A Review of Water Demand Forecasts for the Orange County Water District

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Table of Contents

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About the Author

James Fryer is an environmental scientist who provides environmental and water resource management expertise, research, and analysis to a variety of governmental and non-governmental clients focused on conservation, sustainable watershed, and water resource management projects. He has over 27 years of experience working on freshwater, estuarine, and marine conservation policies, programs, and projects. He has produced numerous papers and reports on water management policies, practices, and economics, and conducted sophisticated GIS analyses of watershed and water management issues, and helped establish and conducted research and monitoring on marine protected areas. He has a M.S. in Environmental Management from the University of San Francisco, where his thesis project developed an Integrated Floodplain Management model for the San Francisco Bay-Delta watershed.

Acronyms and Abbreviations

AF	Acre-feet, 325,851 gallons or enough water to cover an acre of land to a depth of one foot
AFY	Acre-feet per year
GPCD	Gallons per capita per day
IRWD	Irvine Ranch Water District
LTFP	The Orange Countrу Water District’s Long-Term Financial Plan 2015 Update
MET	Metropolitan Water District of Southern California
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
OCWD	Orange County Water District
Reliability Study	The Orange County Reliability Study being conducted by the Municipal Water District of Orange County
UWMP	Urban Water Management Plan

Purpose of the Review

This analysis and report was developed to assess the demand forecasts used by the Orange County Water District as the rationale for new water supply projects.

Summary of Findings & Conclusions

The Orange County Water District uses outdated water demand forecasts for the year 2035 that are 91,846 acre-feet per year, or 17.5%, higher than the more recent water demand forecasts for its service area retailers. In its Long-Term Financial Plan 2014 Update and Groundwater Management Plan 2015 Update, the Orange County Water District (OCWD) uses water demand forecasts derived from its retailers' 2010 Urban Water Management Plans (UWMPs). In the more recent 2016 demand forecasts in the Orange County Reliability Study, used for the updated 2015 UWMPs for the retailers, collectively the water demand forecasts are reduced 17.5% compared earlier forecasts used in the Long-Term Financial Plan 2014 Update.

The previous Urban Water Management Plans consistently overestimated future demand. Starting in the year 2000, for each cycle of the 5-year UWMPs, based on declining actual demand trends the retailers repeatedly reduced demand forecasts for subsequent years compared to previous forecasts.

The Orange County Reliability Study used by the retailers water for their new water demand forecasts, uses multiple instances of conservative assumptions that, as with past UWMPs, can be expected to overestimate future demand. The Reliability Study forecasts are the basis of the Municipal Water District of Orange County and OCWD retailers' 2015 UWMP forecasts. Some fundamental assumptions in the water demand model are inconsistent with historic and recent water use patterns. The assumptions that may lead to overestimates of future demand, and discussed in more detail in this report, include:

Population forecasts
Demand during multiple drought year events
Demand rebound after drought
Drought vs. recession water use patterns
Infill development
Price elasticity of demand
Future conservation innovation

The Long-Term Financial Plan 2014 Update does not account for an additional 65,000 acre-feet per year of high quality treated wastewater that is expected to become available within the next 5 to 10 years. The new source of treated wastewater would be equal or better than the quality of water that is currently used to replenish groundwater basins and would not be subject to shortages during drought. About 65,000 acre-feet per years is expected to become available for groundwater recharge into the Orange County Water District basin.

Water users have repeatedly demonstrated the willingness and ability to substantially curtail water use during serious, multi-year drought events. Many of the early year UWMPs acknowledged that water users would curtail use during serious drought years. But by the 2005 UWMPs, water use was generally assumed to increase 6% to 9% during single and multiple drought years. Since water shortages during drought drives the need for new supplies, underestimating the ability and willingness of water users to curtail demand during serious drought years can lead to unnecessary and expensive new supply projects and financial difficulty for water suppliers.

The retailers' 2015 Urban Water Management Plan demand forecasts, as with the earlier plans, do not account for ongoing conservation innovation. Ongoing conservation innovation, unforeseen at the time of past demand forecasts, is now a well-established pattern that has contributed to actual demand remaining well below forecasted levels. Ongoing innovations in conservation devices and practices can be expected to continue reducing urban per capita water demand during the demand forecast period.

The retailers' 2015 Urban Water Management Plans indicate that most of the service areas are at or near build-out. Since there is relatively little undeveloped space in the OCWD service area, most future development will be in-fill development. This can be expected to lower average per-capita water use and will be an important dynamic that should be addressed in water demand projections.

Water providers with service areas at or near buildout that substantially overestimate future demand risk inefficient use of limited financial resources on unnecessary capital projects, revenue stability problems, and ratepayer backlash. Historically, water demand forecasts used multiple conservative assumptions in an effort to reduce the risk of uncertainties, particularly for rapid growing service areas. However, the situation is different for service areas not experiencing rapid growth, and at or near buildout. Overestimating future demand for service areas at or near build-out creates long-term risks that should be carefully considered.

Methodology

This assessment was done using two fundamental approaches: 1) a review of the accuracy of past UWMP forecasts for future demand for UWMPs from 1995 through 2015, and 2) a review of the demand forecasts in the Municipal Water District of Orange County's "Orange County Supply Reliability Study" (hereinafter Reliability Study) currently in underway during 2016. This includes consideration of assumptions and demand forecasting methodology in the Reliability Study and 2015 UWMPs that affect the accuracy of demand forecasts when compared to past and present day trends. This report is not a comprehensive review of all aspects of the Reliability Study, UWMPs and related demand forecasts. It is more focused on the accuracy of past forecasts and areas where refinements may improve the accuracy of the latest demand forecasts.

The project team collected and reviewed all the UWMPs from 1995 through 2015 that were available for the 19 OCWD retailers. We extracted the present and forecasted population, present and forecasted demand (including losses and direct recycled water use when delineated in the UWMPs), reviewed service area development trends and the supply reliability planning during drought years. We then developed tables and graphs which show the actual and forecasted population and demand trends. Tables and graphs combining the retailers into three groups by similar size are provided in the main body of this report. Tables and graphs for all the individual retailers (except for two, Golden State and Serrano which did not have an adequate number of UWMPs available) are included in Appendix A.

The project team also collected and reviewed numerous relevant documents including, but not limited to:

The Orange County Water District's Long-Term Financial Plan 2014 Update
The Orange County Water District's Groundwater Basin Management Plan 2015 Update
Technical memos and presentations for the Orange County Reliability Study

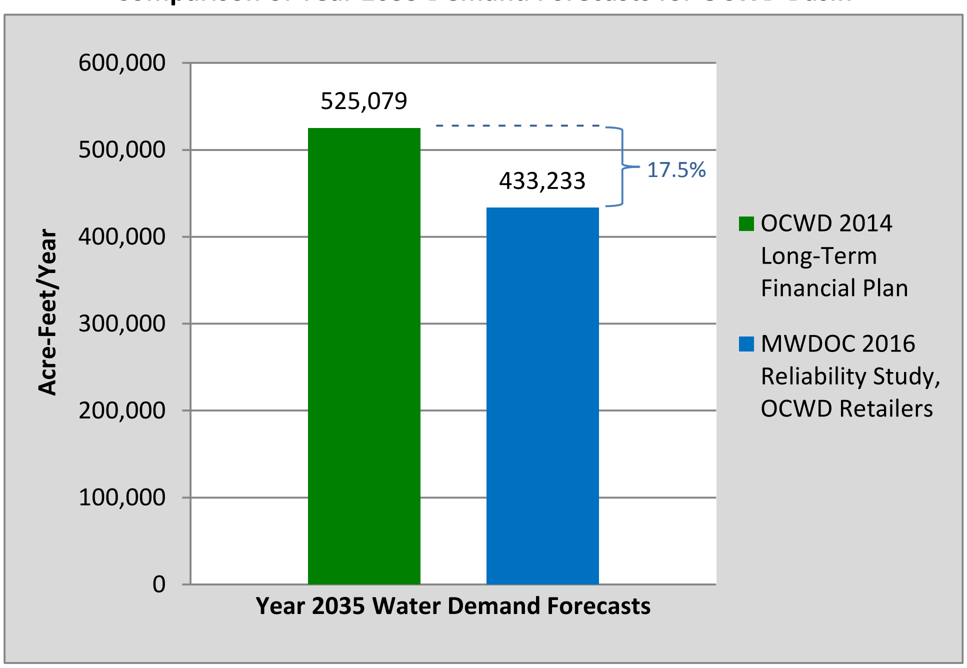
Water recycling documents describing the proposed new 65,000 AFY supply of treated wastewater to the OCWD groundwater basin for indirect potable reuse

Review of Long-Term Financial Plan 2014 Update

The Long-Term Financial Plan (LTFP) was updated by the Orange County Water District in 2014. The LTFP states the water demand forecasts are based primarily on past Urban Water Management Plan (UWMP) forecasts for each retailer.[1] The 2014 updated LTFP plan indicates "One of the key factors influencing water demand is population growth" and indicates population is expected to increase from 2.38 million to 2.54 million, or 6.7% by the year 2035.[2] The plan also notes "Another factor affecting demands is growth of the District's service area through annexations."[3] The 2014 LTFP identifies a year 2035 water demand of 525,079 AFY, including 8,000 AFY for non-agency use.[4]

As shown in the following section reviewing the 1995 through 2015 UWMPs, and for reasons discussed later in this report, UWMP demand forecasts had a consistent pattern of overestimating future demand. With a new round of 2015 UWMPs being readied for release in 2016, and the effects of the recent Great California Drought on water demand, the LTFP is based on obsolete demand forecasts. Both the 2014 Long-Term Financial Plan and OCWD's more recent 2015 Groundwater Basin Management Plan rely on demand forecasts that are substantially higher than the updated demand forecasts for the OCWD retailers in the Municipal Water District of Orange County's Orange County Reliability Study. The LTFP forecasts a year 2035 water demand of 525,079 AFY. This compares to the more recent Orange County Reliability Study forecast of 433,233 AFY for the OCWD retailers in the year 2035.[5] These water demand forecasts are compared in Figure 1 below.

Figure 1
Comparison of Year 2035 Demand Forecasts for OCWD Basin



The more recent water demand forecast represents a reduction of 91,846 afy, or 17.5%, in water demand in the year 2035.

Additional Recycled Water for Groundwater Recharge

Another important consideration is that the 2014 LTFP does not account for a new project expected to increase the availability of indirect potable reuse of highly treated wastewater for OCWD retailers. The Metropolitan Water District of Southern California (MWD) in partnership with the Sanitation Districts of Los Angeles County is developing a new regional indirect potable reuse program that is expected to make available up to 168,000 acre-feet per year of new recycled water for recharging the Orange County and Los Angeles groundwater basins. The presently available planning documents and OCWD staff indicate that at least 65,000 acre-feet per year of new indirect potable reuse water is expected to become available to the OCWD within 5 to 10 years.[6]

Publicly released information by the partnership indicates “Under a partnership with the Sanitation Districts of Los Angeles County, Metropolitan would build a new purification plant and distribution lines to groundwater basins in Los Angeles and Orange counties.”

“The first operational phase will produce about 67,000 acre-feet of recycled water per year and the construction of about 30 miles of distribution lines to replenish groundwater basins in Los Angeles and Orange counties. Additional operational phases could produce up to 168,000 acre-feet per year of purified water for groundwater replenishment.”[7]

A MWD board packet item notes “This program would purify secondary effluent from Sanitation Districts’ Joint Water Pollution Control Plant (JWPCP) using advanced treatment technologies to produce water, which is near distilled quality and would be equal or better than the quality of water that is currently used to replenish groundwater basins in the Southern California region.”[8]

The MWD has approved moving forward with the pilot project for this supply, and indirect potable reuse projects are a proven technology already utilized for the OCWD groundwater basin. Technical Memo #4 for the Orange County Reliability Study identifies this project as “Very Achievable” and “Highly Reliable” in its rankings of new supply project options.[9] This would provide a substantial new high quality water supply for recharging the Orange County Water District groundwater basin. Along with what can reasonably be expected to be lower than forecasted demand, based on the historic water demand forecasting pattern and multiple conservative assumptions in the Reliability Study, this would provide considerable supply reliability improvement for the OCWD retailers beyond what is forecasted in the 2014 LTFP.

Review and Analysis of Retailer Urban Water Management Plans

California's Urban Water Management Planning Act requires water retailers with annual water use over 3,000 acre-feet or more than 3,000 customers to prepare and update an Urban Water Management Plan (UWMP) every 5 years. The UWMPs are required to include a description of the service area, a description of supply sources, present and future demand and population forecasts, and an analysis of supply reliability during single and multiple drought years.

UWMPs that were available for each Orange County Water District retailer for each 5-year cycle from 1995 through 2015 were collected and reviewed. Table 1 below, indicates the UWMPs that were available.

Table 1
Urban Water Management Plans Obtained

Water Retailer	LTFP 2035 Demand (AFY)	Group	1995	2000	2005	2010	2015
IRWD	88,008	1	Yes	Yes	Yes	Yes	Yes
Anaheim	77,700	1	NA	Yes	Yes	Yes	Yes
Santa Ana	50,400	1	NA	Yes	Yes	Yes	Yes
Orange	34,713	2	Yes	Yes	Yes	Yes	Yes
Huntington Beach	34,657	2	Yes	Yes	Yes	Yes	Yes
Fullerton	32,792	2	Yes	Yes	Yes	Yes	Yes
Golden State Water Co.	32,774	2	NA	NA	NA	Yes	NA
Garden Grove	30,907	2	1996	Yes	Yes	Yes	Yes
Yorba Linda WD	27,784	2	Yes	Yes	Yes	Yes	Yes
Buena Park	19,900	3	NA	Yes	Yes	Yes	Yes
Mesa	19,700	3	Yes	Yes	Yes	Yes	Yes
Newport Beach	18,474	3	Yes	Yes	Yes	Yes	yes
Tustin	15,194	3	Yes	Yes	Yes	Yes	Yes
Westminster	12,337	3	Yes	Yes	Yes	Yes	Yes
Fountain Valley	10,165	3	Yes	Yes	Yes	Yes	Yes
Seal Beach	4,880	4	NA	2002	Yes	Yes	Yes
Serrano WD	2,852	4	NA	NA	NA	Yes	Wholesale
La Palma	2,742	4	Yes	NA	Yes	Yes	Yes
East OCWD	1,100	4	NA	NA	Yes	Yes	Yes

Of particular interest for this analysis were the present and forecasted populations and demand figures. We also noted annexes and expansions of the service area and the drought year supply reliability planning.

Review of the UWMPs found that past projections consistently overestimated future demand. The UWMPs indicate actual total demand has generally been decreasing in the more recent 5-year cycles. Nonetheless, the forecasts for demand moving forward from each UWMP starting year continues to increase, but from a lower starting point for each 5-year cycle.

Appendix A contains tables with present and forecasted population and total water demand (including losses and direct recycled) for each of the retailers that had adequate data available. Included are graphs with the population and demand trends and tables providing the percentages of predicted compared to actual population and demand, along with the percent change compared to the 2015 UWMP forecasts. The following pages contain the UWMP data and trends aggregated into similar water use Groups 1 through 3, as in Table 1 above. Since Group 4 had very limited years of UWMPs available and is a small portion of the cumulative water use, tables and graphs of the data for Group 4 retailers are only provided individually in Appendix A.

Table 2

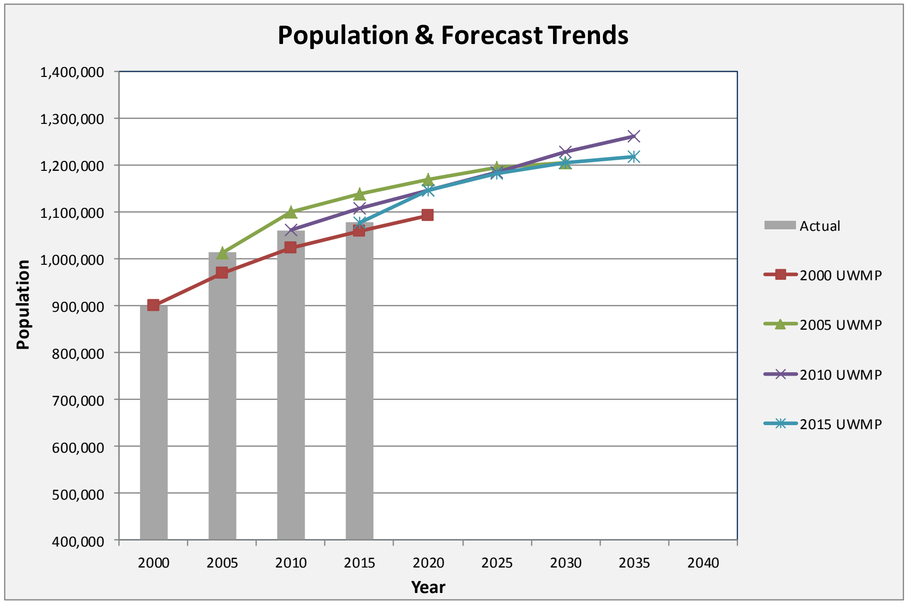
Group 1 - Irvine Ranch, Anaheim and Santa Ana

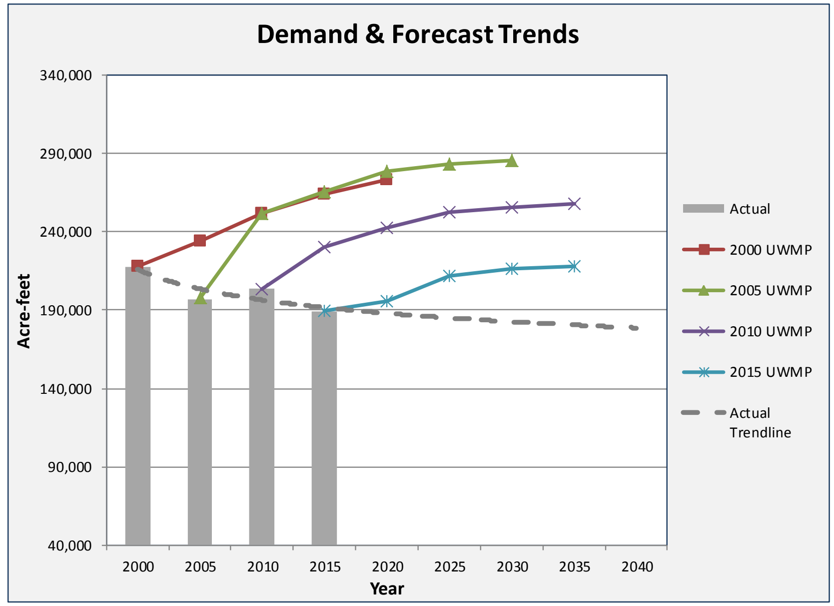
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	899,785	1,013,557	1,060,933	1,076,904					
2000 UWMP	899,785	969,539	1,022,088	1,058,128	1,091,139				
2005 UWMP		1,013,557	1,099,876	1,139,315	1,169,527	1,194,639	1,205,541		
2010 UWMP			1,060,933	1,106,422	1,145,066	1,185,035	1,227,140	1,262,173	
2015 UWMP				1,076,904	1,144,894	1,180,979	1,203,439	1,218,559	

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	217,972	197,113	203,567	189,393					
2000 UWMP	217,972	234,209	251,865	264,093	273,383				
2005 UWMP		197,705	251,530	265,690	278,453	283,478	285,380		
2010 UWMP			203,567	230,499	242,206	252,728	255,908	257,772	
2015 UWMP				189,393	195,338	212,131	216,330	218,147	





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	95.7%	96.3%	98.3%	4.9%			
2005 UWMP		103.7%	105.8%	-2.1%	-1.1%	-0.2%	
2010 UWMP			102.7%	0.0%	-0.3%	-1.9%	-3.5%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	118.5%	123.7%	139.4%	-28.5%			
2005 UWMP		123.6%	140.3%	-29.8%	-25.2%	-24.2%	
2010 UWMP			121.7%	-19.4%	-16.1%	-15.5%	-15.4%

The Irvine Ranch Water District, the largest in population and water use (see Appendix A), experienced annexes and consolidations that were not part of previous forecasts nearly every 5-year cycle of UWMPs. This skewed the population and demand forecasts. But even so, the total demand trendline is down for subsequent year UWMPs. Also Irvine Ranch converted a large portion of its demand to direct recycled use. Therefore, potable water demand for Irvine Ranch and the combine group 1 retailers declined further than the total demand figures used in these tables and graphs.

Table 3

Group 2 - Fullerton, Garden Grove, Huntington Beach, Orange, and Yorba Linda

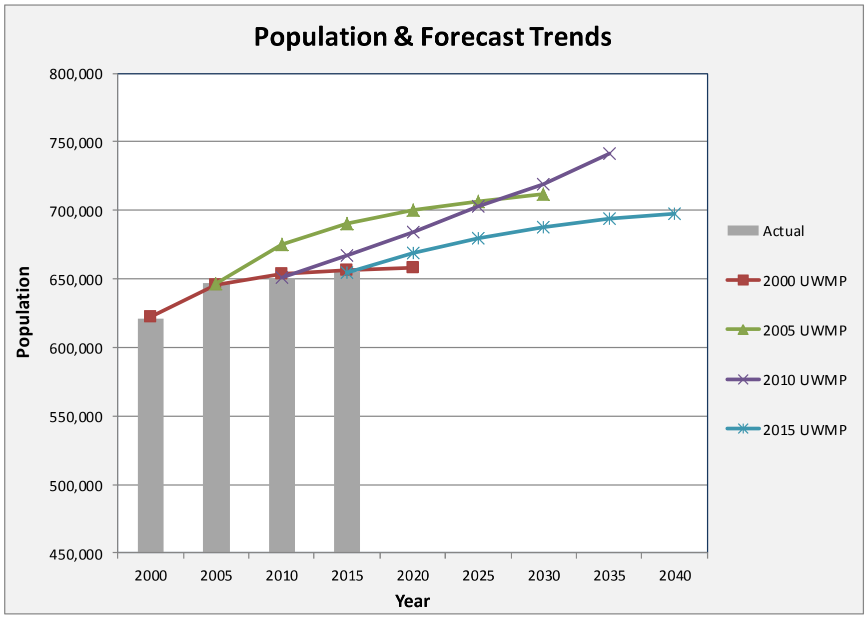
Population
Actual and Forecasted

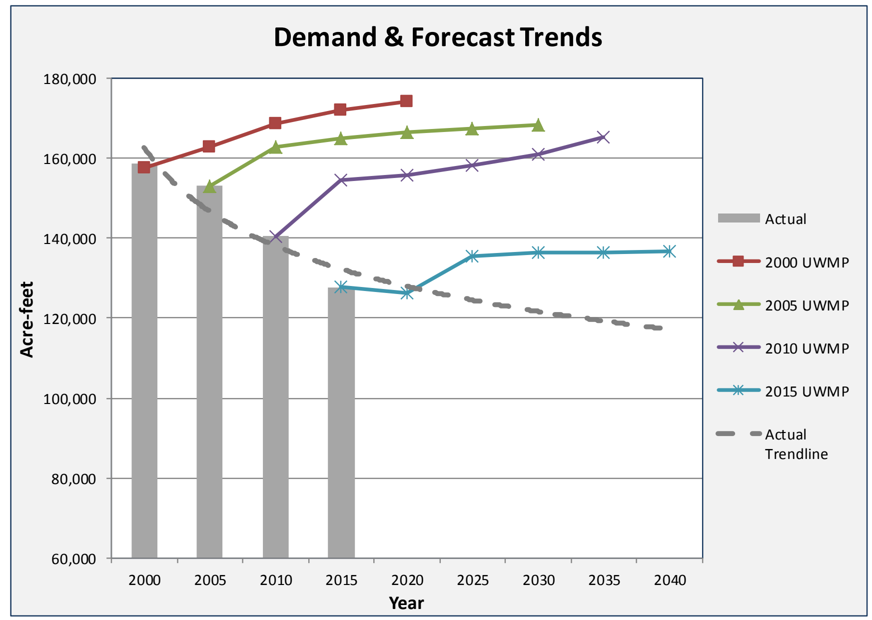
Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	620,683	646,695	650,776	654,892					
2000 UWMP	622,303	646,041	653,607	656,709	658,334				
2005 UWMP		646,695	675,100	690,558	700,462	706,512	711,713		
2010 UWMP			650,776	667,454	684,172	702,594	719,199	741,065	
2015 UWMP				654,892	668,563	679,225	687,834	693,726	697,854

Yorba Linda population and forecast not included in 2000 UWMP, so excluded from population table

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	158,645	153,030	140,487	127,708					
2000 UWMP	157,658	162,896	168,736	171,927	174,277				
2005 UWMP		153,030	162,943	165,075	166,556	167,575	168,499		
2010 UWMP			140,487	154,437	155,613	158,308	160,876	165,418	
2015 UWMP				127,708	126,313	135,571	136,300	136,289	136,694





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	99.9%	100.4%	100.3%	1.6%			
2005 UWMP		103.7%	105.4%	-4.6%	-3.9%	-3.4%	
2010 UWMP			101.9%	-2.3%	-3.3%	-4.4%	-6.4%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	106.4%	120.1%	134.6%	-27.5%			
2005 UWMP		116.0%	129.3%	-24.2%	-19.1%	-19.1%	
2010 UWMP			120.9%	-18.8%	-14.4%	-15.3%	-17.6%

Table 4

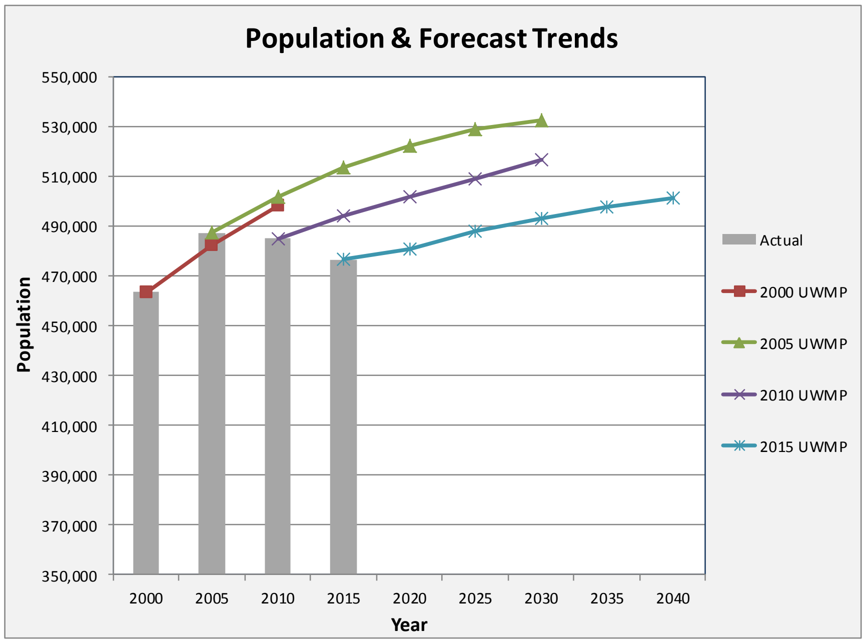
Group 3 - Buena Park, Fountain Valley, Mesa, Newport Beach, Tustin and Westminster

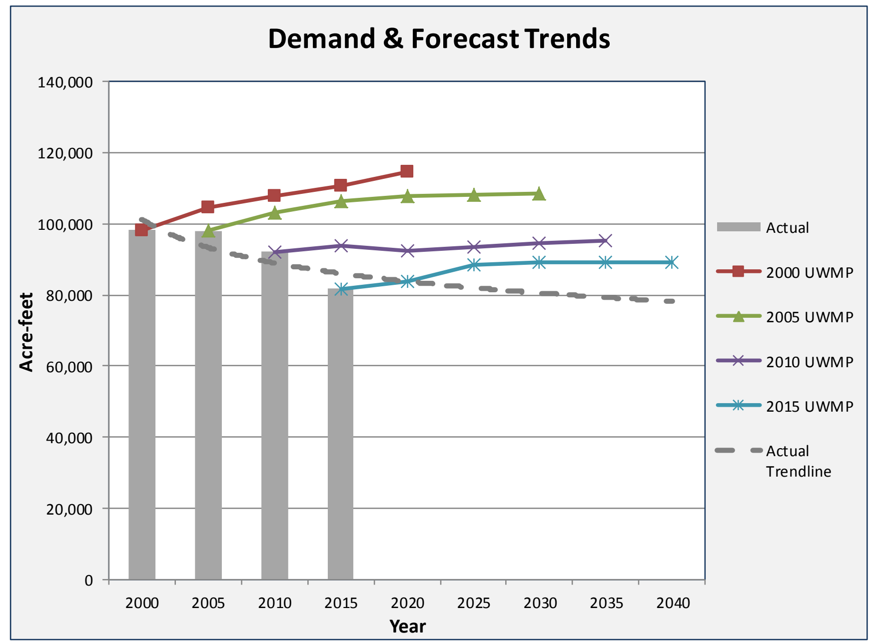
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	463,456	487,200	484,958	476,379					
2000 UWMP	463,456	482,425	498,195						
2005 UWMP		487,200	501,711	513,314	522,159	528,909	532,585		
2010 UWMP			484,958	493,837	501,664	508,788	516,728		
2015 UWMP				476,379	480,897	488,009	493,167	497,851	501,287

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	98,145	97,956	92,018	81,755					
2000 UWMP	98,145	104,707	107,631	110,486	114,520				
2005 UWMP		97,956	102,956	106,384	107,617	108,135	108,504		
2010 UWMP			92,018	93,675	92,426	93,368	94,425	95,297	
2015 UWMP				81,755	83,730	88,605	89,114	89,162	89,312





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs		
2000 UWMP	99.0%	102.7%				
2005 UWMP		103.5%	107.8%	-7.9%	-7.7%	-7.4%
2010 UWMP			103.7%	-4.1%	-4.1%	-4.6%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	106.9%	117.0%	135.1%	-26.9%			
2005 UWMP		111.9%	130.1%	-22.2%	-18.1%	-17.9%	
2010 UWMP			114.6%	-9.4%	-5.1%	-5.6%	-6.4%

Past UWMPs often overestimated future populations. But even when future populations were higher than forecast, demand was substantially lower than forecast. Underestimates of populations were sometimes due to subsequent annexes or consolidations, particularly for Group 1 which includes Irvine Ranch Water District and its frequent annexes and service are expansions.

Some of the UWMPs noted 2005 was a particularly wet year and indicated this suppressed demand. Many 2010 and 2015 UWMPs noted that recent drought years suppressed recent demand. That may be so, but the demand forecasts tended to decline substantially for each subsequent 5-year cycle of UWMPs indicating the wet and drought years do not fully explain the trends.

Most retailers in the Orange County Water District service area indicated they are at or near buildout (see Appendix A for buildout status of individual OCWD retailers). For these retailers, infill development will generally result in reduced average per capita demand, and possibly reduced overall demand since interior water use fixtures are becoming much more efficient and less outdoor area will be available for irrigated landscaping.

Review of Orange County Reliability Study

The Municipal Water District of Orange County (MWDOC) is a regional water wholesaler that provides water to retailers in the Orange County Water District (OCWD) service area, along with additional retailers outside the OCWD boundaries. MWDOC is presently conducting an Orange County Reliability Study (hereinafter Reliability Study) "to comprehensively evaluate current and future water supply and system reliability for all of Orange County."[10] The Reliability Study includes a water demand forecast model that separately delineates the Orange Basin water retailers. The OCWD retailers indicate they are using the water demand forecasts from this model in their 2015 UWMPs.

Since past UWMPs consistently overestimated future water demands, the Reliability Study demand forecasting methodology and assumptions were reviewed. The Reliability Study was not yet final, so this review was based on detailed technical memos and presentation materials provided by MWDOC.

The Reliability Study developed a statistical demand forecasting model with a number of inputs and assumptions. The model is described in Technical Memorandum #1 which states "The explanatory variables for this statistical model included population, temperature, precipitation, unemployment rate, presence of mandatory drought restrictions on water use, and a cumulative measure of passive and active conservation."[11]

The Reliability Study defines "passive conservation" as conservation which "results from codes and ordinances, such as plumbing codes or model landscape water efficient ordinances. This type of conservation requires no financial incentives and grows over time based on new housing stock and remodeling of existing homes."[12] "Active conservation" is defined as conservation "which requires incentives for participation. The SoCal Water$mart grant that is administered by MET, through its member agencies, provides financial incentives for approved active water conservation programs such as high efficiency toilets and clothes washer retrofits."[13] Technical Memorandum #1 for the Reliability Study indicates the passive conservation forecasts are based solely on code requirements for high efficiency toilets and high efficiency clothes washers, and the new California Model Water Efficient Landscape Ordinance that becomes effective in 2016.[14] These are well-proven conservation measures, but many more exist and are known to be effective and in use by consumers, particularly during drought years.[15]

While the technical methods for the demand model in the Reliability Study may be more sophisticated than water demand forecasts in many past UMWPs, any model is only as good as its algorithms, inputs and assumptions. To be manageable, or due to limitations in data or budget constraints, models tend to be simplifications of real world dynamics. Trends in real world water demand dynamics over several decades may be considerably more complex than what is represented with the 6 or 7 explanatory variables used in the Reliability Study water demand model. So it is important to understand the limitations of the model and likely sources of error. Some of the inputs and assumptions appear subject to the same problems and errors as past water demand forecasts, which resulted in overestimating future water demand. Key inputs and assumptions that may introduce errors and overstate future demand are reviewed below.

Population Forecasts

The past UWMPs often overestimated future populations. Some underestimates are due to cases of unforeseen annexes or expansions. But even for the cases where populations exceed forecasts (see Appendix A), and when unforeseen service area annexes and expansions occurred, water demand forecasts consistently exceeded actual demand in future years. Clearly more factors than erroneous population forecasts are driving the overestimates of future demand.

Demand During Multiple Drought Year Events

There are problems and inconsistencies in how the Reliability Study is addressing water conservation dynamics during serious, multi-year droughts. The statistical demand model described in Technical Memorandum #1 attributes only a -6% impact from “drought conservation” during “mandatory drought restrictions” which are generally only enacted during serious, multi-year droughts.[16] Soon thereafter the report states that California instituted a “statewide call for mandatory water use restrictions in April 2015, with a target reduction of 25 percent. Water customers across the state responded to this mandate, with most water agencies seeing water demands reduced by 15 to 30 percent during the summer of 2015.”[17] Table 5 below provides the 2015 drought year conservation during mandatory restrictions reported by the OCWD retailers to the California State Water Resources Control Board.

Table 5
2015 Drought Response[18]

Retailer	Drought Conservation Target	Drought Conservation Achieved June - Dec 2015
Anaheim	20.0%	22.5%
Buena Park	20.0%	22.9%
East OCWD	36.0%	36.5%
Fountain Valley	20.0%	22.9%
Fullerton	28.0%	21.7%
Garden Grove	20.0%	21.2%
Golden State Water Co.	16.0%	22.4%
Huntington Beach	20.0%	23.1%
IRWD	16.0%	17.5%
La Palma	20.0%	23.9%
Mesa	20.0%	18.5%
Newport Beach	28.0%	20.2%
Orange	28.0%	28.0%
Santa Ana	12.0%	17.5%
Seal Beach	8.0%	17.4%
Serrano WD	36.0%	39.4%
Tustin	28.0%	27.6%
Westminster	20.0%	18.8%
Yorba Linda WD	36.0%	37.8%
Average %	**22.7%**	**24.2%**

The Reliability Study water demand model described in Technical Memorandum #1 also assumes “demands during dry years would be 6 to 9 percent greater.”[19] The OCWD retailers use this assumption in their 2015 UWMP supply reliability planning. Assuming water demand will increase in single dry years may be accurate since single dry years are frequent in California and do not necessarily signify a serious drought situation. However, abundant real world evidence, including Table 5 above and Figures 2, 3 and 4 below, demonstrate that water users in California and the OCWD service area can and will substantially curtail water use during serious multiple year drought events. In fact, due to widespread drought messaging some service areas, including Irvine Ranch Water District during the in 2007 through 2010 drought years, and the Marin Municipal Water District in 2015, experienced substantial demand reductions during drought years even when no local water supply shortage existed.[20]

The drought conservation reported by OCWD retailers in Table 5 makes clear that the drought assumptions in the Reliability Study need refinement to better reflect real world events. Water use may increase during single dry year occurrences, and may also increase in multiple dry year events that are not so dry and severe that serious water shortages occur. However, it is clear that in serious multi-year drought water demand may decrease 20% or more.

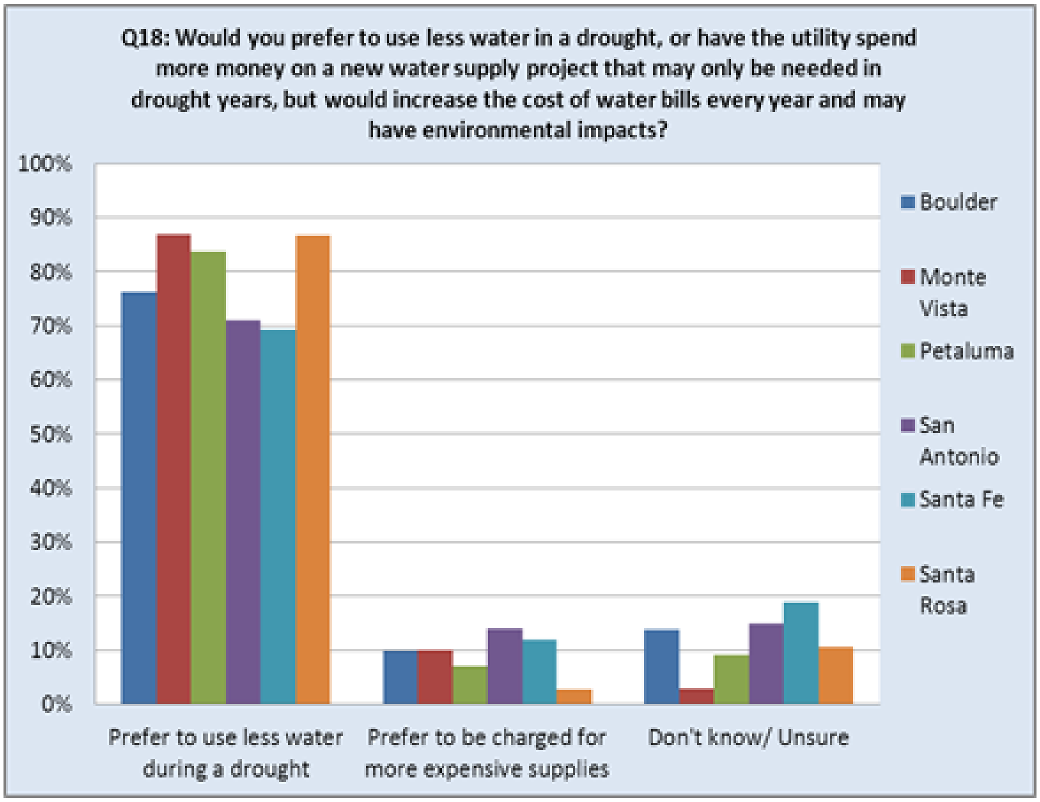
These assumptions regarding water use patterns during serious drought years have an important effect on the calculations that determine need for new water supply. Another key input is the yield of the water supply system. The typical definition of "Net Safe Yield" for a water supply system is the quantify of water from the various supply supplies during "drought of record" conditions (the worst drought) experienced by the utility's water supply sources. In response to climate uncertainty, some California utilities have started adding hypothetical additional drought years to their actual Drought of Record conditions to determine supply reliability, which reduces the theoretical yield.

The Net Safe Yield is then compared to total water demand to determine the need for new supply. If total water demand is assumed to increases 6% to 9% during drought years, this requires 6% to 9% more Net Safe Yield water supply during Drought of Record conditions to achieve 100% supply reliability. However, if water users actually curtail demand 25% during drought of record (or theoretical worse) conditions, instead of needing to supply 6% to 9% more than normal year demand, the utility would need 25% less than normal year demand. This results in a 31% to 34% difference in needed supply for drought of record conditions. Less severe droughts may occur on a less frequent basis, and require less, if any, water use curtailment.

Of course, a valid question exists as to whether water users would prefer to pay for full water supply reliability, even for drought years, or whether they would prefer to conserve water during droughts. The recent report “An Assessment of Demand Elasticity during Drought”[21] (hereinafter Demand during Drought Report) explored this question in phone surveys for water retailers in the Western states that had experienced serious drought. As shown in Figure 2 below, respondents expressed a very strong preference to conserve water during drought compared to paying for costly new water supplies that would only be needed for drought years. It should be noted that respondents for this question had experienced recent drought and this question occurred near the end of a lengthy survey in which respondents were asked a series of very specific questions about 17 water conserving steps they took in a past drought and which specific steps they would consider doing in a future drought. Therefore, the specific steps necessary to conserve additional water were not a vague notion for respondents at this point of the survey.

Furthermore, the same detailed phone surveys of drought affected areas in in California and other Western states found that not only do water users curtail water use during serious drought events, and prefer that compared to paying for new water supply only needed for drought years, but they adopt water saving technologies at a more rapid rate during serious drought events, which essentially accelerates "passive" conservation and can be expected to persist after the drought subsides.[22]

Figure 2
2012 Phone Survey: Conservation vs New Supply during Drought



In Technical Memorandum #4 for the Reliability Study, some of the model runs recognize that a 10% demand curtailment during severe drought is possible and a viable policy alternative.[23] This is an improvement over drought year assumptions in Technical Memorandum #1. However, the 2015 UWMPs for the individual retailers still indicate that demand will increase between 6% and 9% during multi-year droughts which is inconsistent with actual events.

As previously noted, drought year water use assumptions have an important effect on the calculations that determine need for new water supply. Each service area needs to carefully consider the acceptable frequency and depth of water shortages from drought, or the OCWD retailers may decide the most appropriate drought policy for the region as a group. But 100% supply reliability may be economically inefficient use of capital and unnecessary since water users have repeatedly demonstrated that they will curtail demand during serious drought years. In some documented cases in California and the OCWD service areas (noted in the subsequent section of this report), consumers curtailed water use during serious drought years even when a local water shortage did not occur.

Demand Rebound after Drought

Technical Memorandum #1 for the Reliability Study discusses three types of water conservation, passive and active as previously noted, and a third type from drought:

> "The third type is extraordinary conservation that results from mandatory restrictions on water use during extreme droughts. This type of conservation is mainly behavioral, in that water customers change how and when they use water in response to the mandatory restrictions. In droughts past, this type of extraordinary conservation has completely dissipated once water use restrictions were lifted—in other words curtailed water demands fully "bounced back" (returned) to pre-curtailment use levels (higher demand levels, within a relatively short period of time (1-2 years)."[24]

However, no source is cited to corroborate the assumption of fully "bounced back" demand within "1-2 years." In its water demand forecasts, the Reliability Study assumes that after the recent "Great California Drought" demand will rebound 85% in 5 years, and 90% in 10 years.

After the 1976-77 drought in California, many water retailers experienced a fairly rapid rebound to pre drought per capita demand levels. This was because relatively few new conservation technologies were available to be installed during the drought. Instead water users focused on behavioral modifications, and temporary measures such as placing bricks in toilet tanks and reducing landscape irrigation.

Another 6-year drought occurred in California from 1987 to 1992. During this drought, numerous new water savings technologies became available and water savings were based on a combination of new hard-wired efficiency devices and behavioral modifications. Additional drought years occurred during 2007 through 2009, and again in 2014 and 2015. Figures 3 and 4 examine per-capita water use rebound after drought for a couple of California service areas.

Figure 3
Irvine Ranch Water District Drought Rebound

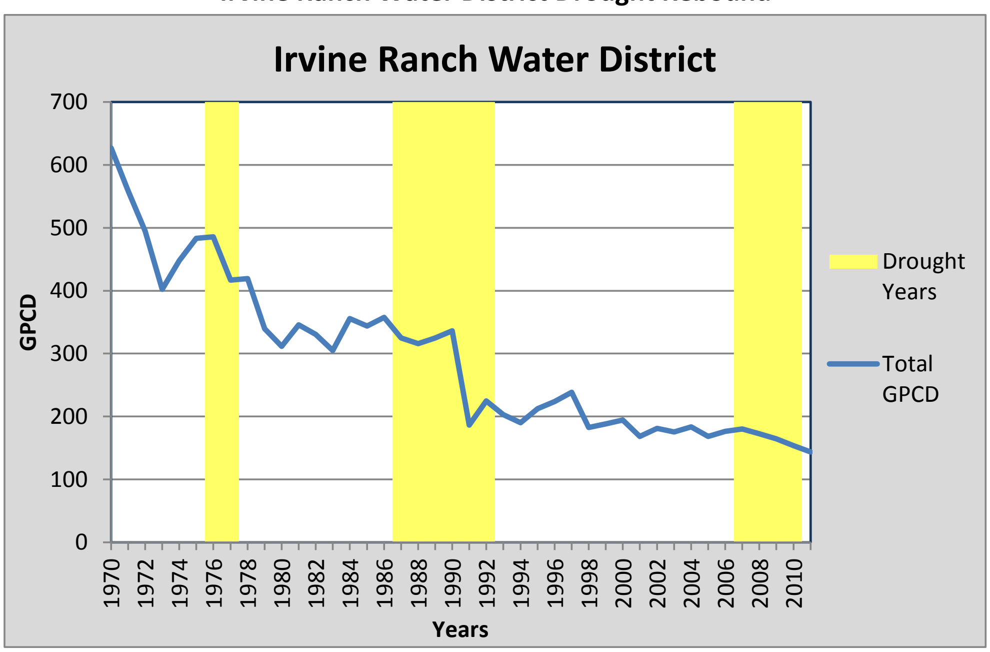
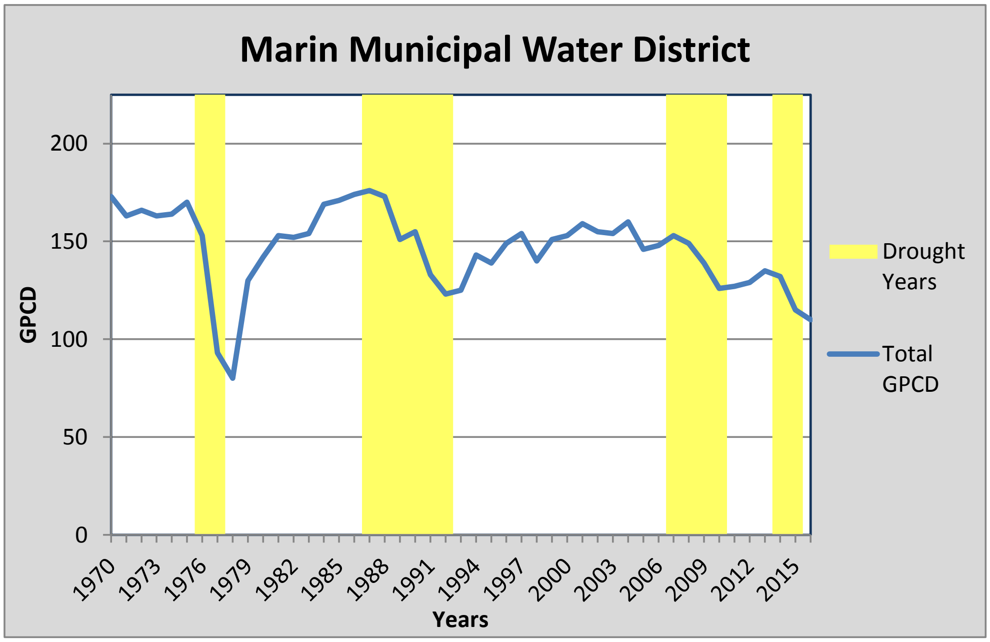


Figure 4
Marin Municipal Water District Drought Rebound



The Marin Municipal Water District data are particularly useful for examining drought rebound since Marin's local watershed and reservoirs only contain a 2- to 3-year carryforward supply, thus the service area is sensitive to drought. Marin's reservoir system is also very efficient at refilling with even a single wet year. So drought years may be of more immediate concern, but also end faster compared with many of California's urban water supply sources.[25]

Both Irvine Ranch and Marin experienced an obvious decline in per capita use during the 1976-77 drought. A relatively wet series of years followed, and over the next 10 years, per-capita water use rebounded to pre-drought levels for Marin, while Irvine Ranch per-capita water use remained at a much lower level (this may have in large part been due to declining agricultural water use in the service area at that time[26]).

When another series of drought years occurred between 1987 through 1992, both Irvine Ranch and Marin experienced a sharp decline in per-capita water use. When a series of wet years followed, per-capita water use for Irvine Ranch again remained below pre-drought levels, apparently due to a new rate structure instituted during the drought years and ongoing active and passive conservation in the service area.[27] During the 15-year wet year interval after 1992, Marin's per capita water use slowly rebounded, but remained well below the pre-drought peak in the mid-1980s.

California experienced another series of dry years between 2007 and 2010, which resulted in widespread concern over water shortages from drought, coinciding with an economic recession (addressed in the next section of this report). Again, both Irvine Ranch and Marin experienced a marked reduction in per-capita water use. Per-capita water use for Irvine Ranch again remained low for the years data were available after this drought, but a noticeable rebound occurs for Marin. With the widely publicized Great California Drought years of 2014 and 2015, Marin's per-capita water use again exhibits a marked decline, even though relatively little rebound had occurred since the previous series of drought years.

The phone surveys in the report "An Assessment of Demand Elasticity during Drought" documented widespread adoption of more efficient water use practices and technologies during recent drought events, essentially accelerating the rate of passive implementation of long-term conservation measures identified in the Reliability Study demand model.[28] Along with the trends in Figures 3 and 4, this suggests that as new conservation technologies and practices – many not considered in the Reliability Study's calculations for passive or active conservation -- are adopted by water users, the Reliability Study's assumption of a 90% rebound is likely to overestimate actual rebound. Additionally, if another series of drought years occurs during the assumed 10-year rebound period, it may significantly reverse the predicted rebound. Given the stretched water supply situation in California and competition for it, even a series of modestly dry years may drive increased adoption of new conservation innovations diminishing rebound after drought.

With a greater range of new conservation devices, technologies and practices available during the recent Great California Drought and widespread concern regarding climate change, if anything, water users can be expected to more strongly adopt and retain water saving devices and practices compared to past drought events. This would result in more persistent water savings from drought years, or less rebound than assumed in the Reliability Study. Though not likely, it is possible that a very long period of wet years will occur during which drought concerns become a distant memory, or a new generation of residents move in and grow up without having experienced a drought. In that unlikely event, increased rebound from growing careless water use would also provide the potential for more demand curtailment during future serious drought years.

Presently, there do not appear to be any thorough studies focused specifically on demand rebound after drought, particularly for recent drought events. But the information available suggests the Reliability Study's assumption of 90% rebound after the recent Great California Drought is likely to significantly contribute to overestimating future demand.

Drought vs. Economic Recession Water Use Patterns

The Reliability Study assumes a demand impact of -13% due to recession, and -6% due to drought.[29] However, recent events in California, the drought response figures in Table 5, and the previously referenced Demand during Drought Report which contains an analysis of water use during the recent simultaneous drought and recession, suggests these assumptions are in error.

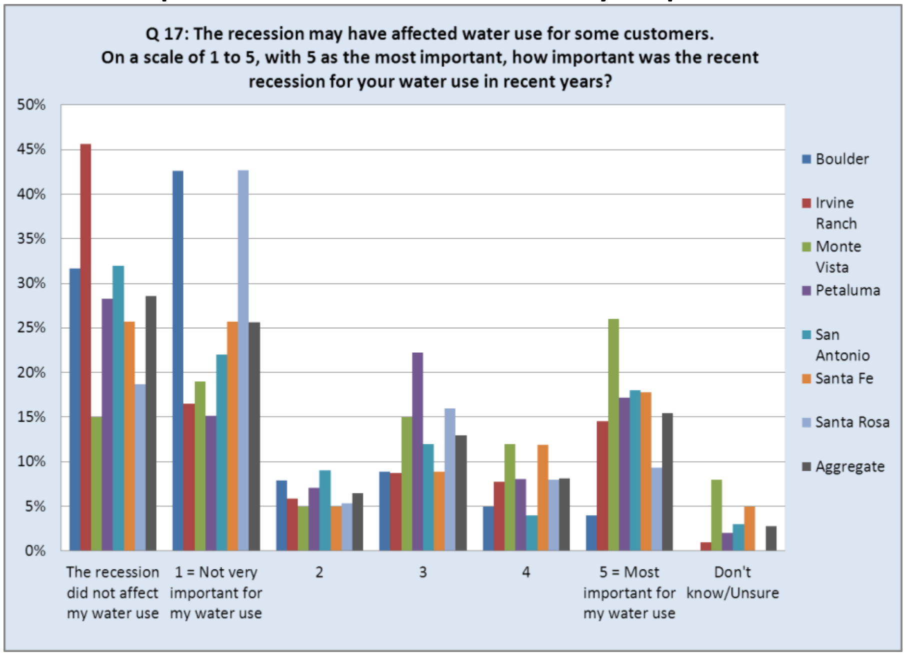
Questioning the long held view that urban water use closely correlates with economic trends is sure to trigger a Semmelweis Reflex from some water managers and analysts.[30] But economic conditions have evolved considerably in recent decades. Process water use for manufacturing and industrial purposes is becoming much less common and on-site recycled water use by remaining large industrial facilities much more common. Much non-residential water use is now for light commercial sites such as office parks, retail stores and restaurants. During economic downturns, much of the water use from these sectors may load shift back to residential sites since local residents may spend relatively more time at home compared to time working, shopping, eating out and other forms of entertainment away from the home. This load shifting will result in less overall impact on water demand during recession compared to the past era of widespread heavy industry and manufacturing.

The disconnect between economic trends and per capita water use has become so striking that in August, 2015 an Op-Ed by prominent water author Charles Fishman appeared in the New York Times. The piece noted that it had been an exceptionally dry 4-year period in California, but that California's economy had grown 27% faster than the nation, and faster every year of the drought.[31]

The relative influence of drought vs. recession in recent years was investigated in the report "An Assessment of Demand Elasticity during Drought" when both occurred simultaneously during the 2007-2010 drought. Some relevant excerpts from the report follow.

> To better understand economic conditions for the seven case studies, and how economic trends may have influenced water use, we collected data on economic trends and compared them to use patterns for each of the seven case studies. The economic indicators included:
>
> Annual unemployment rate
> Annual per-capita income
> Annual home value index
> Median household income
> Median home value
> Percent of population below poverty line
>
> For many of the case studies, in the 1980s there was a period when per-capita water use and economic indicator trends roughly coincided. However, starting in the early 1990s for many case studies, and by the late 1990s for nearly all of them, per-capita water use began a distinctive and persistent downward trend, with only relatively small perturbations during times of recession. As often as not, water use declined in periods of economic expansion and declining unemployment, and particularly during the economic expansion in the 1990s.[32]
>
> We found the economic indicators correlated poorly with the per-capita water use trends. In the last two decades in particular, there was no substantial and sustained correlation between economic vitality and per-capita water use trends. Water use trends appear to correlate much more closely with the ongoing implementation of water conservation programs, including the influence of state and national plumbing codes, the rising cost of water bills, and the influence of drought conditions. This conclusion is consistent with the responses in the phone surveys as noted in Figure 5 below. Most participants indicated that the recession did not affect or was not very important to their water use. Some of the participants who indicated the recession was important to water use may have been impacted in ways that increased use, such as more people living or spending time in the household.

Figure 5
Impact of Recession in Phone Survey Responses[33]



There are many reasons that overall water use for a service area may not sharply decline during a recession when more than the usual number of businesses and water meters are inactive. It is likely that a considerable amount of "load shifting" occurs. Water not used at one site is used somewhere else. Some possible examples include:

- Many more people may be unemployed and spending more time at home rather than in the work place or shopping malls. These unemployed people may be flushing toilets at home more often rather than at work or at the malls.
- Many people may be eating out less frequently, but preparing food and washing dishes more frequently at home. Depending on dishwashing methods, home dishwashing may be less water efficient than in a restaurant.
- There may be more than the normal level of unoccupied dwelling units in a service area, but people may be living more densely in other single-family and multi-family dwelling units (populations did not appear to decline for our case study service areas during the recent recession). Many unoccupied residences and business sites appear to continue watering the landscape with an automatic irrigation system to save landscaping and make the site more attractive to rent or sell. In the case of unoccupied sites that are automatically irrigated, the irrigation management may be less efficient than if the site was occupied.[34]

With regard to the long-term and persistent decline in per capita water use experienced by all the case studies in the study, the report noted "declining per-capita water use did not appear to impose a constraint on economic vitality during periods of economic expansion."[35] This further indicates a growing disconnect between economic trends and overall per capita water use.

Figure 6 below, from the Demand during Drought Study, provides a comparison on aggregate per capita water use trends equally weighted for the seven case studies (four were in California) with economic trends based on real per-capita income.[36]

Figure 6

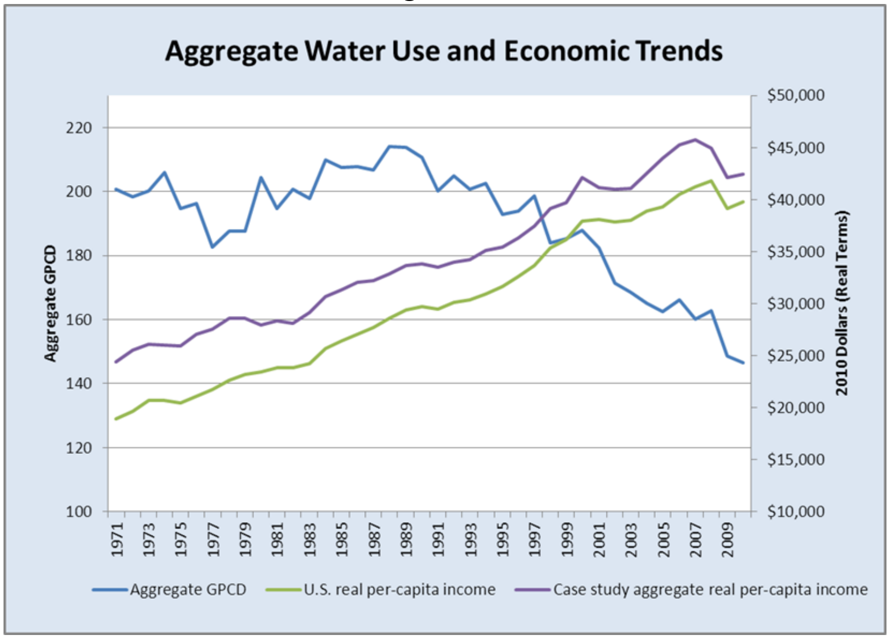


Figure 5 in the Reliability Study Technical Memorandum #1 provides a verification curve of the statistical water use model along with actual water demand.[37] The model appears to predict lower than actual per capita water use for the OCWD basin retailers during the recession years in the early 1990s and early 2000s. The predicted and actual curves appear to match more closely during the late 2000s when the Great Recession and a series of drought years also known to have reduced demand occurred simultaneously. This suggests the impact of recession is over estimated and drought underestimated in the model's assumptions.

Infill Development

As noted in their 2015 Urban Water Management Plans, most Orange County Water District retailers are at or near build-out condition in their service areas (see Appendix A). Future development will consist mostly of infill and higher density development of existing developed areas. This will displace landscape water use, which historically has contained a large percentage of high-water-use plantings and inefficient irrigation systems and practices. The higher density in-fill development pattern is noted in MWDOC's 2015 UWMP; "housing, in particular within the cities, is becoming denser with new multi-storied residential units."[38]

The Demand during Drought Report states "As water utility service areas approach or reach build-out, the trend in declining per-capita water use has important implications for water supply planning."[39] Per capita water use for residents in multi-unit housing stock has historically been lower than in single-family housing. Higher density residential housing stock generally equates to lower per capita demand.

According to Technical Memorandum #1 for the Reliability Study, the "unit use" water use factors used in the model are based on fiscal-year 2013-14 figures provided by the retailers.[40] It is not clear that the trend identified in the UWMPs to higher density, lower per-capita water use housing stock is adequately accounted for in demand forecasts.

Price Elasticity of Demand

Technical Memorandum #1 for the Reliability Study states:

> Price elasticity of water demand reflects the impact that changes in retail cost of water has on water use. Theory states that if price goes up, customers respond by reducing water use. A price elasticity value of -0.2 implies that if the real price of water increases by 10%, water use would decrease by 2%. Price elasticity is estimated by detailed econometric water demand models, where price can be isolated from all other explanatory variables. Many times price is correlated with other variables making it difficult to estimate a significant statistical value. In addition, there is a potential for double counting reduction in water demand if estimates of future conservation from active programs are included in a demand forecast because customers who respond to price take advantage of utility-provided incentives for conservation. MET's 2015 IRP considers the impact of price elasticity in their future water demand scenarios, but does not include future active conservation in its demand forecast. The OC Study included future estimates of water conservation from active conservation, and thus did not include a price elasticity variable in its statistical modeling of water demand. Including both price elasticity and active conservation would have resulted in "double counting" of the future water savings.

While there may be a potential for double counting some active conservation program savings for people motivated by price increases, to entirely disregard the price elasticity of demand is almost certain to under count its effects. Participants in active conservation programs may also be motivated to modify behavior to conserve water in addition to the water savings from the active conservation retrofits. These can both occur simultaneously and result in separate water savings. In addition, many water users may be motivated to conserve based solely on price, without any participation in the active conservation programs. These price only motivated conservers will be lost from the accounting.

The Demand during Drought Study found real marginal prices increased substantially during the last 10 to 20 years.[41] Technical Memorandum #4 for the Reliability Study states "the cost of water will continue to increase over time, and at higher rates than the cost of inflation to deal with these reliability issues."[42] If water prices continue rising in real terms, as water industry analysts predict, this problem will be magnified, particularly for utilities developing more expensive new supply sources. The demand model in the Reliability Study would be better served by reasonable assumptions to address double counting concerns, rather than categorically ignoring a known important water use influence on all of a service area's customers.

F**uture conservation innovation**

> "Everything than can be invented has been invented"
>
> > Quote often erroneously attributed to Charles Holland Duell, commissioner of the United States Patent and Trademark Office in 1898 to 1901 (the quote can be sourced to an 1899 edition of Punch Magazine)[43]
>
> In fact, in 1902 Duell is known to have said:
>
> "In my opinion, all previous advances in the various lines of invention will appear totally insignificant when compared with those which the present century will witness. I almost wish that I might live my life over again to see the wonders which are at the threshold."[44]

Conservation assumptions in demand forecasts tend to underestimate future conservation for a number of reasons. As previously noted, Technical Memorandum #1 for the Reliability Study includes a limited range of presently available conservation measures in its passive conservation projections. Nonetheless, water users employ a broader range of conservation measures, particularly during drought years, which are not considered in the demand forecasts. But even for demand forecasts with the most thorough analysis of conservation measures, it is important to recognize that only present day conservation measures have been included. However, as abundantly clear in recent decades, conservation technologies are rapidly developing. Given well-established trends, future conservation innovations can safely be expected to increase future conservation beyond present day forecasts.

Many examples exist, but the evolution of toilet efficiency is particularly illustrative. During California's 1976-77 drought, the cutting-edge technology was to place a brick (maybe sealed in a plastic bag for the most technologically advanced) in the tank of a 5 to 7 gallon per flush toilet to reduce flushing volume. This soon gave way in the 1980s to 3.5 gallon per flush toilets, and considerable skepticism from plumbing interests. In the early 1990s, 1.6 gallon per flush toilets became available. Conservation skeptics suggested they would never work properly and create havoc with wastewater plumbing. Numerous studies were launched to investigate the dangers of using this new generation of toilets, and prove they could not possibly be practical for widespread use and represent future toilet technology. Water analysts in the 1990s were often hesitant to consider the water savings from 1.6 gallon toilets reliable enough to include in demand forecasts. In a sense they were right, but only because a new, more efficient generation soon superseded the 1.6 gallon toilets.

By the late 2000s, more efficient toilets using 1.28 gallons-per-flush became the new efficiency standard, replacing the 1.6 gallon toilets. Now, the 2015 MWDOC Reliability Study assumes all new and remodeled households will use 1 gallon-per-flush toilets, replacing even those old, inefficient 1.6 gallon toilets. Toilets using 0.8 gallon per flush toilet are now widely available. As populations increase, and more people flush more toilets, seemingly small improvements in toilet efficiency have important cumulative effect on demand. Many other water using technologies such as clothes washers and dishwashers are also advancing in efficiency.

Of course, the demand forecasts from the 1990s and 2000s never contemplated these efficiency innovations that regularly occurred within the planning horizons of the forecasts. For many widely recognized reasons including population increases, over allocated river systems, rising cost of water and concern about climate change, much interest exists in advancing innovative efficient water use technologies. In fact, the Metropolitan Water District of Southern California has for many years provided grants designed specifically to help drive innovation in conservation technologies and practices.

There can be little doubt that conservation innovation has been an important influence in reducing water use below earlier demand forecasts, and all signs suggest that will continue to be the case for the foreseeable future and the planning horizon for the Reliability Study. We may not be able to predict exactly what new innovations will emerge, but we now have a long enough track record of new technologies and efficiencies reducing demand below previous forecasts that water demand modelers can begin to recognize and quantify this variable and develop model runs that incorporate it in a range of alternative demand scenarios.

Risk in Overestimating Future Demand

Water demand forecasters traditionally use conservative estimates for many forecasting assumptions. This is generally done to reduce the risk from uncertainty in the forecasts and to reduce the risk of underestimating water supplies for a growing service area. However, as multiple instances and layers of conservative estimates are incorporated into demand forecasts, the forecasts diverge from real world trends and can lead water agencies to pursue unnecessary or overly costly supplies. Much of water utility costs may be fixed, but the fixed costs become hard-wired from previous capital expenditures in new supplies and facilities.

For service areas undergoing rapid growth and expansions, increased demand may eventually justify overestimated demand forecasts. However, for service areas at or near built-out conditions, as is the case for OCWD retailers, over estimating future demand and pursuing unneeded or overly costly new supplies can place the water utility at considerable financial risk and vulnerable to ratepayer backlash.

Financial risk can result from poor investment strategies and financial instability when water demand is less than forecasted. As water use declines below forecasted levels, revenues needed to pay for capital costs and debt service decline. Further raising rates to generate additional revenue can further suppress demand and create a downward financial spiral for the utility. Likewise, large capital investments for water supply only needed for infrequent serious drought years places additional financial burden on the utility, and financial risk when water users substantially reduce water use during serious drought events, as occurs in California. Political risk can increase as a consequence of ratepayer revolts triggered by rate increases and dissatisfaction regarding past supply investments by utility decision-makers. Risk may also occur when water utilities with a history of overestimating demand are justifiably greeted with skepticism by agencies responsible for permitting new supply projects and facilities, and public interest groups and ratepayers whose approval may be necessary for new projects to move forward.

Many service areas at or near build-out, as is the case for Orange County Water District retailers, may have now reached a point where multiple instances and layers of conservative assumptions for demand forecasts leading to inflated future demand estimates no longer provides the intended risk reduction. Utilities with service areas at or new build-out would be wise to much more carefully scrutinize water demand forecasts and the assumptions on which they are based in order to more closely represent real world events and trends.

Appendix A: Analysis of Individual Retailer Urban Water Management Plans

The below table indicates which UWMPs, from 1995 through 2015 were available for each OCWD retailer, which were used in the analysis of UWMP future populations and demand.

Urban Water Management Plans Obtained

Water Retailer	LTFP 2035 Demand (AFY)	Group	1995	2000	2005	2010	2015
IRWD	88,008	1	Yes	Yes	Yes	Yes	Yes
Anaheim	77,700	1	NA	Yes	Yes	Yes	Yes
Santa Ana	50,400	1	NA	Yes	Yes	Yes	Yes
Orange	34,713	2	Yes	Yes	Yes	Yes	Yes
Huntington Beach	34,657	2	Yes	Yes	Yes	Yes	Yes
Fullerton	32,792	2	Yes	Yes	Yes	Yes	Yes
Golden State Water Co.	32,774	2	NA	NA	NA	Yes	NA
Garden Grove	30,907	2	1996	Yes	Yes	Yes	Yes
Yorba Linda WD	27,784	2	Yes	Yes	Yes	Yes	Yes
Buena Park	19,900	3	NA	Yes	Yes	Yes	Yes
Mesa	19,700	3	Yes	Yes	Yes	Yes	Yes
Newport Beach	18,474	3	Yes	Yes	Yes	Yes	yes
Tustin	15,194	3	Yes	Yes	Yes	Yes	Yes
Westminster	12,337	3	Yes	Yes	Yes	Yes	Yes
Fountain Valley	10,165	3	Yes	Yes	Yes	Yes	Yes
Seal Beach	4,880	4	NA	2002	Yes	Yes	Yes
Serrano WD	2,852	4	NA	NA	NA	Yes	Wholesale
La Palma	2,742	4	Yes	NA	Yes	Yes	Yes
East OCWD	1,100	4	NA	NA	Yes	Yes	Yes

For some of the UWMPs, and particularly the earlier years, population or demand figures were missing. These data gaps are apparent in the individual retailer tables below.

When a subsequent year UWMP had updated demand or population figures for the previous starting year, for example the 2000 UWMP had updated 1995 demand figures, the updated figures were assumed to be more accurate and used. Since the horizontal and vertical scales used in graphs to provide a clearer representation of trends can introduce some distortion, tables providing percent changes are provided below the graphs for each retailer.

UWMP data for each retailer follows (with the exceptions of Golden State and Serrano due to lack of an adequate number of UWMPs) in the order noted in the above table, which is descending water use.

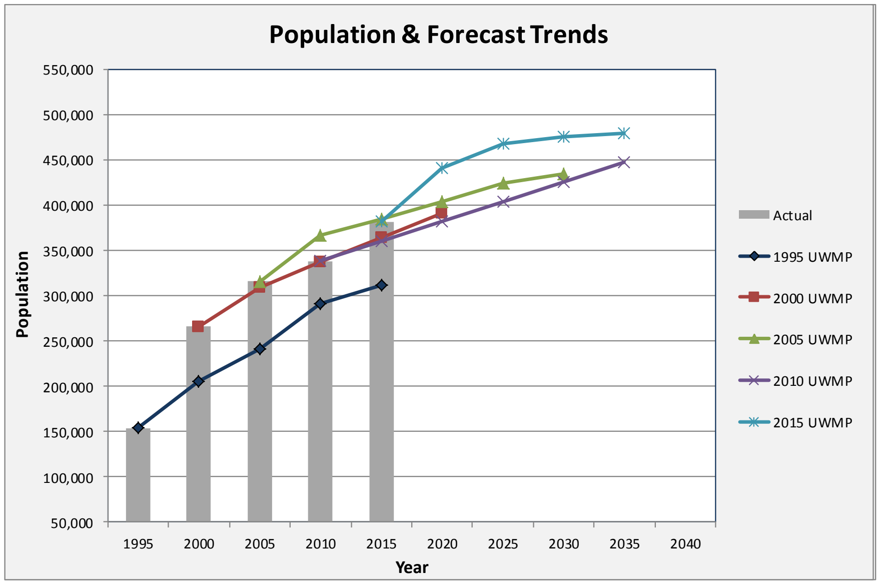
Irvine Ranch

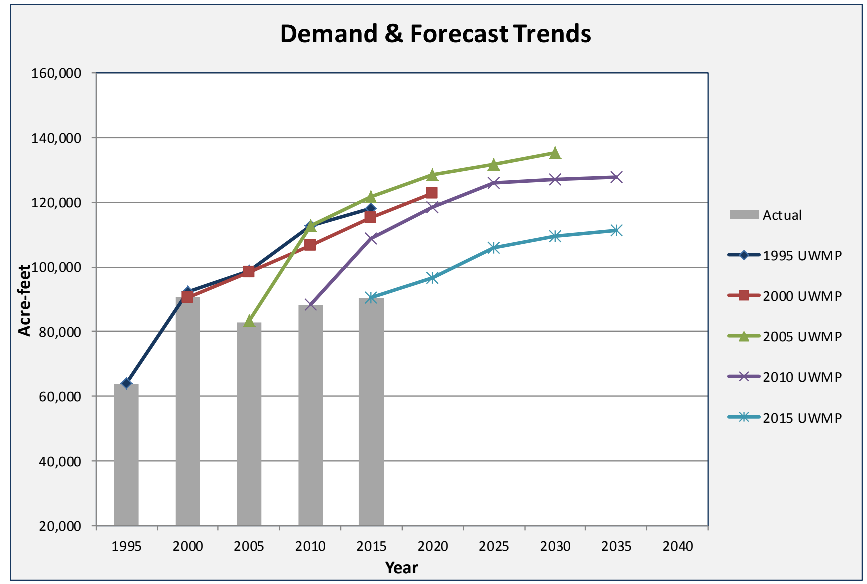
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	154,000	266,000	316,000	337,876	381,463					
1995 UWMP	154,000	205,784	240,757	290,839	312,000					
2000 UWMP		266,000	308,653	337,569	364,018	390,467				
2005 UWMP			316,000	366,192	384,502	403,727	423,914	434,511		
2010 UWMP				337,876	359,627	381,379	403,130	424,882	446,633	
2015 UWMP					381,463	440,981	467,483	475,346	479,783	

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	63,992	90,660	82,916	88,347	90,403					
1995 UWMP	63,992	92,176	98,578	112,716	118,014					
2000 UWMP		90,660	98,339	106,785	115,133	122,833				
2005 UWMP			83,508	112,710	121,620	128,563	131,708	135,130		
2010 UWMP				88,347	108,626	118,512	126,009	126,968	127,908	
2015 UWMP					90,403	96,445	105,961	109,431	111,277	





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	77.4%	78.0%	86.1%	81.8%				
2000 UWMP		97.7%	99.9%	95.4%	12.9%			
2005 UWMP			108.4%	100.8%	9.2%	10.3%	9.4%	
2010 UWMP				94.3%	15.6%	16.0%	11.9%	7.4%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	101.7%	118.0%	127.6%	130.5%				
2000 UWMP		117.8%	120.9%	127.4%	-21.5%			
2005 UWMP			127.6%	134.5%	-25.0%	-19.5%	-19.0%	
2010 UWMP				120.2%	-18.6%	-15.9%	-13.8%	-13.0%

The Irvine Ranch service area experienced annexes and expansions nearly every 5-year cycle of UWMP updates which were generally not accounted for in earlier population and demand forecasts. The 2000 UWMP included both IRWD and the Los Alisos which were being merged. The 2000 UWMP figures represent the combined service areas. Recycled water use is included in demand and represents about 1/3 of total use, therefore potable water use is much lower.

Anaheim

Population

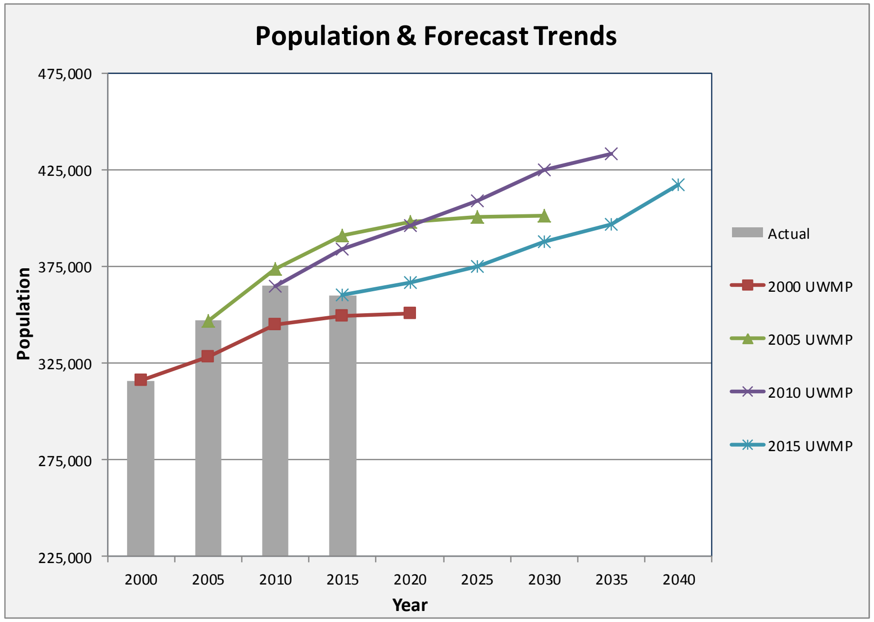
Actual and Forecasted

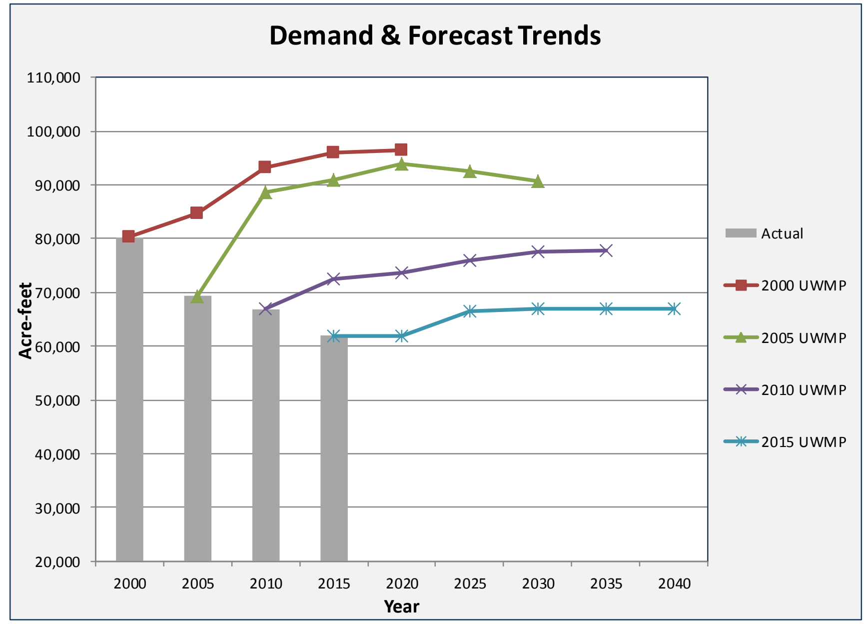
Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	316,100	346,932	364,921	360,142					
2000 UWMP	316,100	328,300	345,100	349,700	350,500				
2005 UWMP		346,932	373,852	390,764	397,774	400,529	400,900		
2010 UWMP			364,921	383,768	395,769	409,096	424,558	432,949	
2015 UWMP				360,142	366,938	374,836	387,739	396,721	417,456

Demand

Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	80,200	69,277	66,829	61,982					
2000 UWMP	80,200	84,700	93,300	96,000	96,400				
2005 UWMP		69,277	88,630	90,890	93,920	92,490	90,710		
2010 UWMP			66,829	72,400	73,600	75,900	77,500	77,700	
2015 UWMP				61,982	61,895	66,453	66,910	66,892	66,988





	Predicted Compared to Subsequent Actual Population			Change in 2015 Population Forecasts Compared to Previous			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	94.6%	94.6%	97.1%	4.7%			
2005 UWMP		102.4%	108.5%	-7.8%	-6.4%	-3.3%	
2010 UWMP			106.6%	-7.3%	-8.4%	-8.7%	-8.4%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	122.3%	139.6%	154.9%	-35.8%			
2005 UWMP		132.6%	146.6%	-34.1%	-28.2%	-26.2%	
2010 UWMP			116.8%	-15.9%	-12.4%	-13.7%	-13.9%

A 1995 UWMP was not available for Anaheim.

The 2015 UWMP indicates “the City is almost completely built-out” and “housing is becoming denser and new residential units are multi-storied.” (p 2-2)

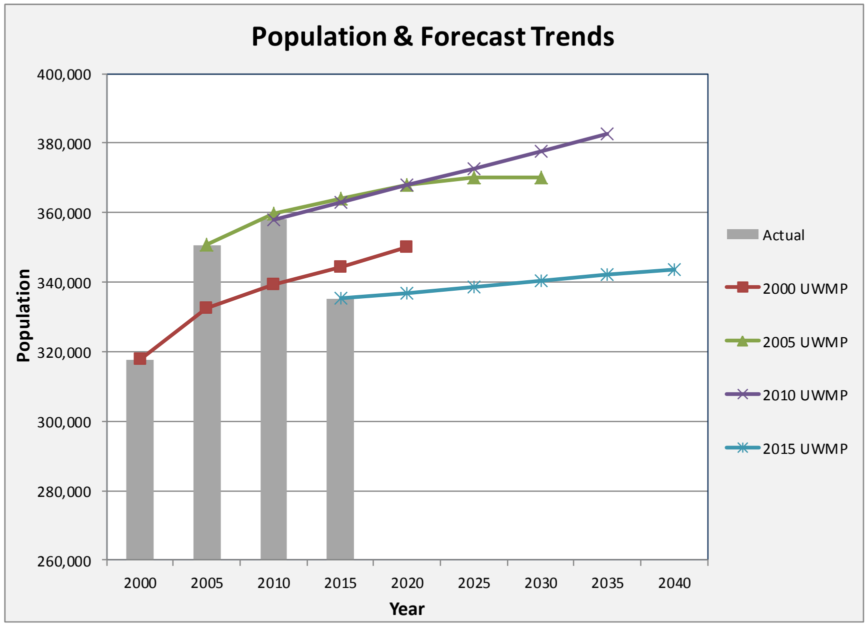
Santa Ana

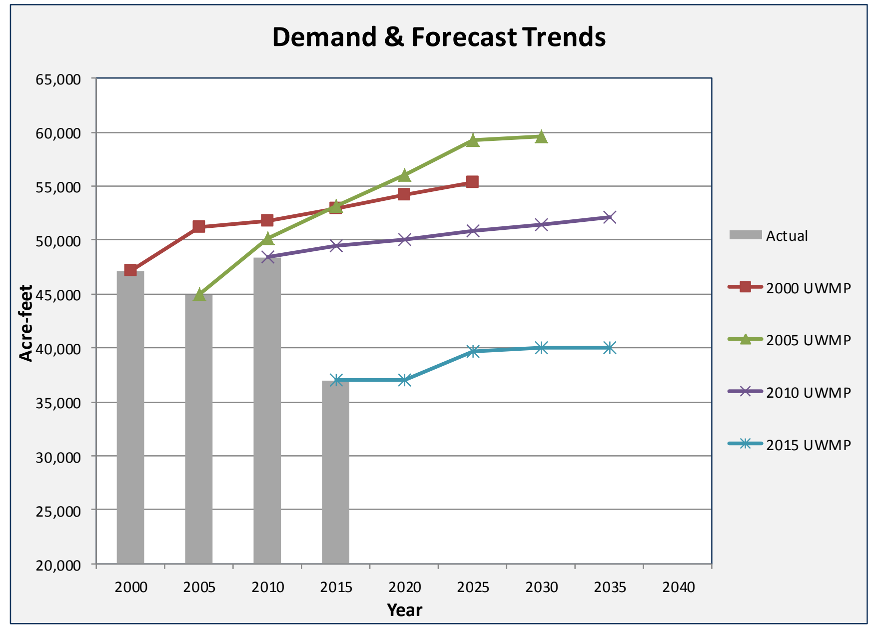
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	317,685	350,625	358,136	335,299					
2000 UWMP	317,685	332,586	339,419	344,410	350,172				
2005 UWMP		350,625	359,832	364,049	368,026	370,196	370,130		
2010 UWMP			358,136	363,027	367,918	372,809	377,700	382,591	
2015 UWMP				335,299	336,975	338,660	340,354	342,055	343,766

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	47,112	44,920	48,391	37,008					
2000 UWMP	47,112	51,170	51,780	52,960	54,150	55,370			
2005 UWMP		44,920	50,190	53,180	55,970	59,280	59,540		
2010 UWMP			48,391	49,473	50,094	50,819	51,440	52,164	
2015 UWMP				37,008	36,998	39,717	39,989	39,978	





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	94.9%	94.8%	102.7%	-3.8%			
2005 UWMP		100.5%	108.6%	-8.4%	-8.5%	-8.0%	
2010 UWMP			108.3%	-8.4%	-9.2%	-9.9%	-10.6%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
Year	2005	2010	2015	2020	2025	2030	2035
2000 UWMP	113.9%	107.0%	143.1%	-31.7%			
2005 UWMP		103.7%	143.7%	-33.9%	-33.0%	-32.8%	
2010 UWMP			133.7%	-26.1%	-21.8%	-22.3%	-23.4%

A 1995 UWMP was not available.

The 2015 UWMP states, “the City is almost completely built-out" and "vacant land within the City is very limited while existing housing is becoming denser and new residential units are multi-storied." (p 2-2)

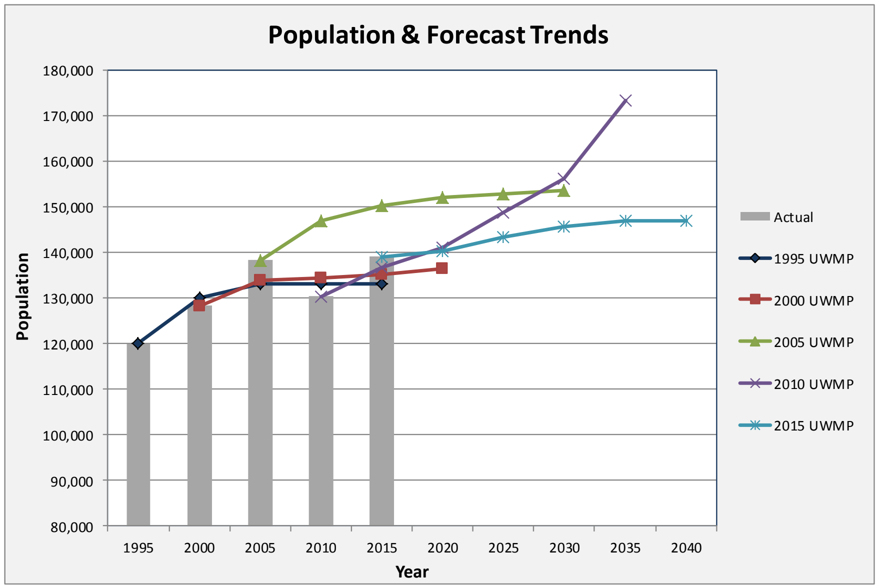
Orange

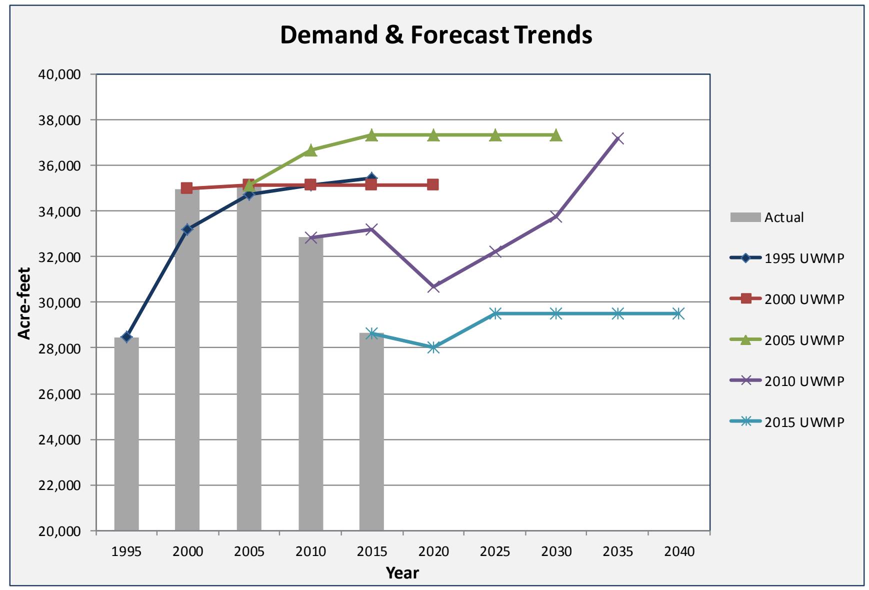
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	120,000	128,309	138,289	130,325	138,987					
1995 UWMP	120,000	130,000	133,000	133,000	133,000					
2000 UWMP		128,309	133,793	134,474	135,230	136,346				
2005 UWMP			138,289	146,950	150,152	151,910	152,792	153,576		
2010 UWMP				130,325	136,703	141,094	148,709	156,125	173,212	
2015 UWMP					138,987	140,203	143,429	145,735	146,916	146,795

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	28,464	34,978	35,156	32,854	28,643					
1995 UWMP	28,464	33,200	34,710	35,160	35,460					
2000 UWMP		34,978	35,156	35,156	35,156	35,156				
2005 UWMP			35,156	36,663	37,319	37,319	37,319	37,319		
2010 UWMP				32,854	33,201	30,681	32,236	33,746	37,165	
2015 UWMP					28,643	28,000	29,500	29,500	29,500	29,500





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	101.3%	NA	102.1%	95.7%				
2000 UWMP		96.7%	103.2%	97.3%	2.8%			
2005 UWMP			112.8%	108.0%	-7.7%	-6.1%	-5.1%	
2010 UWMP				98.4%	-0.6%	-3.6%	-6.7%	-15.2%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	94.9%	98.7%	107.0%	123.8%				
2000 UWMP		100.0%	107.0%	122.7%	-20.4%			
2005 UWMP			111.6%	130.3%	-25.0%	-21.0%	-21.0%	
2010 UWMP				115.9%	-8.7%	-8.5%	-12.6%	-20.6%

The 2015 UMMP states "The City is almost completely built-out, (note: the City continues to see limited development on the very east side with the Santiago Hills II tract development of approximately 1,180 new homes, but this development lies outside of the City of Orange water service area and is in IRWD's service area)" (p 2-2)

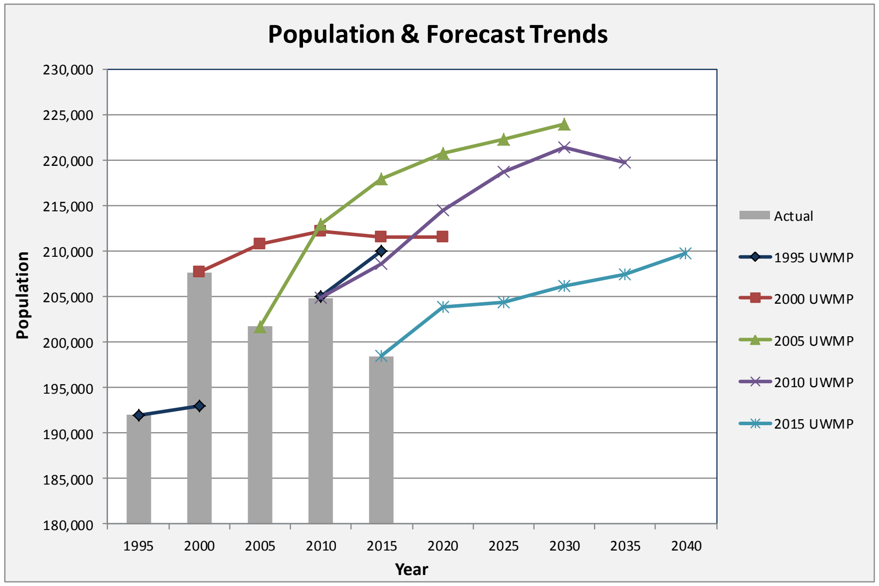
Huntington Beach

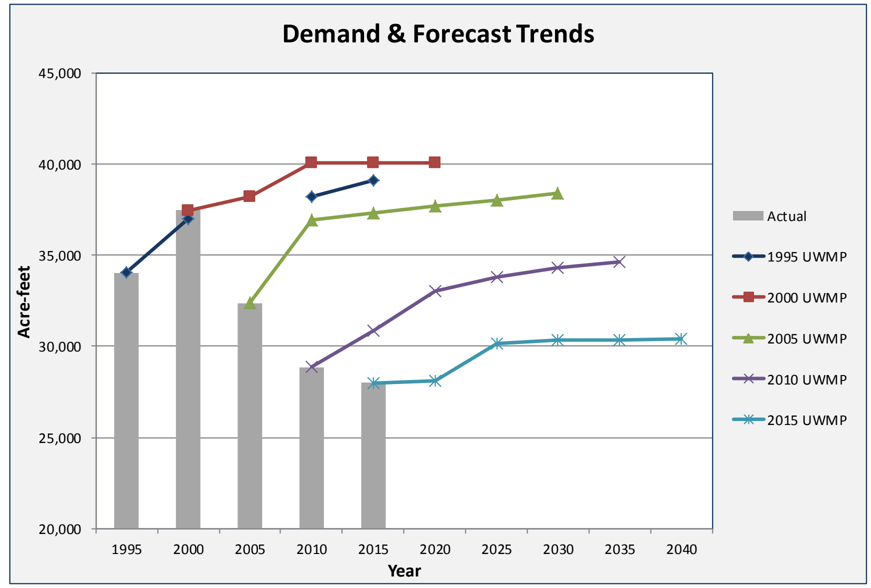
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	192,000	207,639	201,692	204,831	198,429					
1995 UWMP	192,000	193,000		205,000	210,000					
2000 UWMP		207,639	210,734	212,181	211,558	211,581				
2005 UWMP			201,692	212,893	217,957	220,759	222,274	223,992		
2010 UWMP				204,831	208,622	214,441	218,739	221,420	219,690	
2015 UWMP					198,429	203,840	204,330	206,207	207,387	209,689

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	34,063	37,460	32,374	28,879	27,996					
1995 UWMP	34,063	37,000		38,200	39,135					
2000 UWMP		37,460	38,200	40,075	40,100	40,100				
2005 UWMP			32,374	36,931	37,304	37,696	38,059	38,400		
2010 UWMP				28,879	30,888	33,036	33,823	34,324	34,657	
2015 UWMP					27,996	28,090	30,153	30,360	30,352	30,396





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	92.9%	NA	100.1%	105.8%				
2000 UWMP		104.5%	103.6%	106.6%	-3.7%			
2005 UWMP			103.9%	109.8%	-7.7%	-8.1%	-7.9%	
2010 UWMP				105.1%	-4.9%	-6.6%	-6.9%	-5.6%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	98.8%	NA	132.3%	139.8%				
2000 UWMP		118.0%	138.8%	143.2%	-30.0%			
2005 UWMP			127.9%	133.2%	-25.5%	-20.8%	-20.9%	
2010 UWMP				110.3%	-15.0%	-10.9%	-11.5%	-12.4%

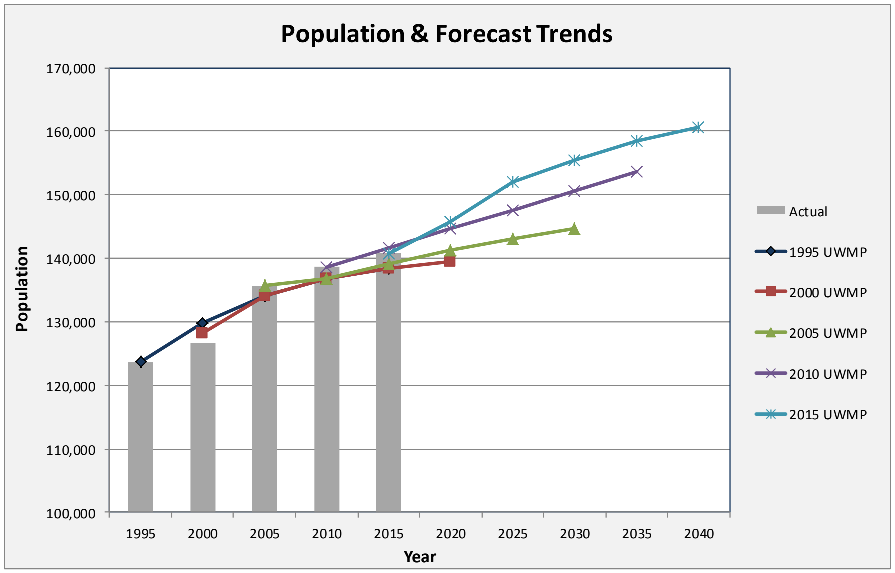
The Huntington Beach 1995 UWMP did not contain a population forecast for the year 2005.

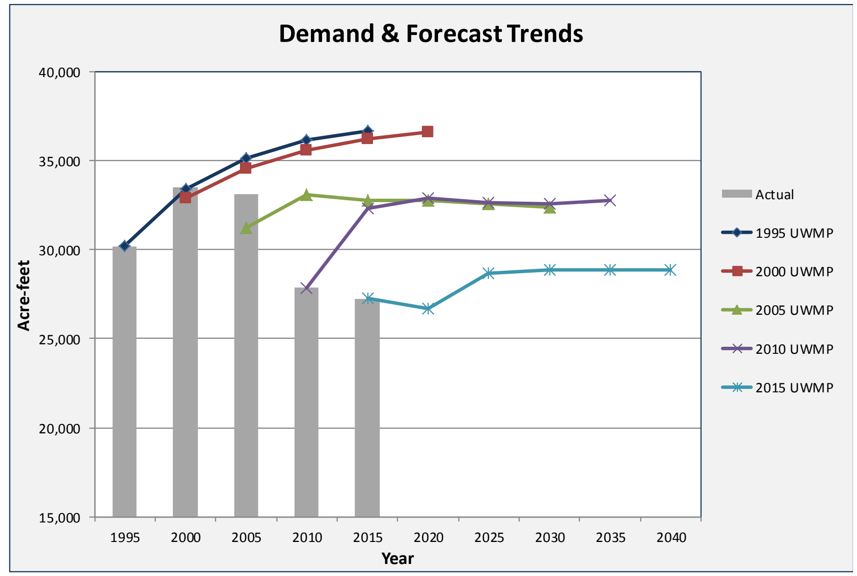
The 2015 UWMP states Huntington Beach is a “predominately residential community” (p 1-3) and “housing is becoming denser and new residential units are multi-storied.” (p 2-2)

Fullerton

Population Actual and Forecasted										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	123,692	126,635	135,672	138,600	140,827					
1995 UWMP	123,692	129,804	134,175	136,845	138,442					
2000 UWMP		128,255	134,175	136,845	138,442	139,556				
2005 UWMP			135,672	136,800	139,200	141,200	143,000	144,700		
2010 UWMP				138,600	141,603	144,605	147,608	150,610	153,613	
2015 UWMP					140,827	145,791	152,026	155,464	158,421	160,545

Demand Actual and Forecasted (AF)										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	30,195	33,530	33,136	27,860	27,244					
1995 UWMP	30,195	33,442	35,169	36,176	36,675					
2000 UWMP		32,913	34,538	35,608	36,210	36,595				
2005 UWMP			31,249	33,100	32,800	32,800	32,600	32,400		
2010 UWMP				27,860	32,305	32,881	32,658	32,602	32,792	
2015 UWMP					27,244	26,699	28,661	28,858	28,850	28,891





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	101.2%	101.1%	98.7%	98.3%				
2000 UWMP		98.9%	98.7%	98.3%	4.5%			
2005 UWMP			98.7%	98.8%	3.3%	6.3%	7.4%	
2010 UWMP				100.6%	0.8%	3.0%	3.2%	3.1%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	101.6%	112.5%	129.8%	134.6%				
2000 UWMP		110.5%	127.8%	132.9%	-27.0%			
2005 UWMP			118.8%	120.4%	-18.6%	-12.1%	-10.9%	
2010 UWMP				118.6%	-18.8%	-12.2%	-11.5%	-12.0%

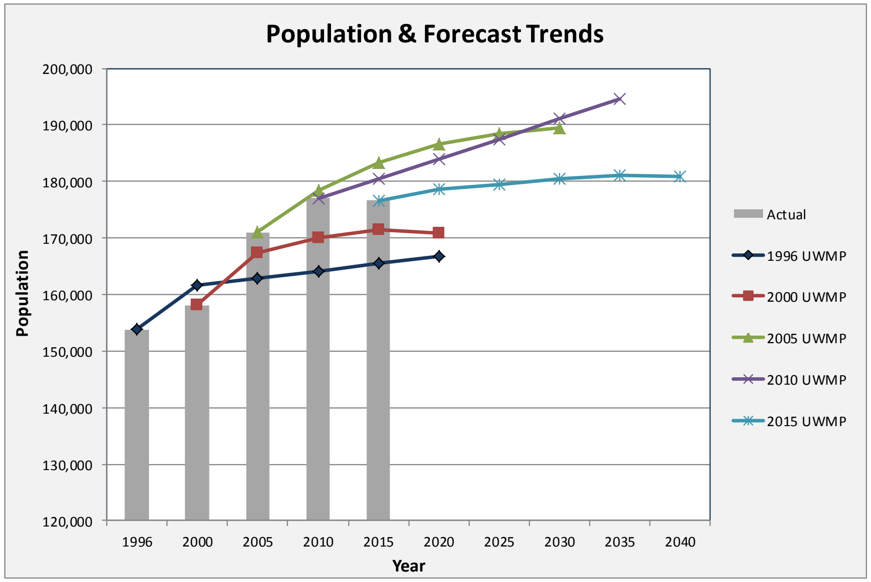
Actual demand for the year 2000 is from the 2005 UWMP. Actual demand for the year 2005 is form the 2010 UWMP.

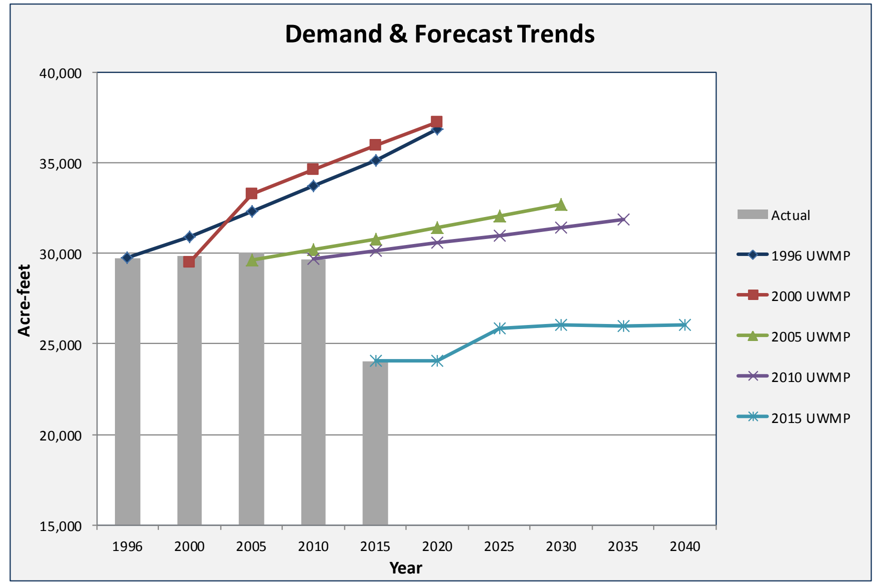
The 2015 UWMP describes the service area as "a predominately residential single and multi-family community" and "multi-family housing units are expected to increase at a faster rate than the single-family housing units. In the older areas of the City, multi-family and mixed use units are increasingly replacing older single-family dwellings." (p 2-2)

Garden Grove

Population Actual and Forecasted										
Year	**1996**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	153,800	158,100	171,042	177,020	176,649					
1996 UWMP	153,800	161,635	162,914	164,193	165,471	166,750				
2000 UWMP		158,100	167,339	170,107	171,479	170,851				
2005 UWMP			171,042	178,457	183,249	186,593	188,446	189,445		
2010 UWMP				177,020	180,526	184,032	187,538	191,044	194,550	
2015 UWMP					176,649	178,729	179,440	180,428	181,002	180,825

Demand Actual and Forecasted (AF)										
Year	**1996**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	29,748	29,857	30,027	29,698	24,049					
1996 UWMP	29,748	30,888	32,312	33,737	35,162	36,856				
2000 UWMP		29,487	33,312	34,637	35,961	37,286				
2005 UWMP			29,620	30,210	30,814	31,431	32,060	32,700		
2010 UWMP				29,698	30,164	30,631	30,986	31,453	31,909	
2015 UWMP					24,049	24,078	25,847	26,024	26,017	26,055





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	102.2%	NA	92.8%	93.7%				
2000 UWMP		97.8%	96.1%	97.1%	4.6%			
2005 UWMP			100.8%	103.7%	-4.2%	-4.8%	-4.8%	
2010 UWMP				102.2%	-2.9%	-4.3%	-5.6%	-7.0%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	104.8%	109.1%	113.6%	146.2%				
2000 UWMP		112.5%	116.6%	149.5%	-35.4%			
2005 UWMP			101.7%	128.1%	-23.4%	-19.4%	-20.4%	
2010 UWMP				125.4%	-21.4%	-16.6%	-17.3%	-18.5%

The 2015 UWMP indicates the service area is “a predominately single and multi-family residential community” and states “the City is almost completely built-out” and "housing is becoming denser and new residential units are multi-storied" (p. 2-2)

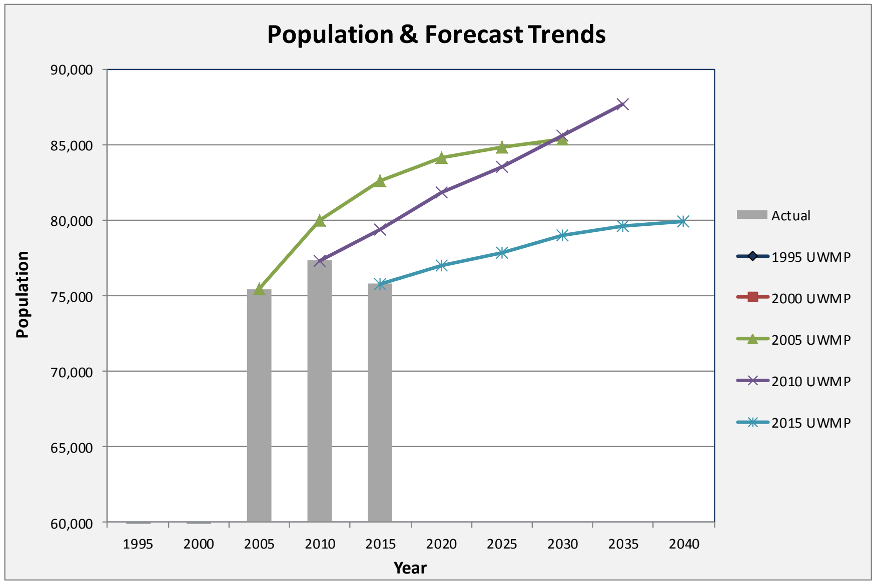
Yorba Linda

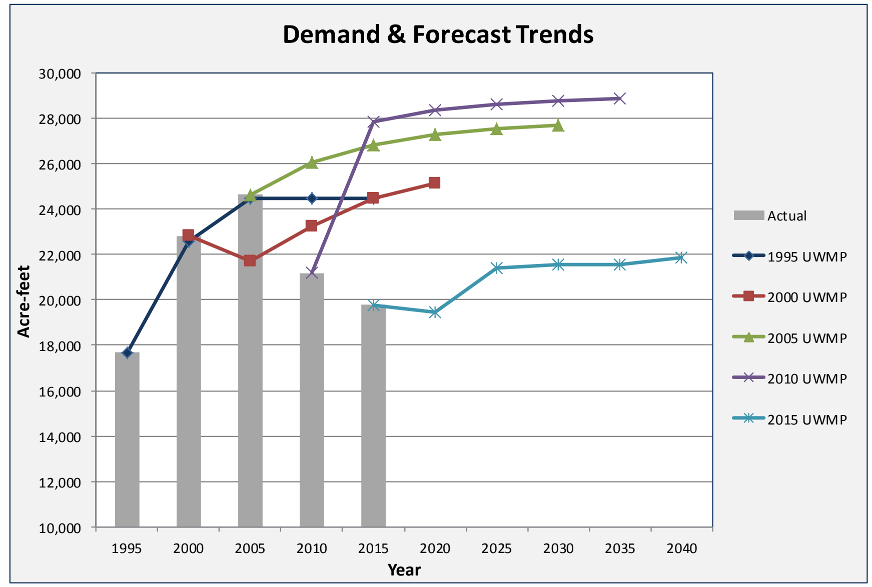
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	NA	NA	75,445	77,320	75,773					
1995 UWMP	NA									
2000 UWMP		NA								
2005 UWMP			75,445	80,007	82,584	84,155	84,860	85,355		
2010 UWMP				77,320	79,391	81,862	83,533	85,604	87,675	
2015 UWMP					75,773	76,998	77,840	78,961	79,640	79,926

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	17,673	22,820	24,631	21,196	19,776					
1995 UWMP	17,673	22,590	24,480	24,480	24,480					
2000 UWMP		22,820	21,690	23,260	24,500	25,140				
2005 UWMP			24,631	26,039	26,838	27,310	27,537	27,680		
2010 UWMP				21,196	27,879	28,384	28,605	28,751	28,895	
2015 UWMP					19,776	19,446	21,410	21,558	21,570	21,852





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	NA	NA	NA	NA				
2000 UWMP		NA	0.0%	0.0%	NA			
2005 UWMP			103.5%	109.0%	-8.5%	-8.3%	-7.5%	
2010 UWMP				104.8%	-5.9%	-6.8%	-7.8%	-9.2%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	99.0%	99.4%	115.5%	123.8%				
2000 UWMP		88.1%	109.7%	123.9%	-22.6%			
2005 UWMP			122.8%	135.7%	-28.8%	-22.3%	-22.1%	
2010 UWMP				141.0%	-31.5%	-25.2%	-25.0%	-25.4%

Yorba Linda’s 1995 and 2000 UWMPs did not contain population figures.

The 2015 UWMP indicates Yorba Linda is "a predominately single and multi-family residential community" and "the District is almost completely built-out." (p. 2-2)

Buena Park

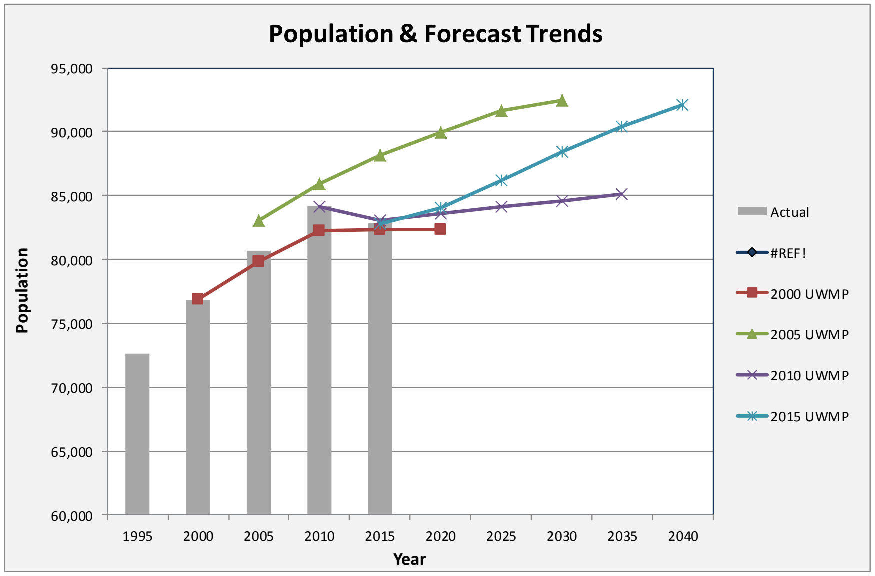
Population
Actual and Forecasted

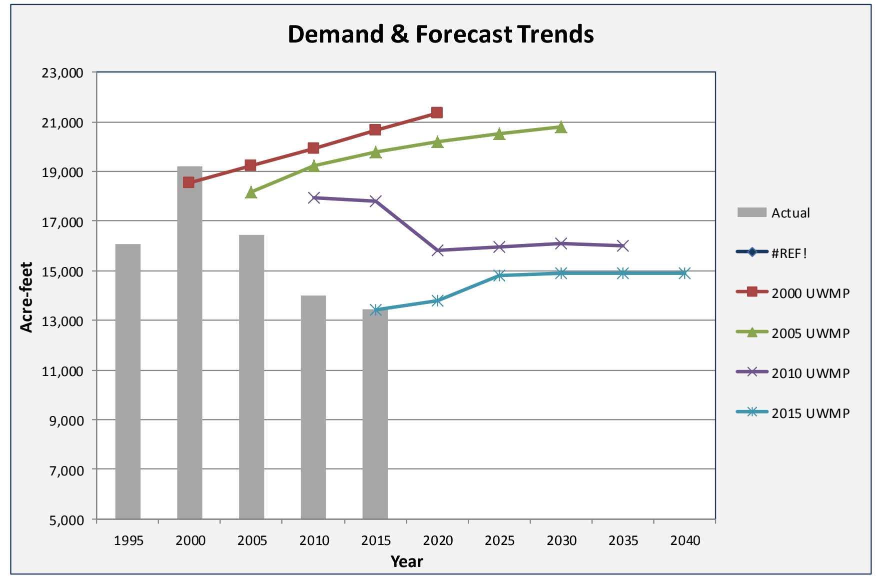
Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	72,610	76,869	80,670	84,141	82,791					
2000 UWMP		76,869	79,859	82,213	82,365	82,315				
2005 UWMP			83,081	85,885	88,134	89,960	91,697	92,481		
2010 UWMP				84,141	83,100	83,600	84,100	84,600	85,100	
2015 UWMP					82,791	84,021	86,159	88,437	90,419	92,110

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	16,050	19,212	16,419	14,019	13,430					
2000 UWMP		18,550	19,245	19,940	20,635	21,330				
2005 UWMP			18,165	19,233	19,760	20,200	20,530	20,798		
2010 UWMP				17,958	17,800	15,820	15,970	16,079	15,984	
2015 UWMP					13,430	13,770	14,782	14,883	14,879	14,900

Buena Park's 2010 UWMP has projections with and without conservation, used figures with conservation





Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	96.1%	97.7%	99.5%	2.1%			
2005 UWMP		102.1%	106.5%	-6.6%	-6.0%	-4.4%	
2010 UWMP			100.4%	0.5%	2.4%	4.5%	6.3%

Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	105.9%	111.0%	153.6%	-35.4%			
2005 UWMP		107.1%	147.1%	-31.8%	-28.0%	-28.4%	
2010 UWMP			132.5%	-13.0%	-7.4%	-7.4%	-6.9%

A 1995 UWMP was not available for Buena Park.

The 2015 UWMP describes the Buena Park service area as “a predominately single and multi-family residential community” and stated “housing is becoming denser and new residential units are multi-storied” and “the City is almost completely built-out" (p 2-2)

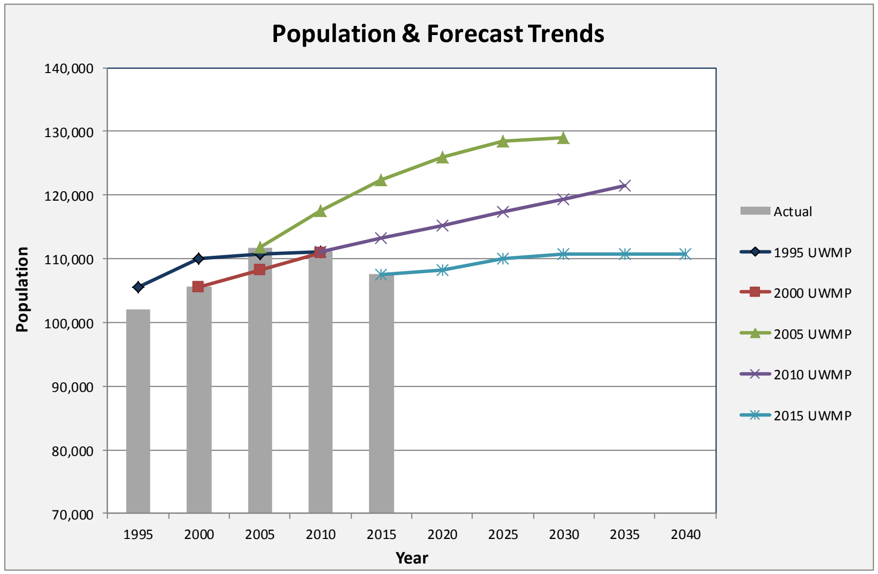
Mesa

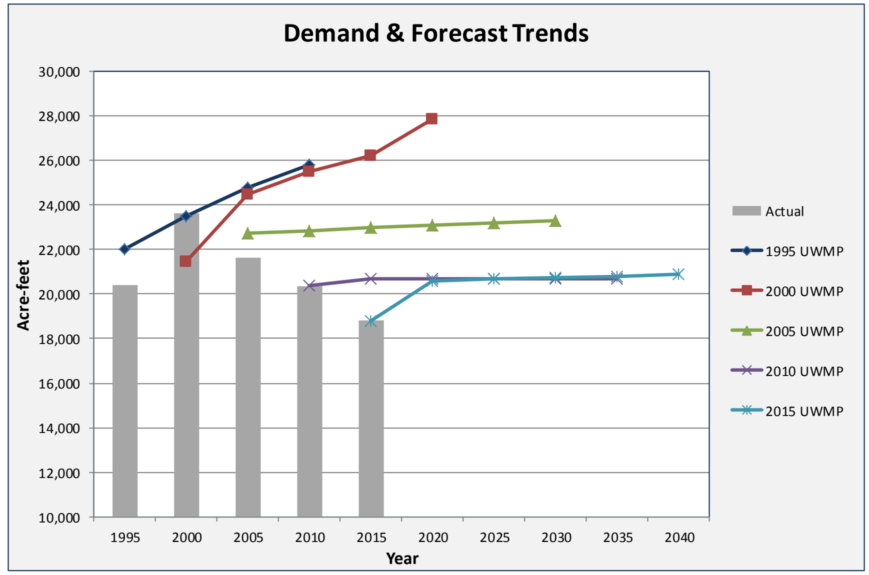
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	102,095	105,608	111,737	111,166	107,588					
1995 UWMP	105,600	110,100	110,700	111,100						
2000 UWMP		105,608	108,300	110,994						
2005 UWMP			111,737	117,492	122,301	125,952	128,483	129,098		
2010 UWMP				111,166	113,218	115,270	117,322	119,374	121,426	
2015 UWMP					107,588	108,186	109,971	110,805	110,774	110,675

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	20,406	23,610	21,620	20,370	18,802					
1995 UWMP	22,000	23,500	24,800	25,800						
2000 UWMP		21,478	24,471	25,489	26,213	27,851				
2005 UWMP			22,724	22,862	22,966	23,081	23,195	23,297		
2010 UWMP				20,370	20,685	20,685	20,685	20,685	20,685	
2015 UWMP					18,802	20,610	20,676	20,742	20,809	20,874





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	104.3%	NA	99.9%					
2000 UWMP		96.9%	99.8%					
2005 UWMP			105.7%	113.7%	-14.1%	-14.4%	-14.2%	
2010 UWMP				105.2%	-6.1%	-6.3%	-7.2%	-8.8%

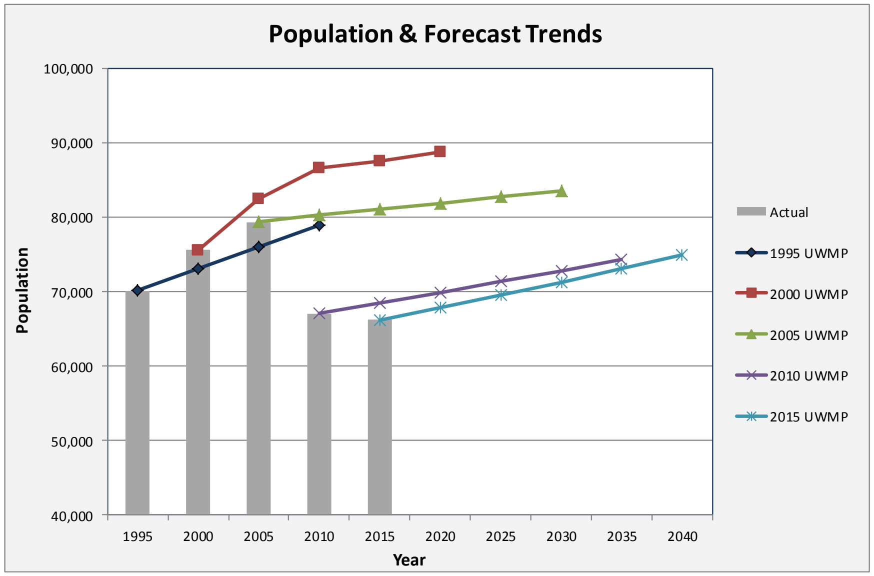
	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	109.4%	109.1%	126.7%					
2000 UWMP		107.7%	125.1%	139.4%	-26.0%			
2005 UWMP			112.2%	122.1%	-10.7%	-10.9%	-11.0%	
2010 UWMP				110.0%	-0.4%	0.0%	0.3%	0.6%

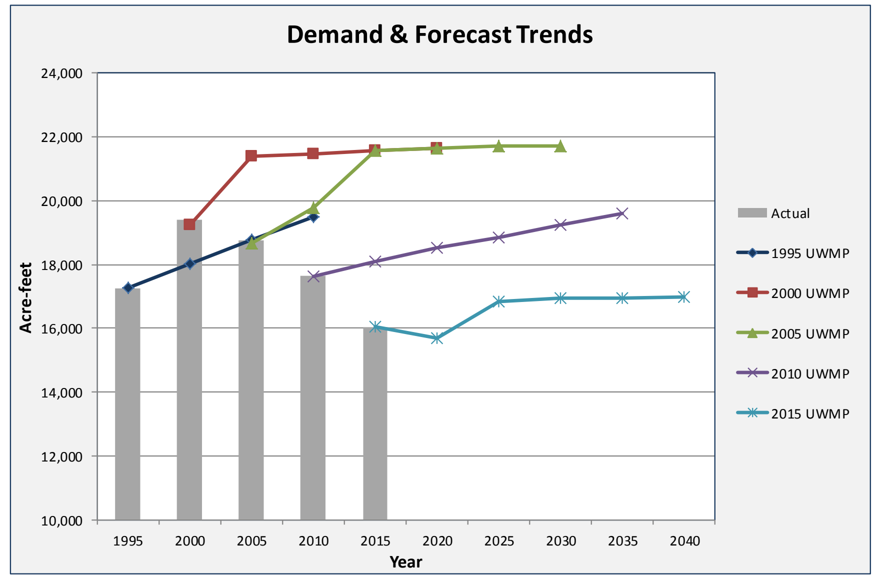
The 2015 UWMP indicate Mesa's service area is a "predominately residential single and multifamily community" (p. 2-2)

Newport Beach

Population Actual and Forecasted										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	70,098	75,600	79,320	67,030	66,219					
1995 UWMP	70,098	73,023	75,948	78,880						
2000 UWMP		75,600	82,409	86,579	87,457	88,676				
2005 UWMP			79,320	80,250	81,052	81,863	82,681	83,508		
2010 UWMP				67,030	68,478	69,926	71,375	72,823	74,271	
2015 UWMP					66,219	67,874	69,571	71,311	73,093	74,921

Demand Actual and Forecasted (AF)										
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Actual	17,254	19,402	18,756	17,635	16,033					
1995 UWMP	17,254	18,004	18,754	19,504						
2000 UWMP		19,235	21,400	21,475	21,550	21,625				
2005 UWMP			18,648	19,791	21,555	21,640	21,716	21,716		
2010 UWMP				17,635	18,101	18,504	18,859	19,223	19,582	
2015 UWMP					16,033	15,685	16,838	16,953	16,944	16,973





Predicted Compared to Subsequent Actual Population					Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	96.6%	NA	117.7%					
2000 UWMP		103.9%	129.2%	132.1%	-23.5%			
2005 UWMP			119.7%	122.4%	-17.1%	-15.9%	-14.6%	
2010 UWMP				103.4%	-2.9%	-2.5%	-2.1%	-1.6%

Predicted Compared to Subsequent Actual Demand					Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	93.6%	100.6%	110.6%	0.0%				
2000 UWMP		114.8%	121.8%	134.4%	-27.5%			
2005 UWMP			112.2%	134.4%	-27.5%	-22.5%	-21.9%	
2010 UWMP				112.9%	-15.2%	-10.7%	-11.8%	-13.5%

The 2015 UWMP states Newport Beach is a "predominately residential single and multi-family community located" and "housing is becoming denser and new residential units are multi-storied. Additional growth within the City will be limited development areas are at their ultimate build-out density. There is one large proposed development of the 401-acre Newport Banning Ranch that would bring residential and commercial units into the City’s Coastal Zone in a previously undeveloped area. The project has been revised several times since 2010 but has not received approval at this time." (p 2-2)

Tustin

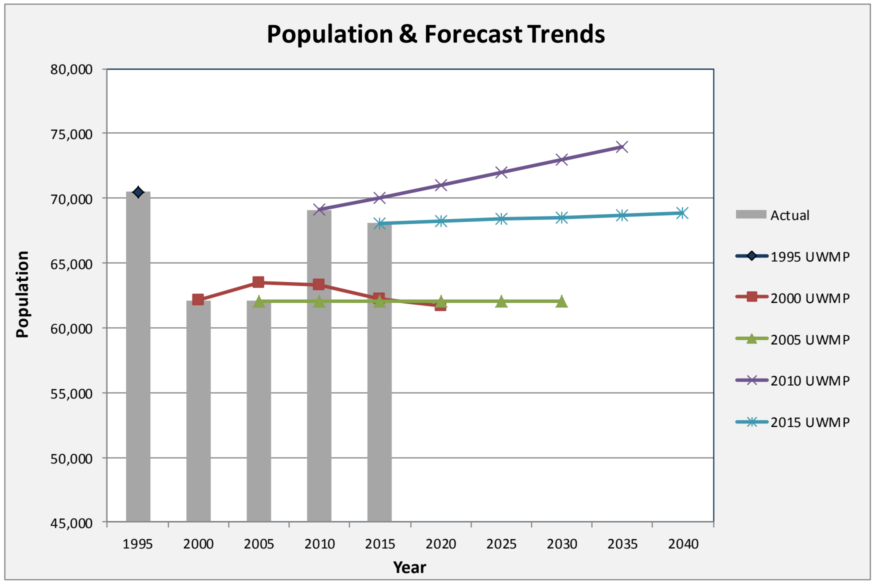
Population
Actual and Forecasted

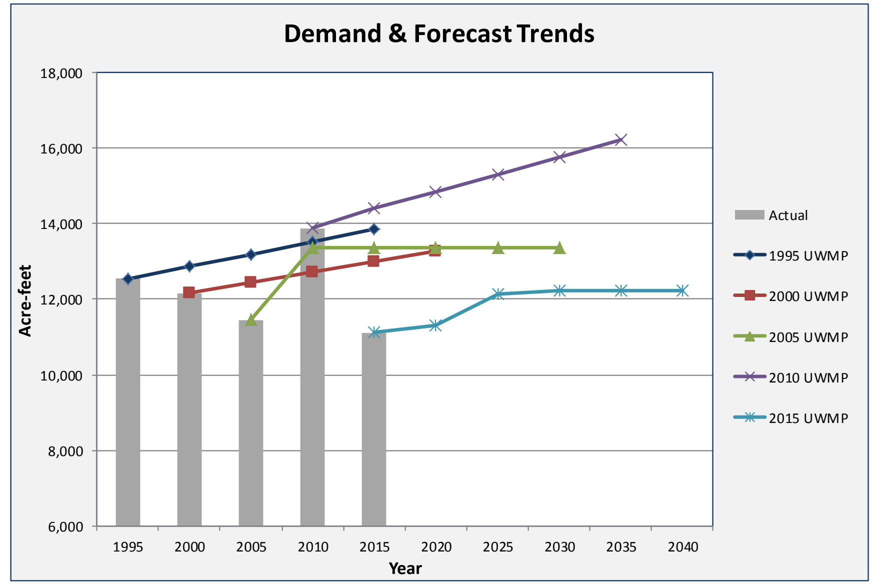
Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	70,500	62,131	62,100	69,100	68,088					
1995 UWMP	70,500									
2000 UWMP		62,131	63,471	63,354	62,259	61,739				
2005 UWMP			62,100	62,100	62,100	62,100	62,100	62,100		
2010 UWMP				69,100	69,999	70,987	71,976	72,964	73,953	
2015 UWMP					68,088	68,238	68,388	68,538	68,669	68,840

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	12,547	12,166	11,449	13,884	11,113					
1995 UWMP	12,547	12,860	13,180	13,510	13,850					
2000 UWMP		12,166	12,429	12,705	12,989	13,282				
2005 UWMP			11,449	13,370	13,370	13,370	13,370	13,370		
2010 UWMP				13,884	14,418	14,851	15,296	15,755	16,227	
2015 UWMP					11,113	11,310	12,141	12,224	12,221	12,238

2000 UWMP figures include conservation





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	100.2%	NA						
2000 UWMP		102.2%	91.7%	88.9%	15.0%			
2005 UWMP			89.9%	91.2%	9.9%	10.1%	10.4%	
2010 UWMP				102.8%	-3.9%	-5.0%	-6.1%	-7.1%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	105.7%	115.1%	97.3%	124.6%				
2000 UWMP		108.6%	91.5%	116.9%	-14.8%			
2005 UWMP			96.3%	120.3%	-15.4%	-9.2%	-8.6%	
2010 UWMP				129.7%	-23.8%	-20.6%	-22.4%	-24.7%

The 2015 UWMP describes the Tustin service area as "a predominately single and multi-family residential community" and states "the City’s water service area is essentially built-out" and "housing is becoming denser and new residential units are multi-storied" (p 2-2)

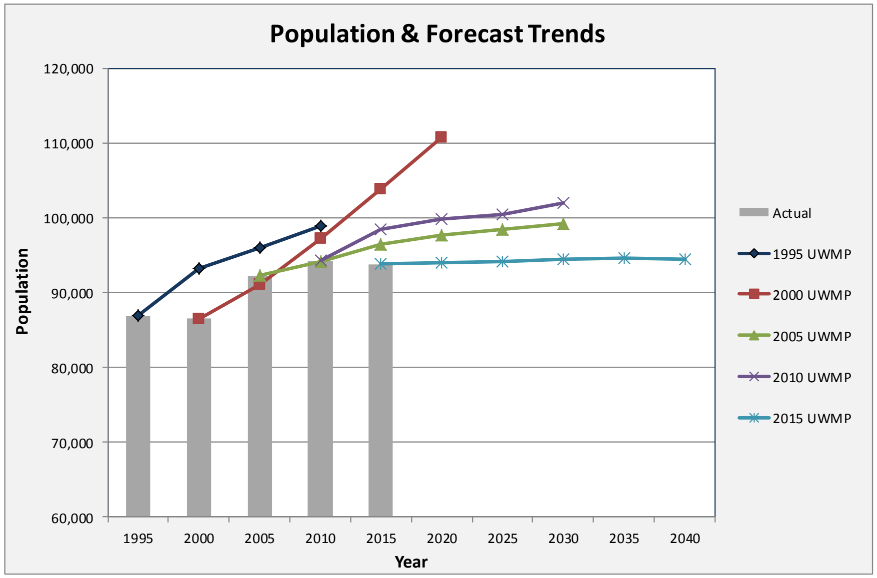
Westminster

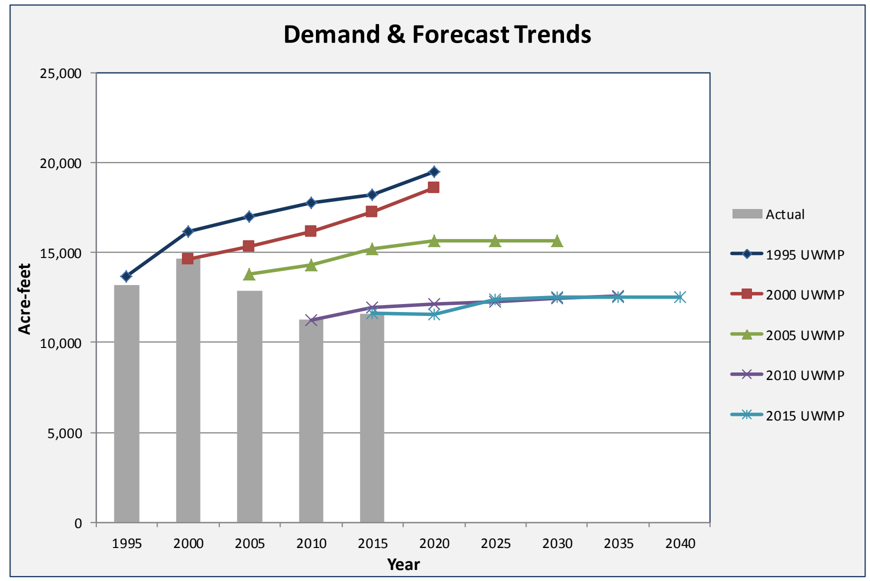
Population — Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	86,889	86,495	92,270	94,294	93,785					
1995 UWMP	86,889	93,212	96,062	98,912						
2000 UWMP		86,495	91,117	97,244	103,782	110,775				
2005 UWMP			92,270	94,226	96,409	97,717	98,458	99,291		
2010 UWMP				94,294	98,384	99,793	100,496	102,018		
2015 UWMP					93,785	94,009	94,118	94,398	94,624	94,531

Demand — Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	13,176	14,668	12,882	11,271	11,622					
1995 UWMP	13,679	16,200	17,000	17,800	18,250	19,500				
2000 UWMP		14,668	15,343	16,203	17,280	18,613				
2005 UWMP			13,810	14,290	15,223	15,666	15,664	15,663		
2010 UWMP				11,271	11,976	12,126	12,278	12,443	12,589	
2015 UWMP					11,622	11,577	12,427	12,512	12,509	12,527





	Predicted Compared to Subsequent Actual Population				Change in 2015 Forecasts Compared to Previous UWMPs		
1995 UWMP	107.8%	NA	104.9%	0.0%			
2000 UWMP		98.8%	103.1%	110.7%	-15.1%		
2005 UWMP			99.9%	102.8%	-3.8%	-4.4%	-4.9%
2010 UWMP				104.9%	-5.8%	-6.3%	-7.5%

	Predicted Compared to Subsequent Actual Demand				Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	110.4%	123.1%	157.9%	157.0%				
2000 UWMP		111.1%	143.8%	148.7%	-37.8%			
2005 UWMP			126.8%	131.0%	-26.1%	-20.7%	-20.1%	
2010 UWMP				103.0%	-4.5%	1.2%	0.6%	-0.6%

The 2015 UWMP describes the Westminster service area as "a predominately single and multi-family residential community" and states "the City is almost completely built-out" and "housing is becoming denser and new residential units are multi-storied." (p 2-2)"

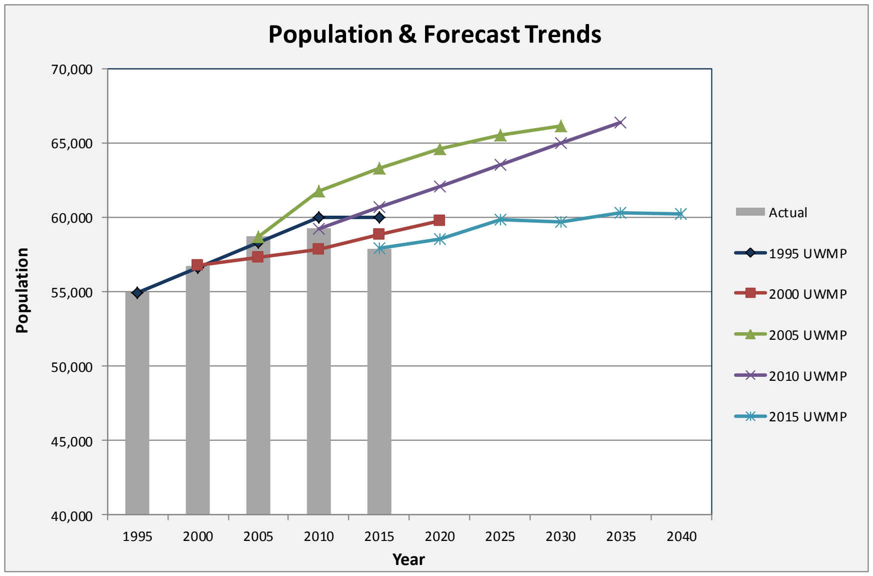
Fountain Valley

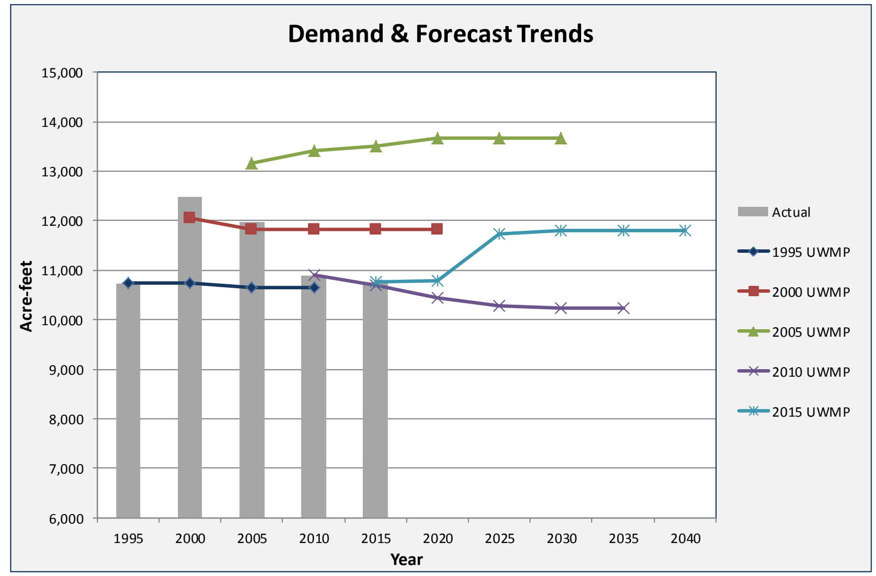
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	54,932	56,753	58,692	59,227	57,908					
1995 UWMP	54,932	56,577	58,272	60,017	60,017					
2000 UWMP		56,753	57,269	57,811	58,836	59,735				
2005 UWMP			58,692	61,758	63,318	64,567	65,490	66,107		
2010 UWMP				59,227	60,658	62,088	63,519	64,949	66,380	
2015 UWMP					57,908	58,569	59,802	59,678	60,272	60,210

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	10,730	12,485	11,962	10,900	10,755					
1995 UWMP	10,730	10,750	10,650	10,650						
2000 UWMP		12,048	11,819	11,819	11,819	11,819				
2005 UWMP			13,160	13,410	13,510	13,660	13,660	13,660		
2010 UWMP				10,900	10,695	10,440	10,280	10,240	10,230	
2015 UWMP					10,755	10,778	11,741	11,800	11,800	11,800





Predicted Compared to Subsequent Actual Population / **Change in 2015 Forecasts Compared to Previous UWMPs**

1995 UWMP	99.7%	NA	101.3%	103.6%				
2000 UWMP		97.6%	97.6%	101.6%	-2.0%			
2005 UWMP			104.3%	109.3%	-9.3%	-8.7%	-9.7%	
2010 UWMP				104.7%	-5.7%	-5.9%	-8.1%	-9.2%

Predicted Compared to Subsequent Actual Demand / **Change in 2015 Demand Forecasts Compared to Previous UWMPs**

1995 UWMP	89.2%	80.9%	97.7%	0.0%				
2000 UWMP		89.8%	108.4%	109.9%	-8.8%			
2005 UWMP			123.0%	125.6%	-21.1%	-14.0%	-13.6%	
2010 UWMP				99.4%	3.2%	14.2%	15.2%	15.3%

The 2015 UWMP describes the service area as "a predominately single and multi-family residential community" and states "the City is almost completely built-out" and "housing is becoming denser and new residential units are multi-storied" (p 2-2)

Seal Beach

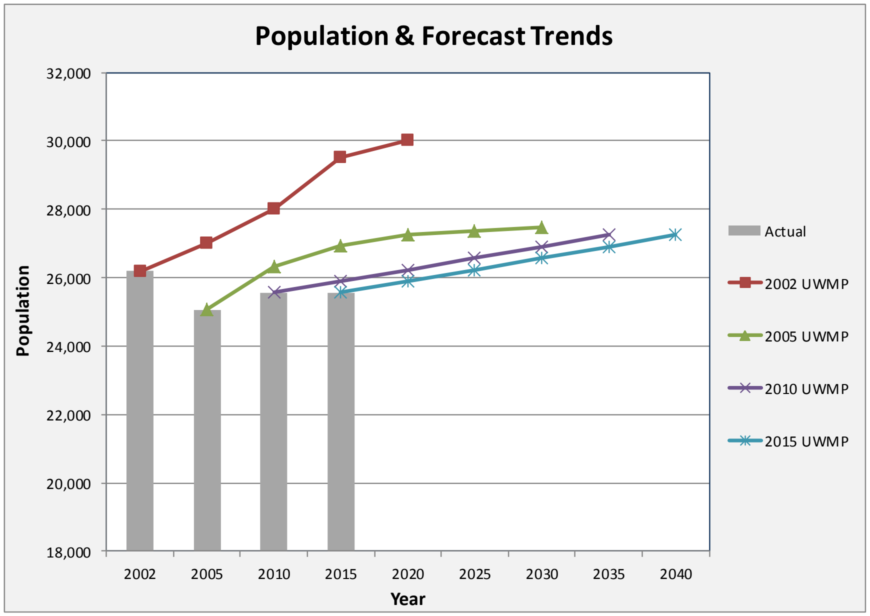
Population
Actual and Forecasted

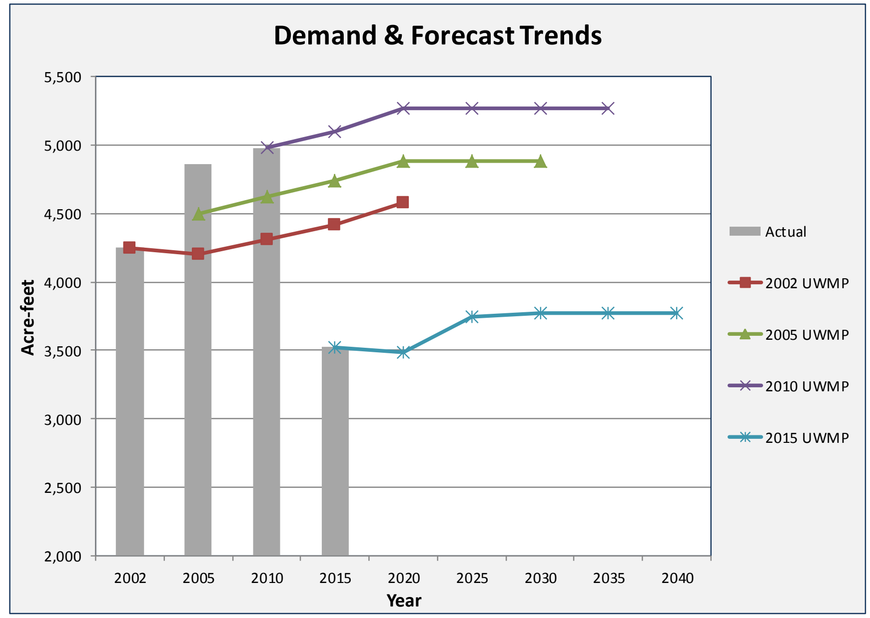
Year	2002	2005	2010	2015	2020	2025	2030	2035	2040
Actual	26,200	25,058	25,561	25,561					
2002 UWMP	26,200	27,000	28,000	29,500	30,000				
2005 UWMP		25,058	26,335	26,922	27,245	27,350	27,471		
2010 UWMP			25,561	25,895	26,223	26,570	26,906	27,242	
2015 UWMP				25,561	25,897	26,223	26,570	26,906	27,242

Demand
Actual and Forecasted (AF)

Year	2002	2005	2010	2015	2020	2025	2030	2035	2040
Actual	4,249	4,860	4,979	3,521					
2002 UWMP	4,249	4,200	4,310	4,420	4,580				
2005 UWMP		4,500	4,622	4,737	4,880	4,880	4,880		
2010 UWMP			4,979	5,098	5,270	5,270	5,270	5,270	
2015 UWMP				3,521	3,488	3,744	3,770	3,769	3,774

For 2005 and 2015 UWMPs losses not indicated, unkown if included in figures above





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
2000 UWMP	107.8%	109.5%	115.4%	-13.7%			
2005 UWMP		103.0%	105.3%	-4.9%	-4.1%	-3.3%	
2010 UWMP			101.3%	-1.2%	-1.3%	-1.2%	-1.2%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2000 UWMP	93.3%	86.6%	125.5%	-23.8%			
2005 UWMP		92.8%	134.5%	-28.5%	-23.3%	-22.7%	
2010 UWMP			144.8%	-33.8%	-29.0%	-28.5%	-28.5%

A 1995 UWMP was not available for Seal Beach. The 2015 UWMP indicate Seal Beach is a “"a predominately single and multi-family residential community" and states, "The City is almost completely built-out” and "housing is becoming denser and new residential units are multi-storied. A single new development within the City is moving forward on the last available piece of ocean front property. On September 9, 2015 the California Coastal Commission (CCC) approved the Ocean Place development for 28 single family residences and four overnight accommodations." (p 2-2)

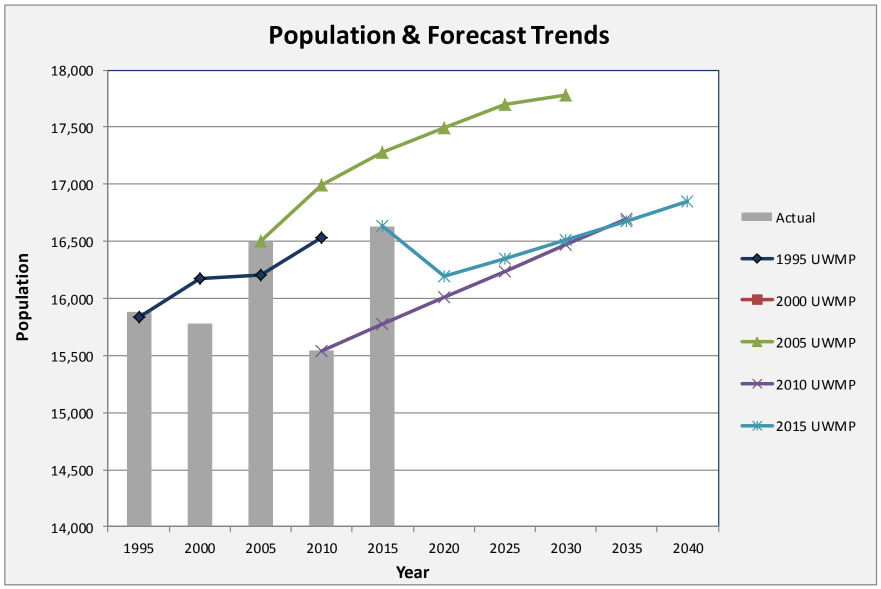
La Palma

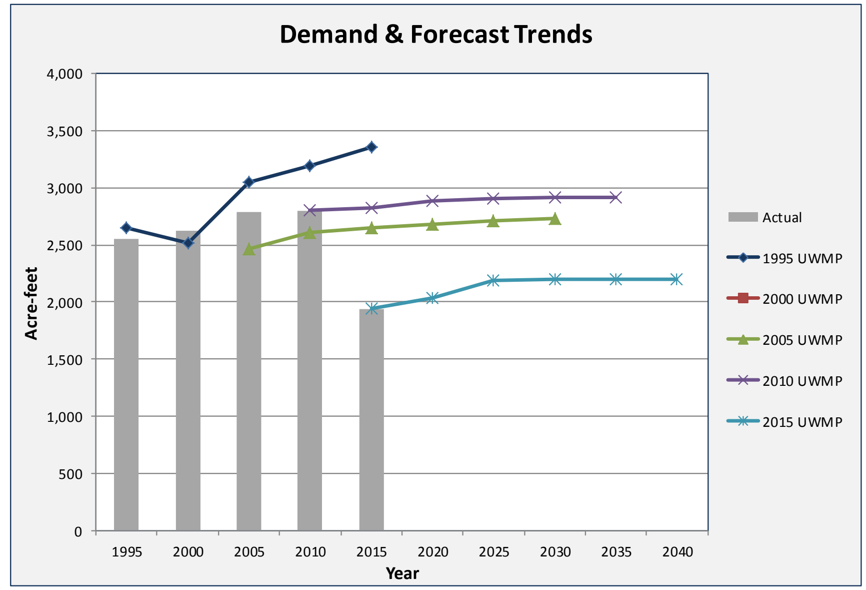
Population
Actual and Forecasted

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	15,885	15,778	16,499	15,544	16,630					
1995 UWMP	15,840	16,177	16,207	16,535						
2000 UWMP										
2005 UWMP			16,499	16,998	17,279	17,496	17,701	17,785		
2010 UWMP				15,544	15,775	16,006	16,237	16,468	16,699	
2015 UWMP					16,630	16,190	16,352	16,516	16,681	16,848

Demand
Actual and Forecasted (AF)

Year	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	2,557	2,627	2,792	2,803	1,940					
1995 UWMP	2,645	2,518	3,044	3,196	3,356					
2000 UWMP										
2005 UWMP			2,468	2,607	2,650	2,684	2,715	2,728		
2010 UWMP				2,803	2,821	2,884	2,903	2,917	2,917	
2015 UWMP					1,940	2,036	2,186	2,201	2,200	2,204





	Predicted Compared to Subsequent Actual Population			Change in 2015 Forecasts Compared to Previous UWMPs			
1995 UWMP	NA	106.4%					
2000 UWMP		NA					
2005 UWMP		109.4%	103.9%	-7.5%	-7.6%	-7.1%	
2010 UWMP			94.9%	1.1%	0.7%	0.3%	-0.1%

	Predicted Compared to Subsequent Actual Demand			Change in 2015 Demand Forecasts Compared to Previous UWMPs			
1995 UWMP	123.3%	114.0%	173.0%				
2000 UWMP	NA						
2005 UWMP		93.0%	136.6%	-24.1%	-19.5%	-19.3%	
2010 UWMP			145.4%	-29.4%	-24.7%	-24.5%	-24.6%

A 2000 UWMP was not available. Actual population and demand figures for 1995 and 2000 are from the 2005 UWMP.

The 2015 UWMP describes the service area as “"predominately single and multi-family residential community" and “the City is almost completely built-out.” (p 2-2)

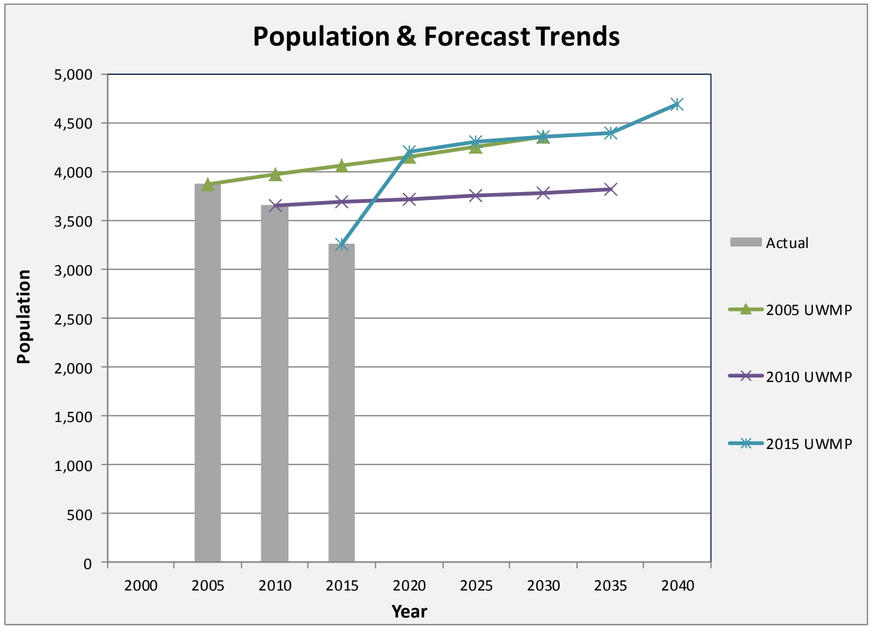
East OCWD

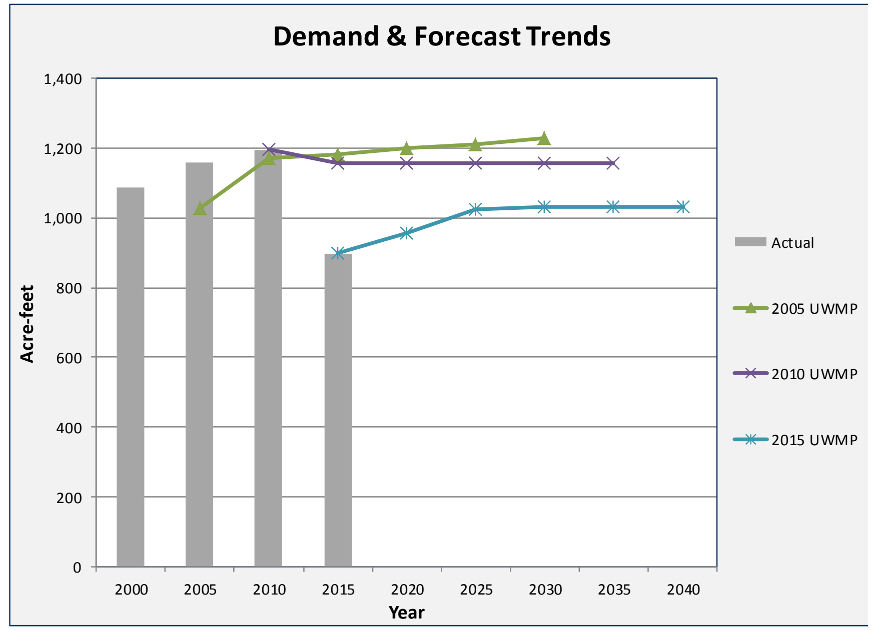
Population
Actual and Forecasted

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual		3,872	3,656	3,257					
2005 UWMP		3,872	3,970	4,060	4,150	4,250	4,350		
2010 UWMP			3,656	3,688	3,720	3,752	3,784	3,816	
2015 UWMP				3,257	4,200	4,300	4,350	4,400	4,686

Demand
Actual and Forecasted (AF)

Year	2000	2005	2010	2015	2020	2025	2030	2035	2040
Actual	1,087	1,160	1,196	897					
2005 UWMP		1,026	1,170	1,180	1,200	1,210	1,230		
2010 UWMP			1,196	1,155	1,155	1,155	1,155	1,155	
2015 UWMP				897	955	1,025	1,032	1,032	1,033





	Predicted Compared to Subsequent Actual Population		Change in 2015 Forecasts Compared to Previous UWMPs			
2005 UWMP	108.6%	124.7%	1.2%	1.2%	0.0%	
2010 UWMP		113.2%	12.9%	14.6%	15.0%	15.3%

	Predicted Compared to Subsequent Actual Demand		Change in 2015 Demand Forecasts Compared to Previous UWMPs			
2005 UWMP	97.8%	131.5%	-20.4%	-15.3%	-16.1%	
2010 UWMP		128.8%	-17.3%	-11.3%	-10.6%	-10.6%

UWMPs for 1995 and 2000 were not available.

The year 2000 actual demand is from the 2005 UWMP.

The 2015 UWMP indicates , “the District’s Retail Zone can best be described as a predominately single and multi-family residential” and “the District is almost built-out with few remaining vacant lots community' (p 2-2, 2-3)

Endnotes

[1] Orange County Water District. "Long-Term Financial Plan 2014 Update." p 2-2.
[2] Ibid. p 2-2.
[3] Ibid, p 2-2.
[4] Ibid, p 2-3.
[5] Municipal Water District of Orange County. Orange County Reliability Study "Final Technical Memorandum #1, by CDM Smith." Table 7, p. 14. John Kennedy, OCWD Executive Director of Engineering and Water Resources, confirmed the comparison of demand forecasts is using the same retailer boundaries, including the 70%/30% boundary split for the Irvine Ranch Water District, in a phone communication with Joe Geever, July 26, 2016.
[6] Metropolitan Water District of Southern California. "Potential regional Recycled Water Program." Water Planning & Stewardship Committee, Item 9-1. September 21, 2015. Slide 16.
John Kennedy, OCWD Executive Director of Engineering and Water Resources, in a personal phone communication with Joe Geever confirmed the 65,000 AFY of new indirect potable recycled water expected to become available to OCWD. July 26, 2016.
[7] Metropolitan Water District of Southern California and Sanitation Districts of Los Angeles County. "Regional Recycled Water Supply Program"
[8] Metropolitan Water District of Southern California. Board of Directors, Water Planning and Stewardship Committee, Item 8-3. November 11, 2015. p. 1.
[9] MWDOC. Reliability Study "Draft Technical Memorandum #4, by CDM Smith." Table 3. June 27, 2016. p. 9.
[10] Reliability Study, Technical Memo #1. p. 1.
[11] Ibid. p. 5.
[12] Ibid. p. 7.
[13] Ibid. p. 7.
[14] Ibid. p. 9, 10, 11.
[15] Fryer, James. "An Assessment of Demand Elasticity during Drought." 2013, revised 2016. See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.
[16] Reliability Study, Technical Memo #1. p. 6.
[17] Ibid. p. 7.
[18] California State Water Resources Control Board. "suppliercompliance_020216"
http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml#monthly_archive
[19] Reliability Study, Technical Memo #1. p. 9.
[20] Fryer, James. "An Assessment of Demand Elasticity during Drought." 2013, revised 2016. p. III-14, F-6.
[21] Ibid
[22] Ibid. See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.
[23] Reliability Study, Technical Memo #4, p. 17 and 31.
[24] Reliability Study, Technical Memo #1., p. 7.
[25] Fryer, James. "Demand Elasticity During a Drought - How Long-Term Conservation Programs Can Offset Demand Hardening During Droughts, and How to Integrate This Into Supply Reliability Planning." Conserv99 Proceedings. 1999. p. 2 and 3.
[26] "An Assessment of Demand Elasticity during Drought" p. A-9.
[27] "An Assessment of Demand Elasticity during Drought" p. III-13.
[28] "An Assessment of Demand Elasticity during Drought" See phone survey question responses in Section V, and in particular Question 7 starting on page V-11, and Question 15 starting on page V-27.

[29] Reliability Study, Technical Memo #1, Figure 6, p. 7.

[30] The Semmelweis Reflex is a metaphor for the reflex-like tendency of rejecting new information or evidence without serious consideration because it contradicts with preconceived beliefs and prevailing norms or paradigms at the time. The metaphor refers to the professional experiences of Dr. Ignaz Semmelweis (1818 – 1865) who developed empirical evidence that childbirth patients handled by doctors that carefully washed their hands in a chlorine solution between patients and after an autopsy experienced a dramatically reduced rate of infectious disease. At the cost of many lives, Dr. Semmelweis' evidence was widely rejected by doctors at the time because germ theory was not understood until several decades later so no exact mechanism could be described, other theories of disease prevailed, and many doctors were offended and scoffed at the idea that a gentleman's hands could communicate disease.
See:
https://en.wikipedia.org/wiki/Semmelweis_reflex
https://en.wikipedia.org/wiki/Ignaz_Semmelweis

[31] Fishman, Charles. "How California is Winning the Drought." The New York Times, August 14, 2015.

[32] "An Assessment of Demand Elasticity during Drought" p. IV-4.

[33] Ibid. p. IV-6.

[34] Ibid. p. VI-8, VI-9.

[35] Ibid. p. VI-9.

[36] Ibid, p. VI-5.

[37] Reliability Study, Technical Memo #1, p. 6.

[38] Municipal Water District of Southern California. "2015 Urban Water Management Plan." p. 2-3.

[39] "An Assessment of Demand Elasticity during Drought" p. VI-9.

[40] Reliability Study, Technical Memo #1, p. 4, 5.

[41] "An Assessment of Demand Elasticity during Drought." See Section VIII, "Trends in the Marginal Price of Water," starting on page VIII-1.

[42] Reliability Study, Technical Memo #4, p. 30.

[43] Crouch, Dennis. Law Professor at the University of Missouri School of Law. Co-director of the Center for Intellectual Property and Entrepreneurship. "Tracing the Quote: Everything that can be Invented has been Invented." January 6, 2011Dennis Crouch
http://patentlyo.com/patent/2011/01/tracing-the-quote-everything-that-can-be-invented-has-been-invented.html

[44] "The Friend" Volume 76, 1902, as quoted in Wikipedia, https://en.wikipedia.org/wiki/Charles_Holland_Duell)