Success Stories in Urban Demand Management During Drought

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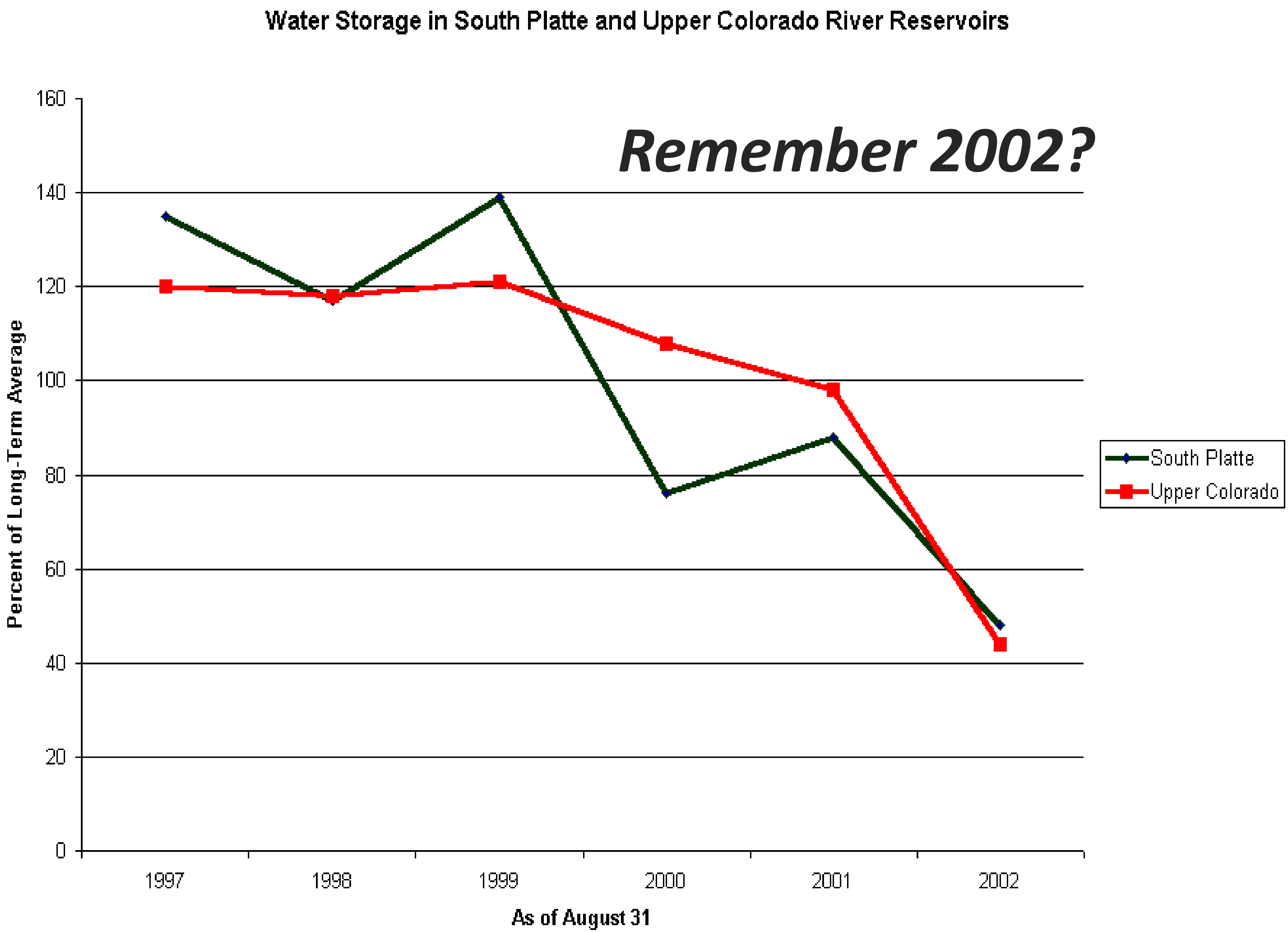
Outline

- Why focus on Demand Management?
- Experience of several Front Range cities using lawn watering restrictions in 2002-2003
- Some lessons from Aurora’s demand management experience (household-level analysis)

Why Focus on Managing Demands (rather than supplies) as a Drought Response?

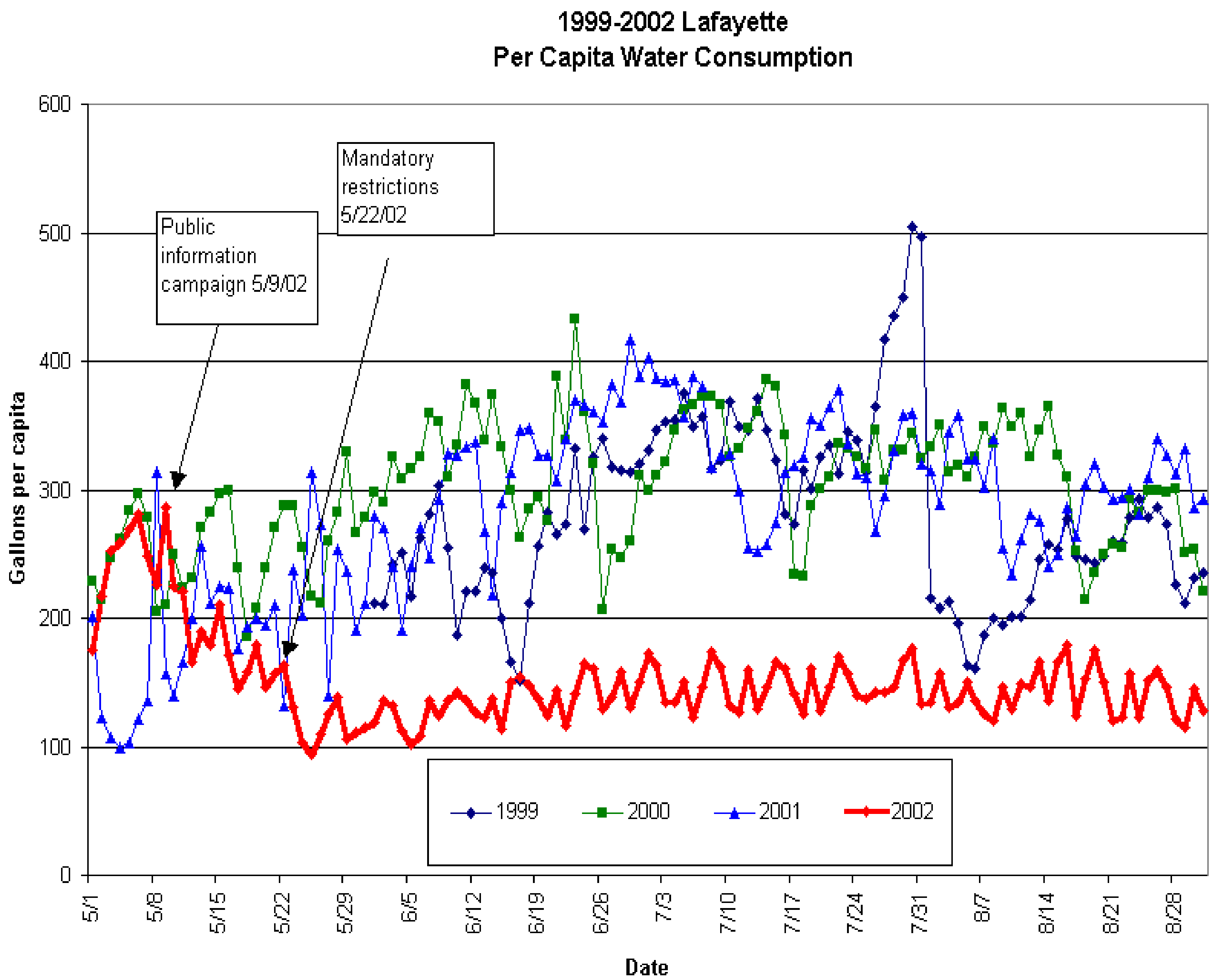
- It’s easier & cheaper than supply-side approaches
- It’s incremental and (nearly) instantaneous
- It saves energy (as well as water) and thus is good for climate change mitigation (as well as adaptation)
- It relieves pressure on other water-using sectors (e.g., the environment, agriculture) during drought
- It works !



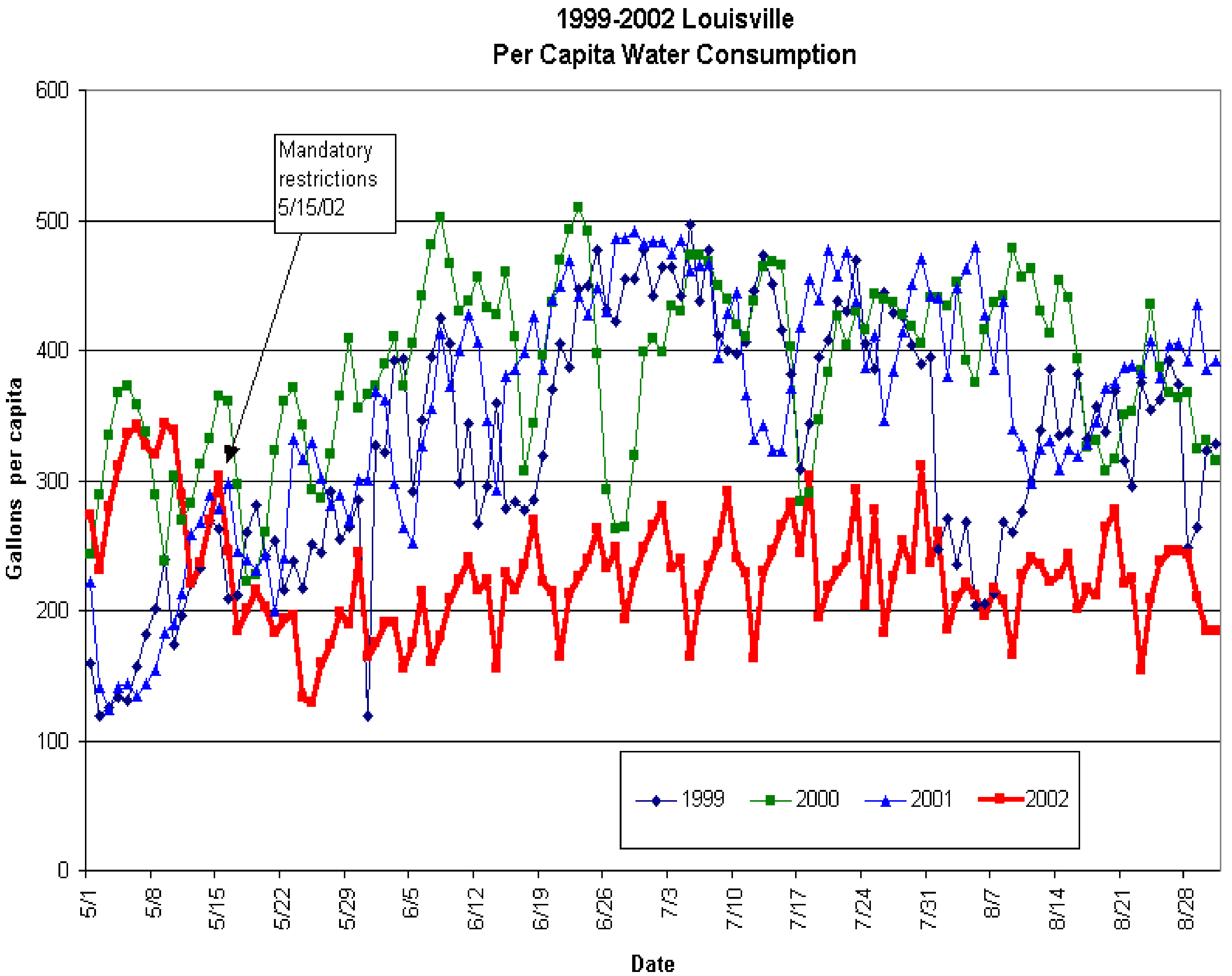
Water Storage in South Platte and Upper Colorado River Reservoirs
Remember 2002?
Percent of Long-Term Average
160
140
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
2002
As of August 31
South Platte
Upper Colorado

Drought-Inspired Municipal Water Restrictions: May 1 to August 31

City	Start of Voluntary Restrictions	Start of Mandatory Restrictions	Lawn Watering Schedule
Aurora	None	May 15	Every 3 days
Boulder	May 8	May 21	2 days/week
Castle Rock	None	None (summer restrictions exist every year)	Every 3 days
Denver	May 8	July 1	Every 3 days
Ft. Collins	June 26	July 22	2 days/week
Lafayette	None	May 22	1 day/week
Louisville	None	May 15	2 days/week
Superior	June 2	August 5	Every 3 days
Thornton	May 8	None	Every 3 days
Westminster	May 22	August 1	Every 3 days



1999-2002 Lafayette
Per Capita Water Consumption
Gallons per capita
600
500
400
300
200
100
0
Public information campaign 5/9/02
Mandatory restrictions 5/22/02
5/1
5/8
5/15
5/22
5/29
6/5
6/12
6/19
6/26
7/3
7/10
7/17
7/24
7/31
8/7
8/14
8/21
8/28
Date
1999
2000
2001
2002


1999-2002 Louisville
Per Capita Water Consumption
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5/29
6/5
6/12
6/19
6/26
7/3
7/10
7/17
7/24
7/31
8/7
8/14
8/21
8/28
Date
1999
2000
2001
2002

Water Savings (%) During Summer 2002 by Cities Using Watering Restrictions

	During Voluntary Restrictions	During Mandatory Restrictions
Aurora	n/a	18
Boulder	4	31
Denver	7	21
Ft. Collins	12	24
Lafayette	n/a	56
Louisville	n/a	45
Thornton	10	n/a
Westminster	11	27

Calculated using the expected use method

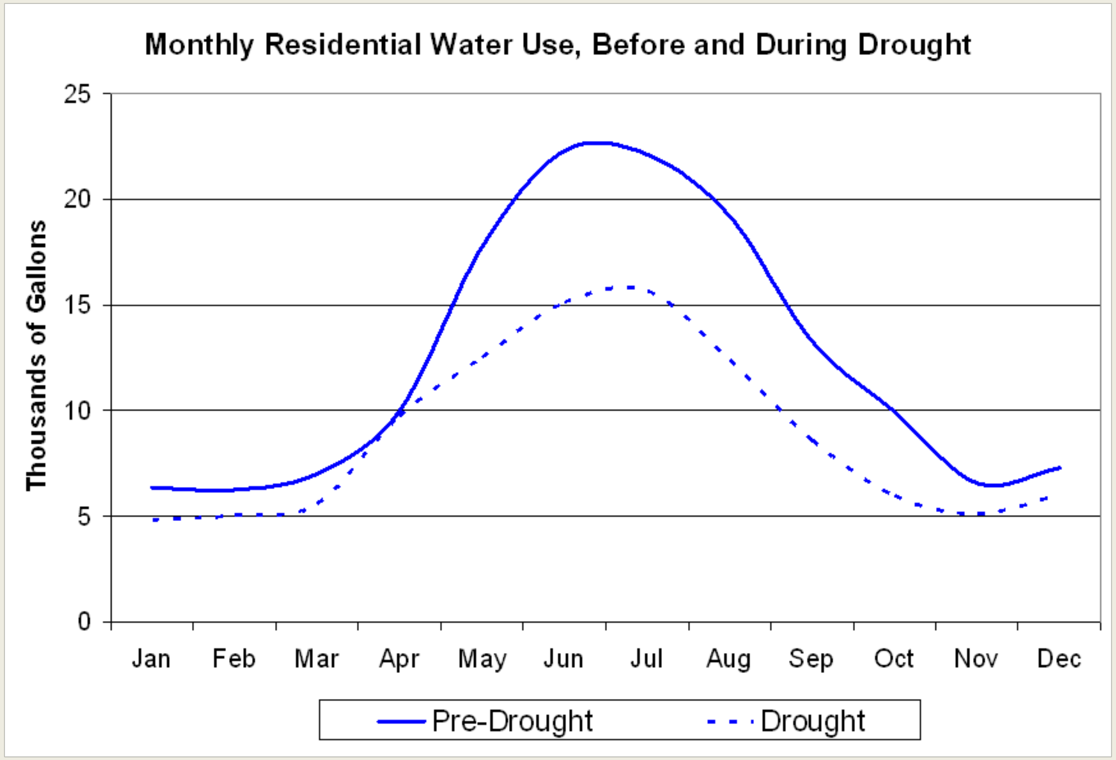
Total savings:
~ 36,000 acre-feet

Mandatory Restrictions Work; *Voluntary* Restrictions May Not Be Worthwhile

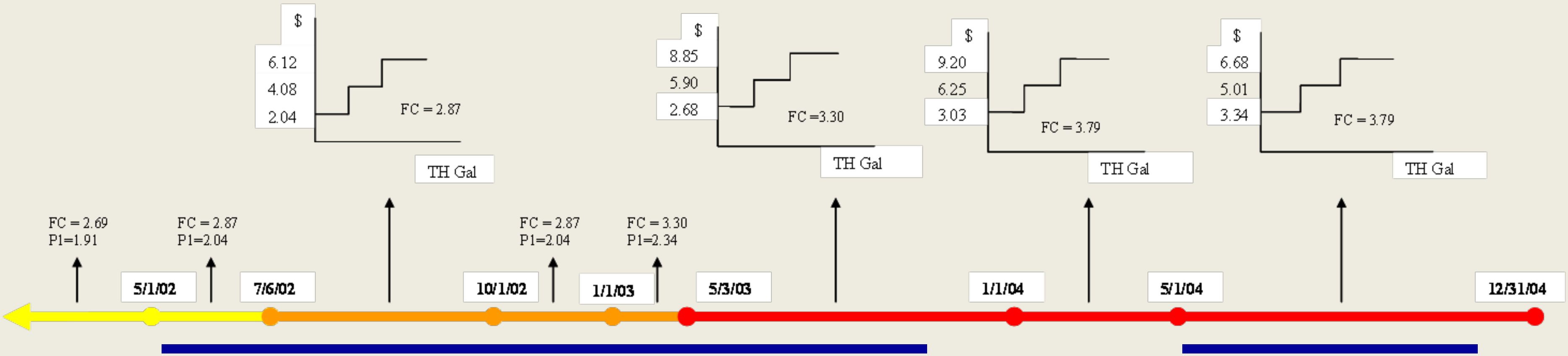
Aurora Case Study

- Demand management worked in Aurora, but we didn't know why:
  - Were savings due to watering restrictions, pricing changes, rebate programs, … ?
  - Which types of households were saving water?

Demand down 8% in 2002 and 26% in 2003 (over the entire year)



Aurora's Pricing & Restrictions Policies (2002-2004)



Single Rate — Households face a fixed service cost (FC) plus a uniform per unit charge (P1); all prices are shown per thousand gallons (TH Gal)

Inc. Block Rate — In addition to FC, households face an increasing block rate structure for all units consumed. Block widths are standardized across all households

Inc. Block Rate based on Water Budgets — In addition to FC, households face an increasing block rate structure for all units consumed. Block widths are **specific** to each household, based on average daily indoor consumption (ADIC) and an irrigation allowance (IA). Households receive a varying percentage of their ADIC and IA in each block depending on drought conditions.

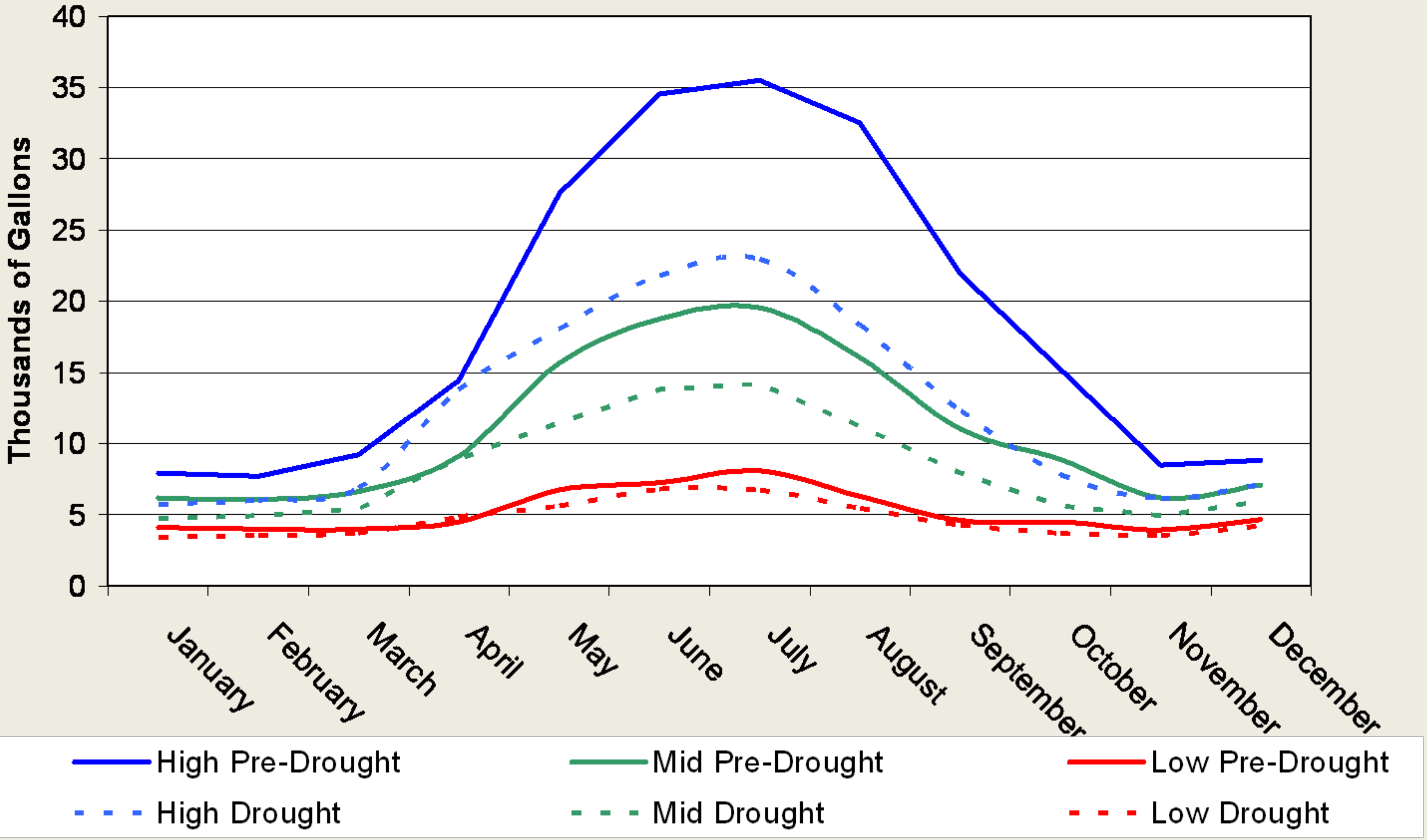
* Block widths in diagrams not to scale
** Rate structure type reflects the rate structure utilized during summer months

Water Restrictions in Effect

Source: City of Aurora: Water Management Plan (2002-2004) and ratesall.txt provided by the City of Aurora Utilities Department.

Data Analysis by User Group and Time Period:

Average Consumption per Billing Period by User Type Before and During Drought



Aurora Case Study

- We analyzed water demand in more than 10,000 single-family households using monthly billing records from 1997 – 2005

$$ln\left(w_{i,t}\right)=\left(\begin{array}{l}\beta_0+\beta_1 ln\left(aveprice_{i,t-1}\right)+\beta_2\left(ln\left(aveprice_{i,t\text{-}1}\right)*restrict_t\right)+\\ \beta_3 restrict_t+\beta_4 blockrate+\beta_5 ln\left(blprddays_{i,t}\right)+\beta_6 outdoorreb_{i,t}+\\ \beta_7 indoorreb_{i,t}+\beta_8 wsr_{i,t}+\beta_9 Irrigation_t+\beta_{10} Holiday_t+\\ \beta_{11} avemaxt_t+\beta_{12} totprecip_t+\phi_1 ln\left(hhinc_i\right)+\phi_2 medage_i+\phi_2 pph_i+\\ \phi_3 houseowned_i+\phi_4 newhome_i+\phi_5 oldhome_i+\phi_6 numbedrooms_i+\varepsilon_{it}\end{array}\right)$$

$$\varepsilon_{it}=\eta_i+\mu_{it}$$

Variations in Price Elasticity:
By User Group & Restrictions Policy

Type of Water User	Overall Price Elasticity	Elasticity During Restrictions
All Households	-0.60	-0.37
Low-Volume Households	-0.34	-0.46
Mid-Volume Households	-0.57	-0.39
High-Volume Households	-0.75	-0.24

Summary of Findings:
Utility Controlled Variables

- Overall price elasticity of demand: -0.60 (10% price increase reduces demand by 6%)
- Restrictions: -0.31 (31% reduction if customers pay no attention to price) & -0.12 (12% reduction assuming average prices) [Interactions issue – savings not additive]
- Rebates. Indoor: -0.10 (10% reduction)
- Block Rate: -0.05 (5% reduction)

Summary: Lessons Learned

- The effectiveness of demand management policies is mostly determined by how they influence the behavior of the high-volume users, who are:
  - Highly responsive to *price* in non-drought periods
  - Highly responsive to *restrictions* during drought periods
- Increasing block rate structures work (even if the pricing tiers are only modestly punitive). (Reduce demand 5% irrespective of pricing.)
- Indoor rebate programs (e.g., for low-flow toilets) are a great long-term investment. (Toilet replacements yield 10% demand reductions.)
- Customers will hit water-use targets if you provide them with proper incentives (via rate structures) and information (via a Water Smart Reader).
- *Larger Policy Lessons*: If a water utility can learn to reliably and predictably reduce demands during years featuring low system yields, then (a) the need to "over-build" water systems is reduced (a tremendous financial and environmental benefit), and (b) already over-built systems can serve more customers than previously assumed. [Similar lessons in the energy sector]

Some Remaining Questions

- How can utilities best maintain adequate revenue streams while suppressing demand?
- How can the culture of water agencies be amended to place demand management on a footing more commensurate with supply management?
- To what extent do long-term conservation efforts restrict the opportunities for short-term (e.g., drought period) demand reductions (i.e., the “demand hardening” question)?
- To what extent is outdoor water use a function of the types of irrigation technologies in use (e.g., hoses, sprinklers, timers), and what opportunities exist to strategically manipulate this as part of demand management programs?

Thank You

- Other members of the research team(s) included Bobbie Klein, Chris Goemans, Jess Lowrey, and Martyn Clark (all of WWA), and Kevin Reidy of Aurora Water
- Read more at the Water Demand and Conservation page at:
  http://wwa.colorado.edu/water_management_and_drought/wtr_dmn_consrv_home.html

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Success Stories in Urban Demand Management During Drought

One of the most practical and cost-effective mechanisms for coping with the impact of drought on municipal water supplies is through the use of temporary water conservation measures, a strategy known simply as demand management. Prompted largely by widespread drought conditions in 2002, several Front Range municipalities recently employed a variety of demand management strategies, including restrictions (of various severity) on lawn watering, modification of water pricing structures, the use of rebates to encourage customers to install water-saving devices (especially low-flow toilets), and a host of public education campaigns. These efforts were highly successful. In this presentation, results of two studies are summarized: one summarizing lawn watering restrictions as applied in Aurora, Boulder, Denver, Fort Collins, Lafayette, Louisville, Thornton, and Westminster; and a follow-up study examining a broader suite of demand management tools applied in Aurora.

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Doug Kenney is a Senior Research Associate at the Natural Resources Law Center, University of Colorado School of Law (Boulder), where he directs the Western Water Policy Program. The majority of his research is focused on western water issues, particularly water law and policy reform, climate change adaptation, and river basin and watershed-level planning and dispute resolution. He has published in a variety of journals, books, and the popular press, and has given speeches in at least 17 states, 3 nations, and 2 continents. Dr. Kenney has served as an advisor to a variety of local, state, multi-state, and federal agencies, including several Interior Department agencies, EPA, the US Forest Service, and special commissions (e.g., the Western Water Policy Review Advisory Commission and the Western States Water Council); the states of Georgia, Alabama and Florida; and national governments and nongovernmental organizations in Asia, Africa and Latin America. He holds a Bachelors degree in Biology from the University of Colorado, a Masters degree in Natural Resources from the University of Michigan, and a Ph.D. in Natural Resources from the University of Arizona.