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# Demand Hardening: Assessing Potential Impacts with End Use Models

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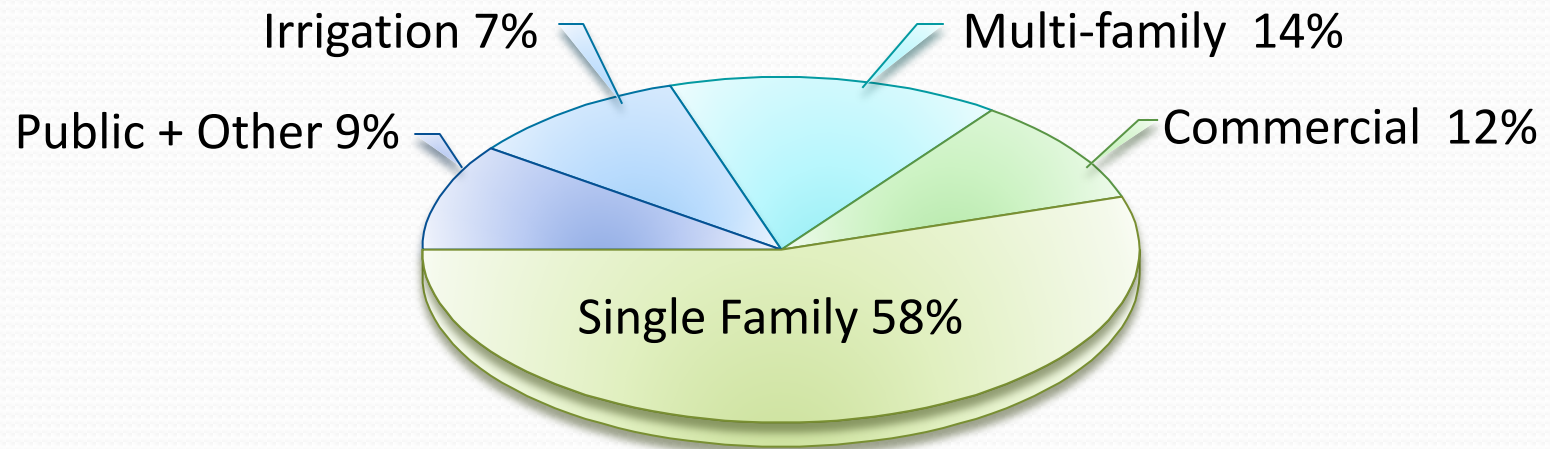
# Demand Hardening – Why Care?

- Important issue for water conservation professionals, water planners, utility managers, drought planners, etc.
- Often used as a critique of long term water conservation efforts.
- Poorly documented and understood.

# Definition of Demand Hardening

Demand Hardening –

As a service area becomes more efficient, it becomes more difficult to reduce customer demand during a shortage or drought.



# Quotes of Demand Hardening

“By saving water, long term conservation can also reduce the water savings potential for short term demand management strategies during water shortages” - Flory and Panella. 1994

“a result of longer term conservation measures...that make it increasingly difficult for the utility to induce further reductions in water use during a drought” - Howe and Goemans. 2007

# From the Definition...

- Demand hardening is only an issue during a supply shortage (drought).
- Demand hardening is only an issue if a portion of conserved water has been used to serve new customers.

# Planning Implications

Since long term conservation savings are achieved by existing customers, it is important that the supply reliability for these existing customers not be negatively impacted as new customers are added to a system.

# Evidence of Demand Hardening

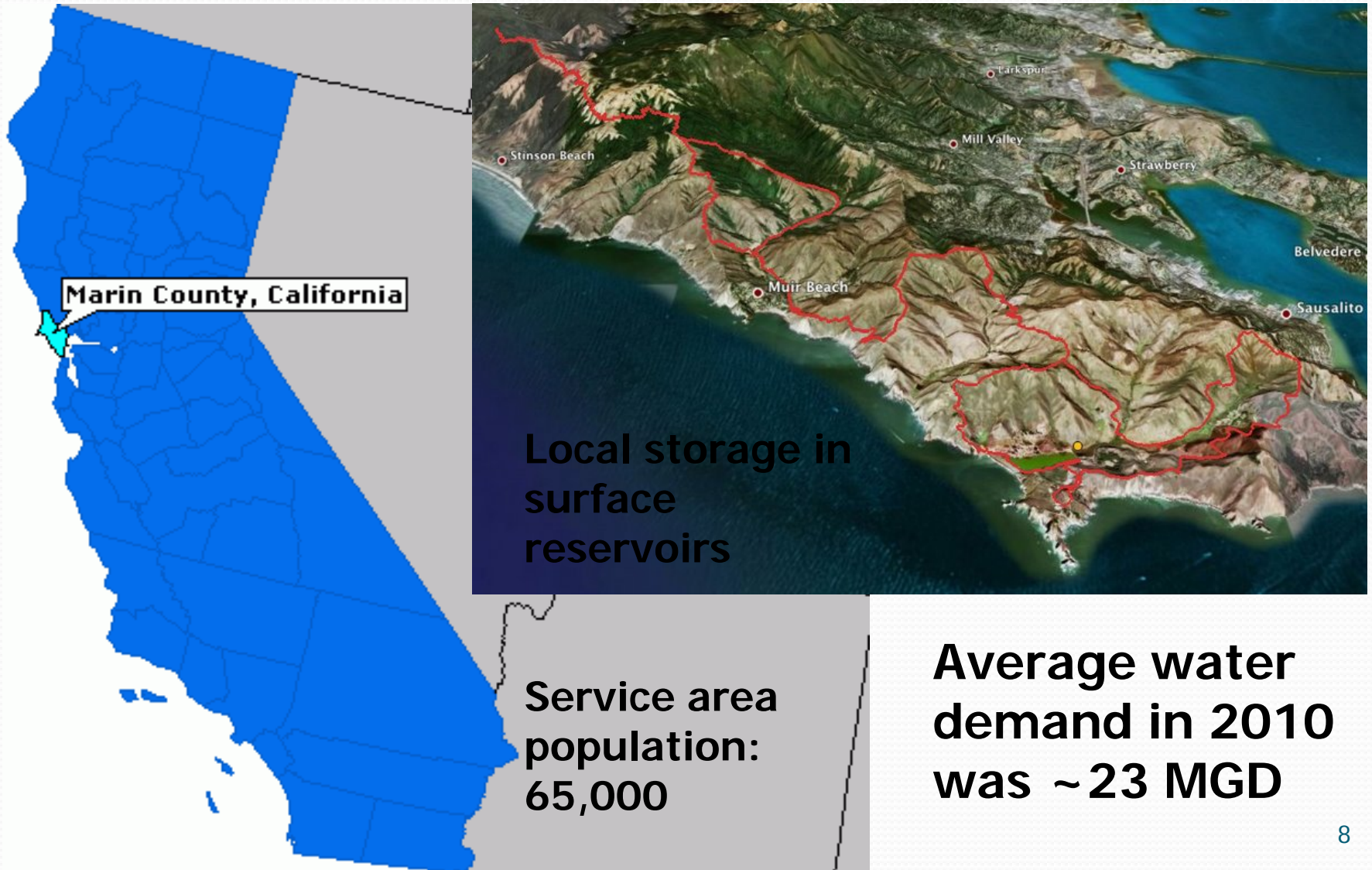
There is little if any documentation in the literature of it ever occurring in Colorado or elsewhere (Mayer and Little. 2006).

Demand hardening could be an issue for water providers in certain situations, but its importance has been overstated (Chesnutt 1997).

Where is the evidence that demand hardening has impacted drought response?



# Case Study: Marin Municipal Water District

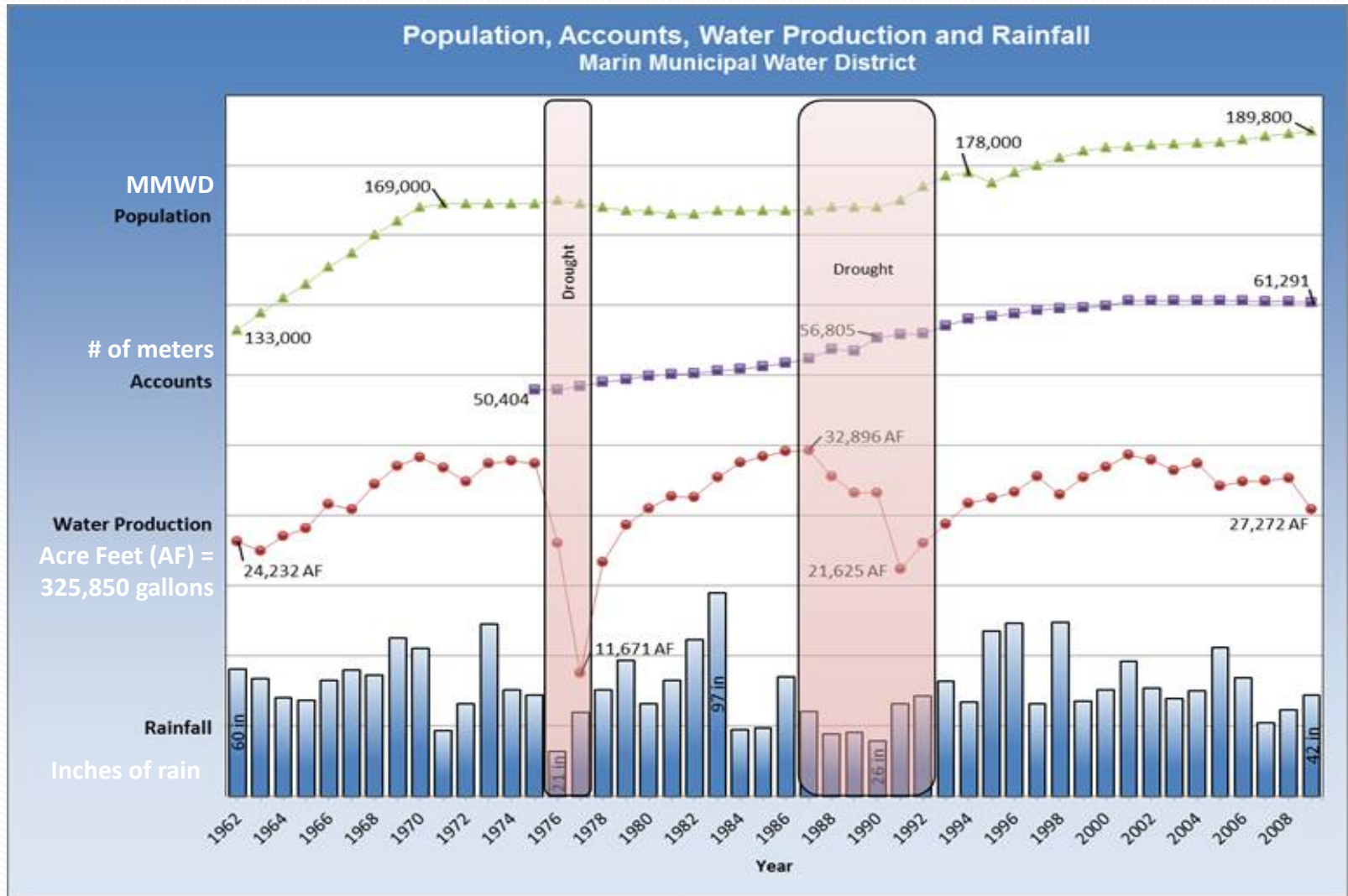


# Project Overview

- ✓ Analyzed 30 Conservation Measures for Marin Municipal Water District (MMWD) Service Area for Conservation Master Plan
- ✓ Constructed and Evaluated Alternative Programs
  - ✓ Long-Term Water Savings
  - ✓ Cost-Effectiveness
- ✓ Analyzed Demand Hardening as a Result of Conservation Programs

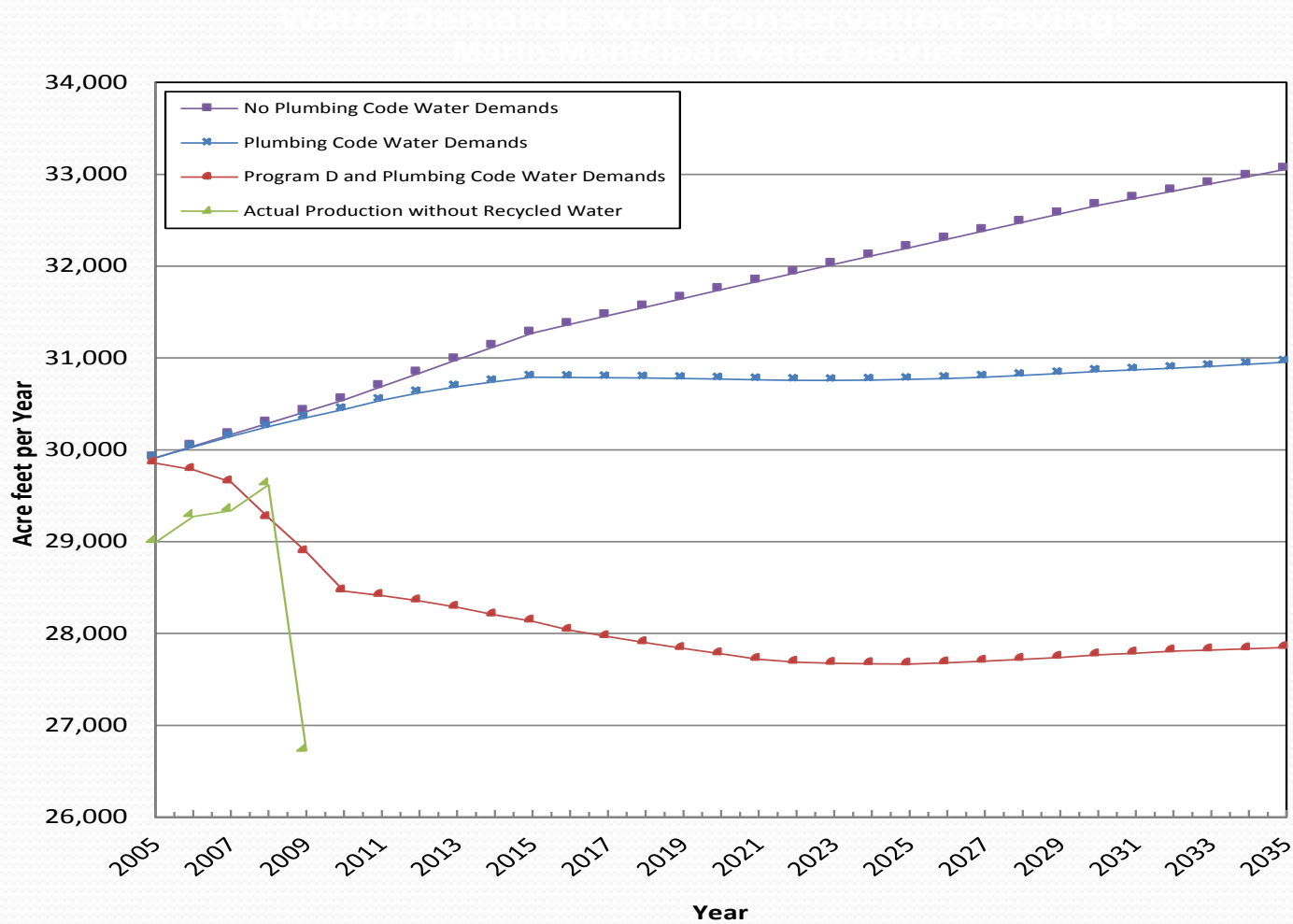


# Historical Context






2010 Production: 25,982 AF/yr      2010 Rainfall: 69.89 inches

# Demands with and w/o Plumbing Code





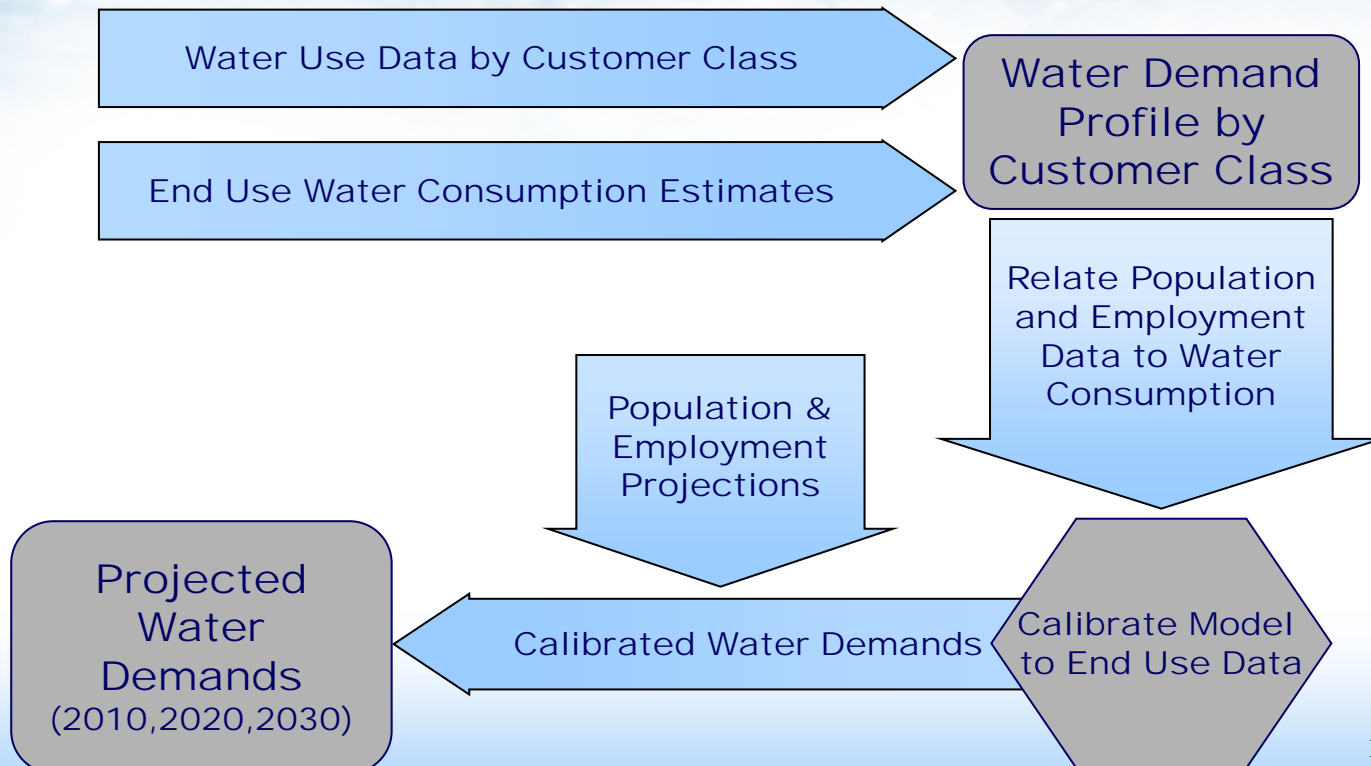
# MMWD Conservation Program D

General Measures	Residential Measures (Indoor)	Commercial Measures (Indoor)	Irrigation Measures (Outdoor)
Public Education	High Efficiency Toilets Rebates	High Efficiency Toilets Rebates	Financial Incentives for Irrigation Upgrades
Water Loss Program	Clothes Washer Rebates	High Efficiency Urinal Rebates	Landscape Requirements New Accounts
New Development MMWD Ordinance 421	Water Use Efficiency Surveys (Audits)	Clothes Washer Rebates	Large Landscape Water Budgets + Audits
		Water Efficiency Surveys (Audits)	Landscape classes for homeowners
		Hotel Retrofit Rebates	
		Efficient Commercial Equipment Rebates	

# DSS Model Overview

## Water Use Data & DSS Modeling

### Least Cost Planning Decision Making System (DSS Model) Process



# MMWD Conservation Program Savings

Program	Description	2030 Program Water Savings, Percent	2030 Water Program Savings + Plumbing Code, Percent
Plumbing Code Only	Non Conservation beyond Plumbing Code	0%	5%
A	Continue Current MMWD Program (Mostly BMPs)	3%	8%
B	Add New Measures to Current Program (low market penetration goal)	7%	12%
C	Add New Measures to Current Program (medium market penetration goal)	9%	14%
D	Add New Measures to Current Program (higher market penetration goal)	11%	16%



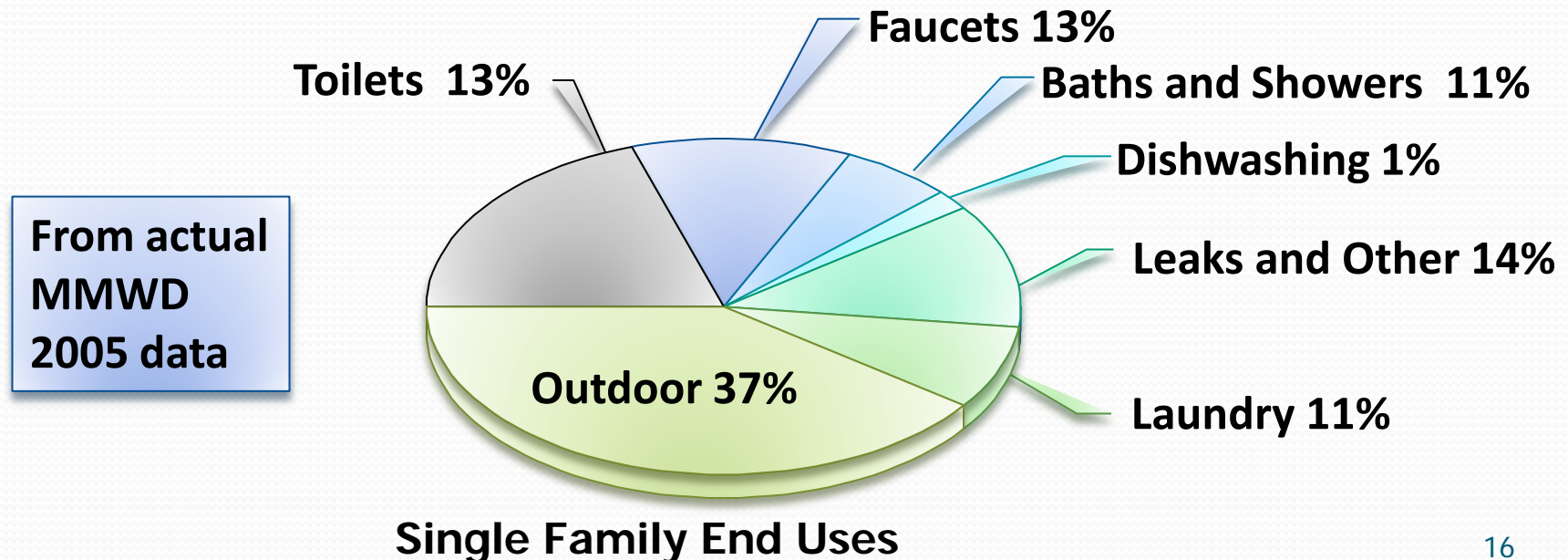
# Demand Hardening Analysis

- Simulating Previously adopted MMWD Drought Ordinance in End Use Model
  - 25% reduction goal
  - 30% reduction goal
  - 40% reduction goal
- Trigger is actual total local reservoir storage on April 1 of each year
- 25% reduction goal is basis of current Integrated Resource Plan



# Demand Hardening Analysis

- Simulating 2 year drought in 2025-2027
- Estimated customer end use reductions with no more than 75% on any one end use



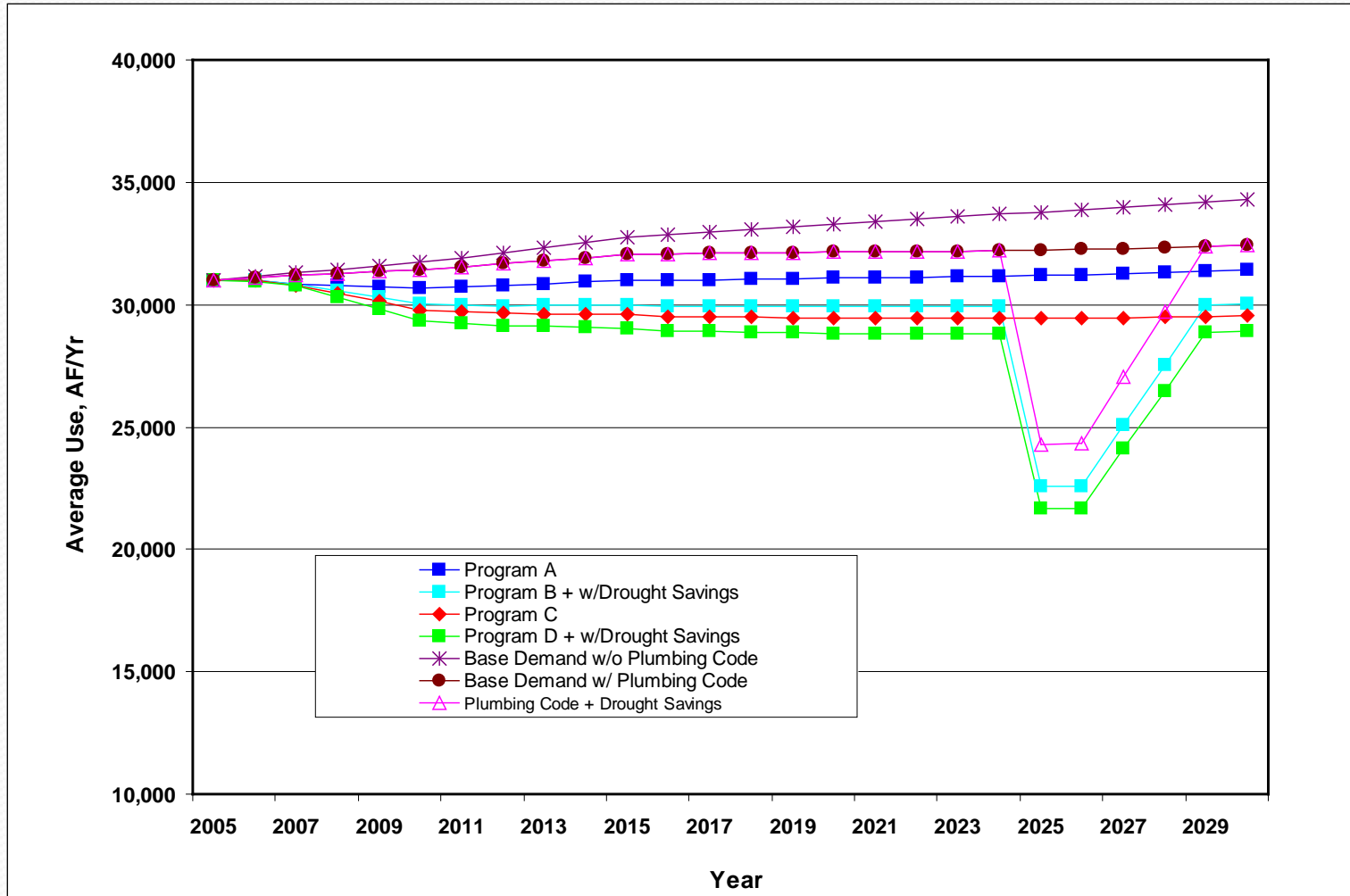
# Demand Hardening End Uses

Customer Category	End Use	Assumed Reduction, %	Assumed Reduction, %	Assumed Reduction, %
		Achieves 25% Reduction	Achieves 30% Reduction	Achieves 40% Reduction
Exist & New Single Family	Toilets	25%	25%	25%
	Baths	50%	50%	75%
	Showers	15%	25%	25%
	Faucets	15%	25%	25%
	Dishwasher	15%	25%	25%
	Laundry	15%	25%	25%
	Other	25%	50%	75%
	Int. Leakage	25%	50%	75%
	Irrigation	50%	50%	65%
	Pools	50%	50%	75%
	Wash-Down	50%	50%	75%
	Ext. Leakage	25%	50%	50%

# Demand Hardening End Uses

Customer Category	End Use	Assumed Reduction, %	Assumed Reduction, %	Assumed Reduction, %
		Achieves 25% Reduction	Achieves 30% Reduction	Achieves 40% Reduction
Commercial	Toilets	15%	15%	25%
	Showers	15%	15%	25%
	Faucets	25%	25%	25%
	Dishwashers	0%	0%	0%
	Laundry	15%	15%	25%
	Urinal	0%	0%	0%
	Hotel-Motel	15%	15%	25%
	Int. leakage	25%	25%	25%
	Irrigation	50%	50%	75%
	Pools/Fountains	50%	50%	50%
	Wash-Down	25%	50%	75%
	Ext. Leakage	25%	50%	50%
Irrigation	Outdoor	50%	50%	75%
Institutional	Toilets	15%	15%	25%
	Process	10%	10%	25%

# Demand Hardening Analysis



# Drought Ordinance Requesting Customer Reduction 25% Total Demand

Scenario	Water Demand % Reduction with code
Plumbing Code Only	24.6%
Program B	22.8%
Program D	22.2%

If a drought happens in the year 2025, and MMWD requests the customers to cut back 25%, and they have been running Program D for a long period, then they would obtain a 22.2% reduction, not 25% due to demand hardening.

# Demand Hardening or Reduction in Effectiveness of Drought Ordinance Combined with Long Term Conservation with Plumbing Code

Scenario	Drought Water Savings (Acre-Feet/Yr)	Decrease in Efficiency of Ordinance in 2025 (Acre-Feet/Yr)	% Reduction in Savings with the plumbing code
No plumbing code	8,448	0	0%
Plumbing Code Only	7,919	529	6.3%
Program B	7,351	917	10.8%
Program D	7,146	1,302	15.4%

# Implications of Demand Hardening

“the existence of demand hardening...does not imply that a utility should ‘oversize’ its systems and ignore wasteful water use by its clients just so it will be easier to cut back when a drought comes along. **System capacity decisions and linked supply reliability should be based on long-term, net-benefit criteria.**”

“to ignore long-term conservation benefits and to build excess water supply capacity simply to facilitate cutbacks during a drought can be highly uneconomic, akin to overfeeding people so that dieting will be easier.”

Howe and Goemans. AWWA Journal, 2007.

# Conclusions

- Demand hardening is a real phenomena, but there are no examples in the literature.
- Demand hardening is only an issue during a supply shortage requiring cutbacks.
- Models indicate that you can analyze the approximate amount of demand hardening from a conservation program. Then you can modify your demand ordinance to ask for a slightly higher reduction from customers.



# Conclusions (Cont.)

- For MMWD Drought Ordinance, we would recommend to ask for a 30% demand reduction, so that the target of 25% demand reduction is obtained.
- Concern about demand hardening is not a sound argument against implementing long-term water conservation.

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