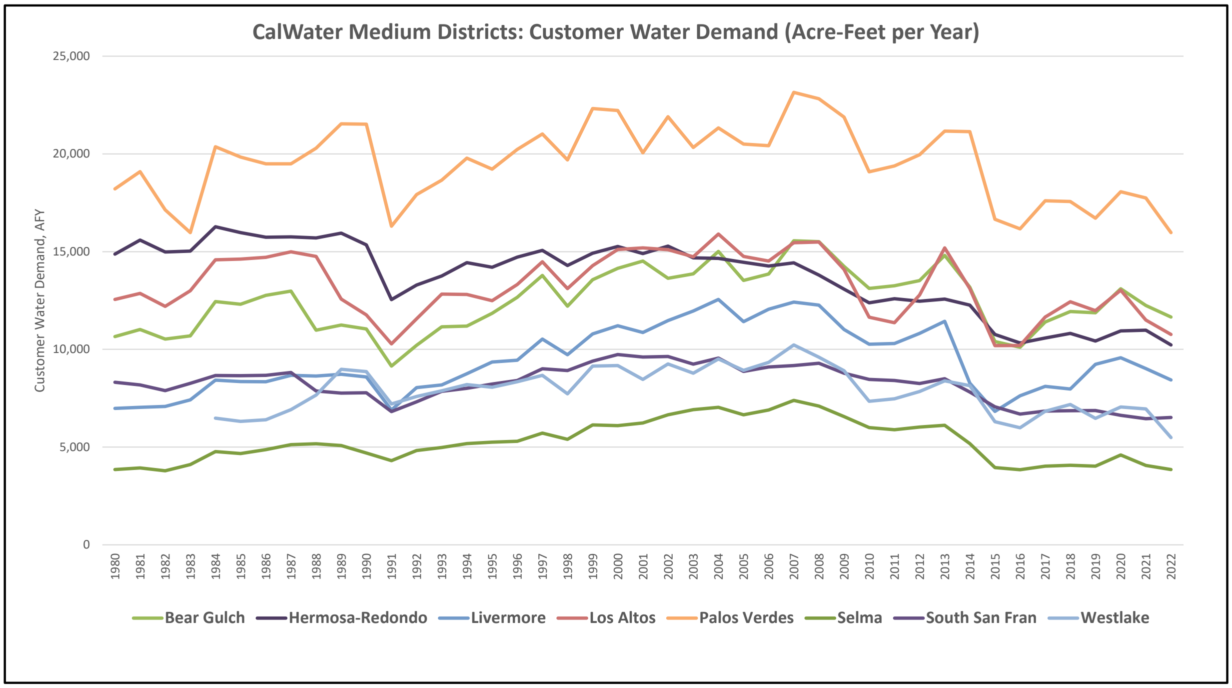
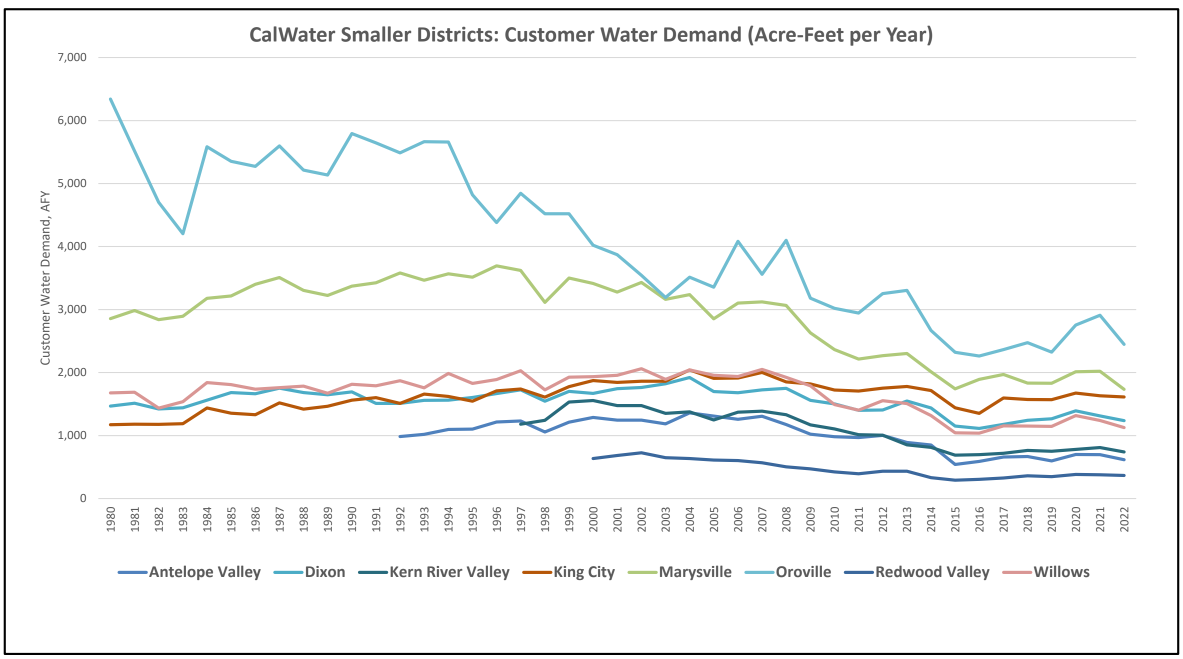


Figure 6 Cal Water Smaller Districts: Customer Water Demand (AFY)



Since dividing customer demand by population standardizes for size, Figures 7 through 9 alphabetically display customer demand in per capita terms (gallons per capita per day, or GPCD) over the same period of analysis. We see that until 2008-2009, GPCD was relatively flat. After 2008-2009, GPCD demand visibly declined until 2015-2016. All districts show at least a dip in demand during the drought of the early 1990s.

Figure 7 Cal Water Large Districts: Customer Per Capita Demand GPCD

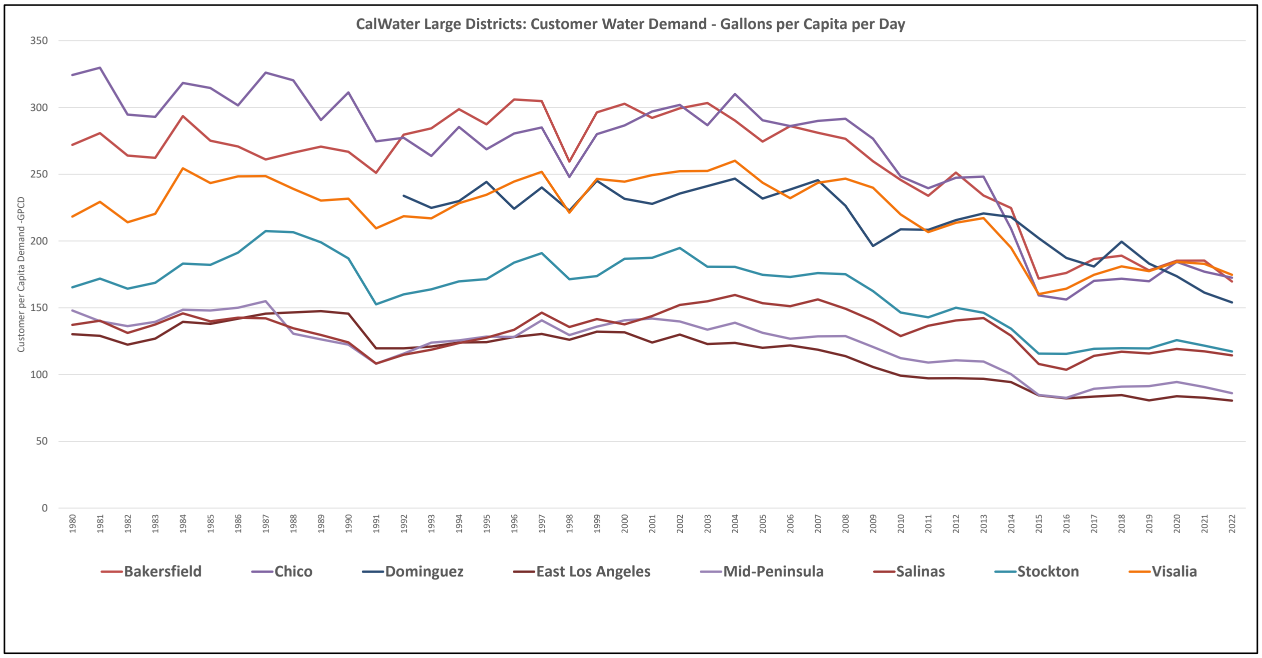


Figure 8 Cal Water Medium Districts: Customer Per Capita Demand GPCD

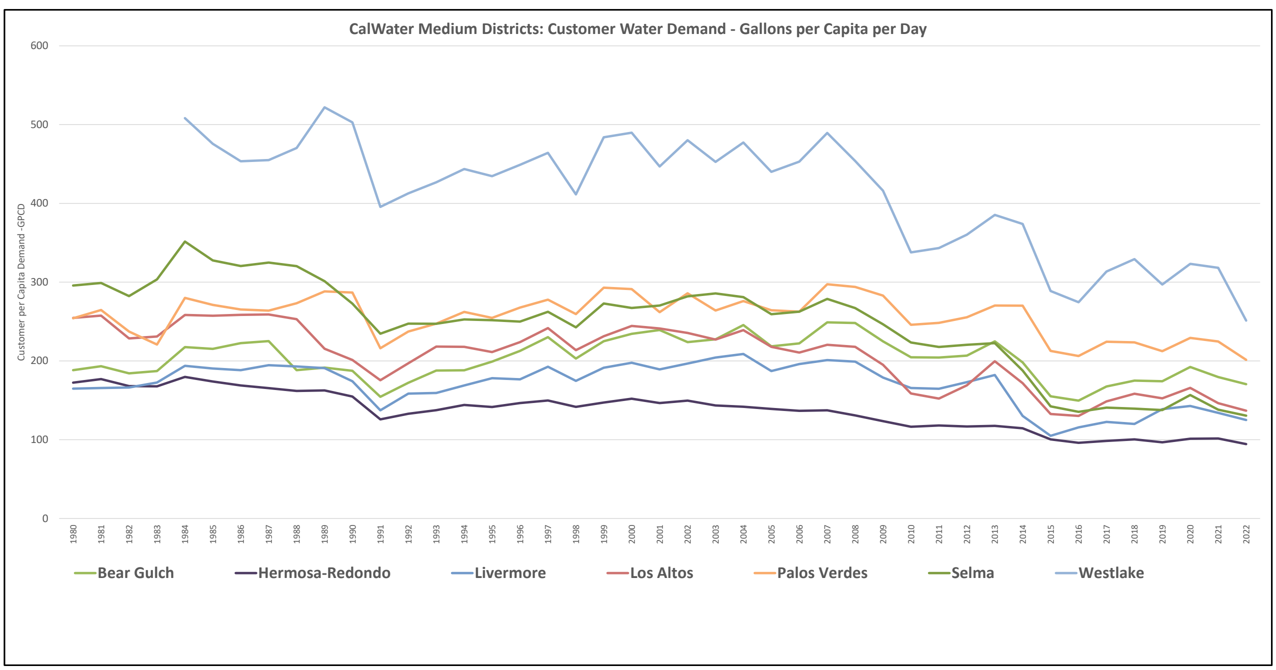
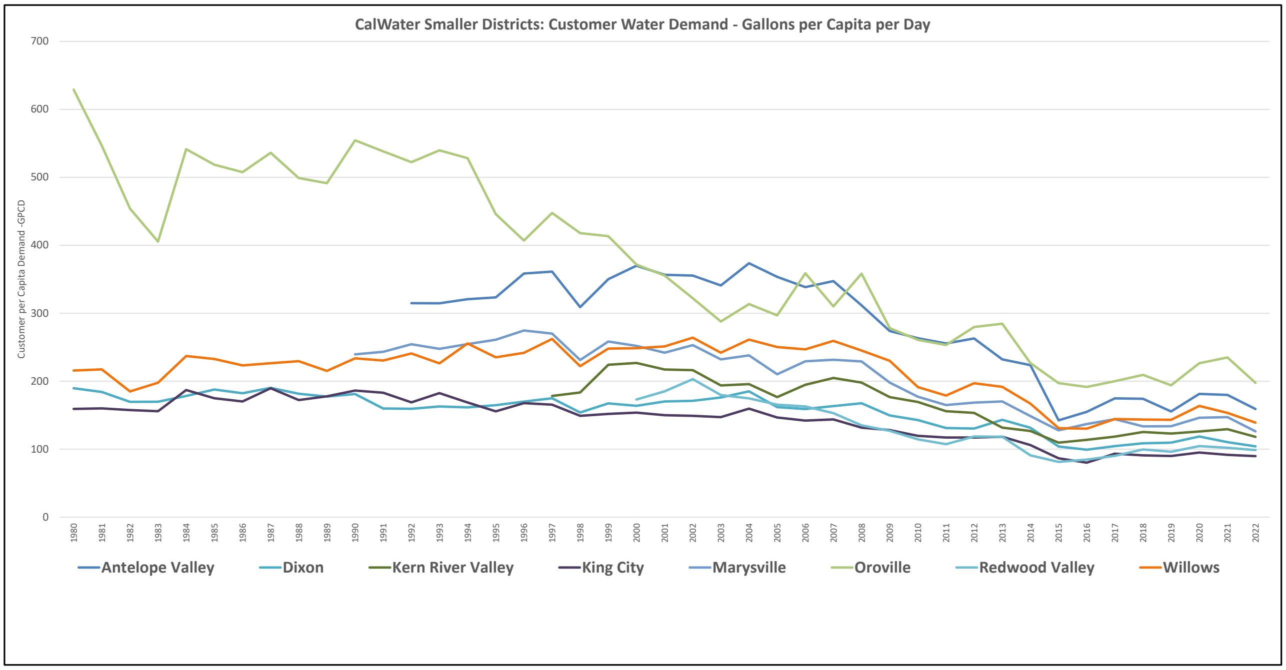


Figure 9 Cal Water Smaller Districts: Customer Per Capita Demand GPCD



WATER RATES

Figures 10 to 12 show melded water rates from 1990 to 2022 (melded across all customer classes per district) expressed in real 2022 dollars per hundred cubic feet (CCF). Notice that the rates increase slowly until the 2007 timeframe, and after that rates increase at a steeper rate.

Note that the historical highest water rates were in Bear Gulch, Kern Valley, and Redwood Valley, all relatively small Districts with unique acquisition histories. East Los Angeles, Mid-Peninsula, South San Francisco, Westlake have higher rates than the other districts, because of their dependence on imported water.

Figure 10 Cal Water Large Districts: Real Water Rates (2022$ per hundred cubic feet, CCF)

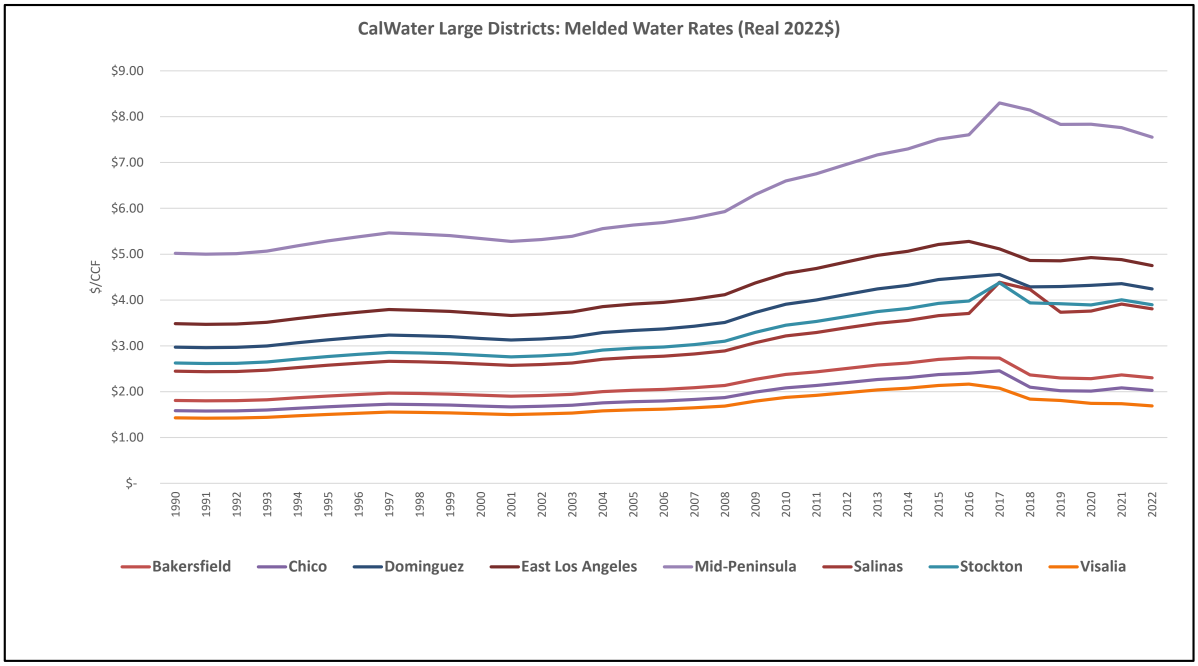


Figure 11 Cal Water Medium Districts: Real Water Rates (2022$ per hundred cubic feet, CCF)

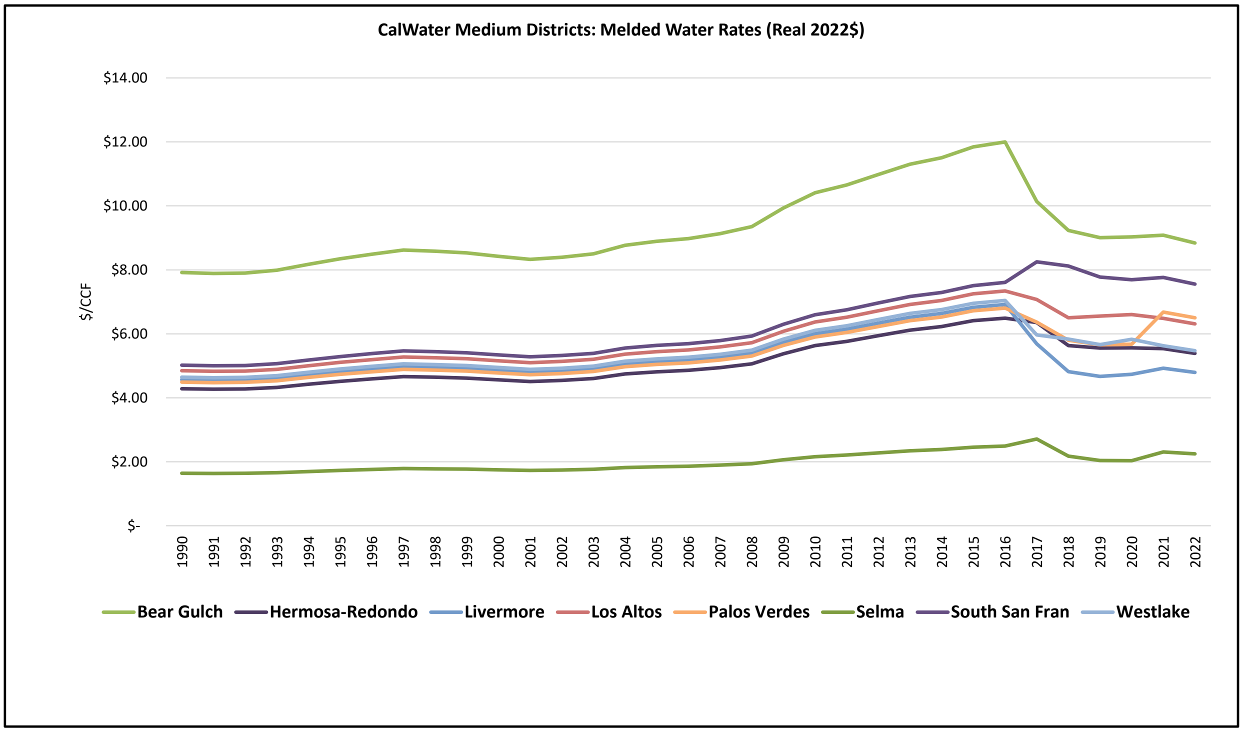
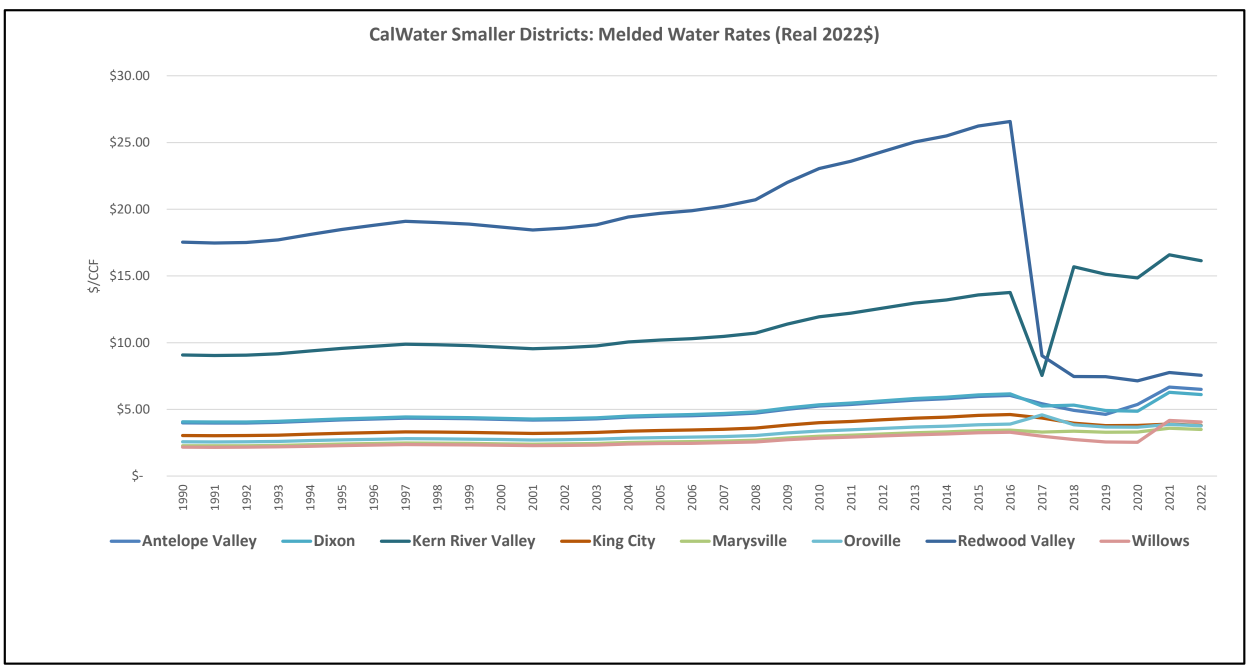


Figure 12 Cal Water Smaller Districts: Real Water Rates (2022$ per hundred cubic feet, CCF)



AVOIDED COSTS

Cal Water has published estimates of the variable cost of water production in their DWR Water Loss Audits. The State method and water district interpretation of the Water Loss Audits has evolved since they were first required in 2016. It is known that within the AWWA/IWA water loss audit standard that the "Variable Production Cost" can exclude some long-term supply costs. Effective water conservation can allow water utilities to avoid very large water infrastructure expansion costs: Such as deferring the need for a reservoir, new pipelines, water purchase agreements, etc. We adopt avoidable variable production cost estimate as a conservative lower bound on the value of water saved.

For this analysis, we have updated the estimates to 2022 dollars, and we have used the CPI-U Water and Sewer index to extend the estimates back to 1990. These estimates are shown in Figures 13-15.[5] As shown by these figures, avoided costs are significantly higher for Districts in the Bay Area (Mid-Peninsula and South San Francisco) and Southern California (East Los Angeles, Hermosa, Westlake), which primarily rely on imported surface water, than for Districts which mainly or exclusively rely on local groundwater (e.g. Chico, and Selma).

While avoided cost is used as the primary measure of benefit in this Report, it is important to recognize its limitations in districts where water supply comes mainly or exclusively from an over-drafted groundwater basin, as is the case Stockton, Salinas, Selma and Visalia. In this circumstance, the avoided cost estimate is not capturing the negative externality cost of continued overdraft of the groundwater resource and therefore is going to understate the value of demand management programs in these districts. As noted in the introduction, SGMA will eventually compel groundwater users to jointly address groundwater overdraft, and this is expected to entail substantial future capital investment in new sources of surface or recycled water supply as well as possible new fees and limitations on groundwater pumping. However, these future costs are still uncertain and therefore are not reflected in the avoided cost estimates used for this Report.

[5] The spreadsheet model provides a user-selectable switch to choose alternative estimates of the avoided cost of water supply for sensitivity analyses. The user-selectable alternatives include the estimate used in our 2021 analysis (Chesnutt, et al., 2021) derived from Cal Water commissioned studies in 2012 and 2015 to estimate the avoided water supply cost for each service areas (M.Cubed, 2012; M.Cubed, 2015 as found in Conservation Master Plans). Those studies used the CUWCC/Water Research Foundation Avoided Cost Model to estimate the costs that a water utility would avoid as a result of each acre foot of water conserved. The CUWCC/Water Research Foundation model estimates both short run and long run avoided costs, and differentiates between water saved in the peak and off-peak seasons.

Figure 13 Cal Water Large Districts Avoided Costs: Variable Production Cost (Real 2022$/AF)

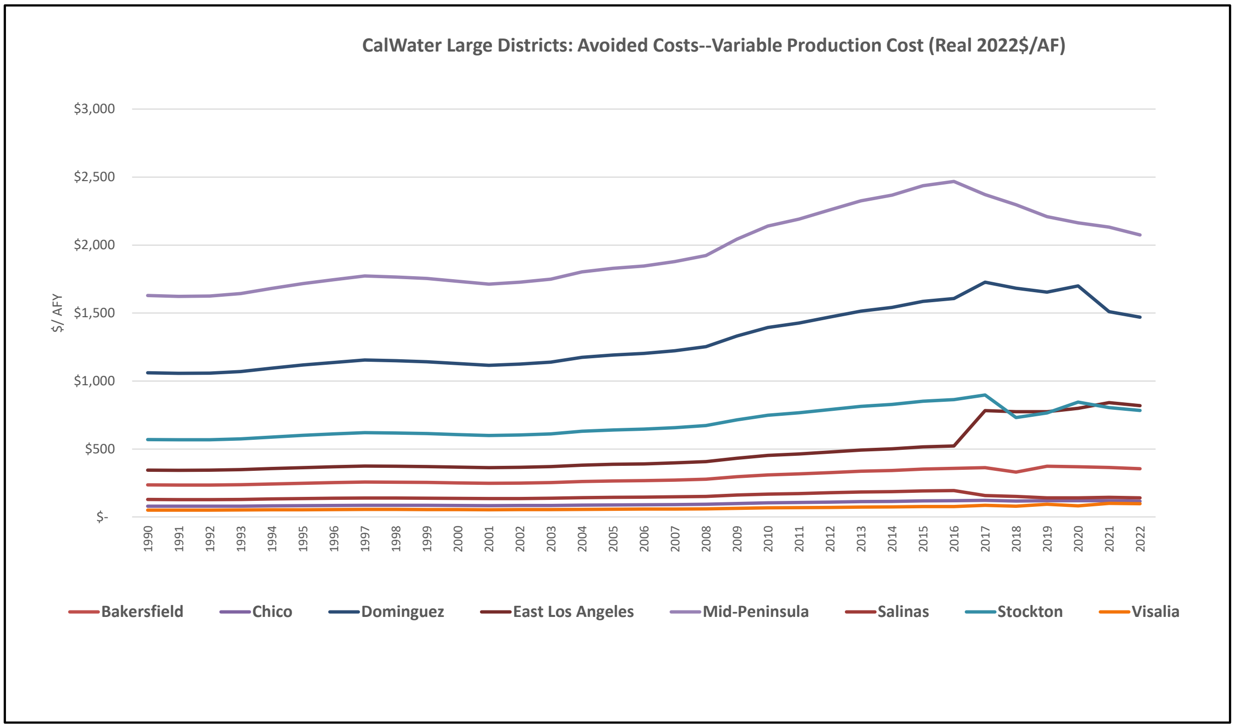


Figure 14 Cal Water Medium Districts Avoided Costs: Variable Production Cost (Real 2022$/AF)

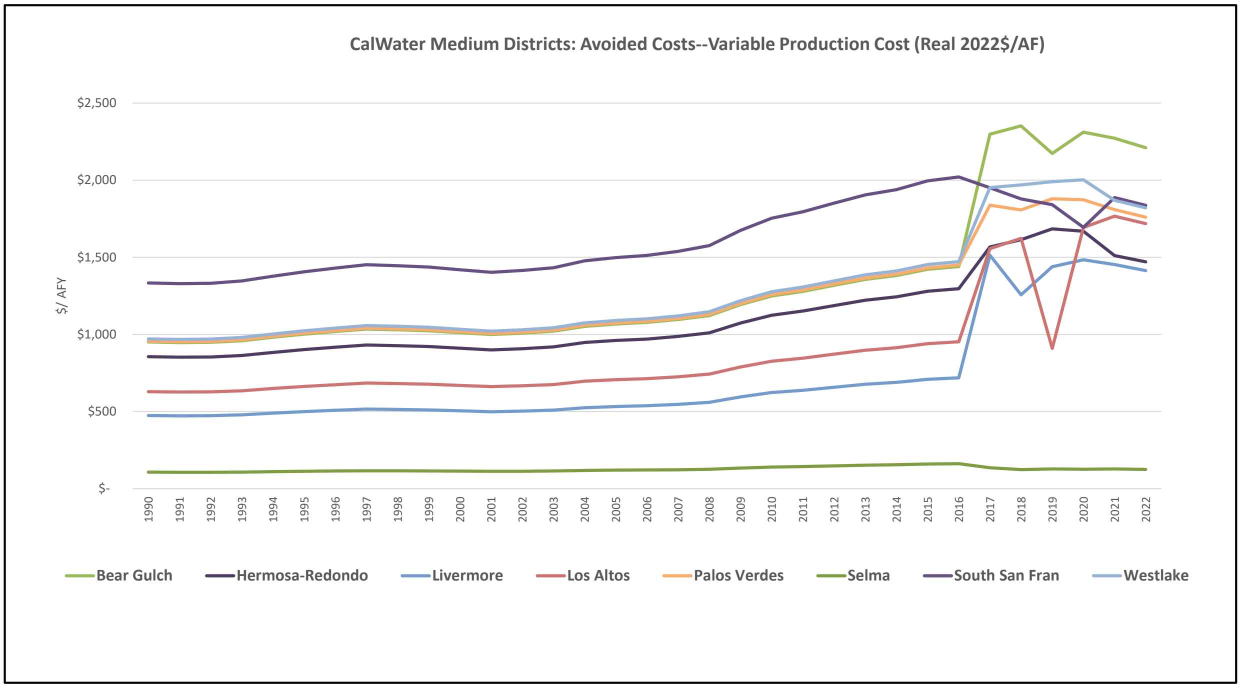
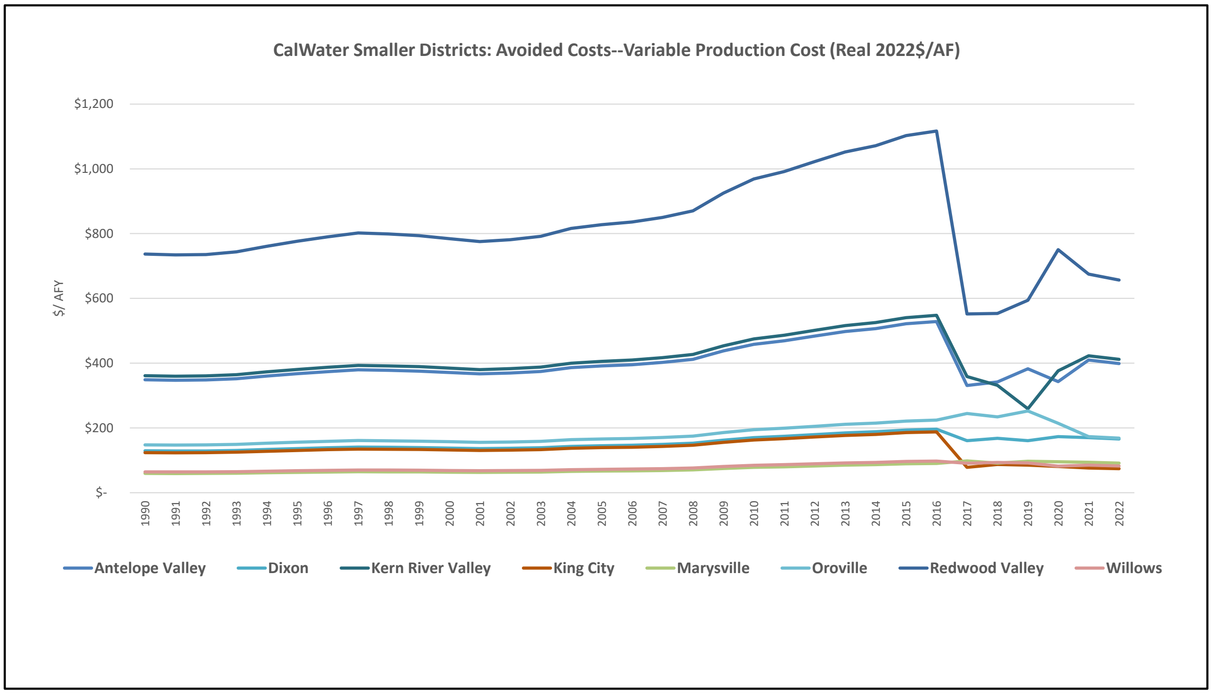


Figure 15 Cal Water Smaller Districts Avoided Costs: Variable Production Cost (Real 2022$/AF)



ANNUAL OPERATING REVENUE

Figures 16 to 18 depict the operating revenues for each size district (Large>100K, Medium 20-100K, Smaller <20K in 2022 population). Operating revenues are closely associated with the revenue requirements used to set customer bills. To understand the relative magnitude of the costs avoided by efficiency, these costs are compared to operating revenue. Cal Water provided operating revenue data for each of the 24 districts.

Figure 16 Cal Water Large Districts: Annual Operating Revenue (Real 2022$/AF)

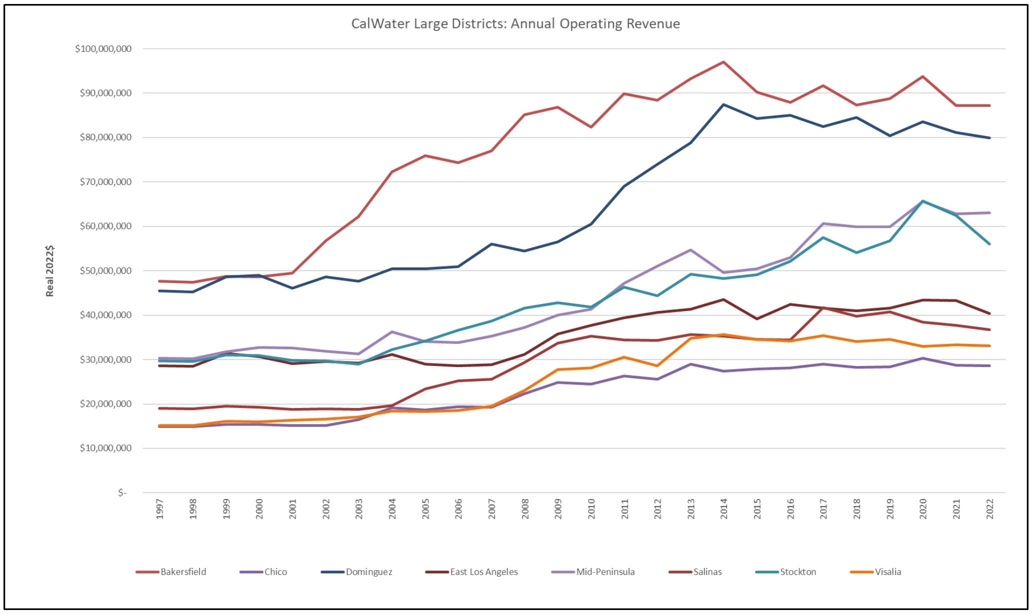


Figure 17 Cal Water Medium Districts: Annual Operating Revenue (Real 2022$/AF)

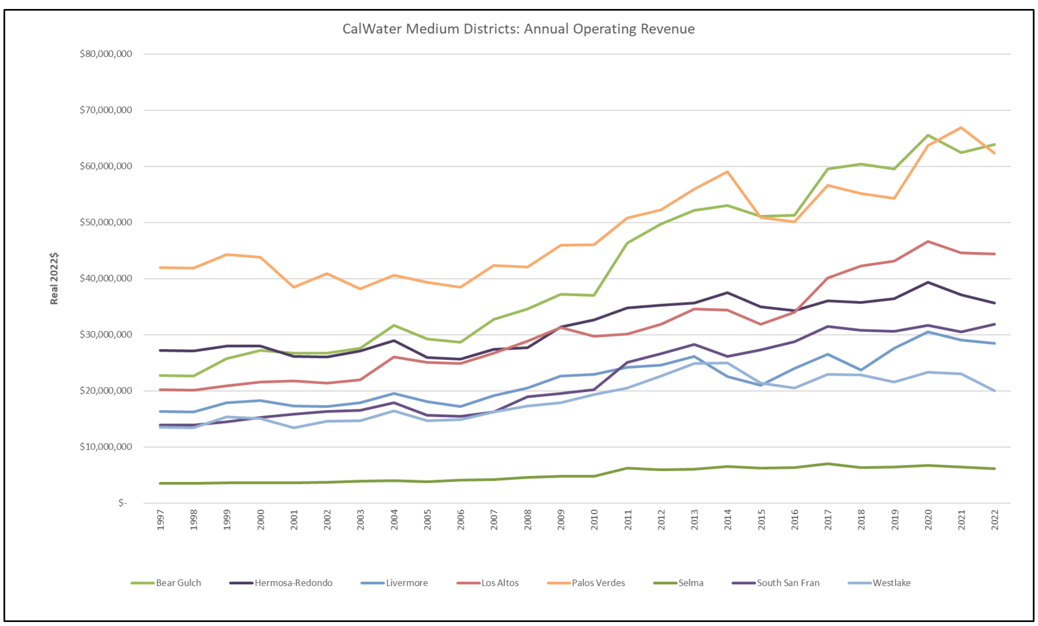
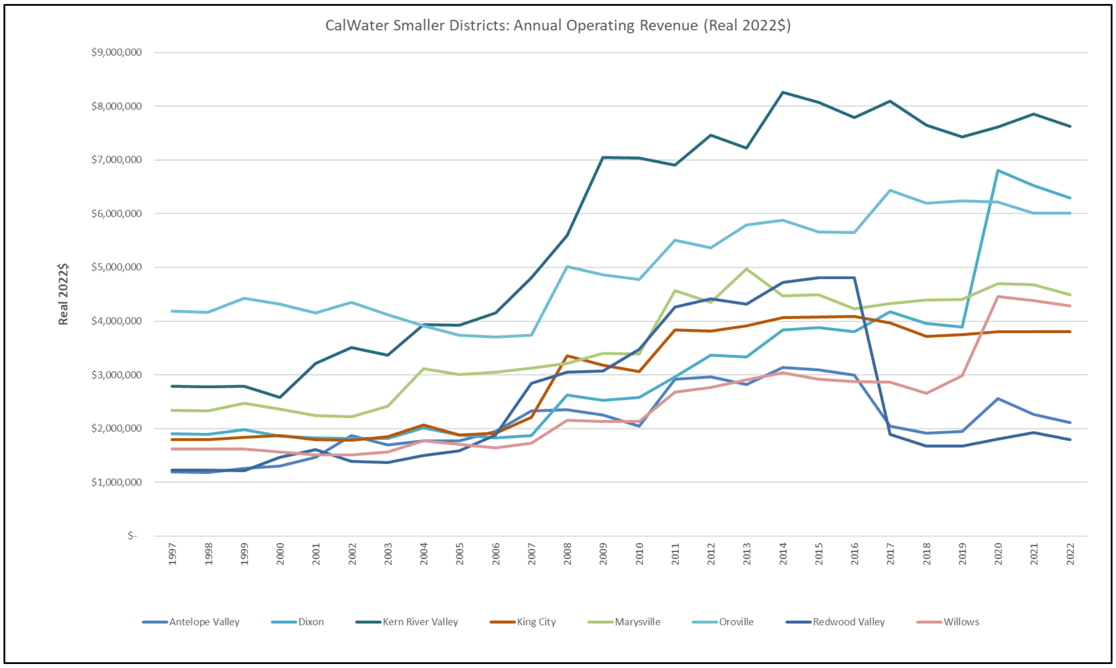


Figure 18 Cal Water Smaller Districts: Annual Operating Revenue (Real 2022$/AF)



DEMAND, POPULATION, AND GPCD BY DISTRICT

This section provides a higher-resolution look at customer demand and population for each district. The series of graphs in Figures 19 to 66 show the demand and population used to calculate GPCD for each district and the actual demand and the counterfactual demand calculated with constant GPCD.

Figure 19 Antelope Valley Demand versus Population

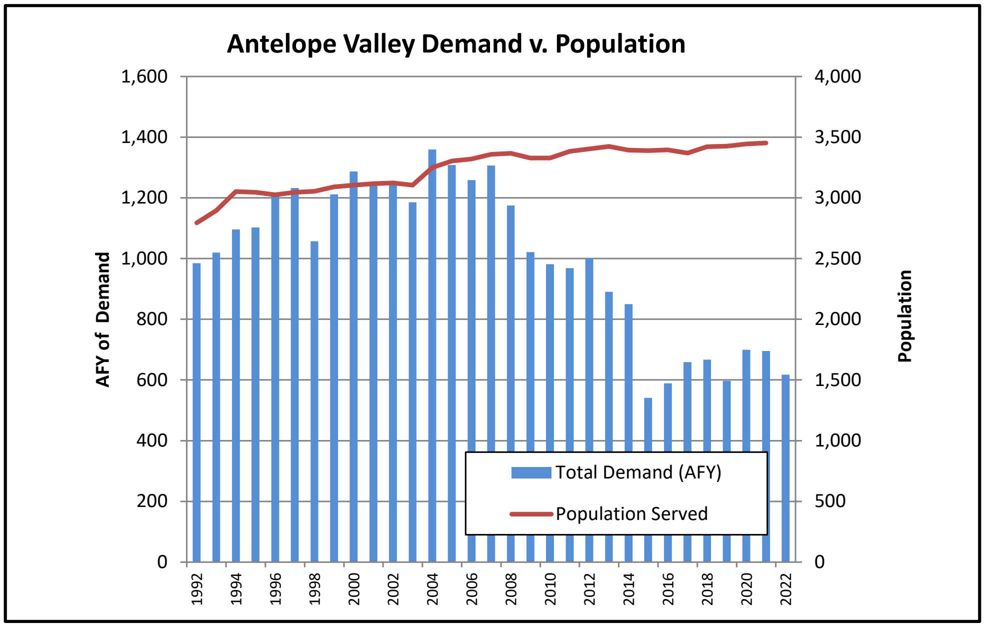


Figure 20 Antelope Valley Historical versus Demand

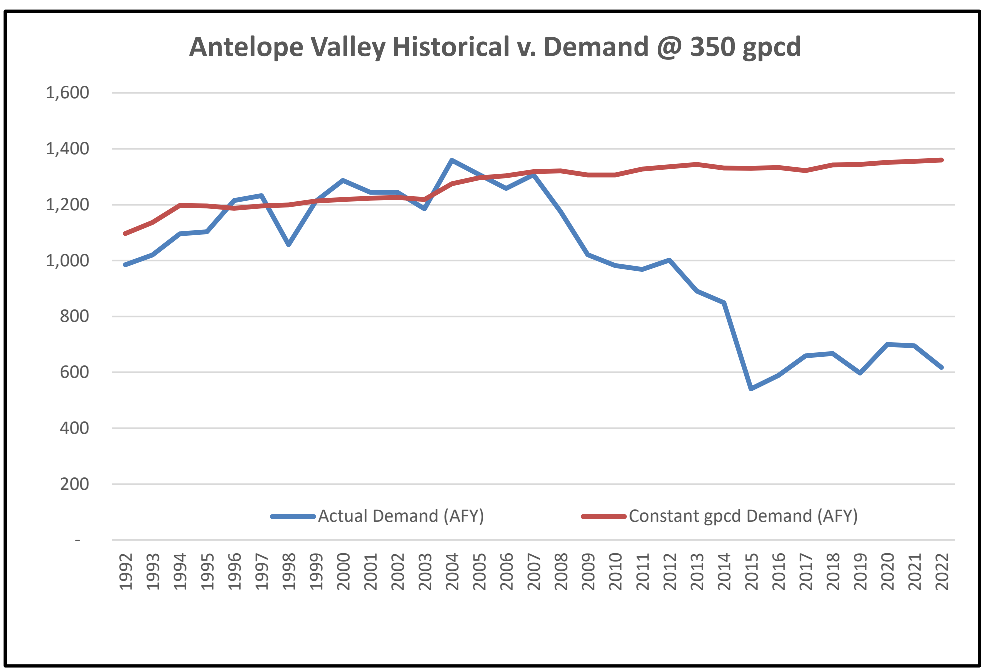


Figure 21 Bakersfield Demand versus Population

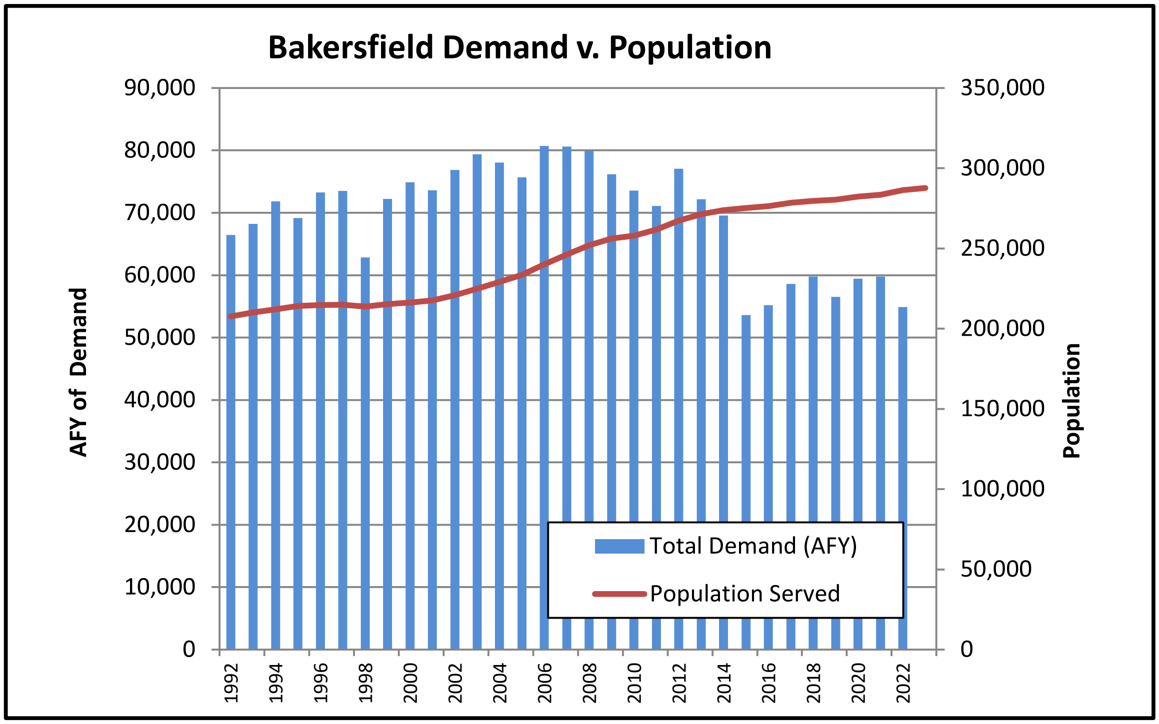


Figure 22 Bakersfield Historical Population versus Demand

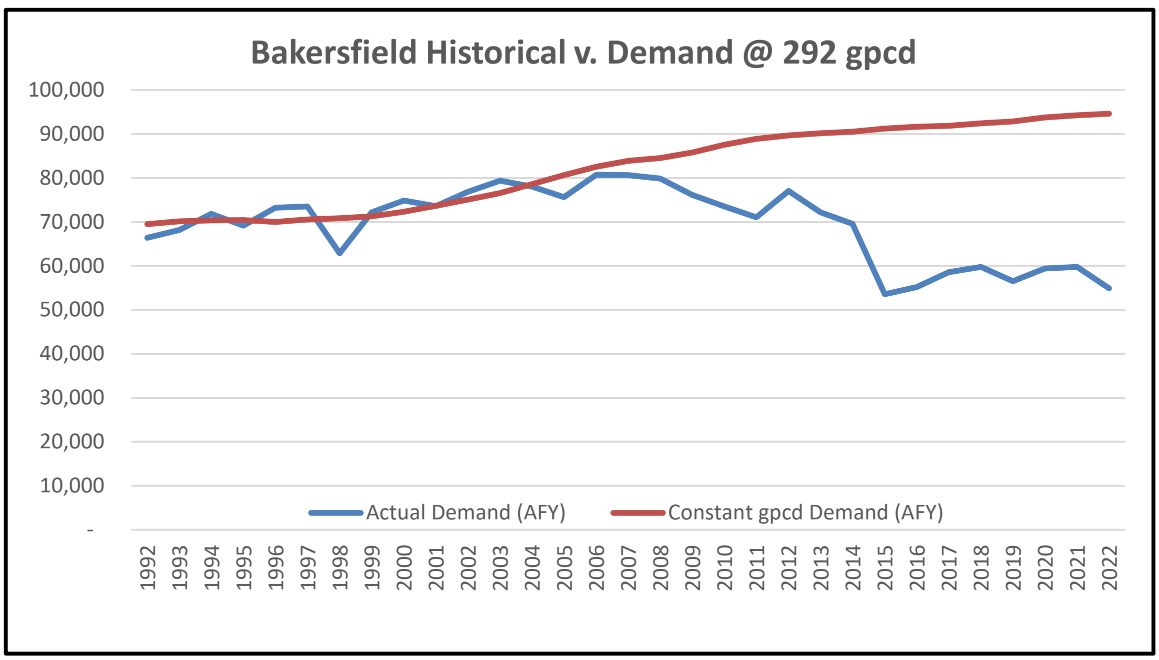


Figure 23 Bear Gulch Demand versus Population

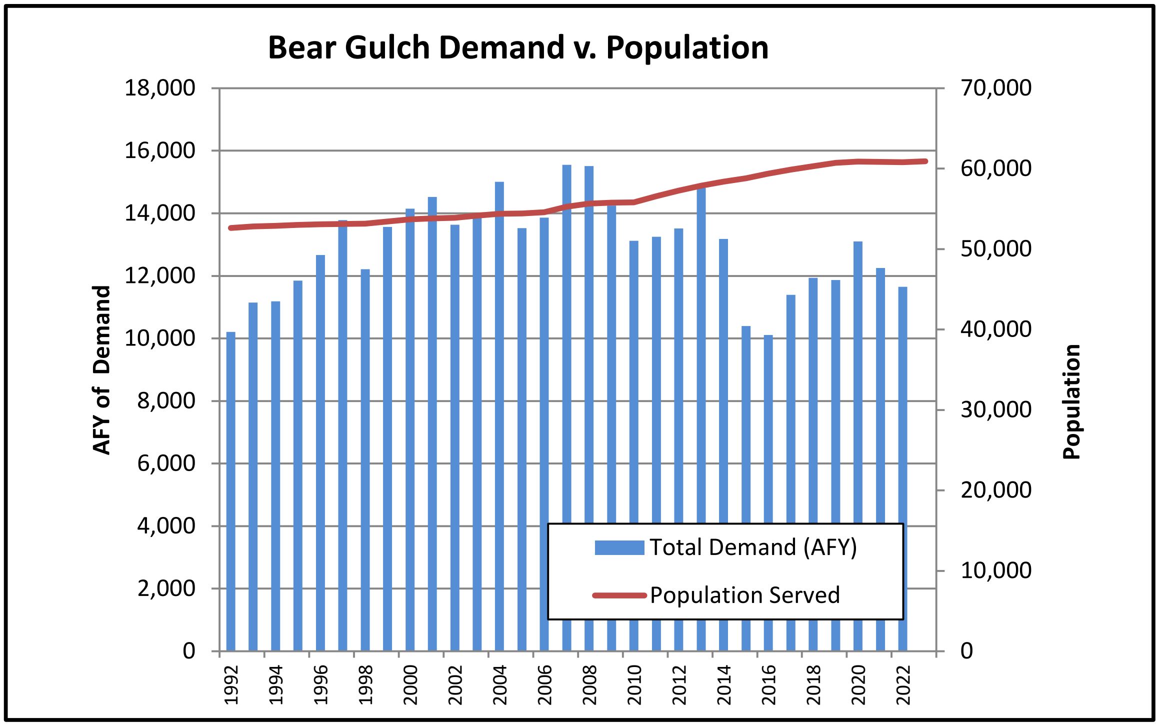


Figure 24 Bear Gulch Historical versus Demand

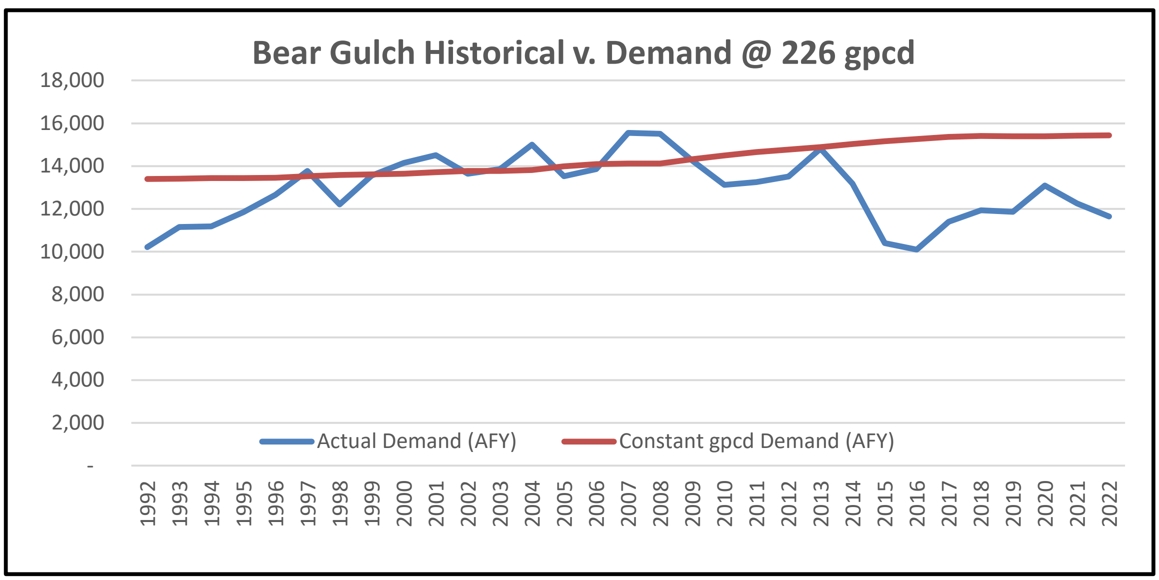


Figure 25 Chico Demand v Population

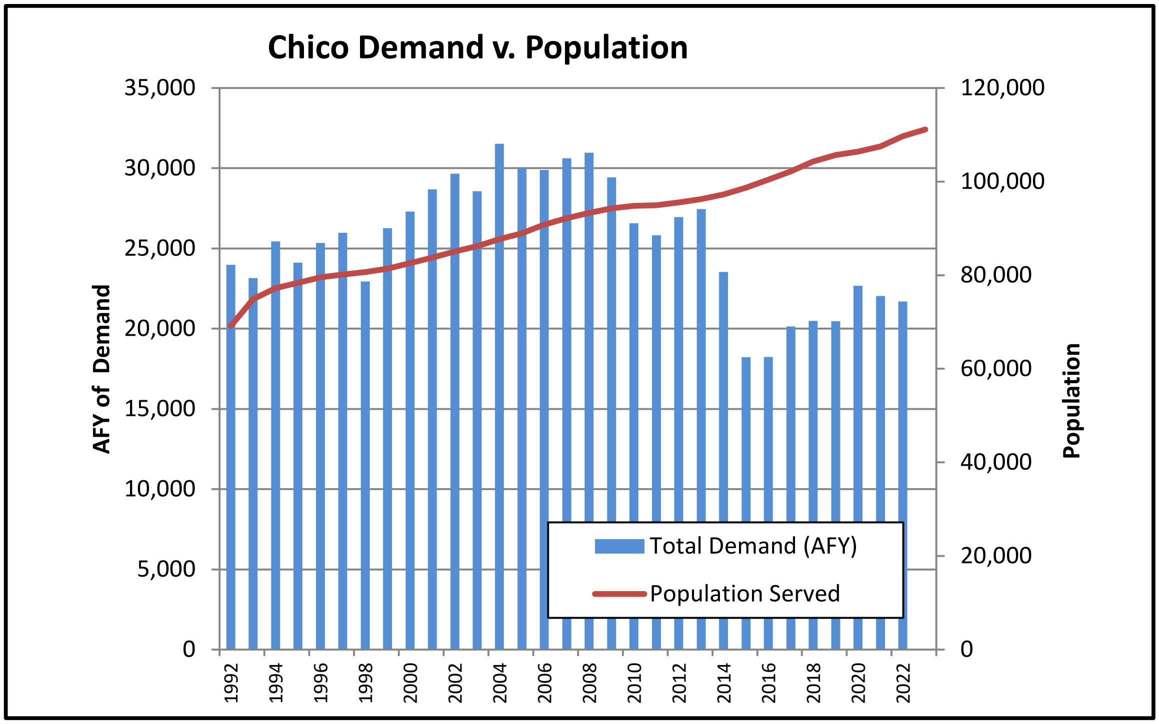


Figure 26 Chico Historical v Demand

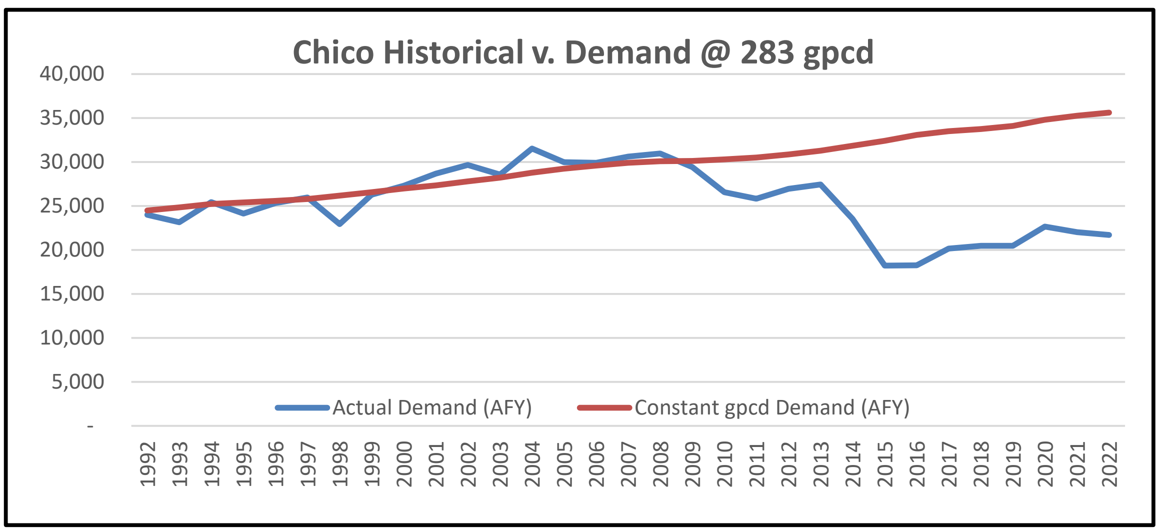


Figure 27 Dixon Demand versus Population

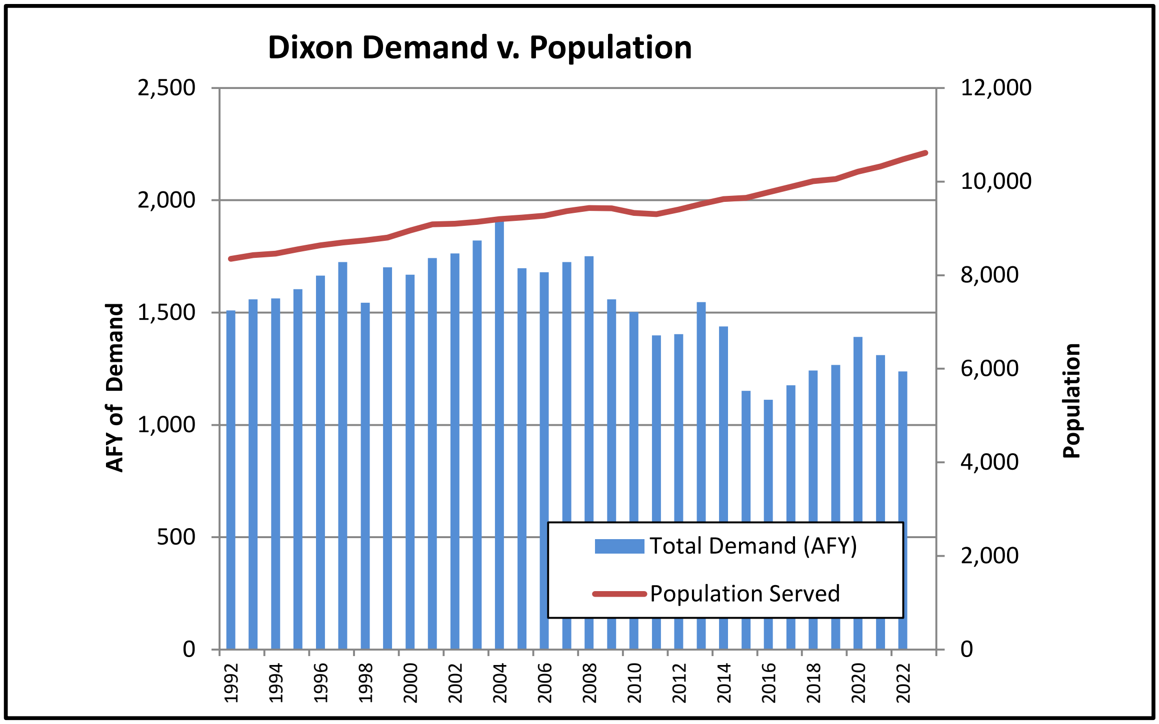


Figure 28 Dixon Historical versus Demand

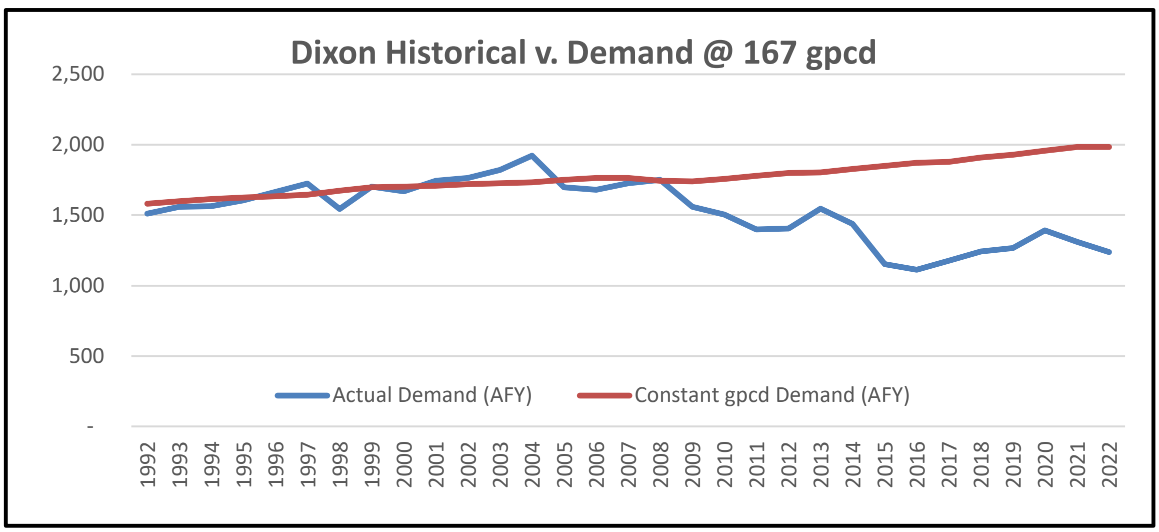


Figure 29 Dominguez Demand versus Population

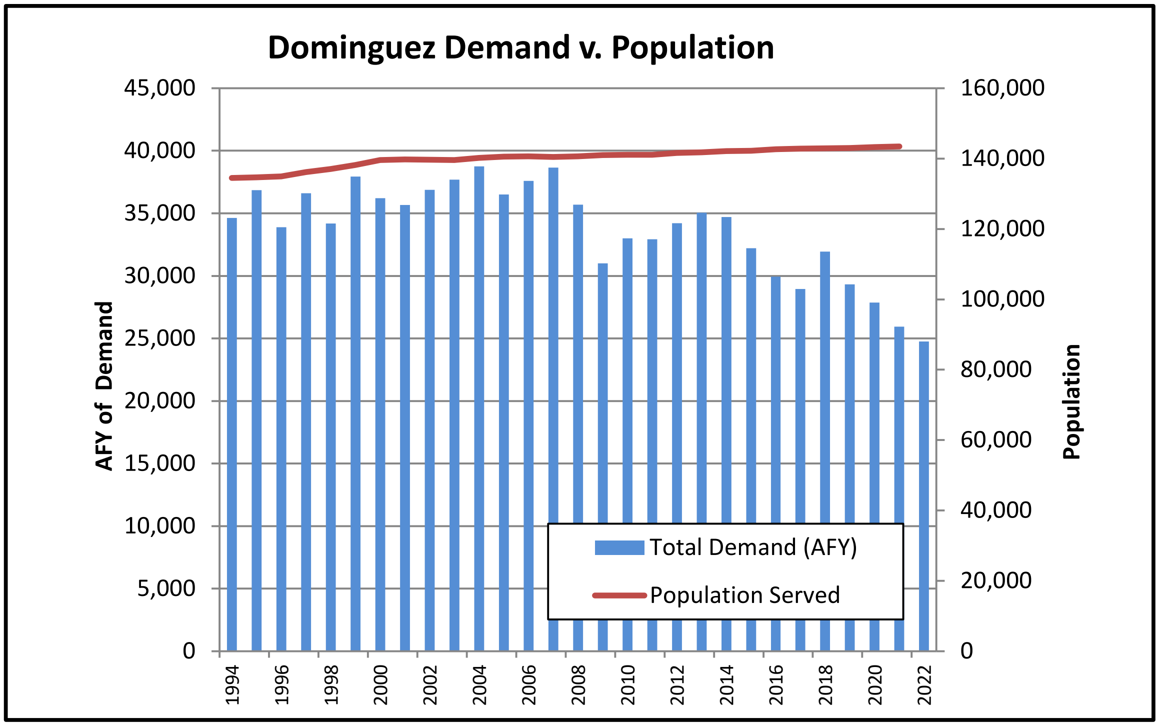


Figure 30 Dominguez Historical versus Demand

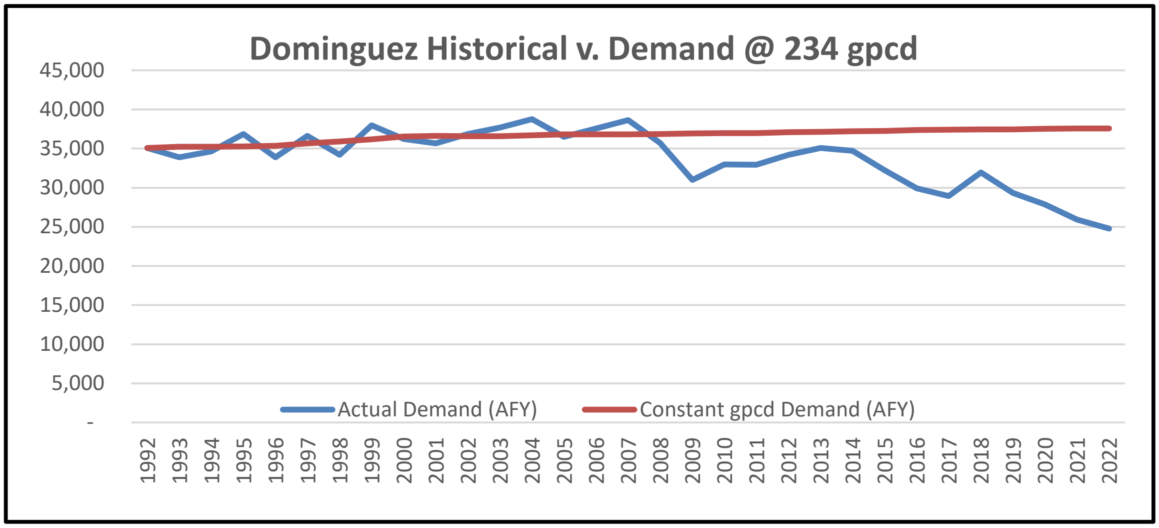


Figure 31 East Los Angeles Demand v Population

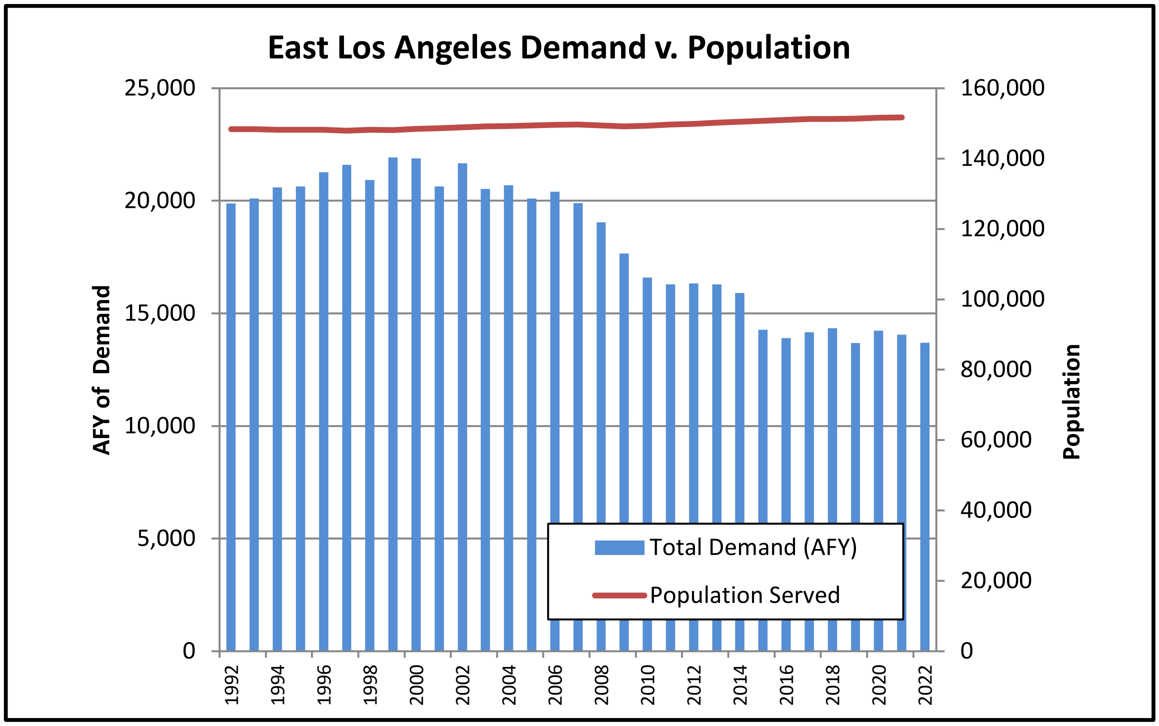


Figure 32 East Los Angeles Historical v Demand

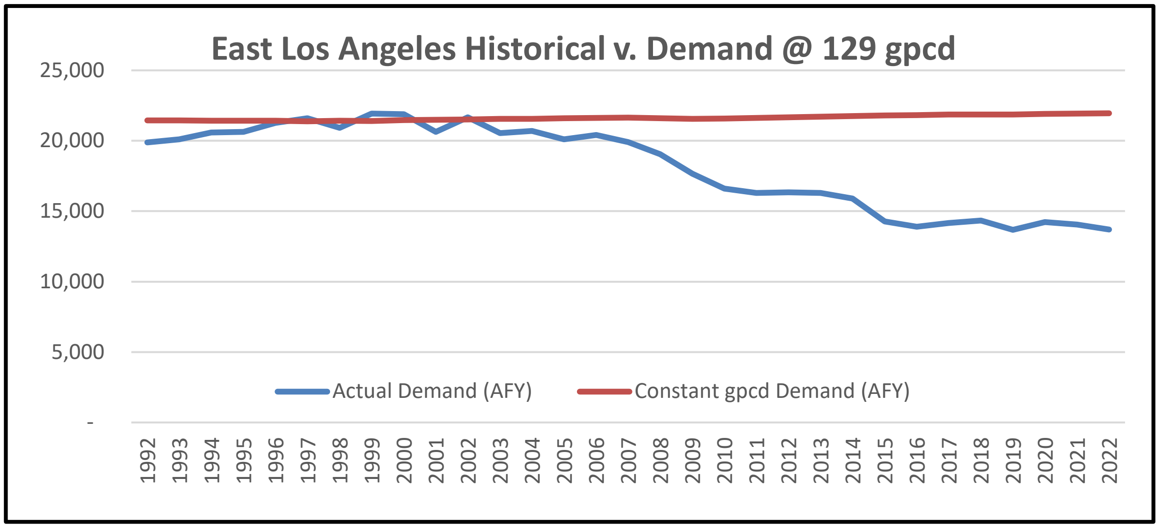


Figure 33 Hermosa-Redondo Demand versus Population

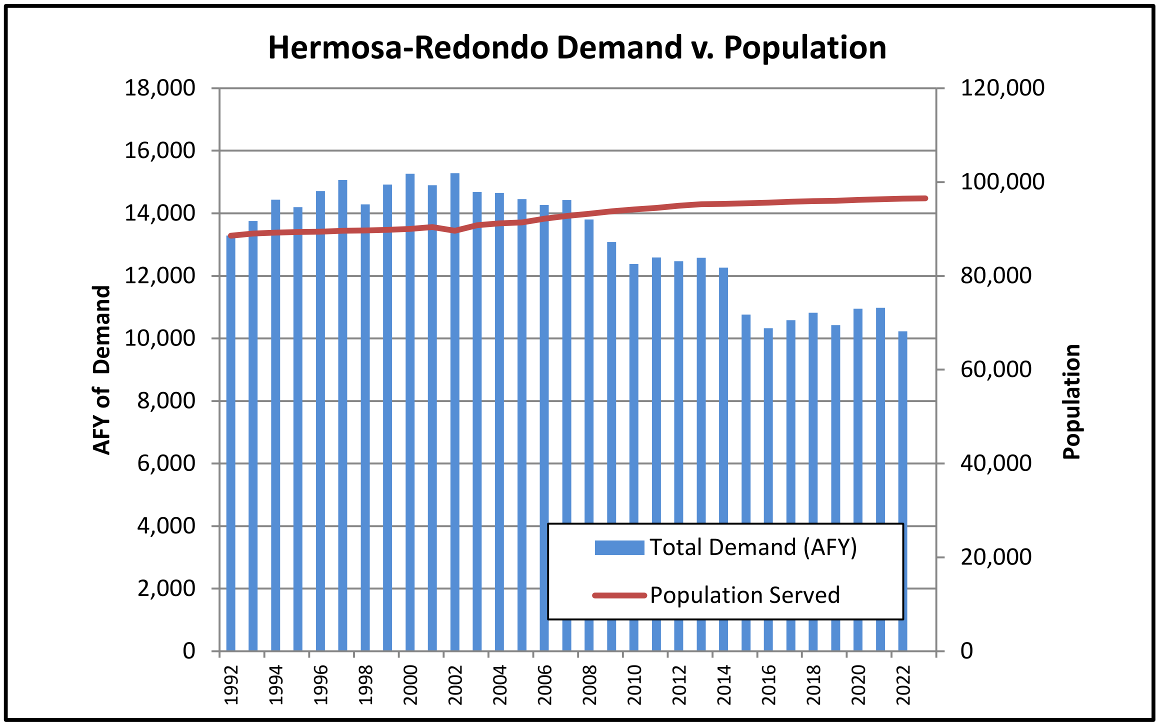


Figure 34 Hermosa-Redondo Historical versus Population

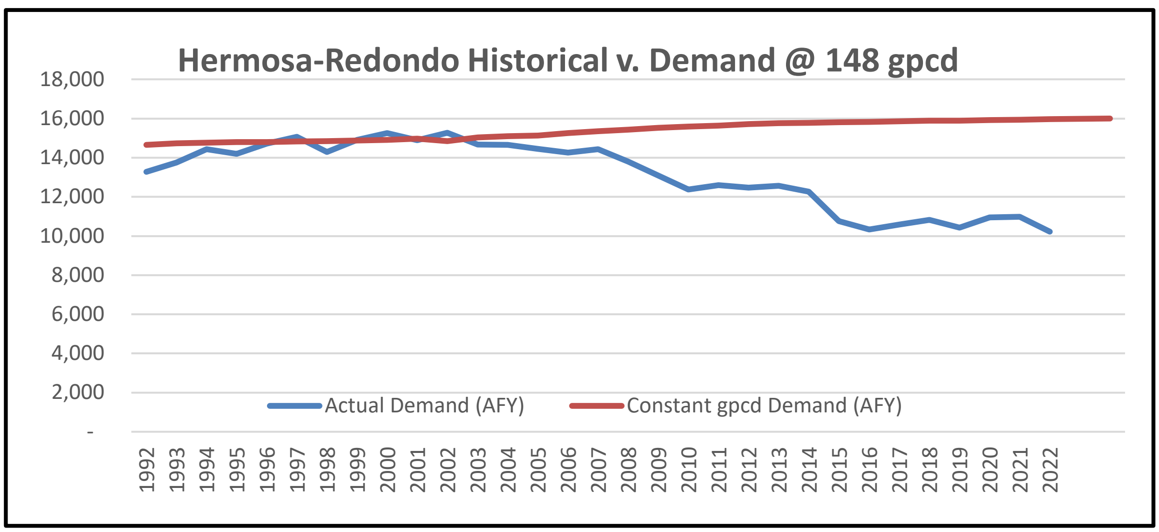


Figure 35 Kern River Valley Demand versus Population

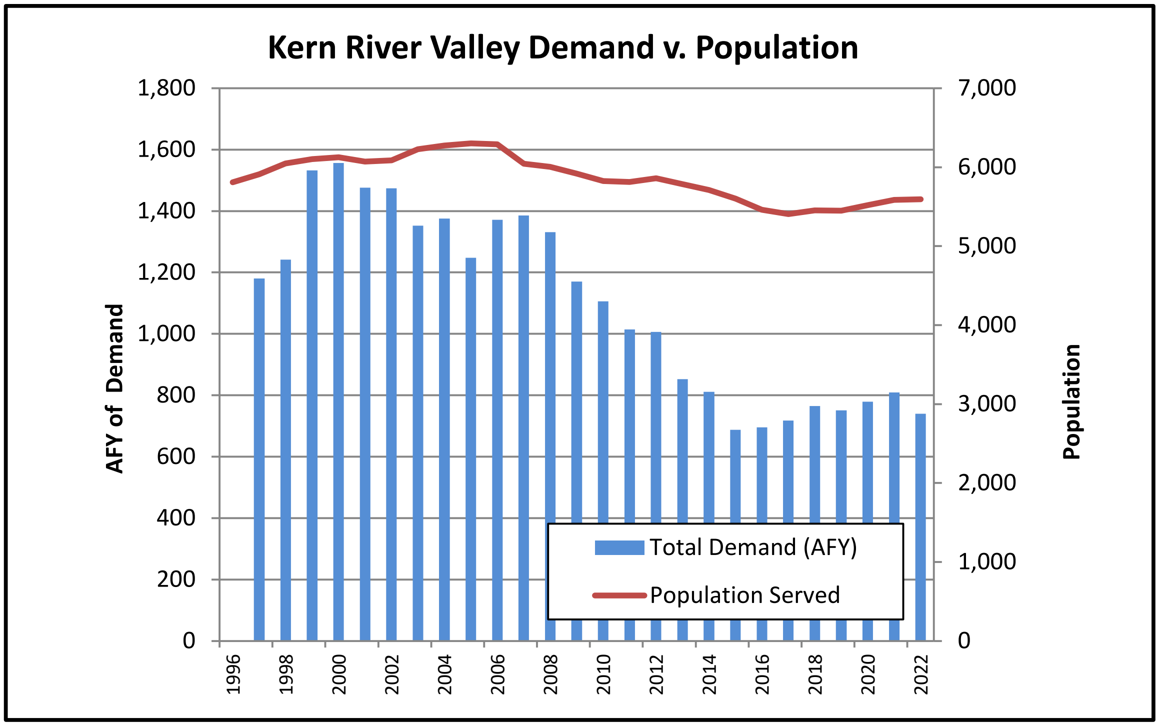


Figure 36 Kern River Valley Historical versus Demand

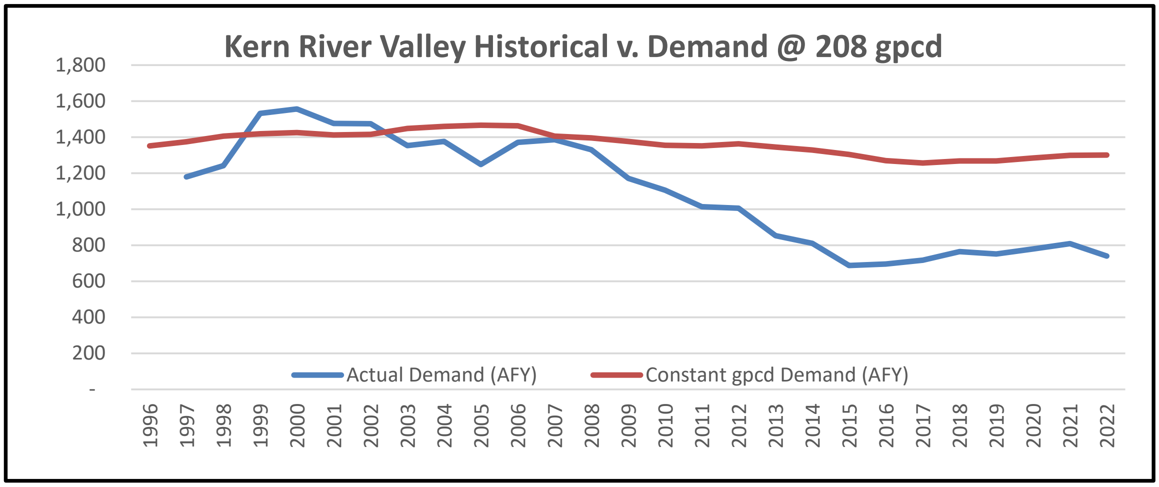


Figure 37 King City Demand versus Population

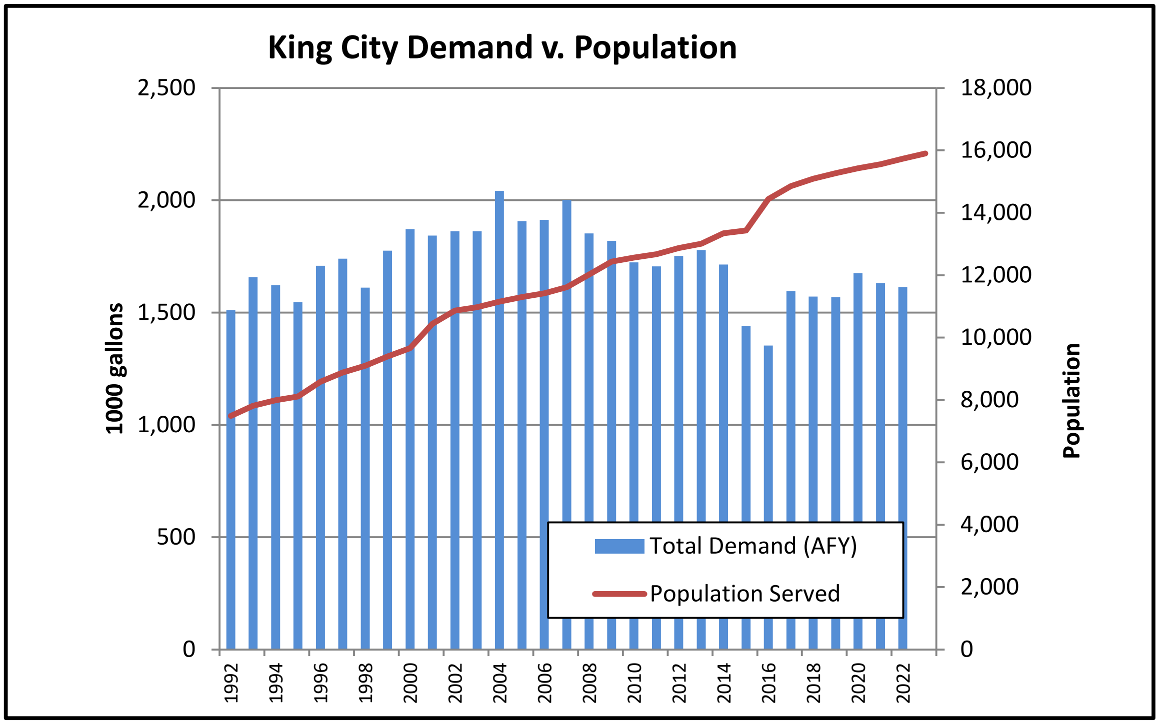


Figure 38 King City Historical versus Demand

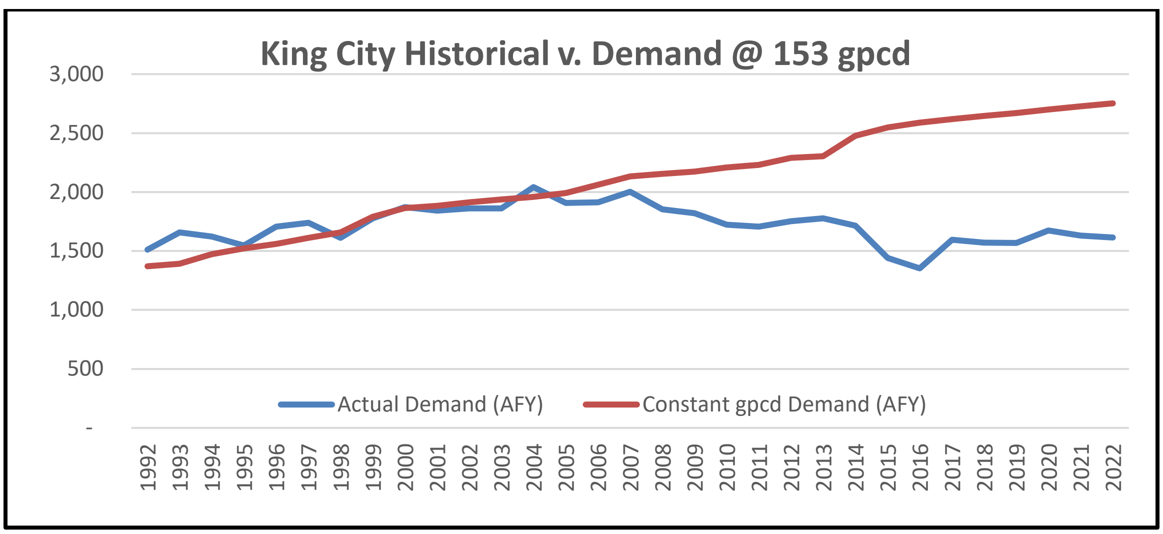


Figure 39 Livermore Demand versus Population

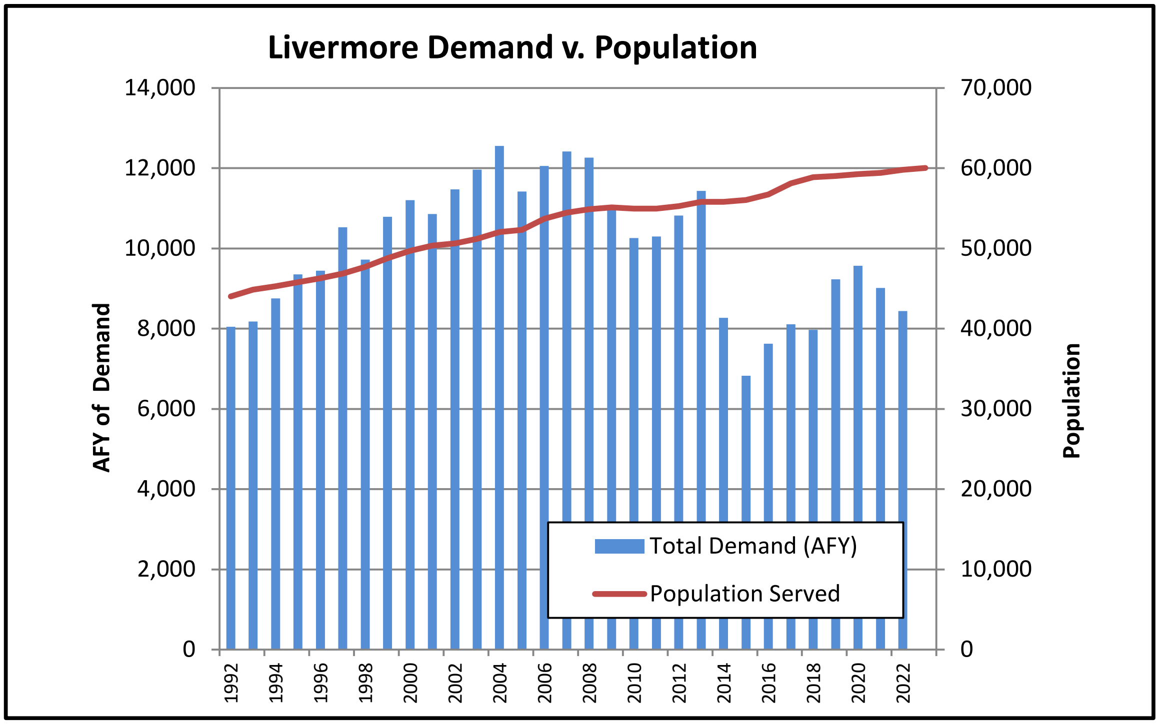


Figure 40 Livermore Historical versus Demand

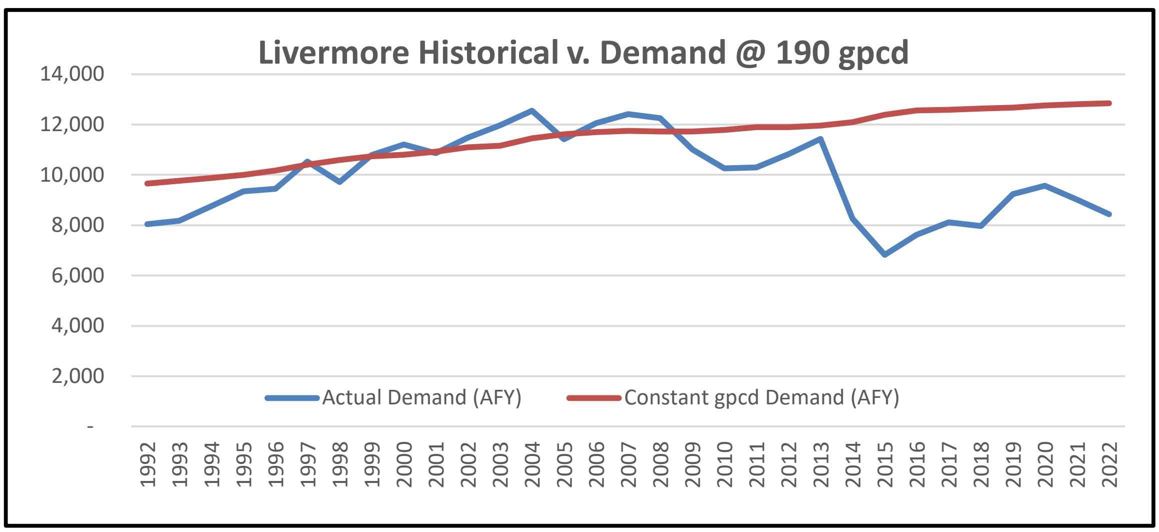


Figure 41 Los Altos demand versus Population

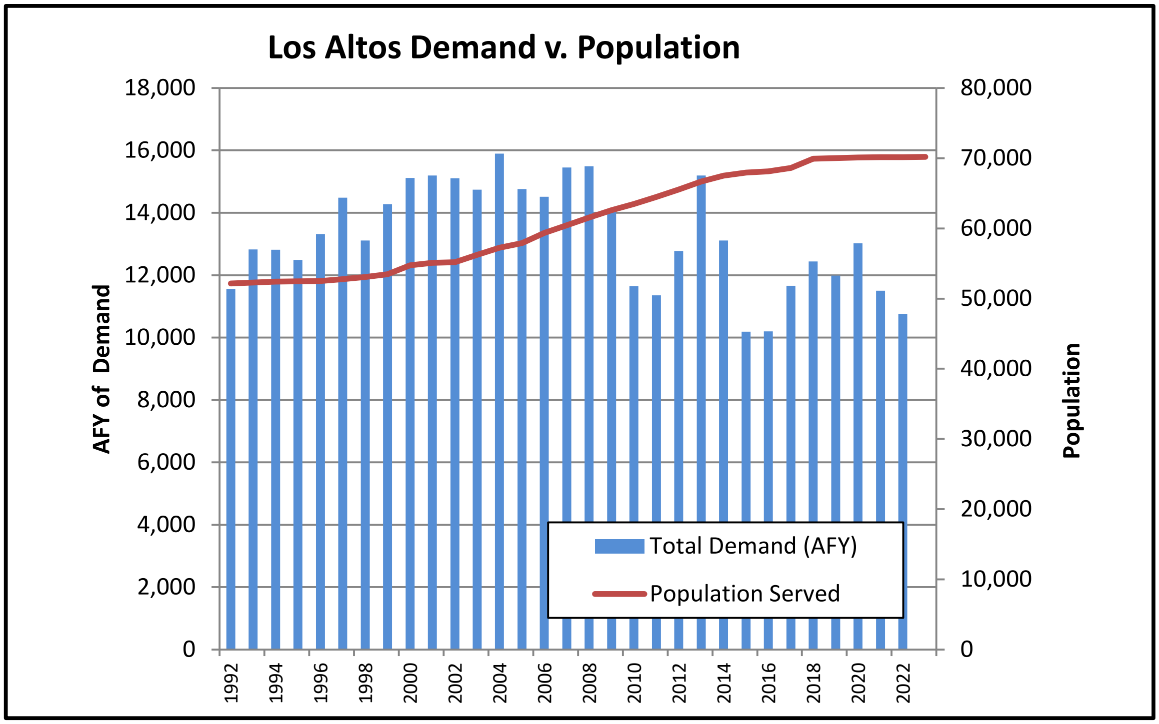


Figure 42 Los Altos Historical versus Demand

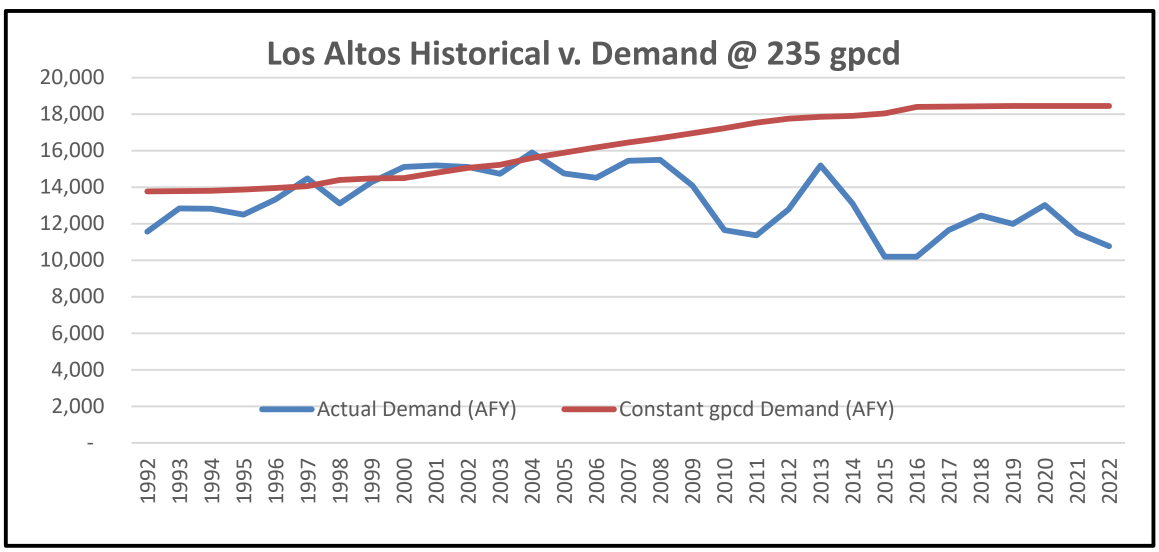


Figure 43 Marysville Demand versus Population

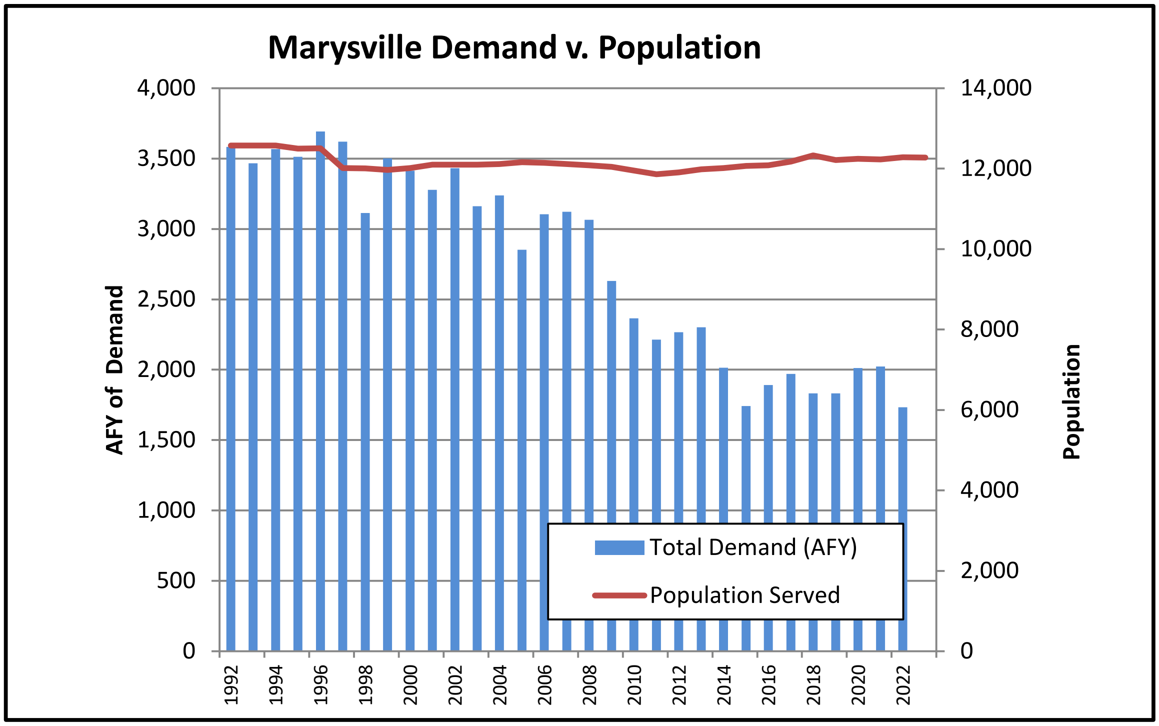


Figure 44 Marysville Historical versus Demand

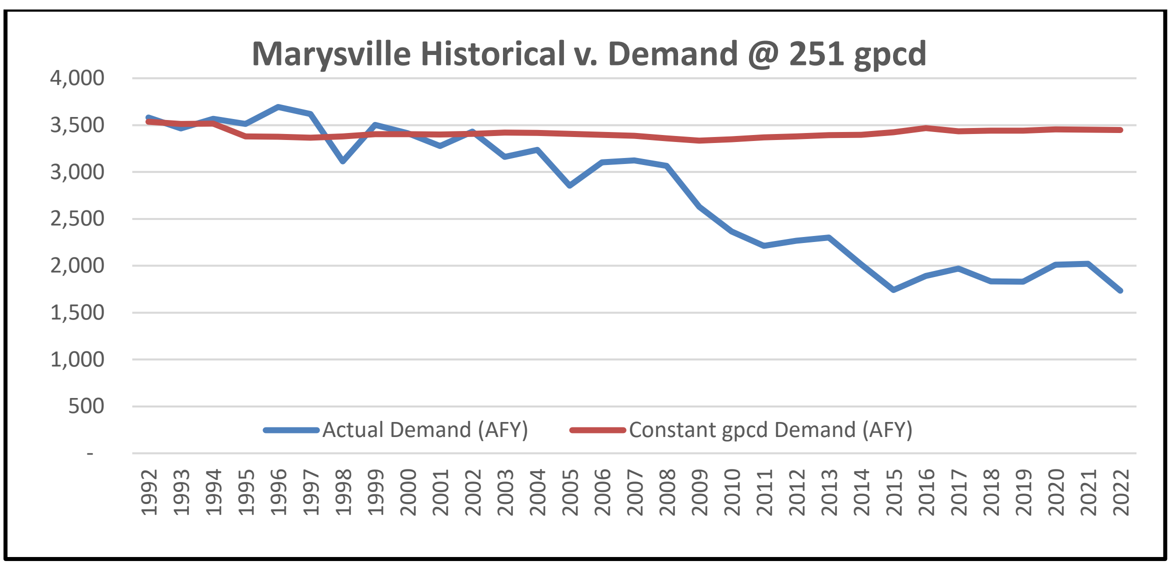


Figure 45 Mid-Peninsula Demand versus Population

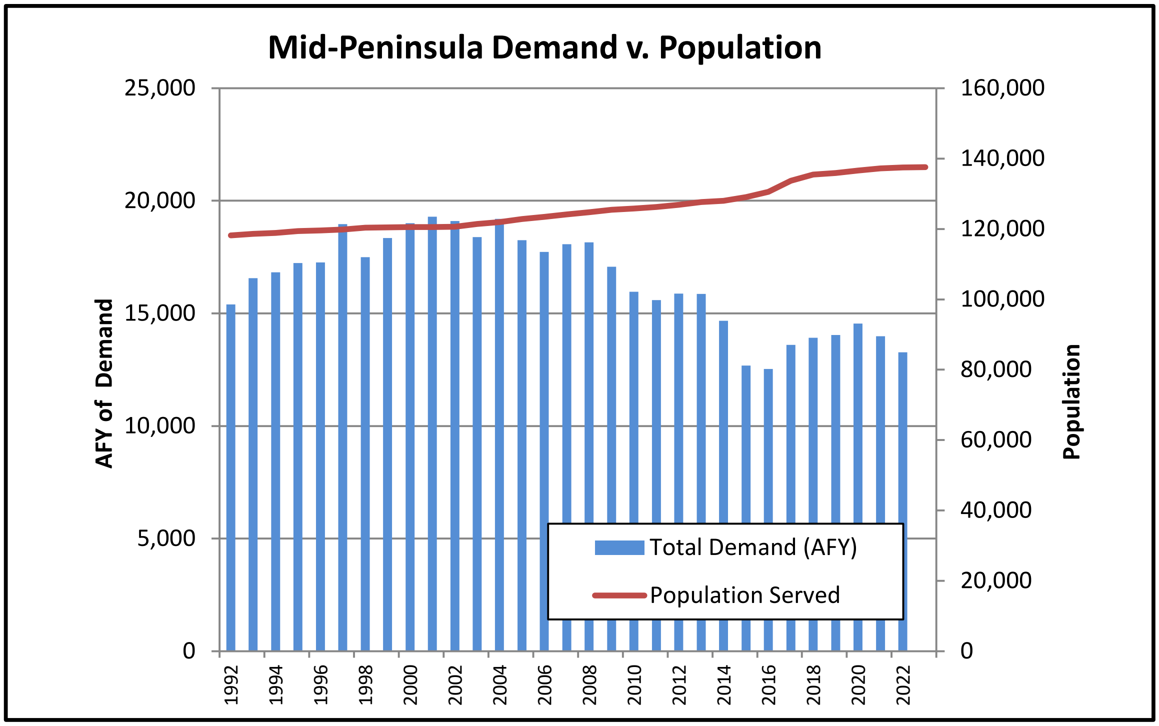


Figure 46 Mid-Peninsula Historical versus Demand

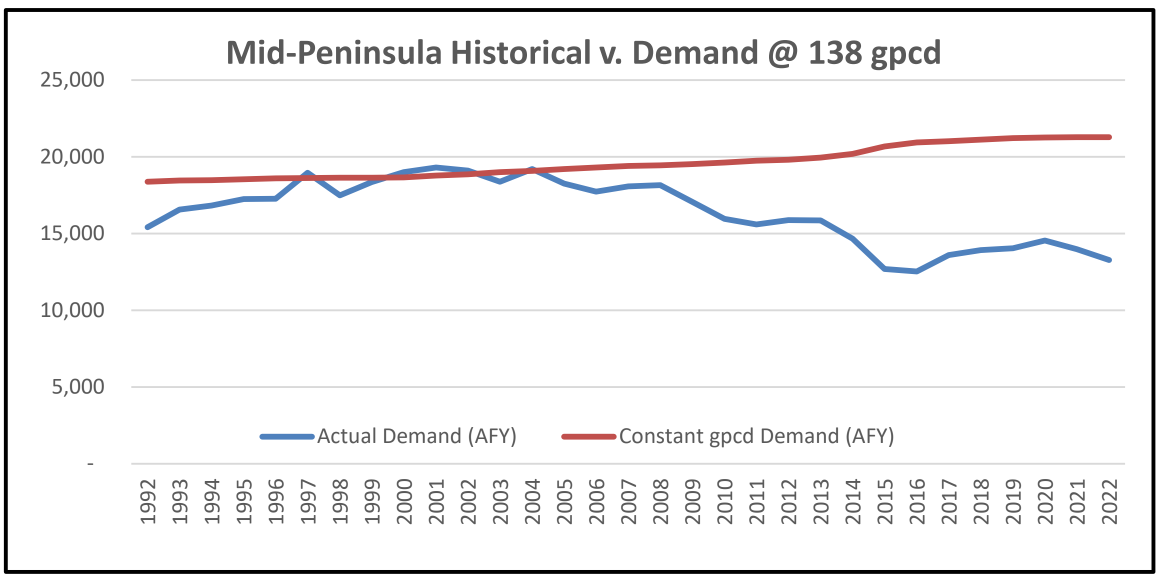


Figure 47 Oroville Demand versus Population

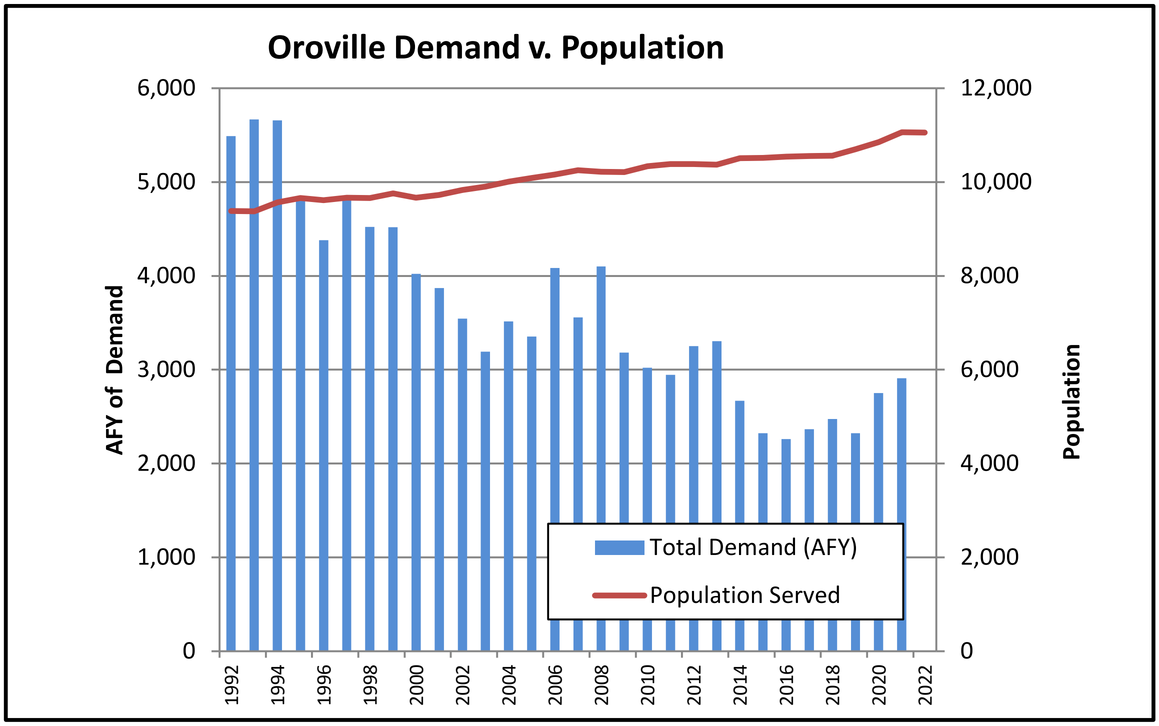


Figure 48 Oroville Historical versus Demand

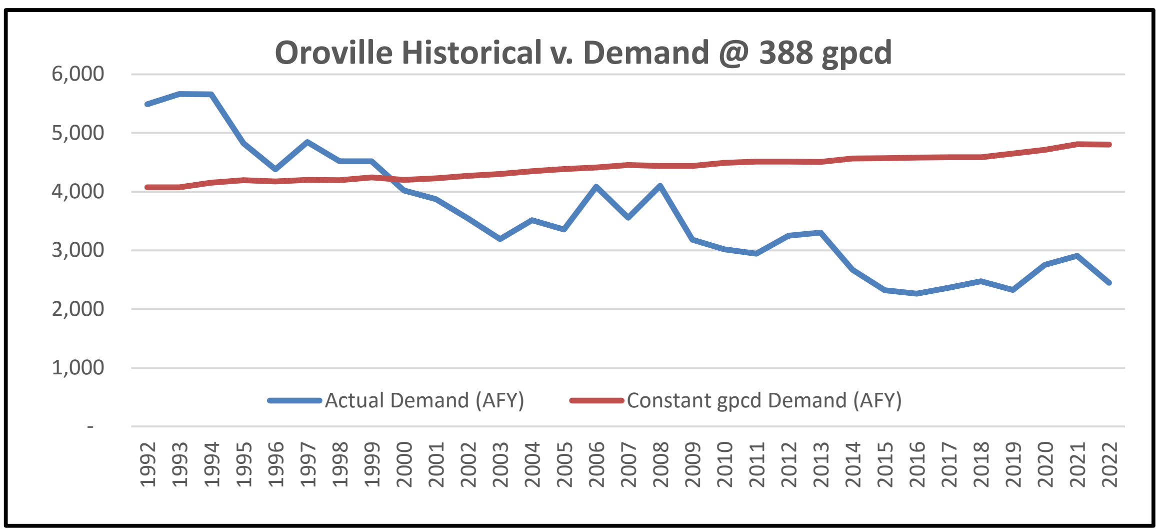


Figure 49 Palos Verdes Demand versus Population

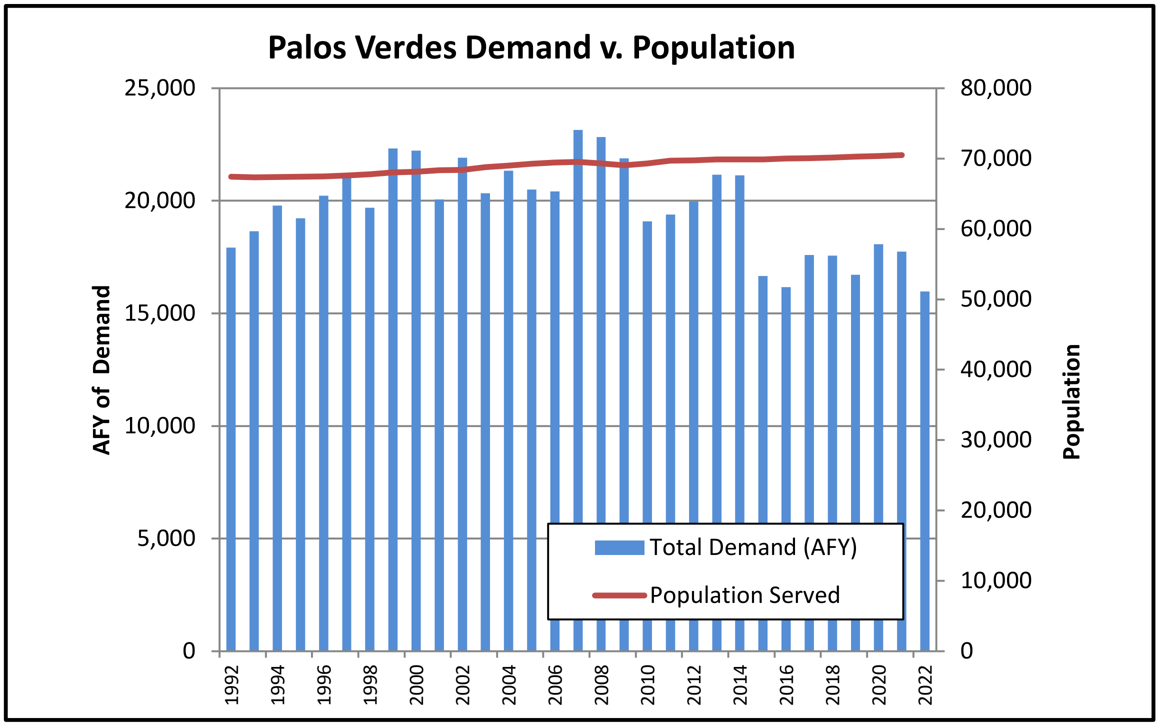


Figure 50 Palos Verdes Historical versus Demand

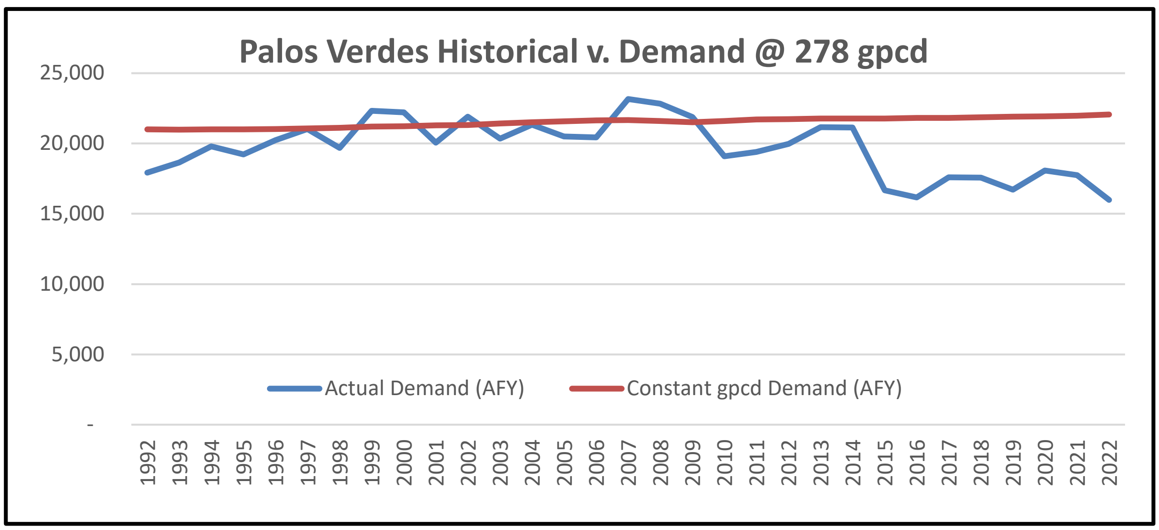


Figure 51 Redwood Valley Demand versus Population

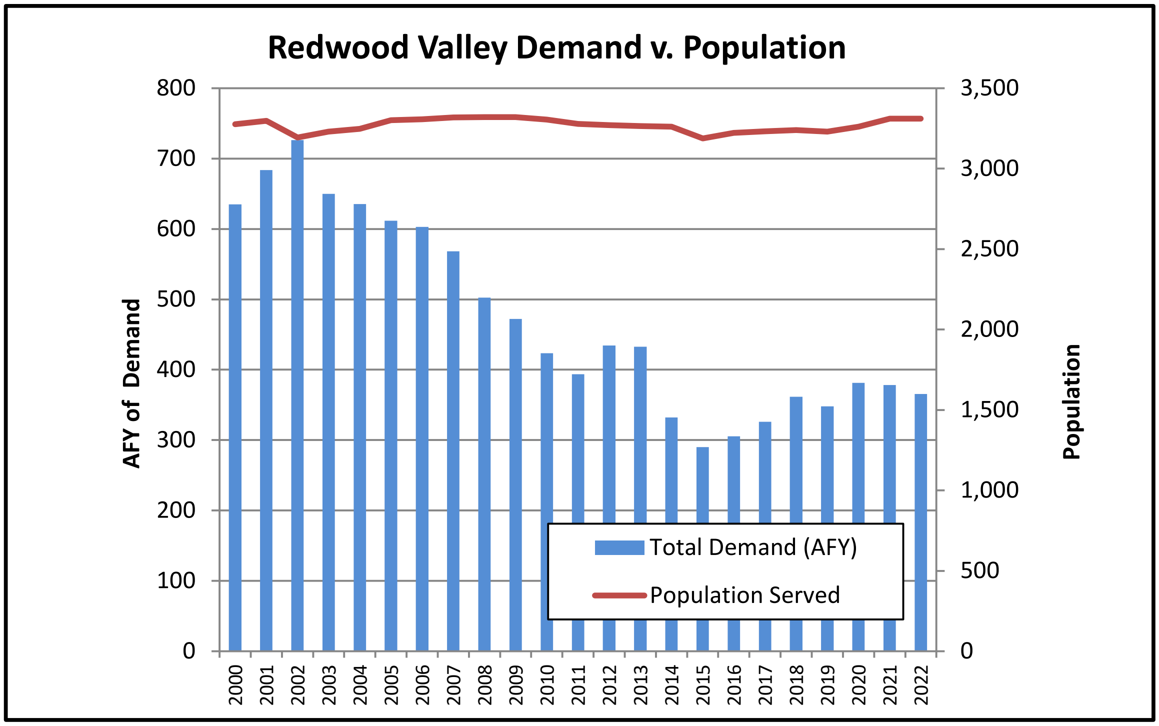


Figure 52 Redwood Valley Historical versus Demand

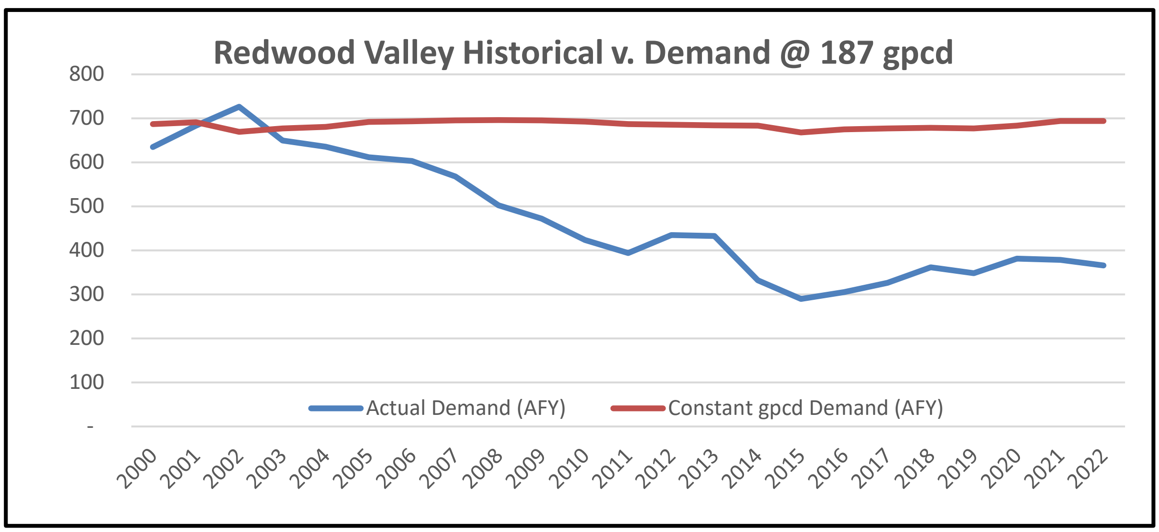


Figure 53 Salinas Demand versus Population

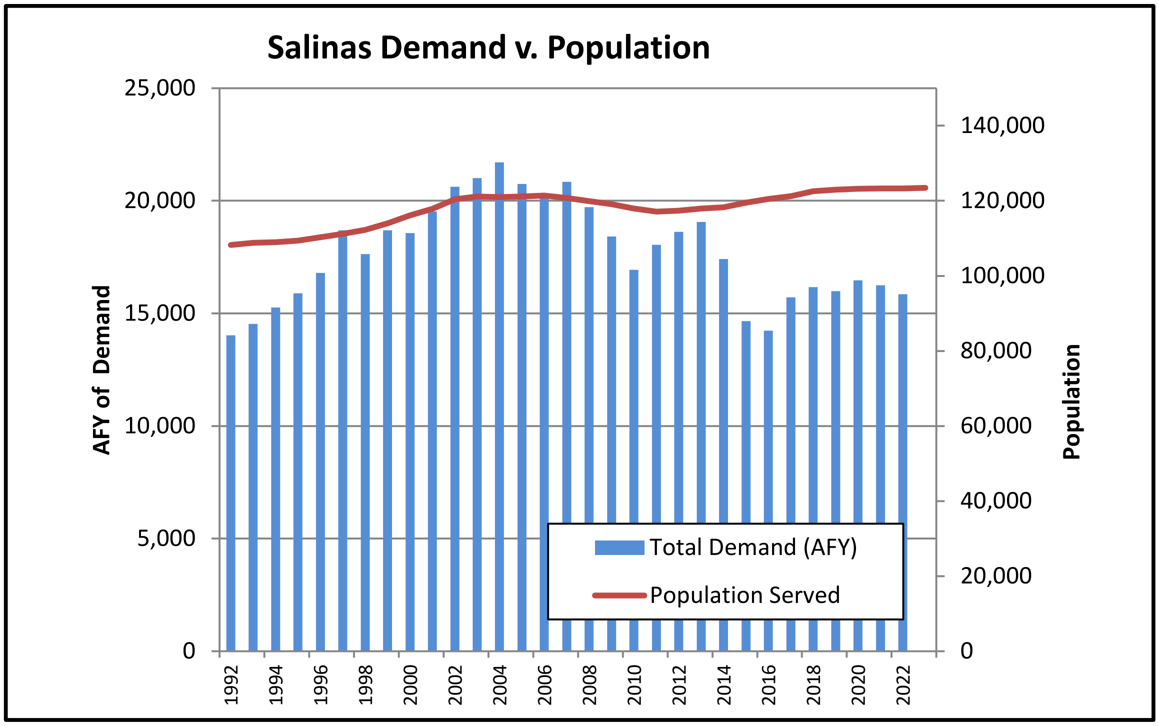


Figure 54 Salinas Historical versus Demand

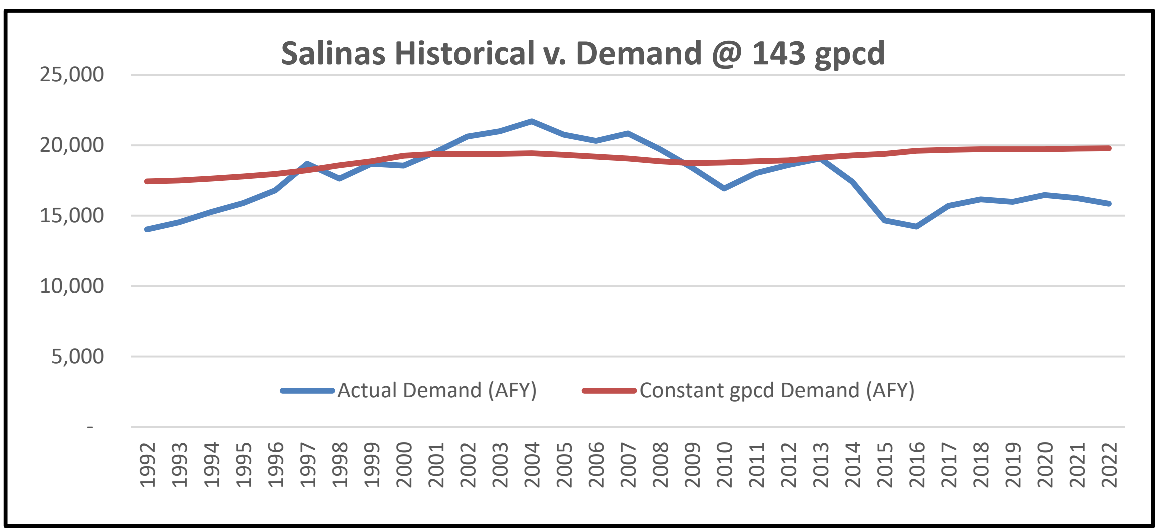


Figure 55 Selma Demand v Population

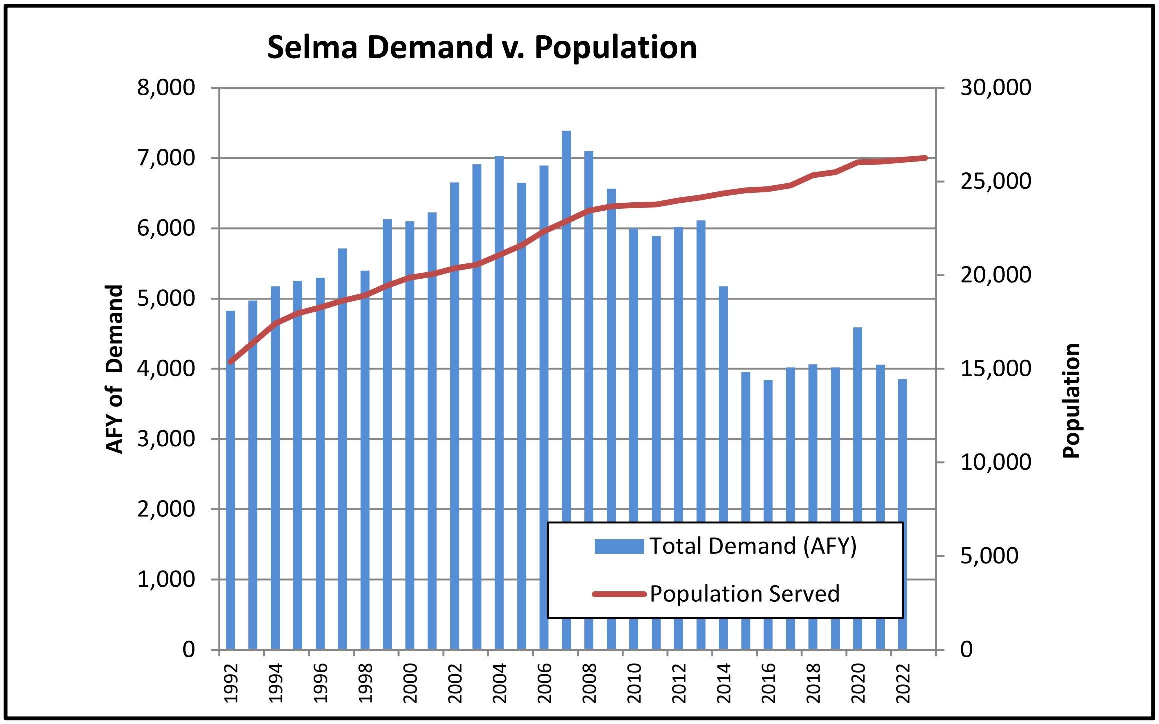


Figure 56 Selma Historical v Demand

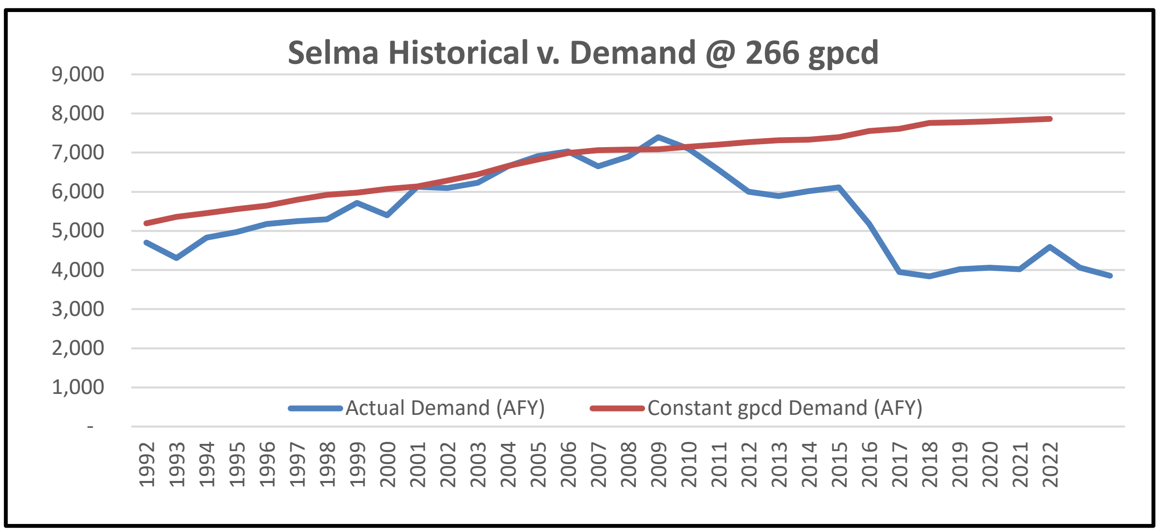


Figure 57 South San Francisco Demand v Population

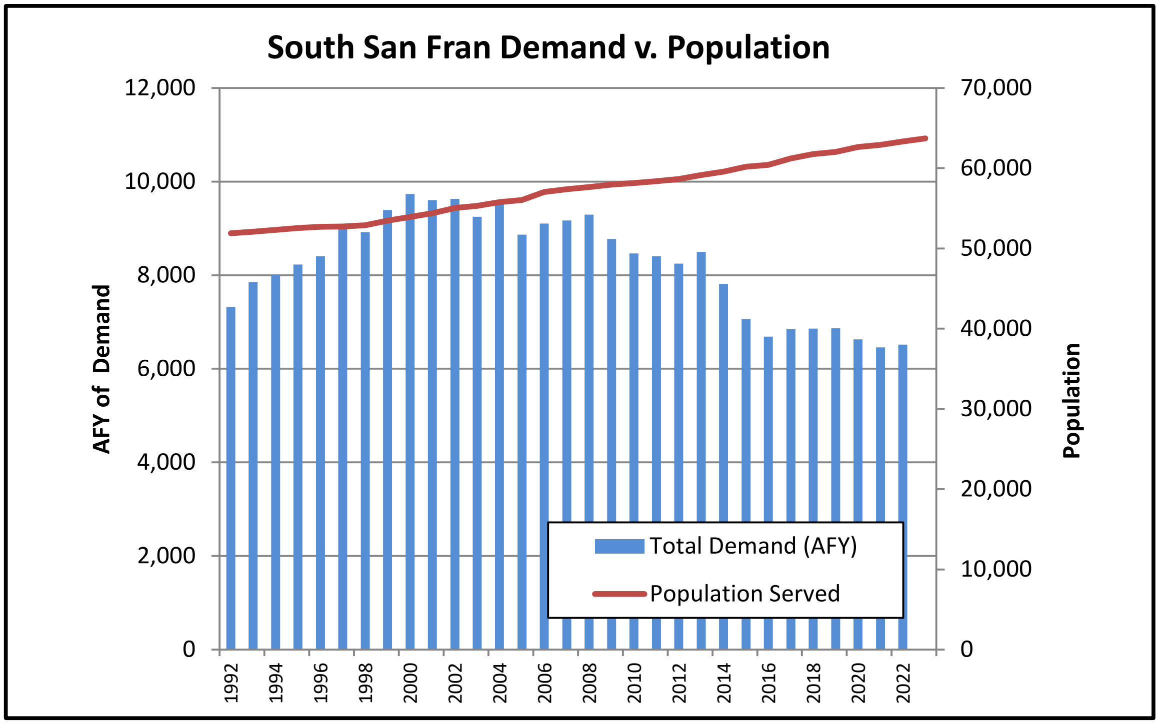


Figure 58 South San Francisco Historical v Demand

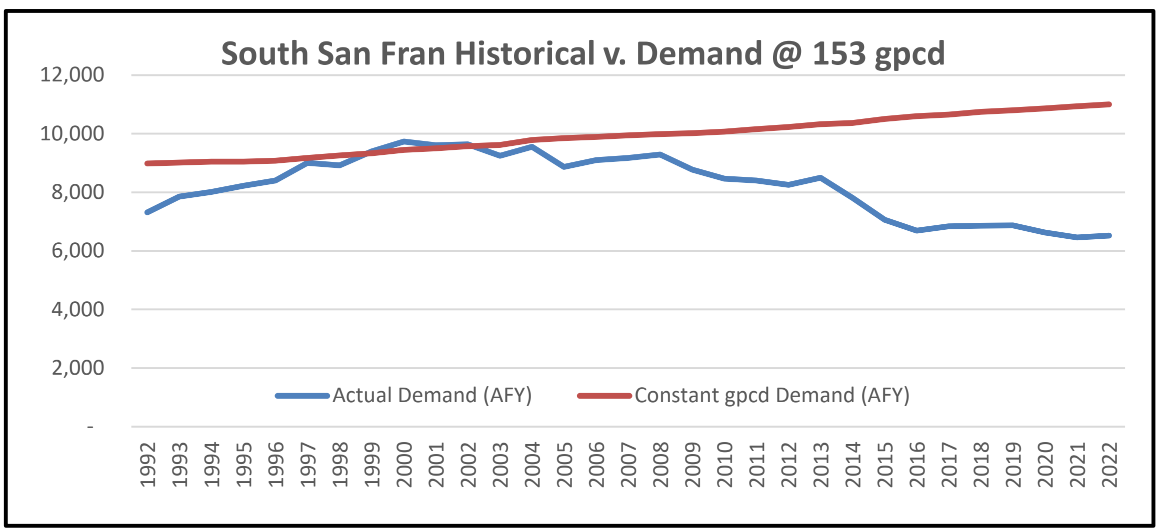


Figure 59 Stockton Demand versus Population

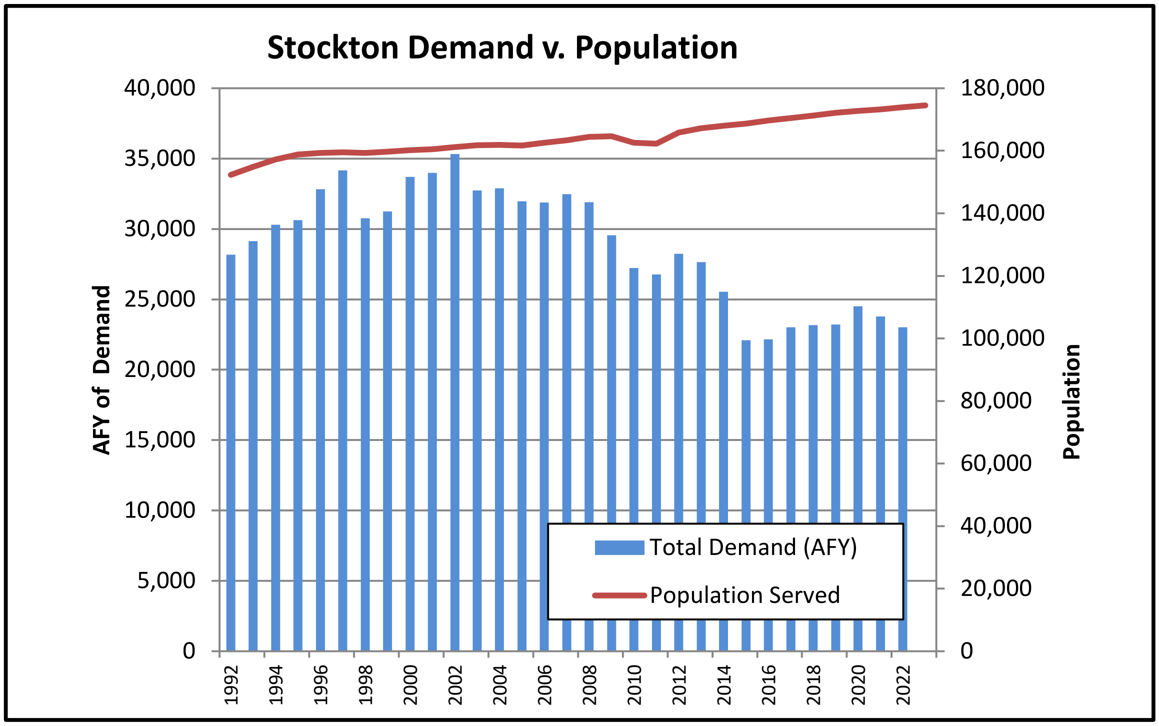


Figure 60 Stockton Historical versus Demand

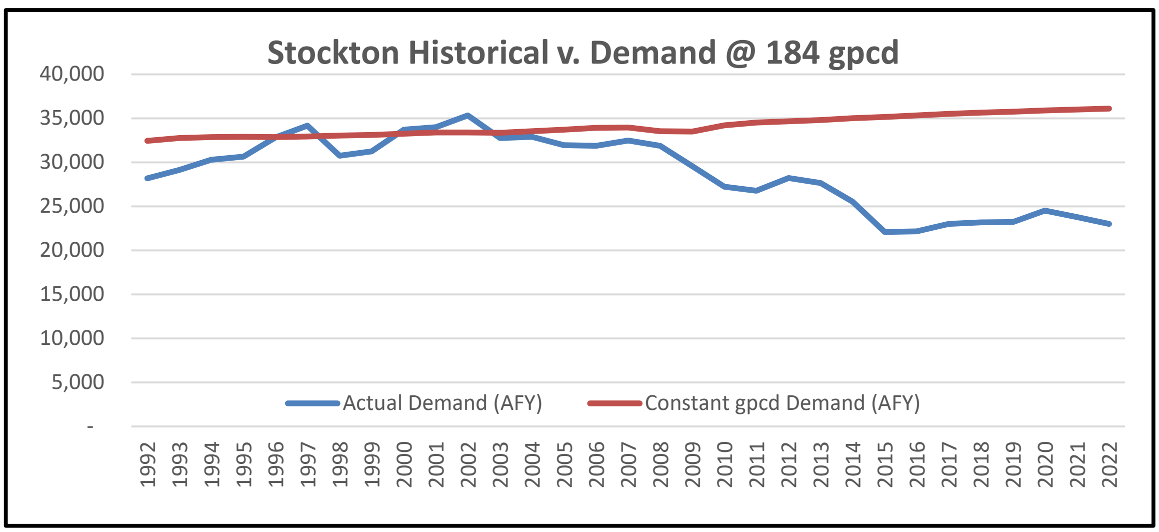


Figure 61 Visalia Demand versus Population

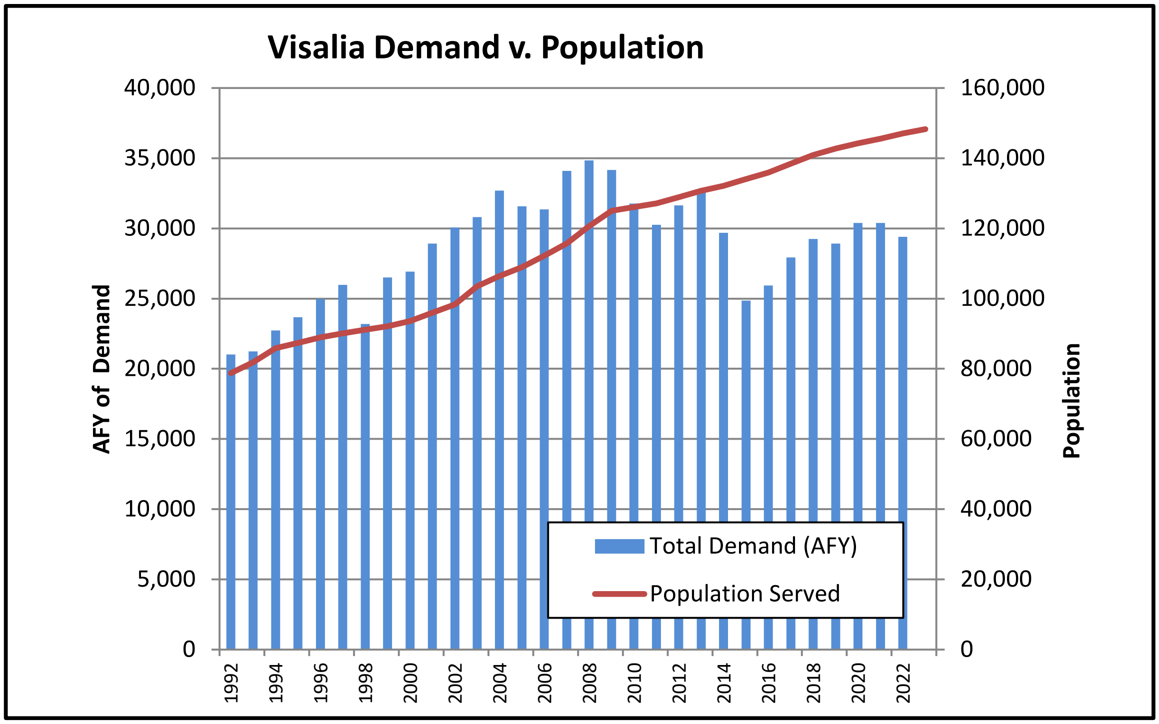


Figure 62 Visalia Historical versus Demand

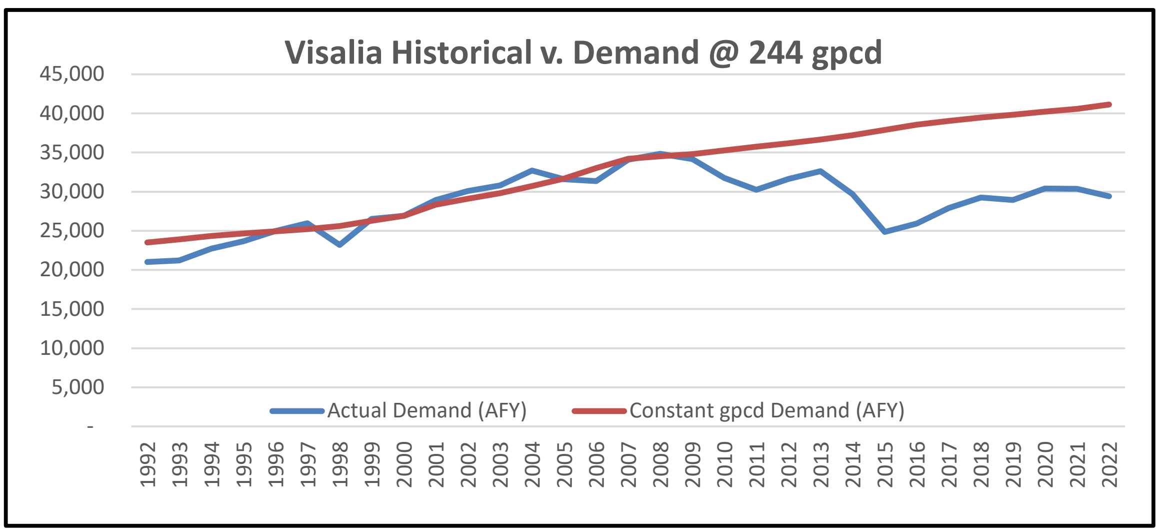


Figure 63 Westlake Demand versus Population

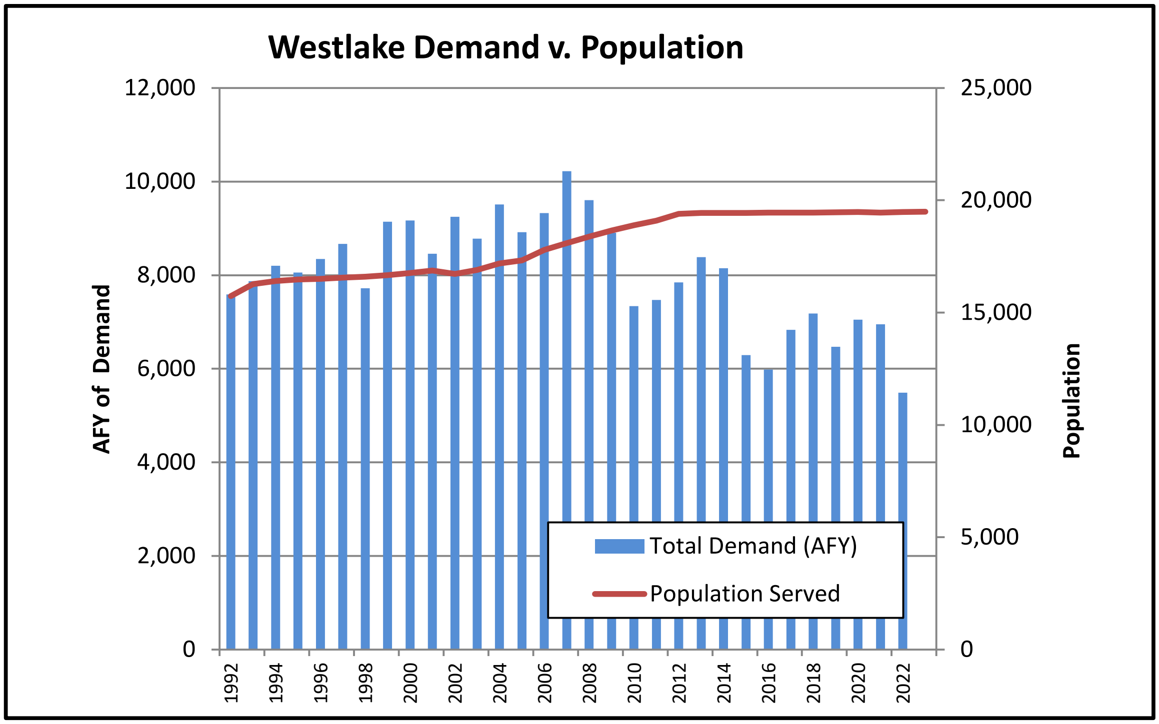


Figure 64 Westlake Historical versus Demand

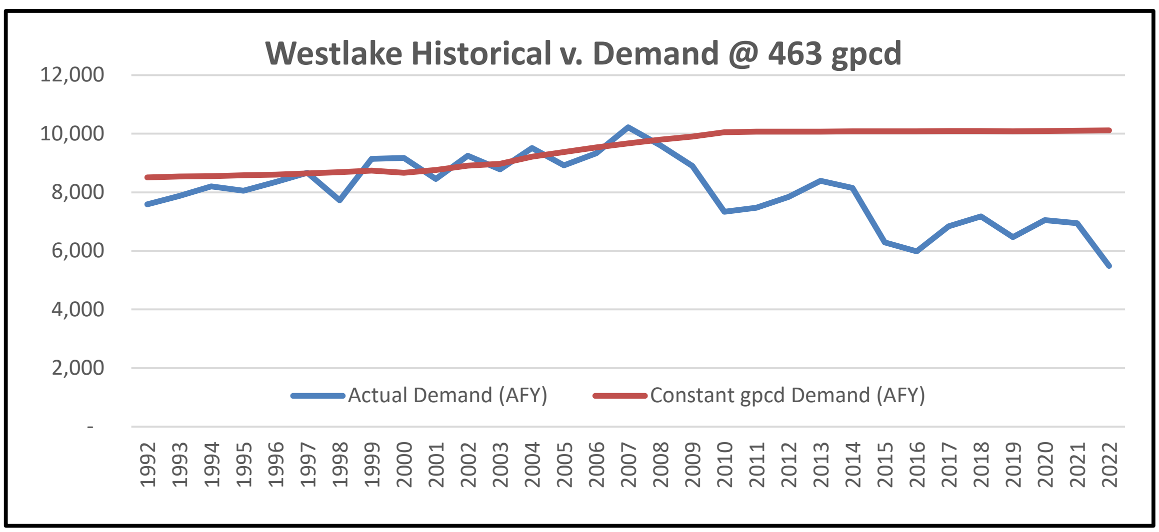


Figure 65 Willows Demand versus Population

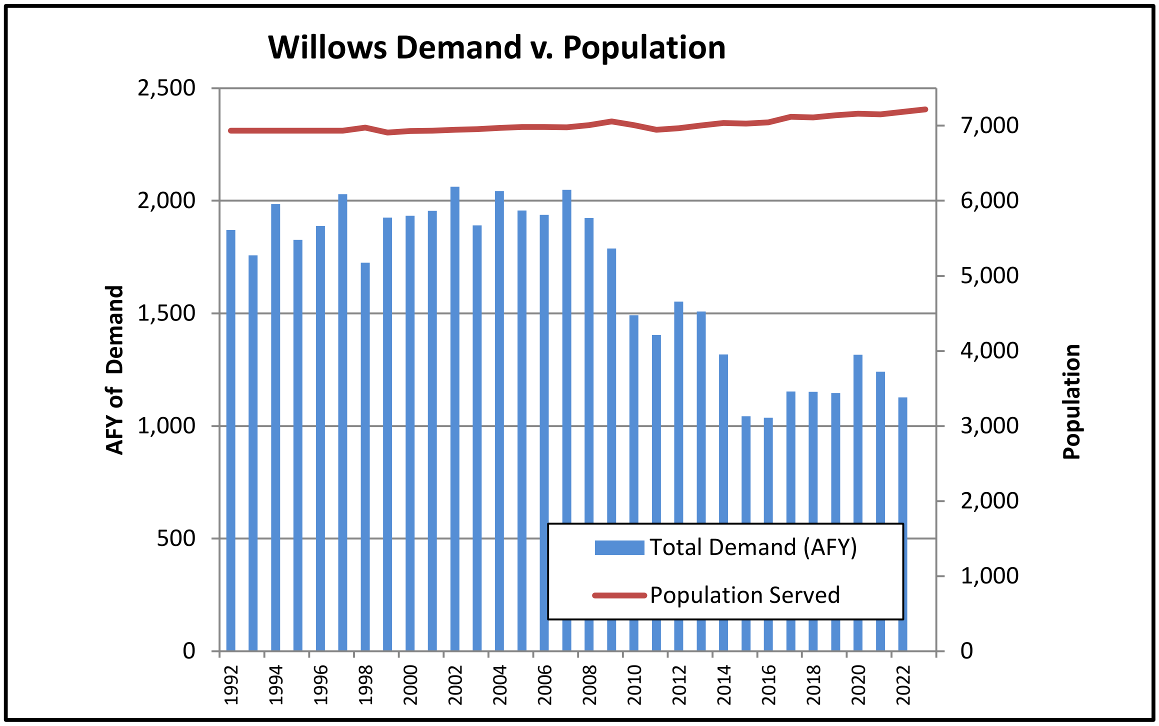
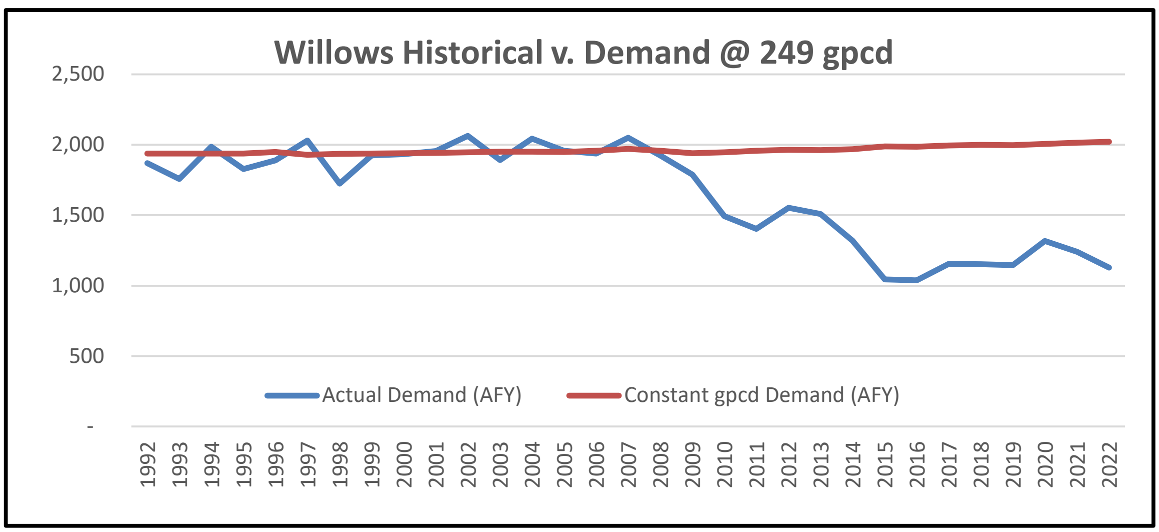


Figure 66 Willows Historical versus Demand



METHOD

The method used to economically value the water saved from water efficiency efforts can be easily understood as a set of simple steps:

1. Compute per-capita water demand in gallons per capita per day (GPCD). Average GPCD for the baseline period -- historical years 1997 to 2002, prior to the effect of utility-sponsored plumbing code changes that required higher levels of water efficiency.
2. Calculate counterfactual demand assuming the constant GPCD level from the baseline period.
3. Calculate the difference between counterfactual demand and actual demand. This difference is conservation savings.
4. Multiply the avoided cost per acre-foot (2022$/AF) by the volume of conservation savings (AF) each year. Avoided costs in 2022 were taken from district water loss reports. A complete historical time series of avoided costs were back-casted from 2022 to 1990 using the CPI-U for Water and Sewer. These were then expressed in 2022$ using the California CPI-U.
5. The time series of annual avoided costs was summed over the historical years and compared to the sum of operating revenues over the same period. The percentage change in customer water bills was estimated by comparing the estimated avoided cost savings to the actual total operating revenue over the period of analysis.

RESULTS

Table 3 shows the summary of results for each of the districts: customer water bills in all districts are lower due to conservation. The results show that the districts with relatively low avoided costs have smaller percent reductions in customer bills. Dominguez, Hermosa-Redondo, Los Altos, Mid-Peninsula, South San Francisco, and Westlake--with their higher avoided costs due to purchased water--have achieved significantly higher percentage reductions in customer bills.

Table 3 Estimate of Economic Benefit of Water Efficiency from 2010 to 2022: Reduced Customer Bills by District

Item	Unit MC Cost in 2010 (2022$/AF)	Unit MC Cost in 2022 (2022$/AF)	MC times Demand Difference, Sum 2010 to 2022 (2022$)	Operating Revenue, Sum 2010 to 2022 (2022$)	Estimated 2010-2022 Cumulative Operating Costs w/o Conservation (2022$)	Percent Bill Reduction due to Conservation 2010-2022
Antelope Valley	$459	$399	$3,281,074	$32,836,756	$36,117,831	9.08%
Bakersfield	$310	$355	$129,501,094	$1,164,880,790	$1,294,381,883	10.00%
Bear Gulch	$1,250	$2,211	$67,876,837	$712,001,017	$779,877,854	8.70%
Chico	$104	$116	$15,630,184	$361,926,794	$377,556,978	4.14%
Dixon	$170	$166	$1,252,758	$55,424,049	$56,676,807	2.21%
Dominguez	$1,394	$1,470	$132,606,400	$1,031,249,826	$1,163,856,226	11.39%
East Los Angeles	$453	$819	$58,601,153	$535,680,902	$594,282,055	9.86%
Hermosa-Redondo	$1,125	$1,471	$83,805,854	$465,390,572	$549,196,426	15.26%
Kern River Valley	$475	$412	$2,756,714	$98,991,871	$101,748,585	2.71%
King City	$163	$74	$1,447,801	$49,701,321	$51,149,123	2.83%
Livermore	$623	$1,414	$47,227,842	$331,290,531	$378,518,373	12.48%
Los Altos	$827	$1,719	$96,875,120	$487,628,872	$584,503,992	16.57%
Marysville	$79	$92	$1,646,971	$57,450,134	$59,097,105	2.79%
Mid-Peninsula	$2,140	$2,075	$185,343,927	$719,291,102	$904,635,030	20.49%
Oroville	$195	$169	$5,309,245	$75,728,204	$81,037,449	6.55%
Palos Verdes	$1,258	$1,761	$76,583,669	$724,057,411	$800,641,080	9.57%
Redwood Valley	$969	$657	$3,498,229	$41,576,862	$45,075,091	7.76%
Salinas	$169	$141	$6,042,158	$479,033,915	$485,076,073	1.25%
Selma	$140	$124	$5,000,820	$81,376,529	$86,377,349	5.79%

South San Fran	$1,754	$1,837	$78,673,309	$369,459,250	$448,132,559	17.56%
Stockton	$749	$783	$112,052,448	$683,852,369	$795,904,817	14.08%
Visalia	$67	$97	$9,517,173	$430,092,944	$439,610,117	2.16%
Westlake	$1,277	$1,820	$66,164,971	$287,936,129	$354,101,100	18.69%
Willows	$85	$83	$841,383	$40,954,392	$41,795,775	2.01%
All Cal Water Service Areas (million 2022$)			**$1,191.8**	**$9,317,8**	**$10,509.3**	11.3%

The calculations within Table 3 can be understood as follows. The first two columns show the unit marginal costs (avoided costs) for the first and last year of the analysis period, expressed in constant 2022 dollars. The third column shows the marginal cost (avoided costs) multiplied by the difference in demand between the counterfactual and actual demand; this annual avoided cost is then summed over all historical years. The fourth column shows the sum of operating revenue over the period of analysis. The fifth column shows the estimated cumulative operating costs *without* conservation. The sixth column shows the percent bill reduction, assuming the avoided cost savings reduce what would otherwise need to be collected in operating revenue.

DISCUSSION

These estimates are believed to be conservative. The most recent estimates of avoided water costs are only beginning to show the effects of the implementation of the Sustainable Groundwater Management Act (SGMA); there were no identified long-run supply costs for three of the districts that lie in critically over-drafted groundwater basins. A very different estimate of long-run supply costs might be obtained to account for the SGMA compliance costs.

It could also be asserted that the direct costs of conservation programs would be an avoided cost within the constant GPCD scenario. In the last decade, conservation program budgets for these districts have ranged from 1% to 1.7% of operating revenues (and are very close to 1%, averaged across all years and districts).[6] Changing the customer bill reductions by one percent does not flip the result.[7]

Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs, and, hence, lower water bills for its customers. In California's urban areas, monthly water bills have been outpacing general price inflation for some time now (Hanak et al., 2014). Water service affordability is a growing concern in California and nationally (Hiltzik, 2017). Increases in water service costs are being driven by multiple factors, including the need to rehabilitate or replace aging infrastructure, new and more stringent water regulations, higher costs for construction, and growing competition for available water supply (Griffin, 2001). Investing in water conservation is a proven way to attenuate the rise in system costs over the long-run. In regions with high water supply and infrastructure costs, water conservation is often the least-cost way to meet future water demands (Gleick et al., 2003). Deferring or reducing the need for new water supply infrastructure through increased conservation can yield large dividends for ratepayers, as this study has shown.

These results are not anomalous but rather extend a wide body of research into the long-run benefits of conservation for utility ratepayers. For example, the Los Angeles Department of Water and Power has calculated that its residents and businesses paid water rates that were 27% lower because of investments in water conservation over the previous three decades (Chesnutt, Pekelney, and Spacht, 2019). A similar study for Tucson, Arizona, concluded that water conservation helped the city avoid hundreds of millions of dollars in water and wastewater operating and capital costs (Rupprecht, 2020). In yet another study, the City of Westminster, Colorado, calculated that its residents and businesses paid water and wastewater rates that were 47% lower and development fees that were 44% lower because of investments in water conservation over the previous three decades (Feinglas et al., 2017). Investing in water conservation directly benefits ratepayers by helping to slow the increase in water service costs over time. Economic investments in water efficiency are critical to help ensure that water utilities can continue to provide water service that is both affordable and sustainable.

---

[6] Source: GRC conservation budgets and *Conservation Budget and Measurement & Evaluation Reports*.

[7] Universal customer metering is a non-avoidable cost due to statewide requirements. Water rate reform appears to have been accomplished with existing management resources.

BIBLIOGRAPHY

AWWA. (2017) *Water Rates. M1*, Seventh Edition, American Water Works Association. Denver Colorado. http://www.awwa.org.

AWWA. (2017) *Water Conservation Programs - A Planning Manual. M54*, Second Edition, American Water Works Association. Denver Colorado. http://www.awwa.org.

AWWA. (2004) *Avoiding Rate Shock: Making the Case for Water Rates.* American Water Works Association, Denver Colorado, http://www.awwa.org.

Beecher, J.A. and T.W. Chesnutt, *Declining Sales and Water Utility Revenues: A Framework for Understanding and Adapting*. A White Paper for the Alliance for Water Efficiency National Water Rates Summit –Racine, Wisconsin, October 24, 2012.

Boiteux, M. (1949) La tarification des demandes en point : application de la théorie de la vente au coût marginal. *Revue générale de l'Electricité,* Vol. 58, 321-340.

Bonbright, James C., A.L. Danielson, D.R. Kamershen (1988) *Principles of Public Utility Rates*. Public Utilities Report Arlington VA.

Chesnutt, T.W., G. Fiske, J.A. Beecher, D.M. Pekelney, *Water Efficiency Programs for Integrated Water Management*, Water Research Foundation, (1P-4.5C-91149-01/07-NH) January 2007. Contains planning models for estimating Water Utility Direct Avoided Costs from WUE programs and WUE Benefit Cost Planning.

Chesnutt, T.W. and J.A. Beecher, "The Tragedy of Common Benefits: Implementing Regional Conservation Anyway", Proceedings of the American Water Works Association Water Sources Conference 2004 in Austin, January 2004.

Chesnutt, T.W., et al., (2014) *Building Better Water Rates in an Uncertain World, A Water Rates Handbook* for the Alliance for Water Efficiency as part of the Financing Sustainable Water project, August 2014. http://www.financingsustainablewater.org/tools/building-better-water-rates-uncertain-world

Chesnutt, T.W., D.M. Pekelney, and J. Spacht, "Water Conservation and Efficient Water Rates Produce Lower Water Bills in Los Angeles", Journal AWWA, 111:4, April 2019, pp 24-30.

Chesnutt, T.W., D.M. Pekelney, and J. Spacht, *Lower Water Bills: The City of Los Angeles Shows How Water Conservation and Efficient Water Rates Produce Affordable and Sustainable Use*, A White Paper for the Alliance for Water Efficiency, Aug 2018.

https://www.allianceforwaterefficiency.org/resources/publications/la-shows-how-water-conservation-and-efficient-water-rates-produce-affordable

Chesnutt, T.W., D.M. Pekelney, and D. Mitchell, (April 2022) *The Economic Value Of Efficiency For California Water Service: Lower Water Bills, A White Paper for California Water Service Group,* https://www.Cal Water.com/docs/conservation/Economic-Value-of-Water-Efficiency-Lower-Water-Bills.pdf

Dupuit, Jules. (1844) “De la mesure de l'utilité des travaux publics, On the Measurement of the Utility of Public Works.” *Annales des Ponts at Chausséss*; in *Readings in Welfare Economics,* K. J. Arrow and T. Scitovsky, eds. Homewood: Irwin, pp. 255-283.

Ekelund, R.B. and R.F. Hebert (1999) *The Secret Origins of Modern Microeconomics: Dupuit and the Engineers,* University of Chicago Press.

Feinglas, S., C. Gray, P. Mayer (2013) *Conservation Limits Rate Increases for a Colorado Utility Demand Reductions Over 30 Years Have Dramatically Reduced Capital Costs,* Alliance for Water Efficiency.

Fiske, G. and T.W. Chesnutt, (2010) *The California Urban Water Conservation Council Wastewater Avoided Cost Model: Final Report,* A report for CUWCC and the US EPA.

Gleik, Peter, Dana Haasz, Christine Henges-Jeck, Veena Srinivasan, Gary Wolf, et al. 2003*. Waste Not, Want Not: The Potential for Urban Conservation in California*. Pacific Institute.

Griffin, Ronald. 2001. “Effective Water Pricing”*. Journal of the American Water Resources Association*. Vol. 37. No. 5. 1335-1347.

Hanak, Ellen, Brian Gray, Jay Lund, David Mitchell, et al. 2014. *Paying for Water in California*. Public Policy Institute of California.

Hiltzik, Michael. July 7, 2017. *The next crisis for California will be the affordability of water*. Accessed from the Los Angeles Times on February 14, 2018. http://www.latimes.com/business/hiltzik/la-fi-hiltzik-water-afford-20170709-story.html

Hanke, S. H. and R.W. Wentworth (1981) "Project evaluation during inflation, revisited: A solution to Turvey's relative price change problem". Water Resources Research. 17: 1737–1738

Kahn, Alfred E. (1991) *The Economics of Regulation, Principles, and Institutions*. The MIT Press Camb., MA.

Mitchell D. and T. Chesnutt, (2014) *The AWE Sales Forecasting and Rate Model*, part of the Alliance for Water Efficiency Financing Sustainable Water project, August 2014. http://www.financingsustainablewater.org/tools/awe-sales-forecasting-and-rate-model

Mitchell, David L., et al. (2017). Building Drought Resilience in California’s Cities and Suburbs. Public Policy Institute of California. Accessible from: https://www.ppic.org/content/pubs/report/R_0617DMR.pdf

Mitchell, David, Tom Chesnutt, and Gary Fiske, “Impacts on Customer Bills and Water Use of Recoupling Water Utility Revenue and Sales: Analysis of CPUC Proposed Decision to Transition all Class A Utilities to a Monterey-Style Water Revenue Adjustment Mechanism. August 2020.

Rupprecht, C., M. M. Allen, and P. Mayer. “Tucson Examines the Rate Impacts of Increased Water Efficiency and Finds Customer Savings.” *Journal - American Water Works Association* 112, no. 1 (2020): 32–39. https://doi.org/10.1002/awwa.1429.

Vickers, A. (2001) *Handbook of Water Use and Conservation,* Waterplow Press. http://waterplowpress.com/index.php/book-info/

Alliance for Water Efficiency

A&N Technical Services, Inc.

POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS

M.CUBED