

The Surprising Slide in Domestic Demand: Be careful what you wish for

Gary Woodard, JD MPP



MONTGOMERY
& ASSOCIATES

WRRC

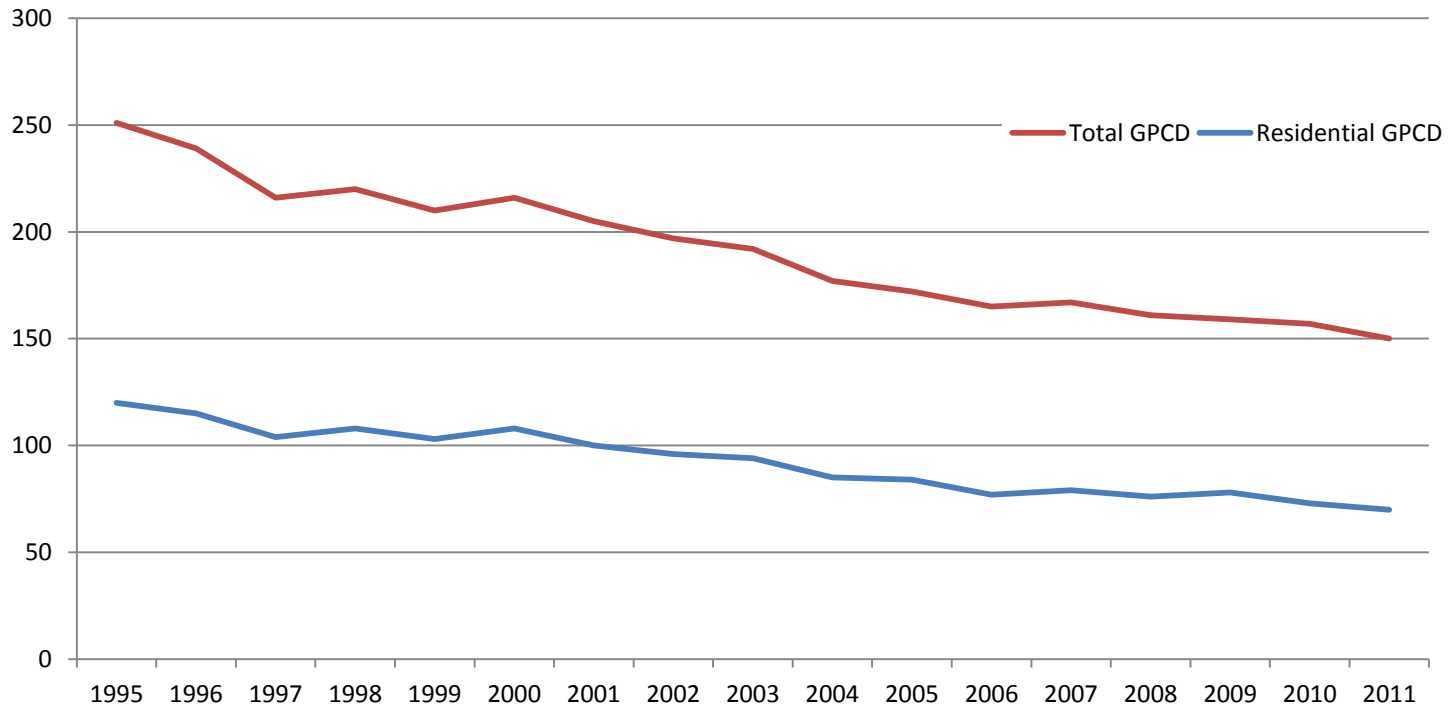
**Sol Resnick Room
University of Arizona**

**Brown Bag Seminar
11 March 2015**

Albuquerque-Bernalillo County WD deliveries

Deliveries in 2013 were the same as in 1983...

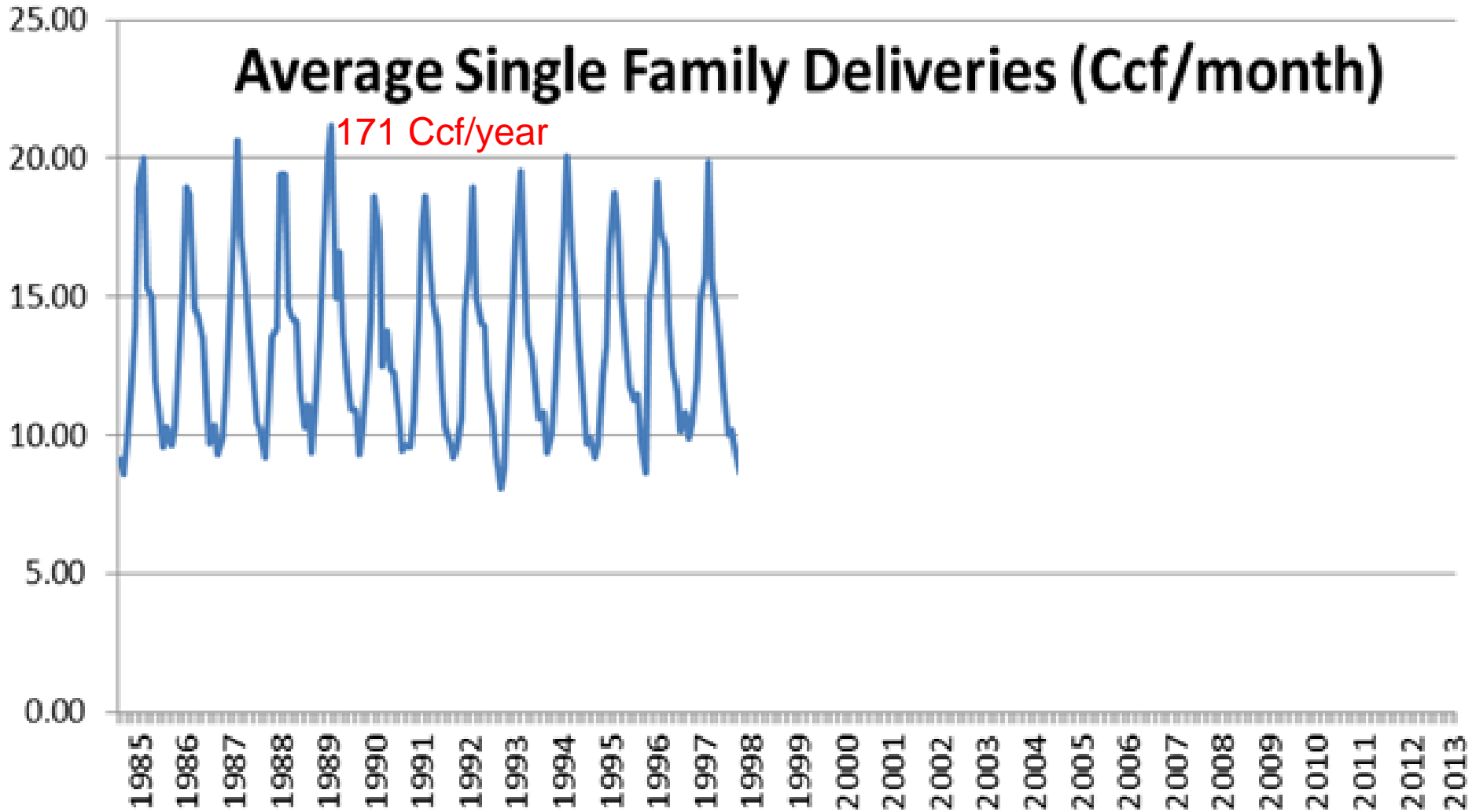
...despite a 70% increase in population, because GPCD was down 40%



Tucson, Arizona

Average Single Family Deliveries (Ccf/month)

171 Ccf/year

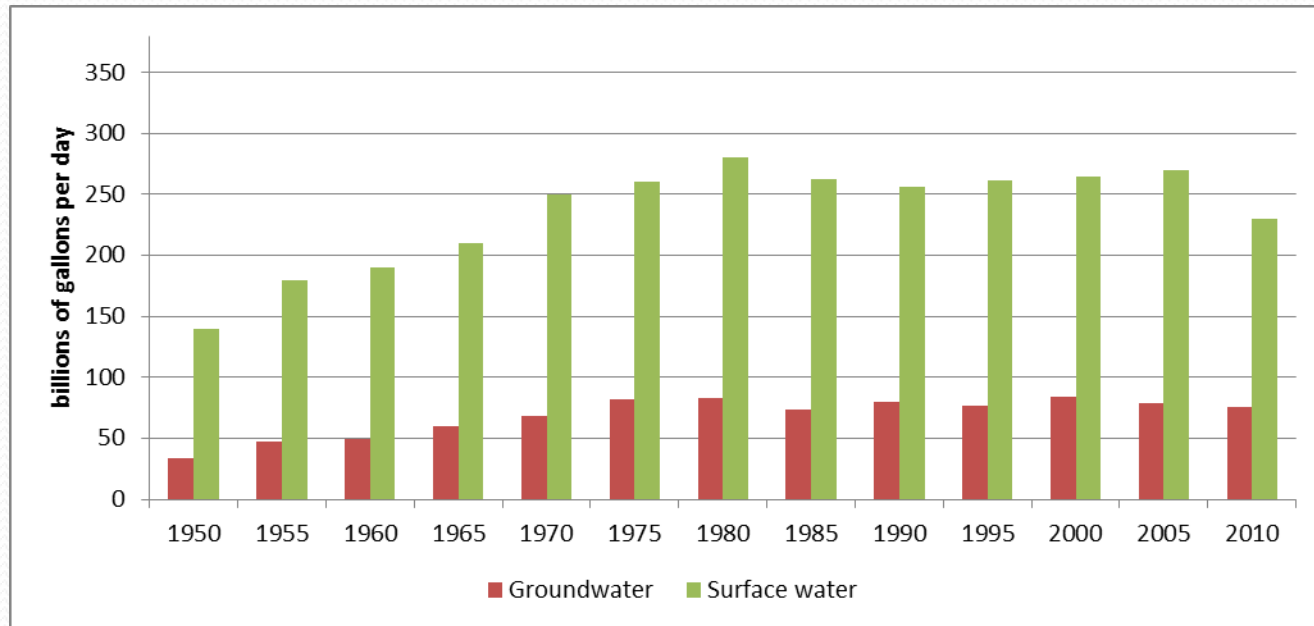


Demand Trends, Pima & Maricopa County

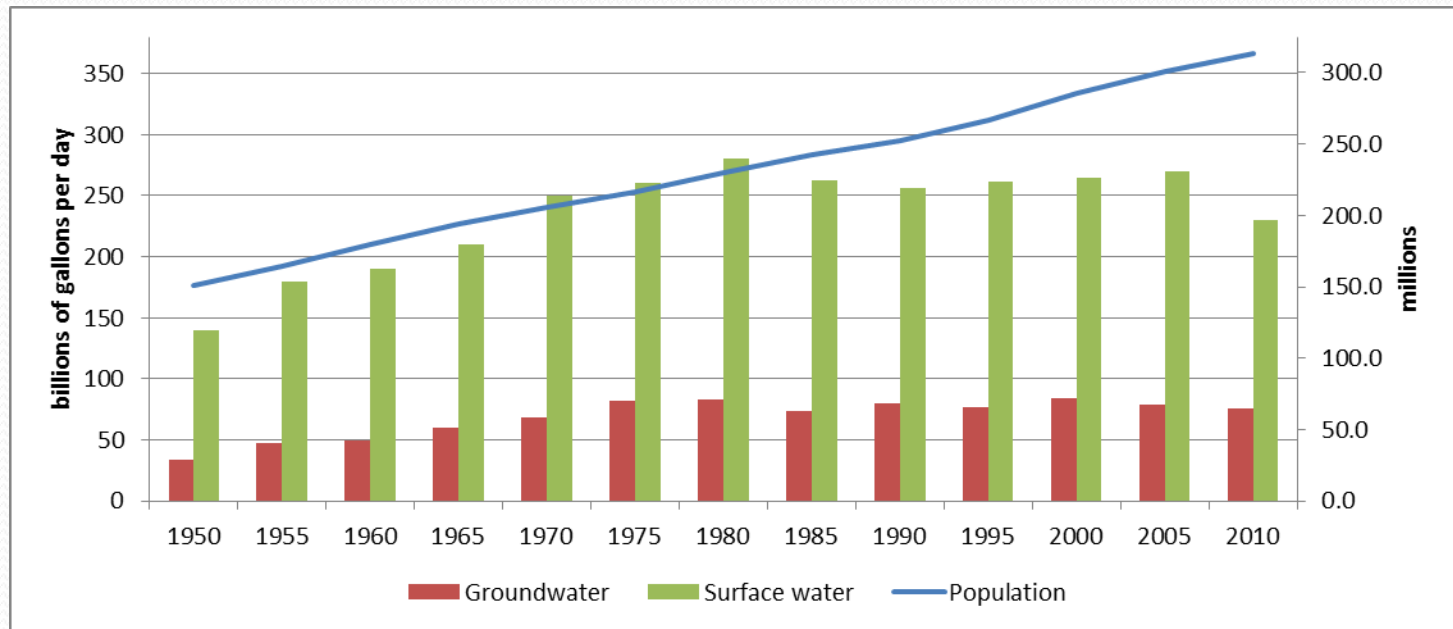
Annual Percent Changes in SFR Water Demand, 2000-2013

Area	Total	Indoor	Outdoor	Peak Outdoor
Pima County	-2.3	-1.5	-4.8	-4.9
Community Water	-2.0	-1.5	-3.2	-3.6
Metro Water	-2.2	-2.0	-2.8	-2.5
Tucson Water	-2.3	-1.5	-5.0	-5.1
Maricopa County	-2.1	-2.0	-2.3	-2.9

USGS report shows reduced water diversions

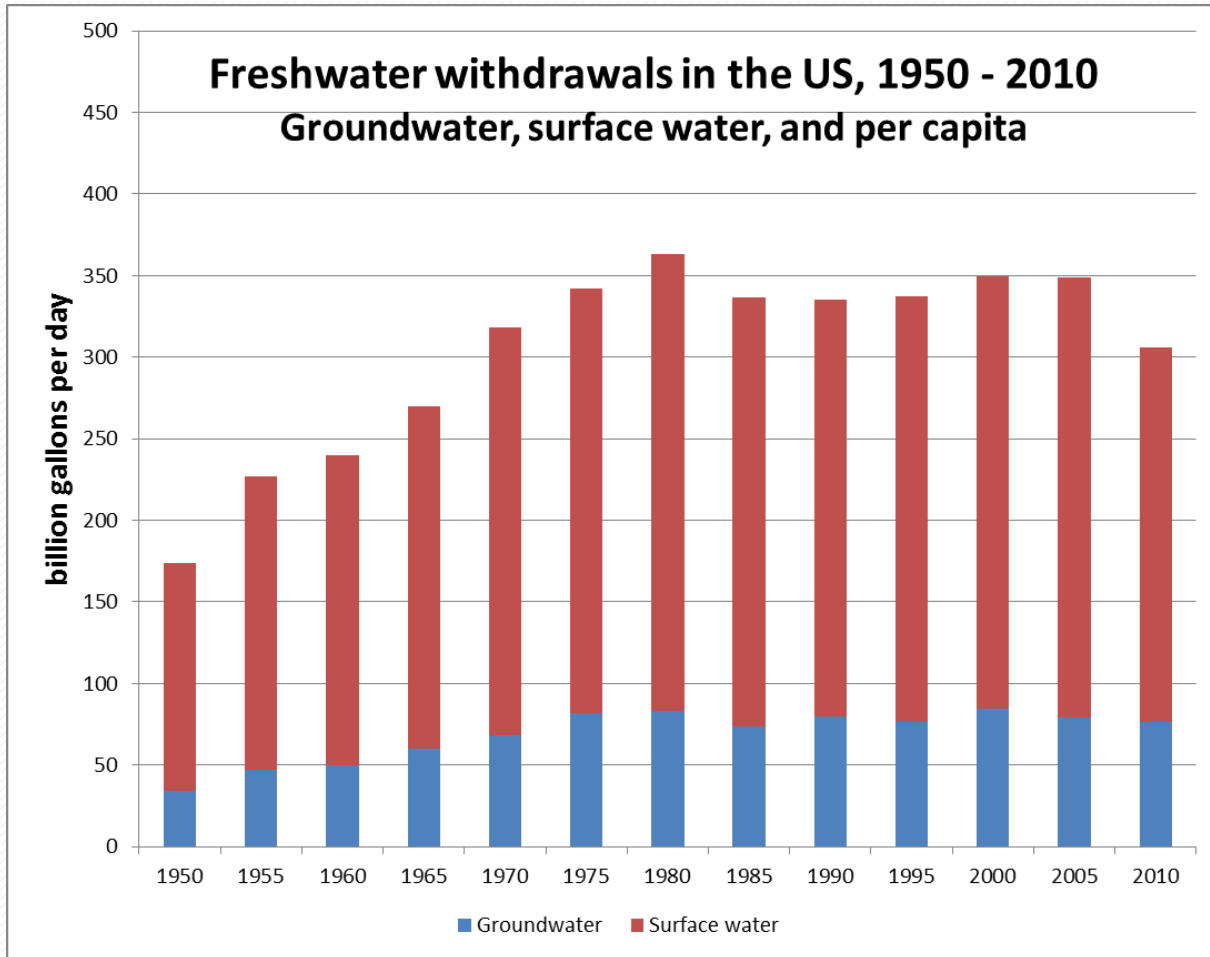


USGS report shows reduced water diversions

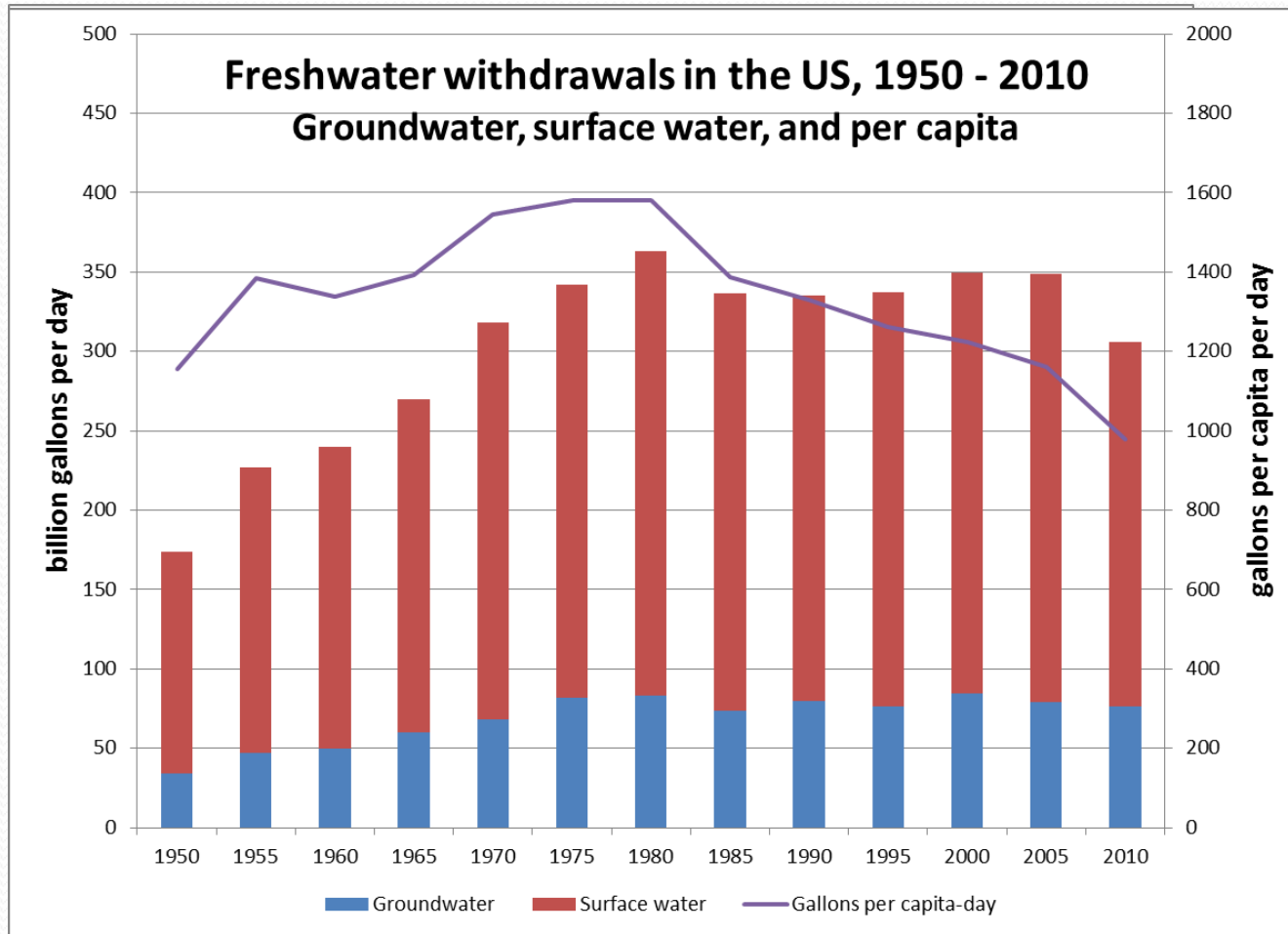


Between 1980 and 2010, we managed to support 85 million more people and a growing economy while reducing water use by 57 billion gallons per day.

Total U.S. water diversions peaked 35 years ago



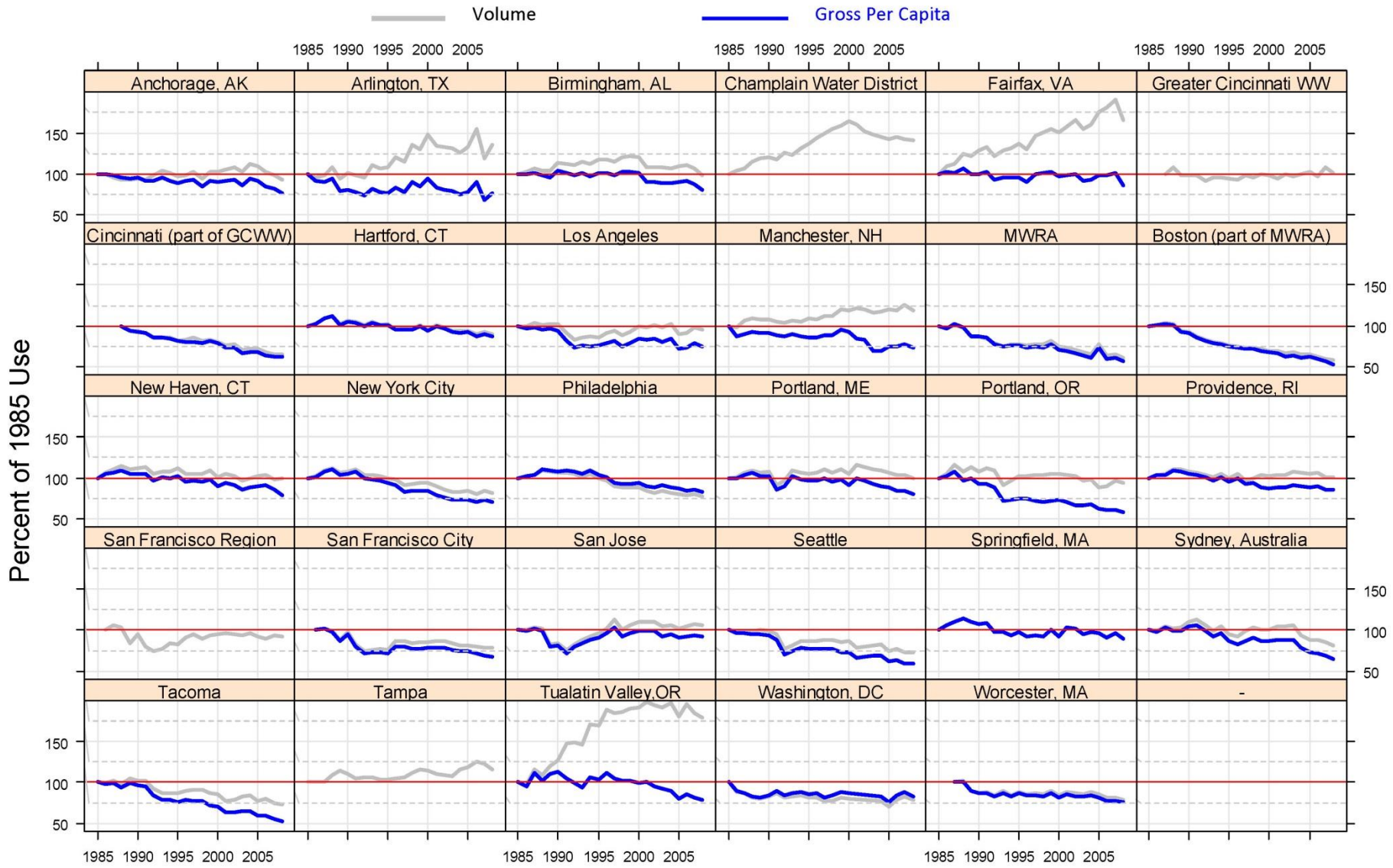
Total U.S. water diversions peaked 35 years ago



The declines are both wide and deep, occurring in municipal, industrial, agricultural, and power sectors, across the U.S.

National Water Use Comparison

(Compiled by the Massachusetts Water Resource Authority)



Year

* For a few cities where 1985 data was not available the indexing is on the earliest date provided.

Questions this raises:

Why has household water demand been dropping for decades in AZ, NV, NM, and across North America?

And in particular:

- *What are the underlying causes of declining demand?*
- *Which impacts of the “great recession” were temporary?*
- *What will future housing construction look like?*
- *How low could it go?*

Another question - Isn't this a good thing?

Despite growing populations and more customers, many water providers in the Southwest have experienced flat or even declining water demand.

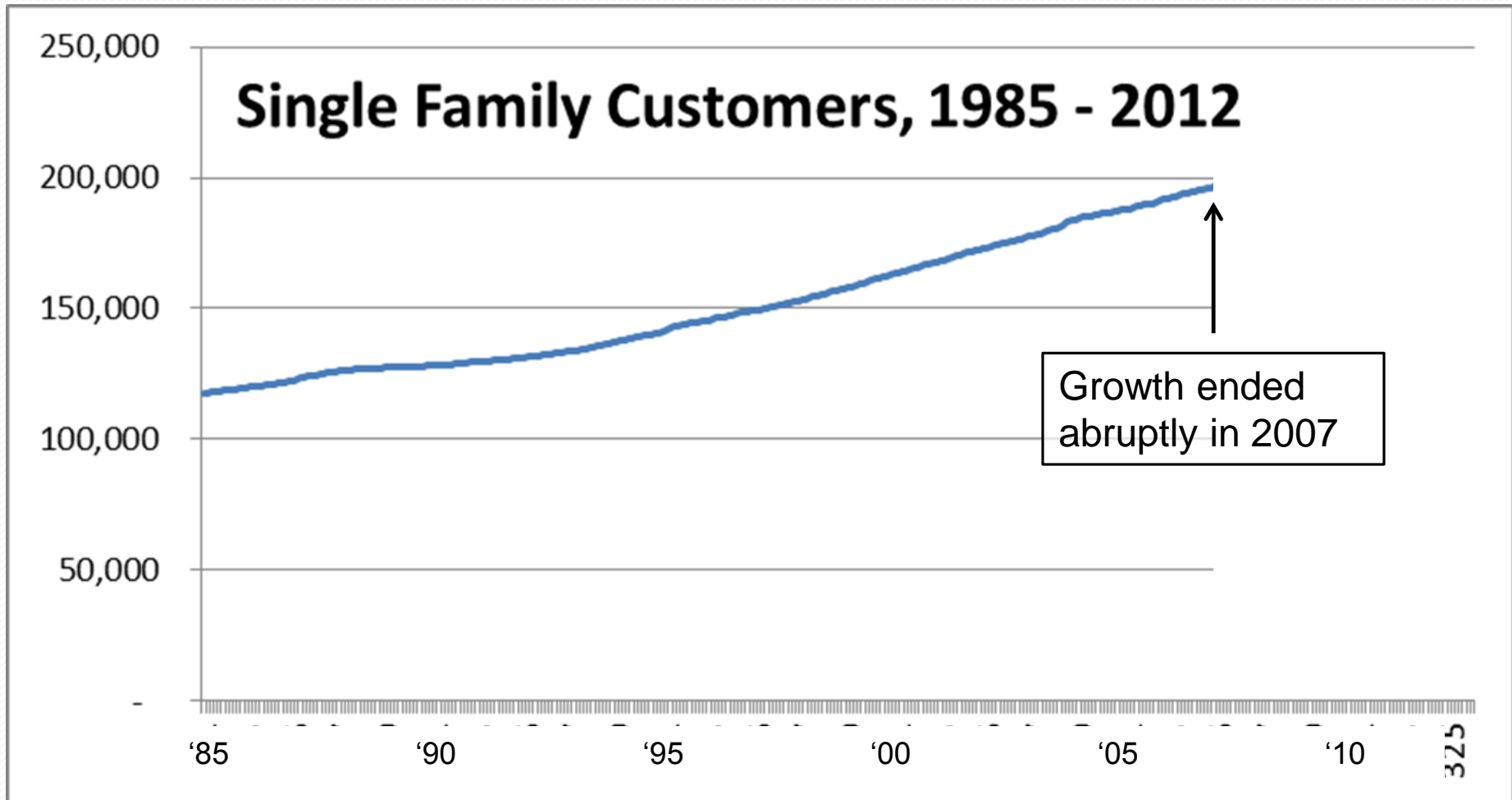
Decreasing per-household demand over the last 20-30 years has offset growing populations.

This saved a lot of water and a lot of money.

Then the “Great Recession” came along...

Housing collapse abruptly stopped new hookups

Tucson Water



The housing bubble burst resulted in:

- plunging hook-up fees
- paying for unused system capacity
- vacant homes not using water
- delinquent water bill payments
- political resistance to rate hikes

Result was steeper declines in demand and substantial reductions in utility revenues.

Other consequences include:

- an aversion to water conservation spending;
- a deeper interest in understanding long-term demand declines; and
- the need to improve ability to forecast future demand trends.

Given the long-term declines in demand, why were so many caught by surprise?

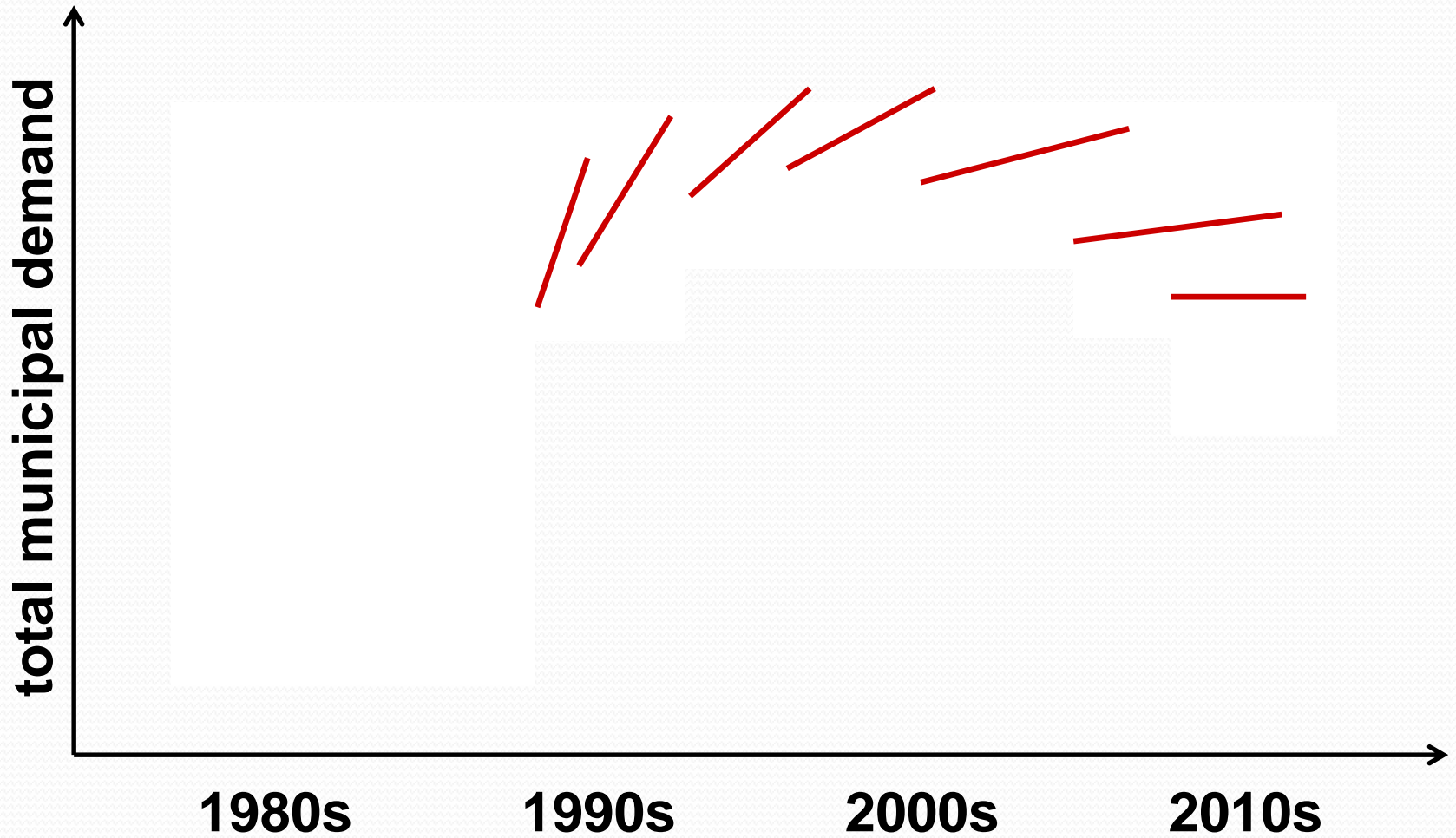
Misperceptions to trend lines can include:

- Over-reacting to short-term events
- Under-reacting to or explaining away turning points
- Defining the long-run by the most recent short-run – “the tail wagging the dog”
- Better to have too much capacity than not enough – can “grow into” premature capacity
- Being optimistic during economic booms and pessimistic during downturns
- Waiting for things to “bounce back” or “return to normal”

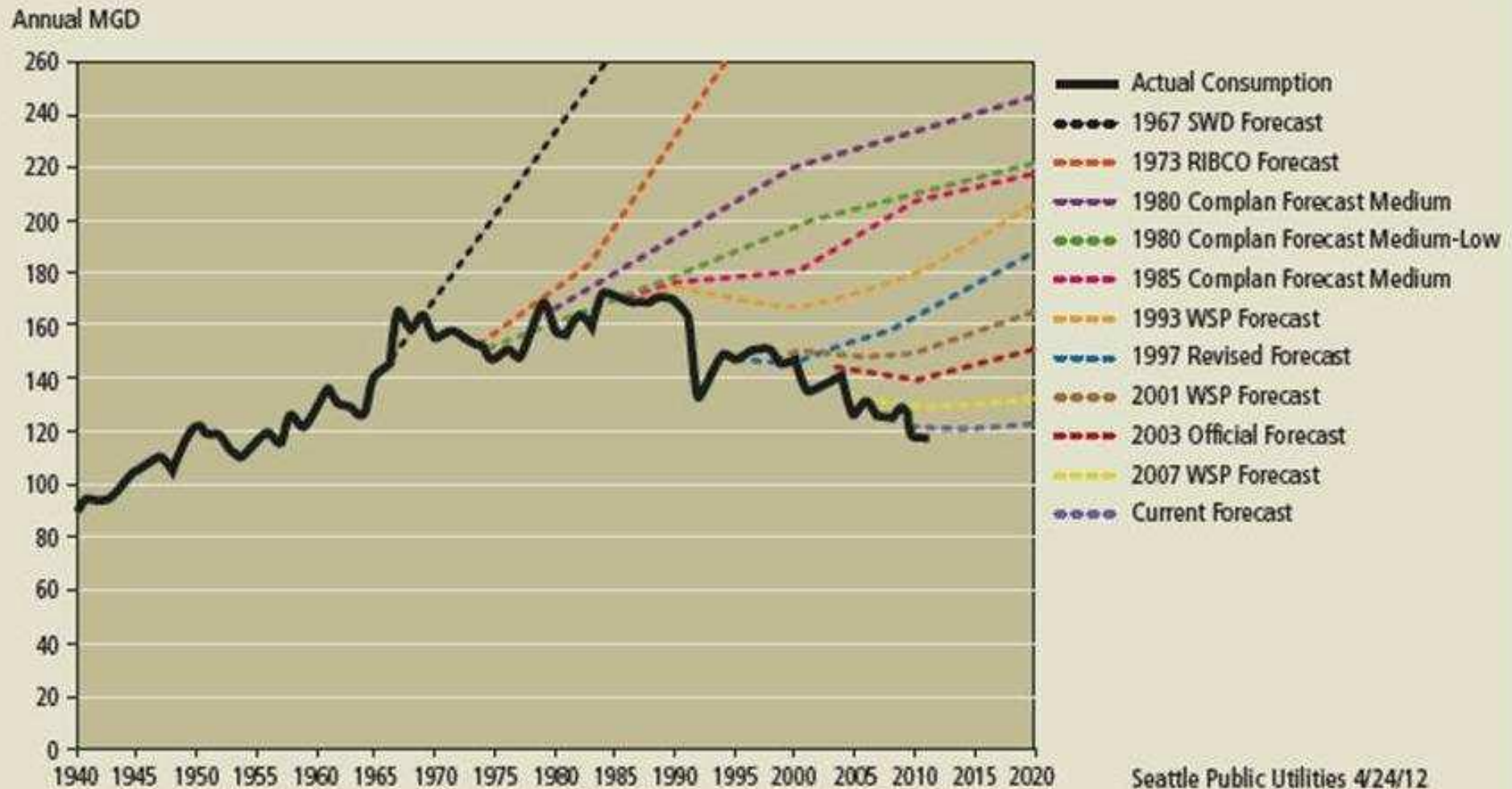
What's a doghair demand curve?



Building a doghair demand curve:



Seattle – total deliveries

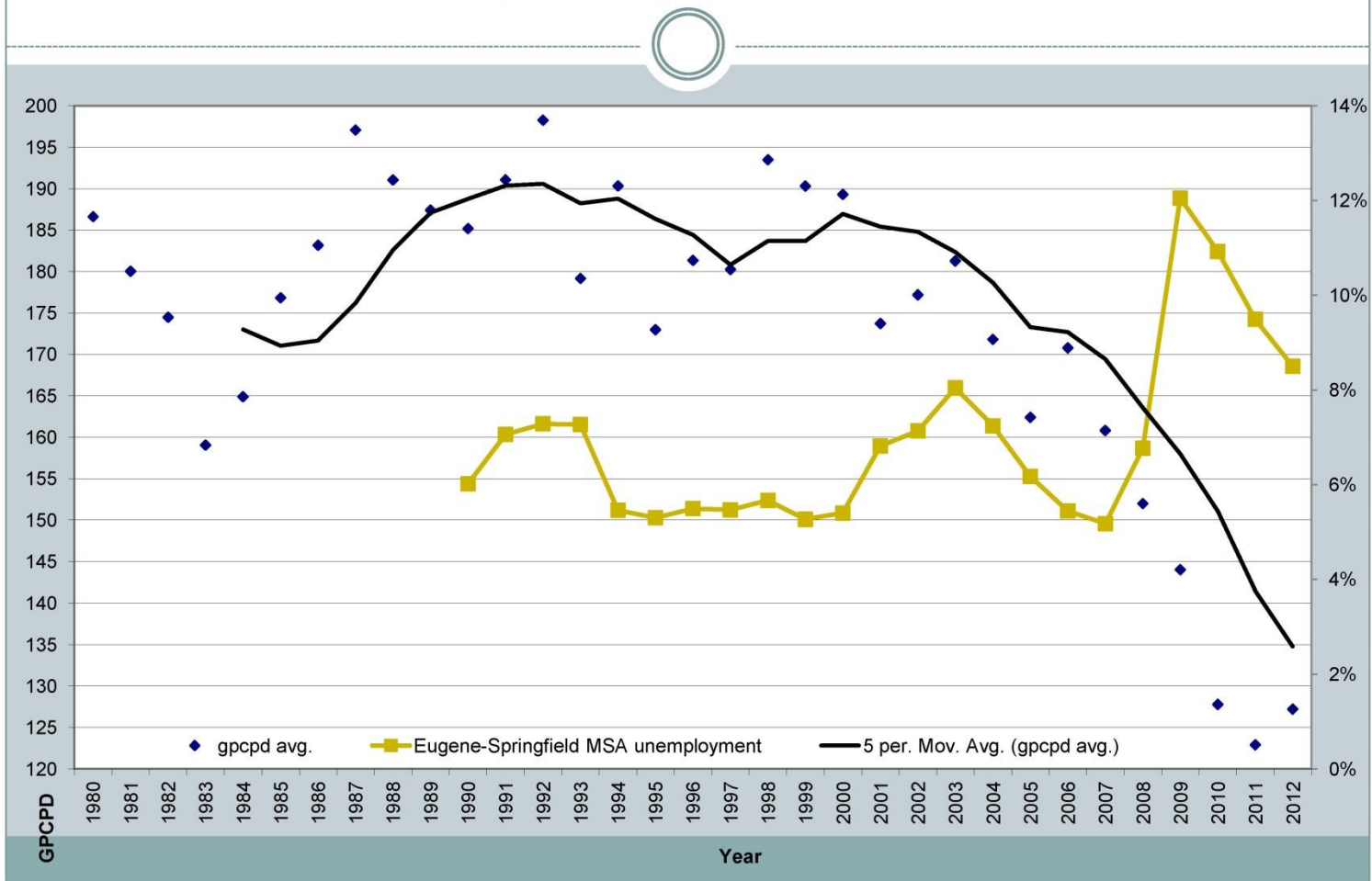


Dog-hair demand curves result from:

- Tying demand to population projections
- Being overly conservative
- Over-reacting to short-term events
- Ignoring or misinterpreting long-term trends

Eugene, OR – water demand & jobs

Estimated daily per capita gallons (vs. unemployment)

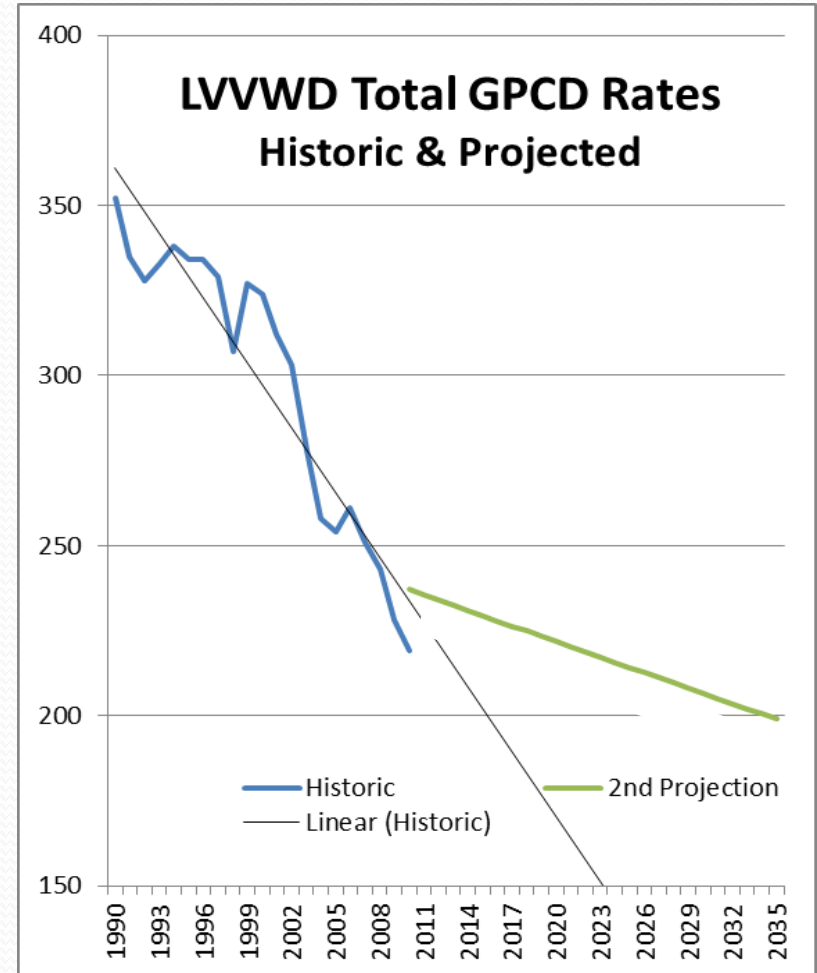
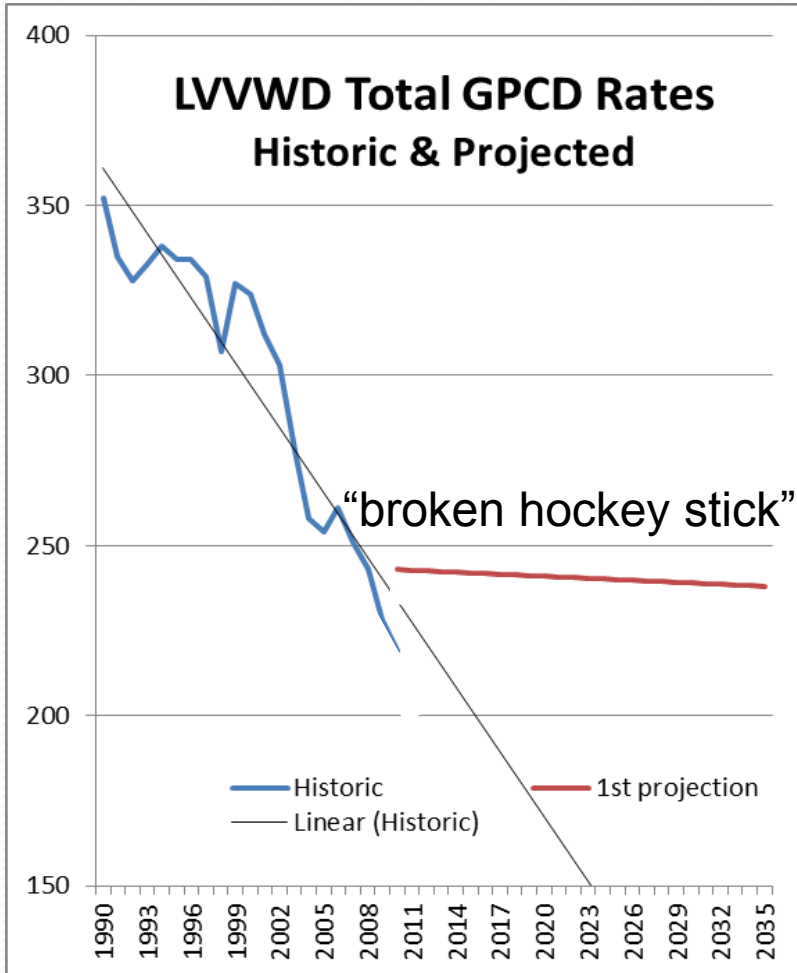


Other ways to be blindsided:

Assume most or all changes in water demand rates are due to active or deliberate conservation programs...

...and incidentally protect the underlying rationale for large hook-up fees.

Las Vegas Valley Water District gpcd rates



Not understanding or denying the trend creates planning challenges...

Water providers, wholesalers, wastewater plant operators, water regulatory agencies must adjust:

- optimal timing of capital improvements
- acquisition of new supplies
- rate setting
- budgeting uncertainties
- design of water conservation programs
- reuse of reclaimed water

...and some unintended consequences

Lower demand in new developments means:

- fire flows increasingly determine pipe sizes
- water stays in distribution system longer – “water age”
- more chlorine must be added, at new points
- water becomes warmer

All this results in more disinfection byproducts, such as THMs, and can lead to more hydrant flushing or DBP treatment.



...and some wastewater consequences

Lower demand in new development has some interesting wastewater treatment consequences:

- ADEQ and Table 1
- Tempe and contract with Reclamation
- Trend toward reuse/recharge of all A & A+ class effluent, but quantities are uncertain



Summary of issues raised

A number of issues have arisen, including:

- fiscal consequences
- operational issues
- planning challenges and
- public perception issues.

Water providers & regulators supporting this work:

- Tucson Water
- Central Arizona Project
- Bureau of Reclamation
- AZ Dept. of Water Resources
- SAWUA
- Metro Water
- Comm. Water - Green Valley
- Pima County Wastewater
- Salt River Project
- Central Arizona Project
- Bureau of Reclamation
- AZ Dept. of Water Resources
- Chandler
- Gilbert
- Glendale
- Mesa
- Peoria
- Scottsdale
- Tempe

Additional work for litigation support in Clark County

Specific questions & concerns

- Are some recession-caused drops in demand permanent?
- What will new housing look like in 3-5 years?
- Why the sharp drop in pools?
- Is turf dead?
- Is demand becoming more seasonal?
- How to adjust rate-making?
- How to distinguish between active and passive conservation?

Factors affecting municipal water demand:

Economics

- Water & sewer rates
- Income levels

Changing Tastes

- Pools
- Landscapes
- New homes

Environment

- Persistent drought
- Climate change
- Urban heat island

Conservation

- Education & preachments
- Rebates & give-aways
- Demonstration sites

Changing Socio-demographics

- Composition of households
- Seasonal residents

Efficiency Standards

- Federal mandatory
- Federal voluntary
- Neighboring state effects

New Technology

- Smart meters
- Next generation washers
- Smart irrigation controllers

New approach to demand forecasting

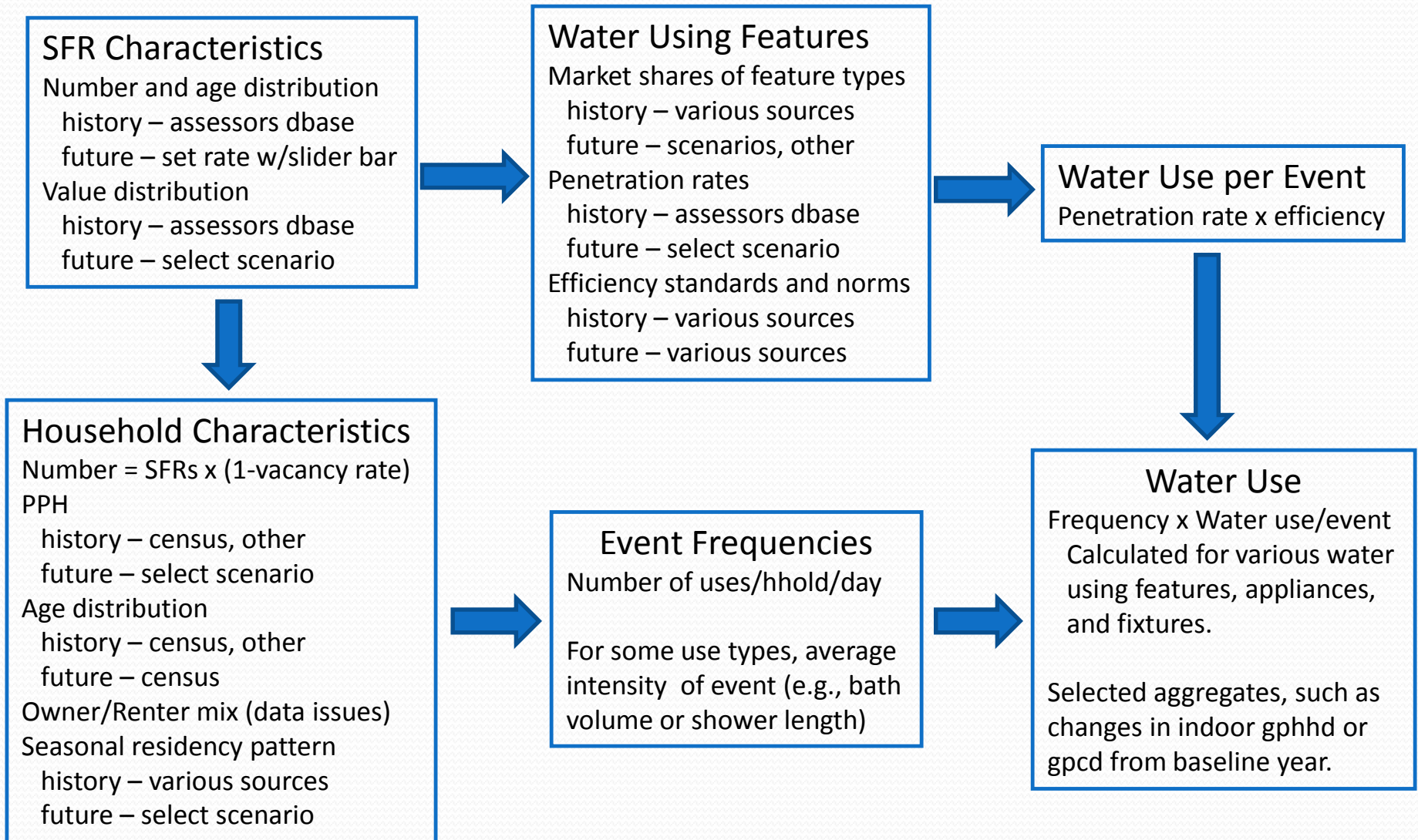
Most studies of municipal demand:

- Focus on small subset of factors
- Attempt to measure water associated with particular use(s) or change in use

This study of municipal demand:

- Looks at all significant factors
- Relies on existing information on water use rates whenever possible
- Focuses on rates of change in stocks of appliances, fixtures, and landscape characteristics
- Examines triggers of change

Model Structure for Residential Demand Trends

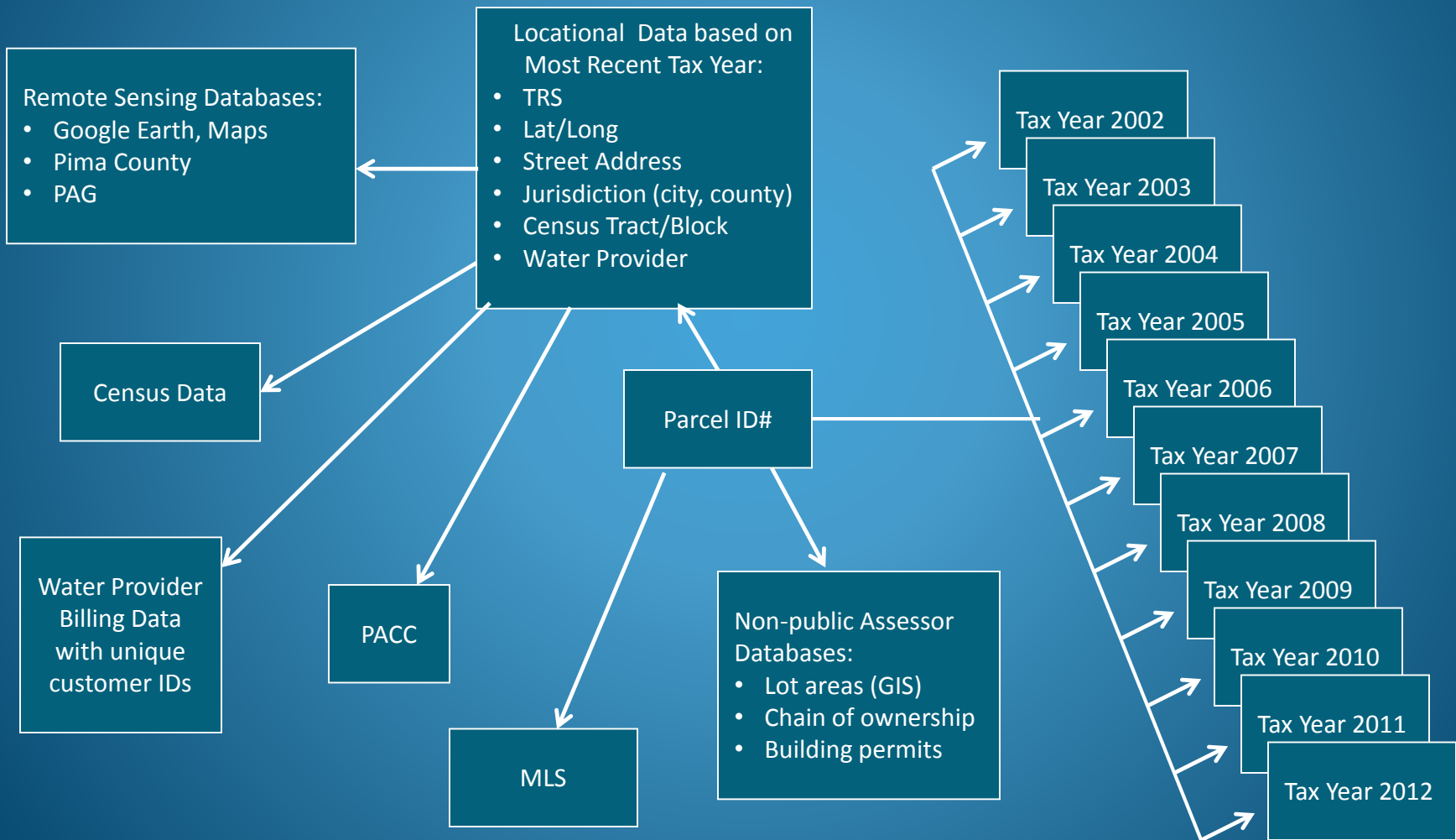


What we modeled... and didn't model

This is a model of significant changes in SFR demand, not absolute levels of demand. We modeled those demand factors that account for substantial amounts of water and that are, or may be, changing at a significant rate.

We did not model demand components that appear relatively stable or that account for relatively minor amounts of water (e.g., car washing, garbage disposals) or that have all but disappeared (e.g., winter Rye in Pima County, evaporative coolers in Maricopa County).

Databases for Pima County Demand Trends Project



Why a dynamic simulation model?

- Integrates significant SFR water demand
- Addresses uncertainty
- Compares scenarios
- User interface
- Transparent
- Graphical outputs



f_x Avg_Pool_Area_All_SFR (sqft/SFR)
Average pool area per all SFRs

Value: 74.29026 sqft/SFR

Equation: Percent_SFR_Pool*Avg_Pool_Area

Disaggregation levels

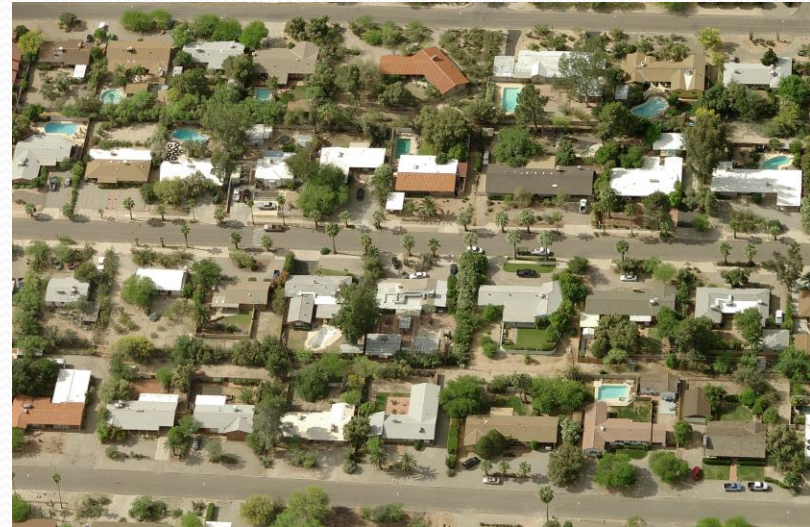
Basic units that define SFR water demand:

- Time step is 1 year
- Households are defined by PPH and 4 age cohorts
- Housing stock includes existing, new, and quasi-new
- Home values are defined by 7 value classes

Users can ask “What if?” questions and define a scenario

Adjustable factors include:

- Housing markets
- Socio-demographics
- Device water use efficiency
- Mandates and rebates
- Increase in water-conscious consumers






Users can also select a pre-defined scenario

EDIT INPUTS & RUN MODEL

DOCUMENTATION 

EDIT INPUTS & RUN MODEL 

VIEW RESULTS

- Summary 
- Demographics 
- Indoor Uses 
- Outdoor Uses 


Before you can edit inputs, the model must be in edit mode, with **Live Model** selected in the Scenarios dropdown in the box to the right.

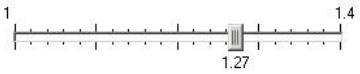
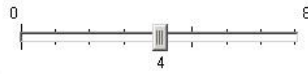

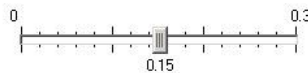
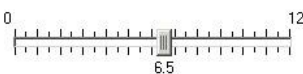
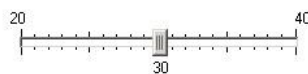
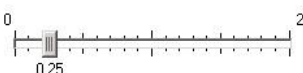
- To activate edit mode, press **F4**. To activate results mode, click .
- To save a scenario for future use, click .
- To run the model using a preset or saved scenario, select an option from the Scenarios dropdown and click .

SCENARIOS

Run Model & Select / Save Scenarios

Live Model + -



DEMOGRAPHICS	INDOOR USES	OUTDOOR USES
<p>Annual birth rate, %</p> 	<p>Clothes washer efficiency, gals/load</p> <p>Current <input type="button" value="v"/></p>	<p>Annual backyard turf removal rate, %</p> 
<p>Annual growth rate of new SFRs, %</p> 	<p>Start date, 2-gpm shower head mandate</p> <p>2016 <input type="button" value="v"/></p>	<p>Annual pool removal rate per year, %</p> 
<p>Annual sales rate of existing SFRs, %</p> 	<p>Year dual-flush toilet rebate began</p> <p>Never <input type="button" value="v"/></p>	<p>Evaporative cooler consumption, gpd</p> 
<p>Houses flipped, % existing homes</p> 		



Predefined scenarios

In addition to modifying the baseline scenario to create a scenario, the user can select predefined scenarios of:

- Long-term economic upturn
- Long-term economic downturn
- Long-term drought conditions

Dynamic simulation allows models to incorporate deep and complex linkages

Selecting an economic scenario changes

the rate of housing construction

and the distribution of new homes by value

which affect percent of new homes with pools

and the average size of pools

both of which affect outdoor water demand

New SFRs also have larger households with more pre-adults

which changes overall household socio-demographics, and

frequency of use of appliances & fixtures

which affects all facets of indoor demand

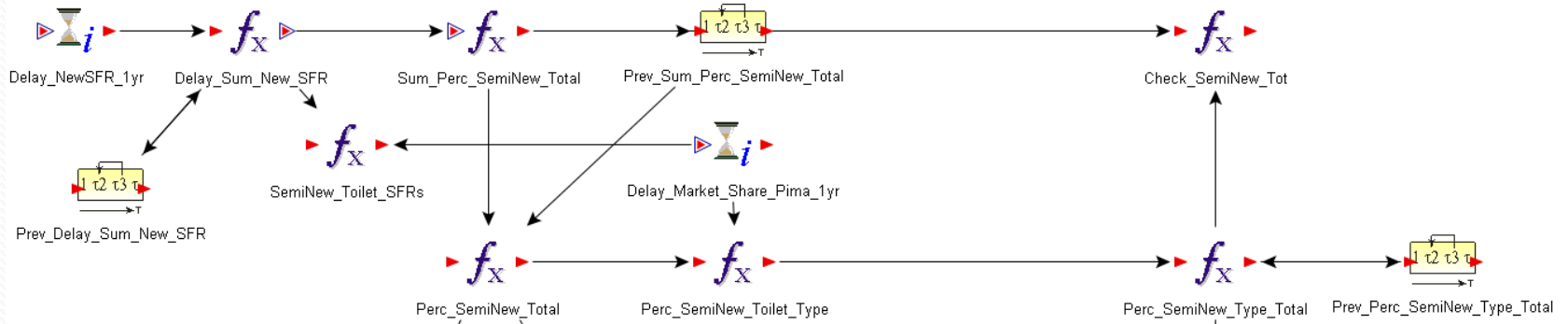
And more linkages...

Selecting an economic scenario also changes
the rate of sales of existing houses
and the distribution of existing home sales by value
which affect home remodeling
which affects indoor water demand

Sales of existing SFRs also trigger conversion of swamp to AC
which affects outdoor demand

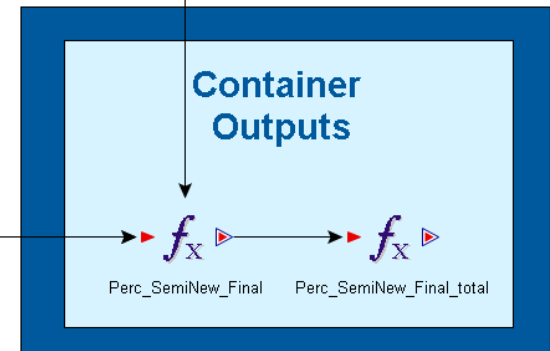
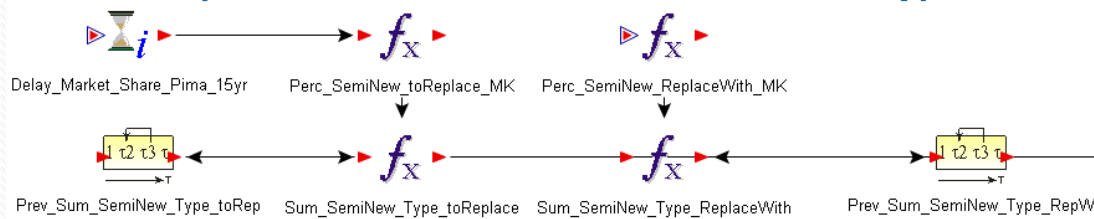
Everything affects everything, and this model captures that.

Semi-New SFR Toilet Types



Toilet Types to Replace

Replace With Toilet Types



VIEW RESULTS > INDOOR USES

DOCUMENTATION >

EDIT INPUTS & RUN MODEL >

VIEW RESULTS

- Summary >
- Demographics >
- Indoor Uses >
- Outdoor Uses >

Click a button below to view results for the last model run. To compare results for two or more scenarios, run each one first.

The graphs will display each variable individually. You can toggle between variables using the dropdown menu at the top of the results window.

CLOTHES WASHERS

- Market Share
- Penetration Rate
- Average Water Consumption per Load
- Loads per Day by Age Cohort
- Water Consumption per SFR
- Total Consumption for Service Area or County**

SHOWERS

- Market Share
- Penetration Rate
- Average Water Consumption per Shower
- Baths/Showers per Day by Age Cohort
- Water Consumption per SFR
- Total Consumption for Service Area or County**

TOILETS

- Market Share
- Penetration Rate
- Average Water Consumption per Flush
- Flushes per Day by Age Cohort
- Water Consumption per SFR
- Total Consumption for Service Area or County**



Possible factors of long-term decline:

- water (and sewer) rate increases
- more effective water conservation programs
- declining household sizes (PPH)
- changing tastes in landscaping
- more water-efficient fixtures and appliances in new homes
- replacement of inefficient fixtures, appliances in older homes
- declines in popularity of backyard pools, use of pool covers
- shrinking lot sizes
- swamp coolers replaced by AC
- more seasonal (part-time) residents

One way that PPH can decrease...



...and some alternative mechanisms:

- delayed age at first marriage
- more people never marrying
- declining birth rates
- more single-parent families
- increased longevity
- more affordable housing
- rising incomes

What does declining PPH actually do?

- Increases the number of homes needed for a given population...
- Which results in a newer housing stock...
- With more efficient fixtures and appliances and therefore lower indoor demand rates...
- But with more landscapes and pools per capita, thereby increasing outdoor demand rates.

Evidence suggests PPH no longer declining:

- Boomerang kids
- Growing percentage of 3-generation households
- More alternate household living arrangements
- Building industry responding with “home within a home” floor plans

But households are still changing:

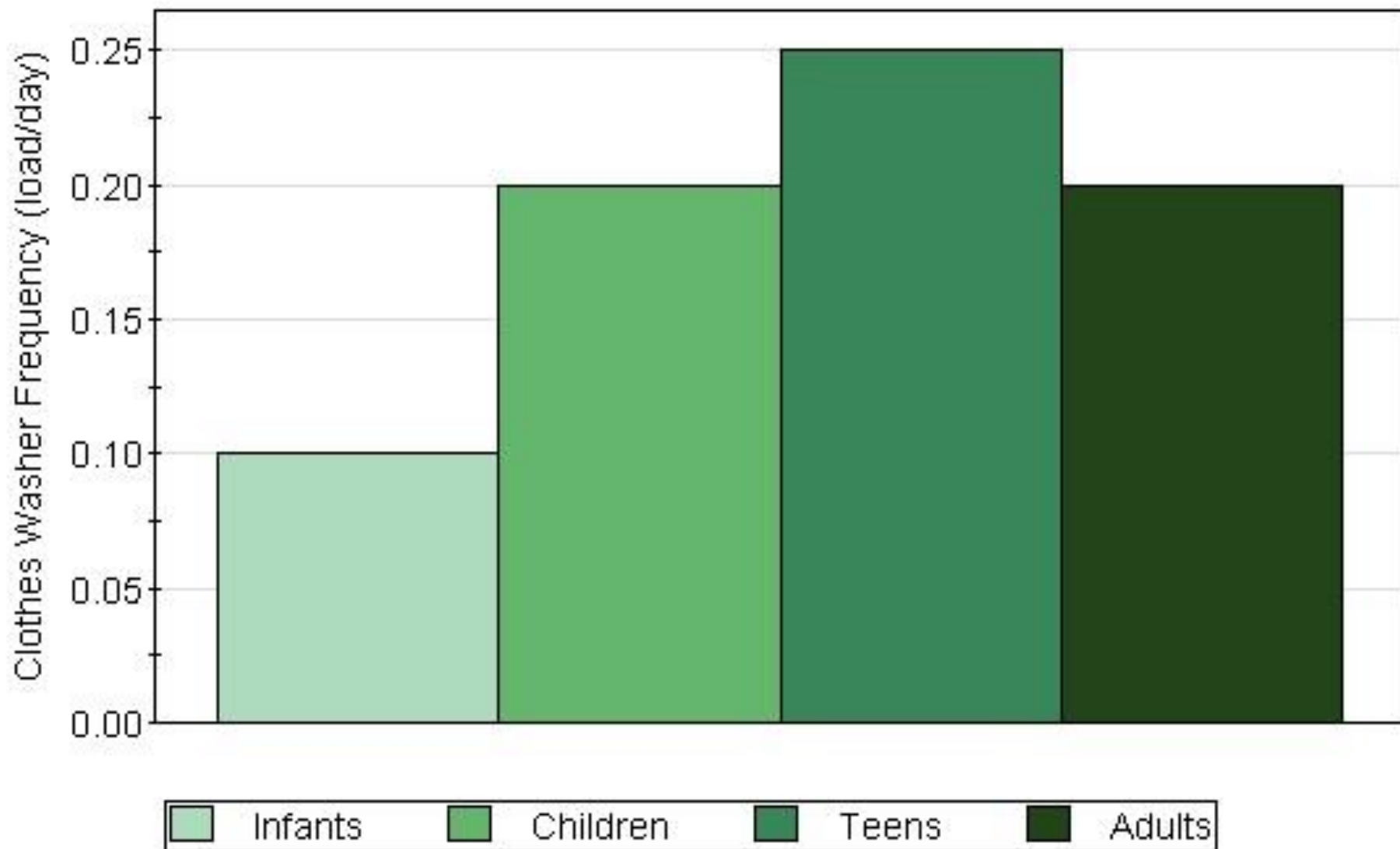
- Fewer infants, children and teens
- More 1-adult households, including with children
- More retirees and snowbirds
- In general, a graying population

Changes in households are affecting frequencies of indoor water uses

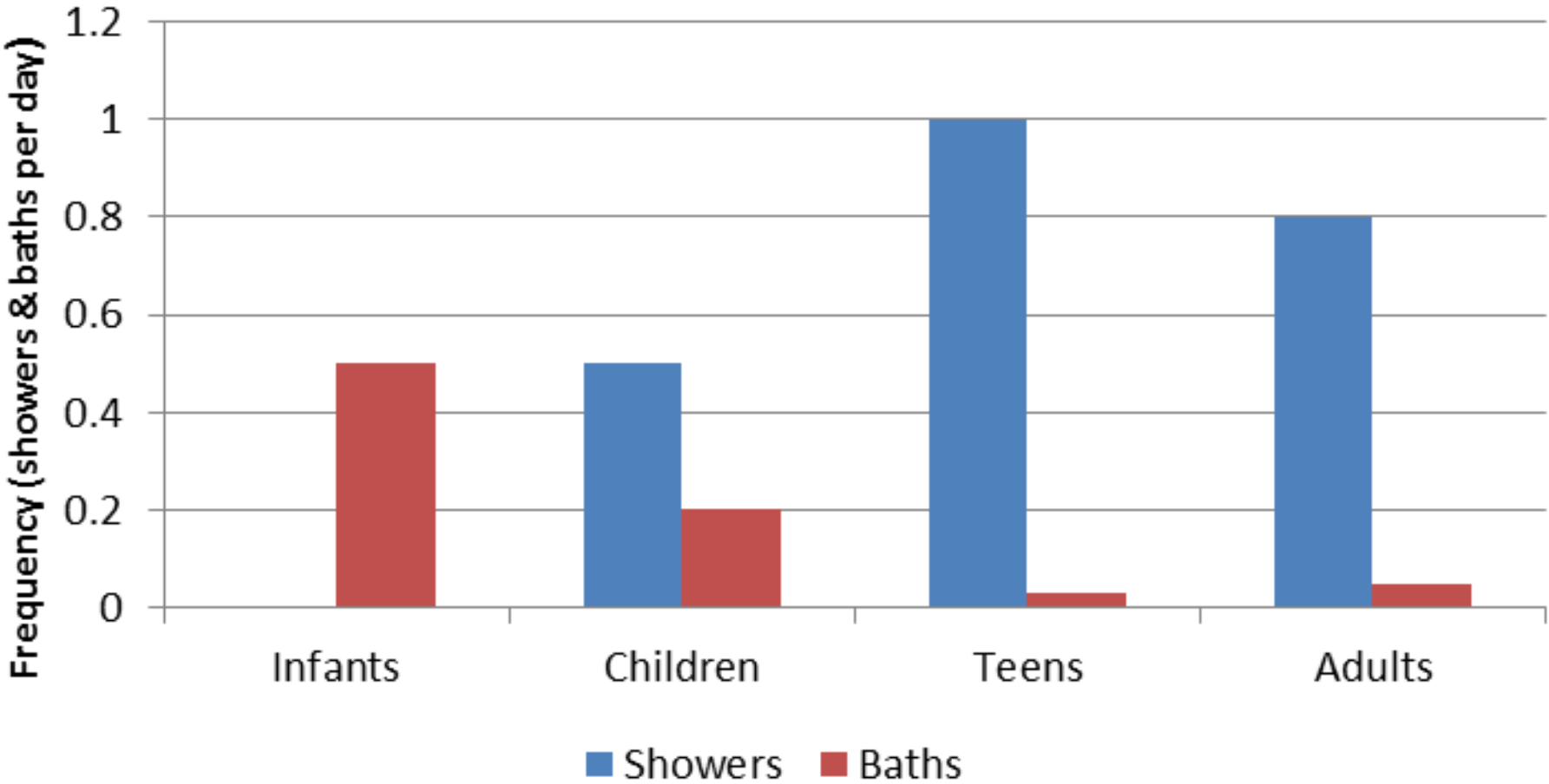
Regressions run on AquaCraft WRF data reveal:

- Shower, clothes washer, and dish washer usage is affected by temperature
- Infants don't flush toilets or take showers
- Children account for most baths
- Teenagers really do take more frequent and longer showers than adults
- Most usage rates hold across 9 urban areas

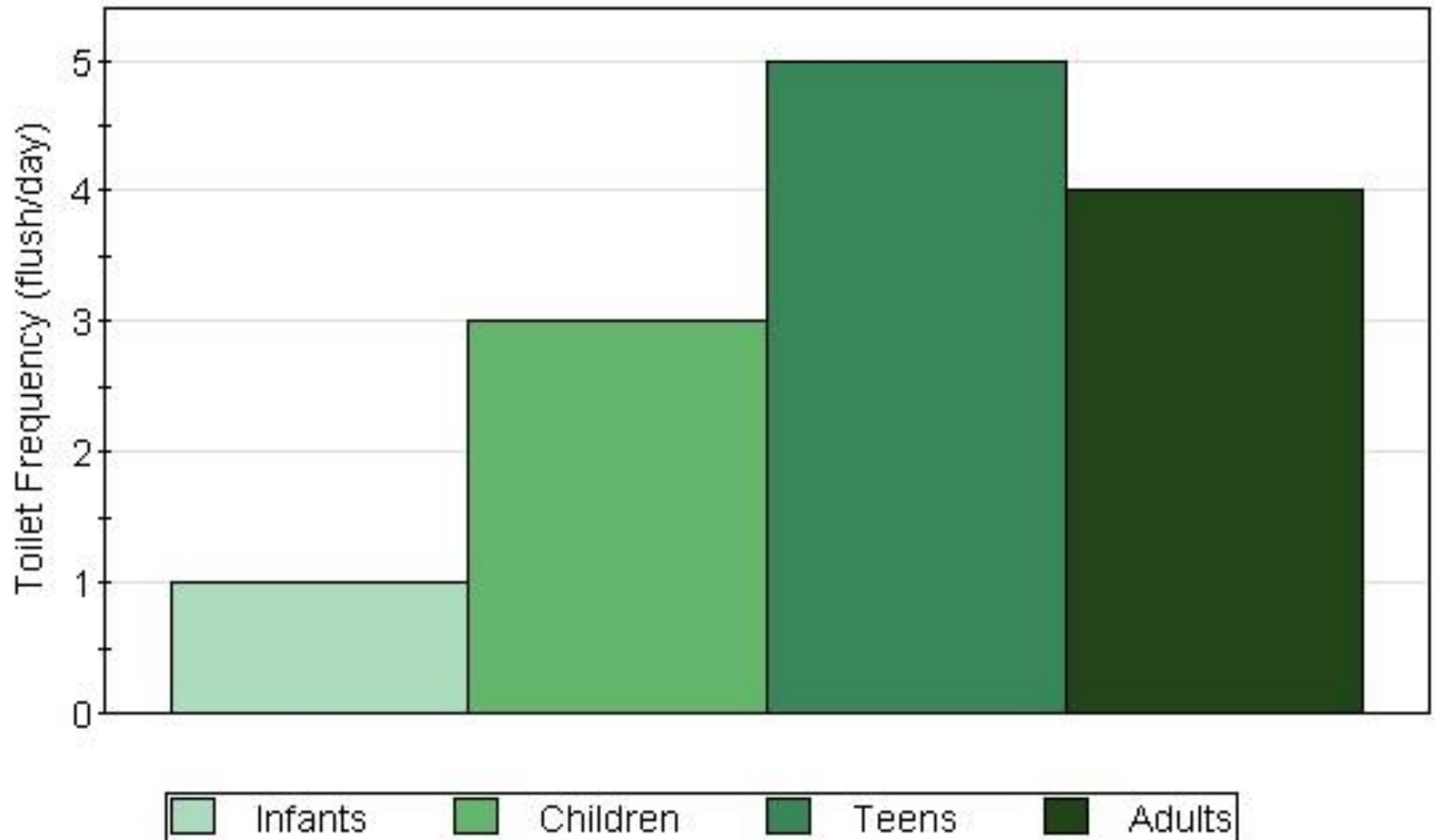
Clothes Washer Loads per Day by Age Cohort in 2020



Showers and Baths per Day by Age Cohort



Toilet Flushes per Day by Age Cohort in 2020



AquaCraft study also reveals real-world usage rates for fixtures and appliances:

- 1.6 gpf toilets average about 1.45 gpf
- 2.5 gpm shower heads average about 2.1 gpm
- Clothes washers appear to use their rated water demand
- Biggest issue with water used for dish washing is whether the household has, and uses, a dishwasher

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Reduced turf irrigation due to:

- Abandonment
- Reductions in area
- Replacement with xeriscapes, drought-tolerant plant species
- Restrictions in new construction
- Less winter over-seeding with rye grass
- Replacement with artificial turf

A market exists for plastic grass

Many sellers of artificial turf for residences:

- 5 in Pima County
- 12 or more in Maricopa County
- 7 or 8 in Clark County

Three top marketing pitches are:

#3 – Have your own backyard putting green!

#2 – It's a great place for the kids to play!

#1 – Do it for your dogs!

We recently had a Tucson Turf Lawn installed, and with 4 dogs it has made all the difference. The interior of our home is much cleaner without the dogs tracking in dirt from the yard. Thank you! - Karen F., Tucson, AZ

I wanted to let you know how much we love and enjoy our new backyard patio with your turf. Even our dog loves it. She rolls and sleeps on it (and doesn't dig or rip at it!).

Source of the quotes and pictures is:

www.tucsonturf.com/testimonials.html

NOTE – *not one photo or mention of kids.*



Our new puppy loves her new lawn, as do all of us.



My two small puppies love their new playground. They used to tip-toe around on the rocks - now they run and play like crazy! After playing and chasing each other on the grass for awhile, they love to lay on the grass to catch their breath (and pose for a quick pic). Thanks again. - Sam

Changing face of the American family



Only 33% of households have children, and the figure is declining.

About 45% of households have at least one dog.





Elvis Best "reads" the Torah at his Bark Mitzvah in 2007

Attorney Rachel Herschfeld's mission in life is making certain that companion animals are cared for through pet trusts. Illegal until 1993, it's now legal in all 50 states! (See PetTrustLawyer.com)



St. Francis of Assisi "Blessing of the Animals"



FEMA changed policies after Hurricane Katrina when many people refused to evacuate without their pets.

Congress then passed the Pets Evacuation and Transportation Standards Act of 2006 mandating state and local plans.

Bring children at your own risk.



1. No dogs without people. No people without dogs.
2. Watch your dogs at all times. Discourage barking and digging. If your dog digs a hole, fill it in.
3. No aggressive dogs. Do not touch, pick up, or hug other dogs. Watch for signs of aggression.
4. No dogs in heat. Closely monitor un-neutered males.
5. If your dog gets in a fight, exchange contact information and leave the dog run. You are responsible for any injury caused by your dog.
6. Dogs must be licensed and immunized.
7. **Bring children at your own risk. Children under 10 must be accompanied by an adult.**
8. No glass containers. Use caution and judgement when bringing food into the run.

Turf in Pima County:

- 35% of SFRs have some backyard turf
- 22% of SFRs have a backyard pool
- Correlation between turf and pools is ZERO!

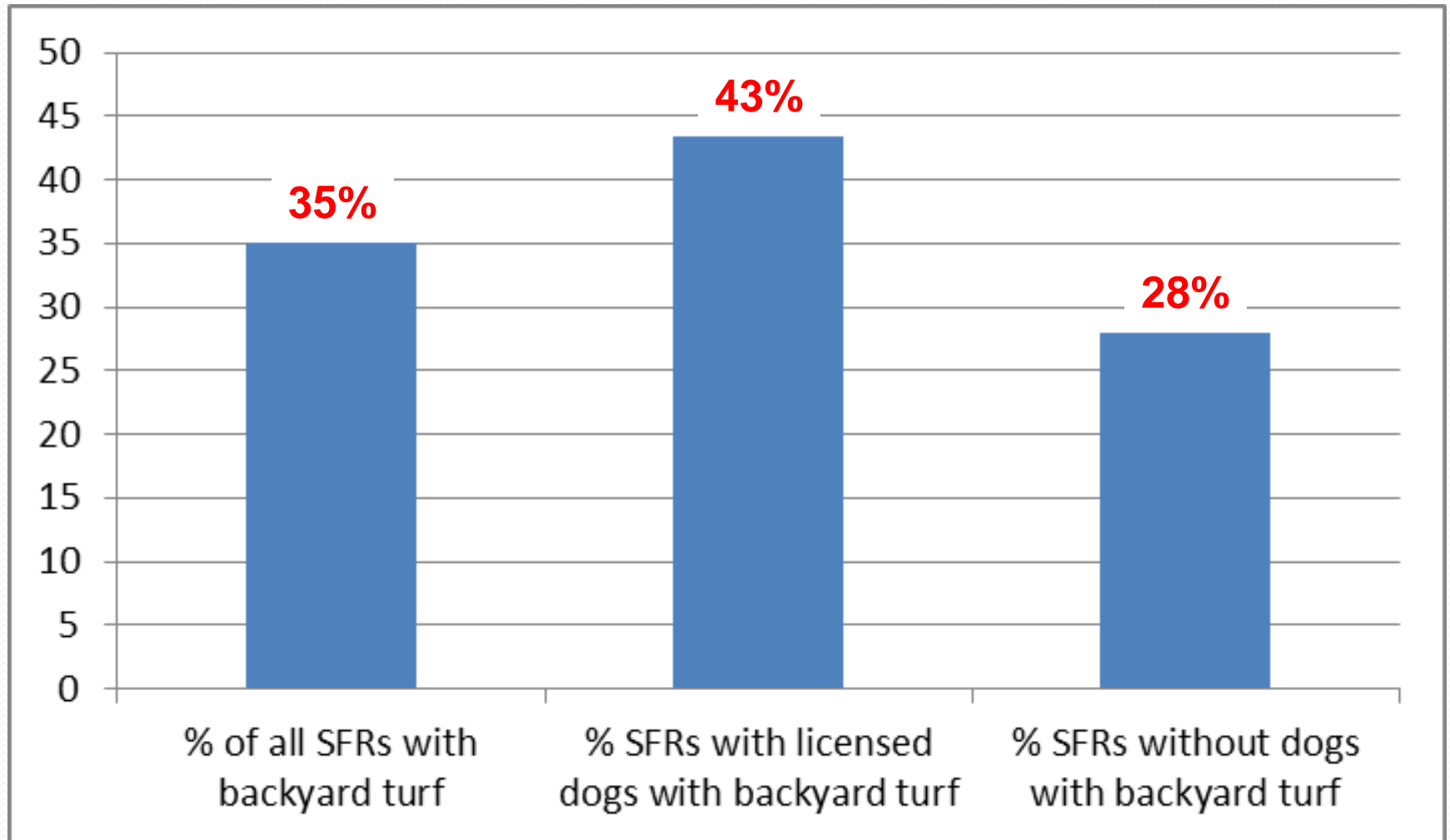
What factors are driving backyard turf?

Dog stats from PACC & PetSmart

- 20% of Pima County households have a licensed dog
- Fewer than half of dogs in Pima County are licensed
- About 45% of households have one or more dogs.

PACC provided a random sample of 500 addresses of licensed dog owners.

Dog ownership and backyard turf are definitely correlated



Do dogs affect other areas of water demand?

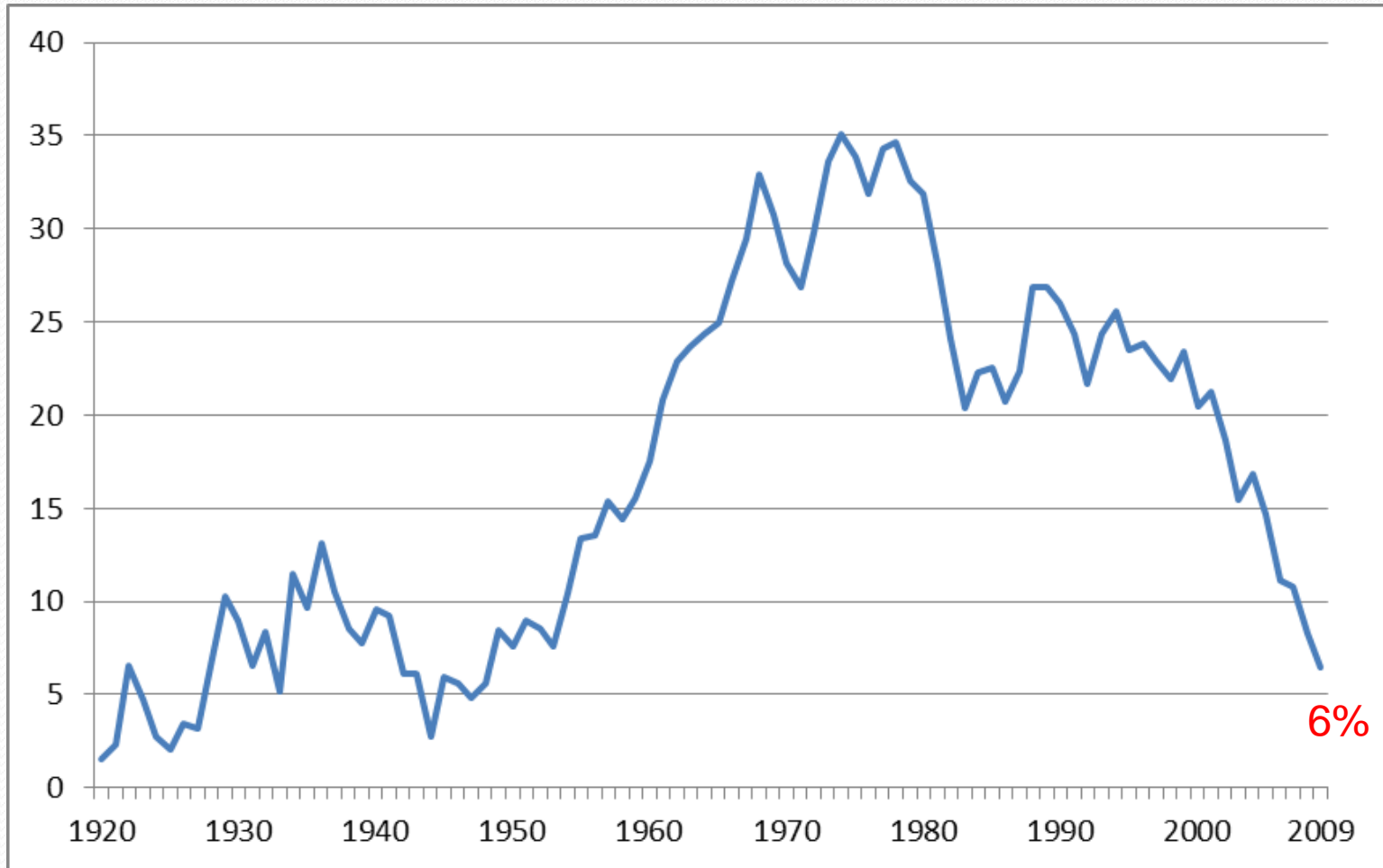


NOBODY includes dog ownership in their socio-demographic sub-model.
ALMOST NOBODY even has a socio-economic submodel.
MOST make simplistic assumptions about population and gpcd.
SOME don't even have a model.

Possible factors of long-term decline:

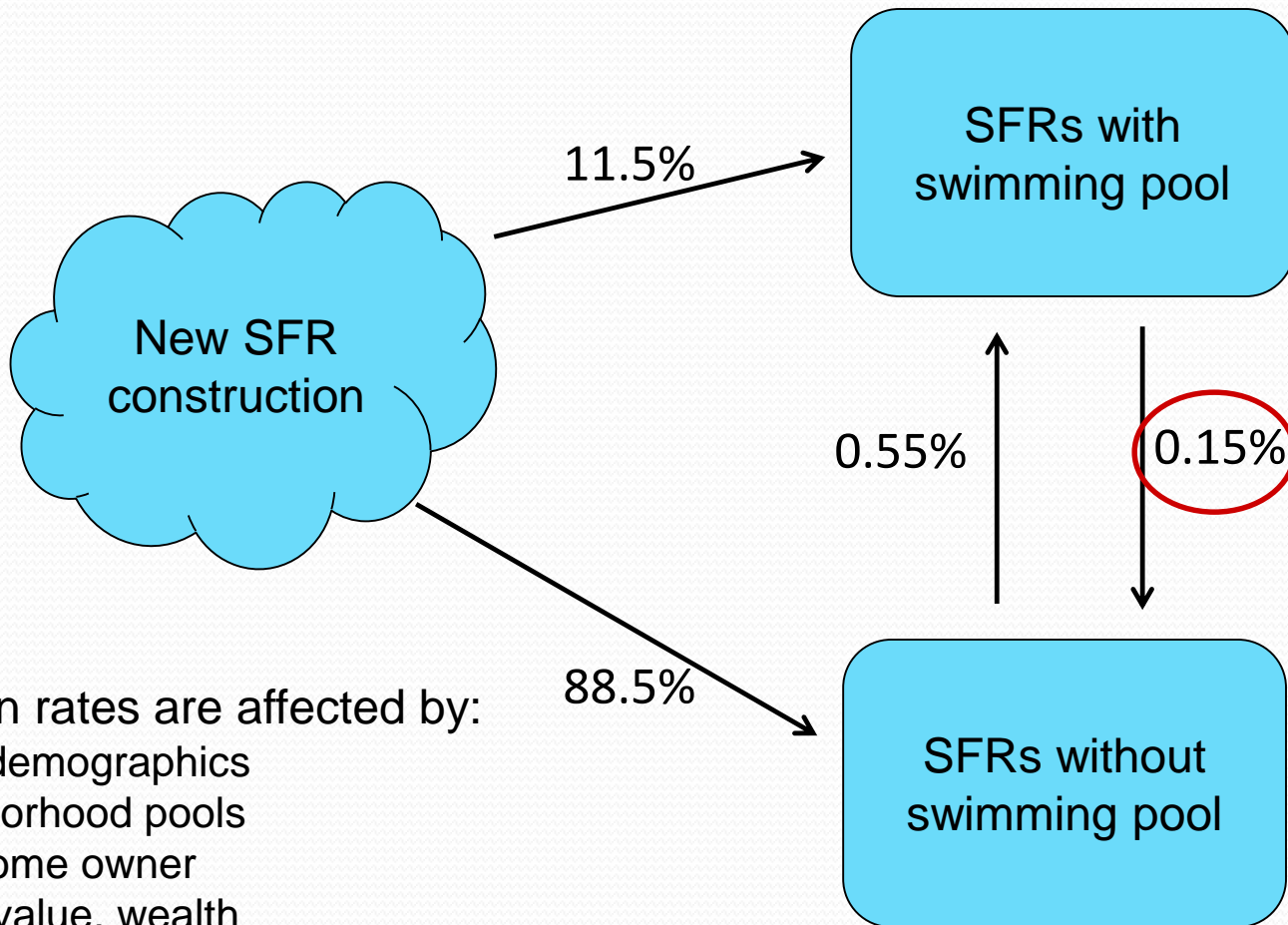
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- more seasonal (part-time) residents

Other outdoor water uses - pools



20% of SFRs have a pool, but the popularity appears to have been in decline for decades.

Home swimming pools and transition rates



Transition rates are affected by:

- PPH, demographics
- neighborhood pools
- new home owner
- home value, wealth

When do anecdotes become a trend?

Maybe when humorists start to notice...



F Minus, *Arizona Daily Star*, Jan. 5, 2013

...or maybe when someone discovers a profit motive.



Webinar:

Swimming pools converted to rainwater harvesting tanks

Swimming pools are fun, but are they worth the time and effort?

Feb. 26, 2013

See how you can save time and money by converting a swimming pool to a rainwater harvesting tank.

\$20 for Members
\$40 for Nonmembers



When it's a home improvement topic in the paper, it's passe.

New uses for old swimming pools

Convert space into useful, attractive landscape features



Mark "Eb" Eberlein, near a pond on his property, put a deck over the swimming pool and created a cistern that stores rainwater for a Painted Hills home's garden and desert landscaping. *Arizona Daily Star, March 7, 2013.*

Pools are not only scarcer, they're shrinking

Swimming pools built today are only a bit more than half the size of pools installed in the 1970s and early 1980s.

What's a spool?



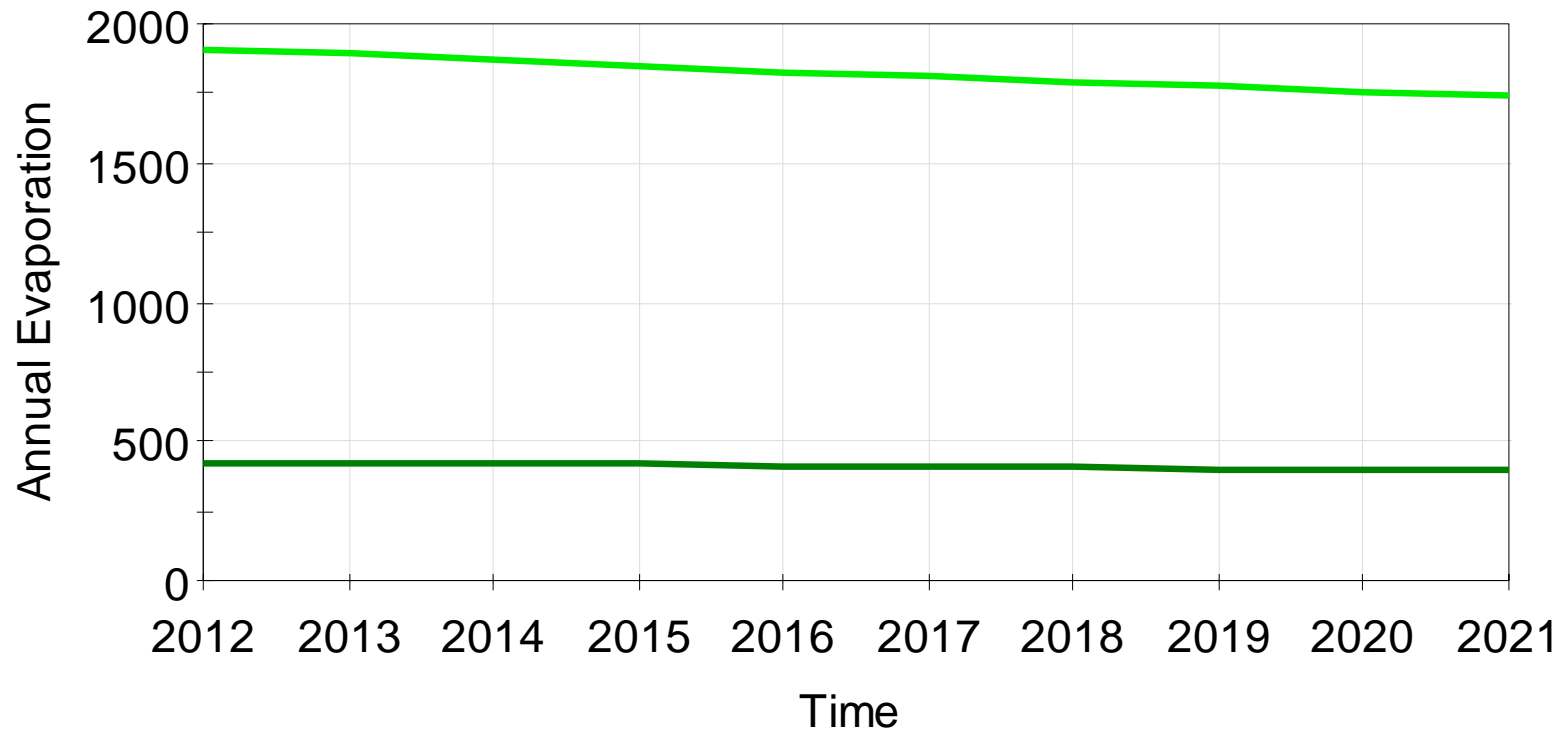
"Stu sure is getting a lot of use out of the new lap pool."

Typical pools – past, present, future



Trend driven by shrinking pools

Evaporation per Pool and Per SFR



— Evaporation per SFR — Evaporation_per_Pool

Backyard pools are becoming:

- less popular
- smaller in size
- used by adults, not families with children
- more likely to be removed

The concept of a *trigger*

Why does someone decide today to put in a pool, or to replace their evaporative cooler with AC, or to buy a horizontal-axis clothes washer?

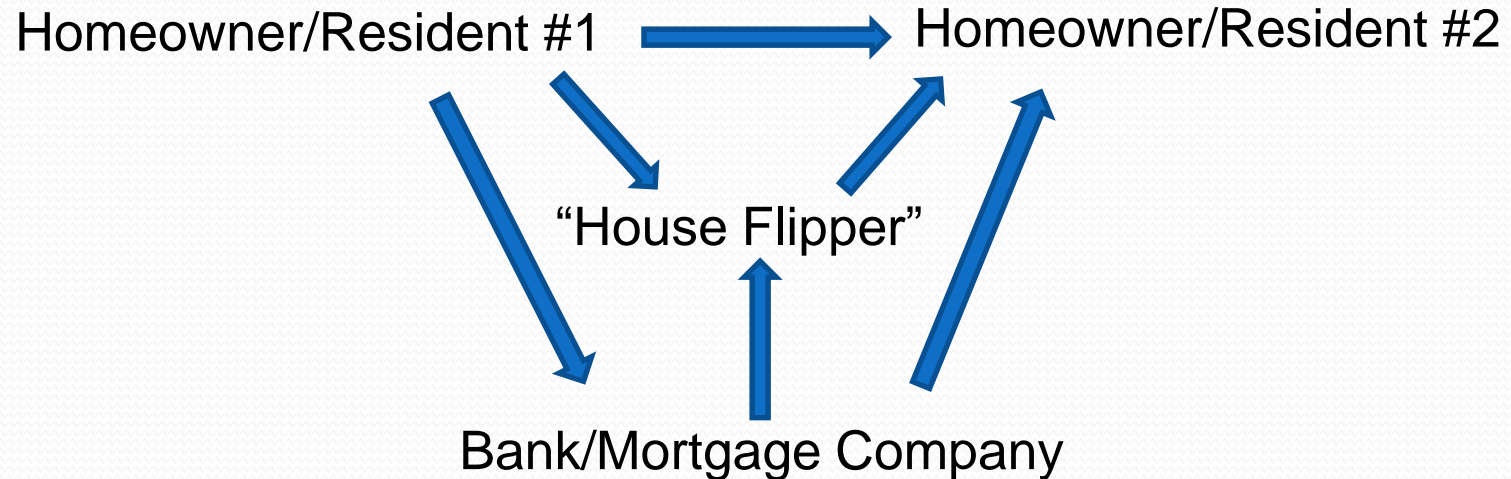
Why today and not yesterday, or a month ago?

What triggers these types of decisions?

Transitions can be triggered by:

- new home owners
- switch between owner-occupied and rented
- major home renovation
- water-using fixture or appliance or landscape dies
- targeted conservation program, e.g., rebate
- having kids / empty nest syndrome
- contagion effect – the neighbors do something
- drought, price shock, recession, etc.

Home ownership transfers



How many foreclosed homes have landscapes die due to irrigation turned off or system failure?

How many homes that are "flipped" have bathroom remodels and/or new washer/dryers installed?

Is house flipping a water conservation trigger?



What is effect of house flipping on demand?

A house with 3 owners within 1 year is likely to:

- be over 10 years old and not well-maintained
- get new water-efficient fixtures in bathrooms and kitchen
- have one or more new water-using appliances
- have its landscaping reduced
- be sold to an investor and then rented

One major trigger – it died

End of useful life for appliance or fixture can trigger water savings because:

- new appliances and fixtures are increasingly efficient
- voluntary standards have become de facto standards

Landscape vegetation also has a finite lifespan, and landscapers are planting more drought-resistant species

Swimming pools never die of natural causes, but old ones may be removed.

Clothes washers as prime example

Municipal Water Demand Washing Machine Sub-Model

User Inputs:
SFR Growth Rate (%)

Seattle Run + -

Annual SFR Growth (%)

0 2 4

Choose Efficiency

Existing
Seattle

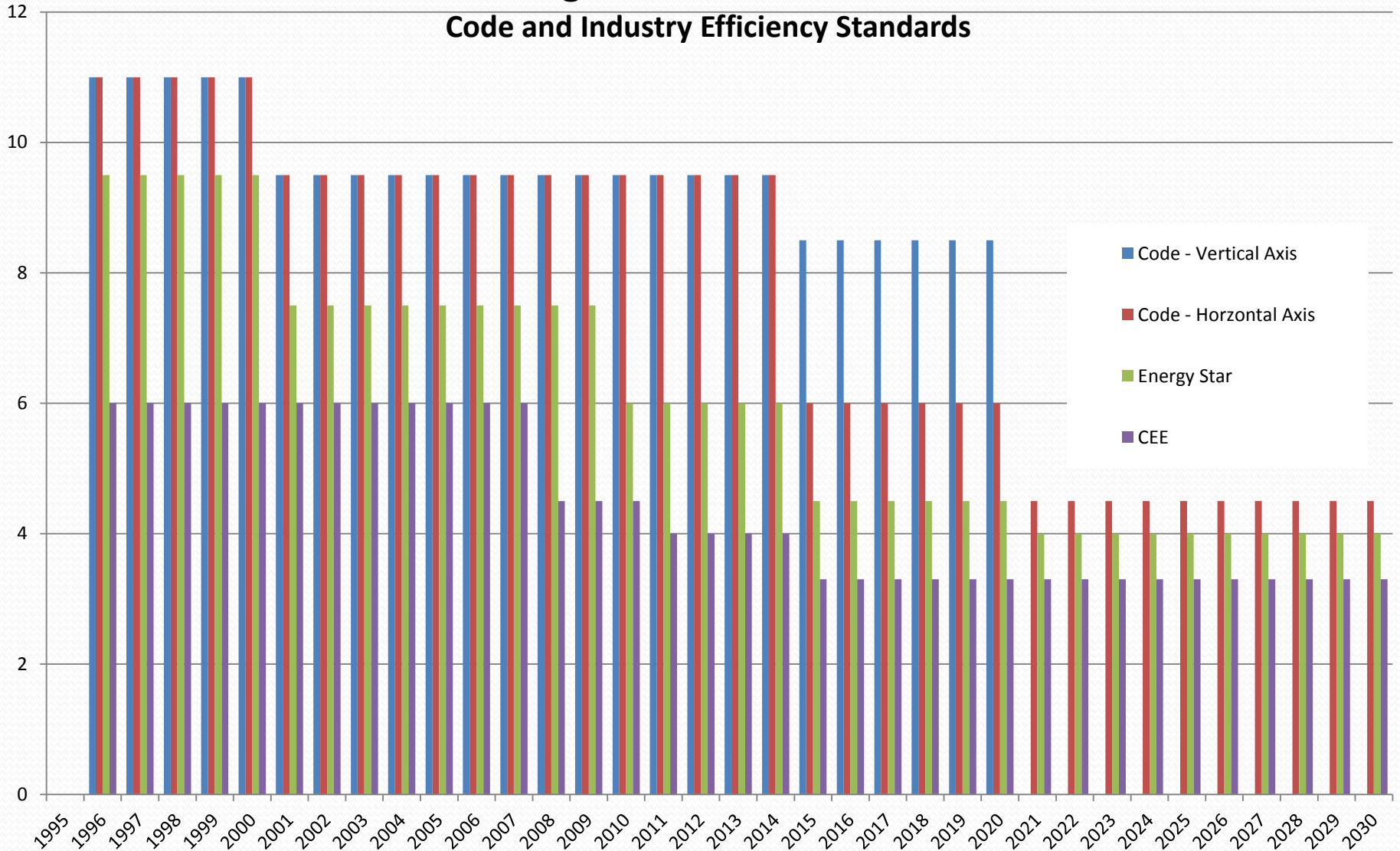
Results

Number of SFRs Normalized Washer Efficiency Weighted Washer Efficiency Total Water Consumption Water Consumption Per SFR

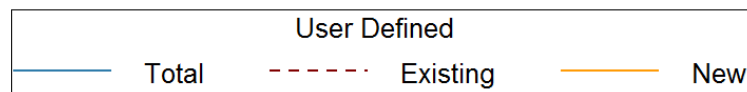
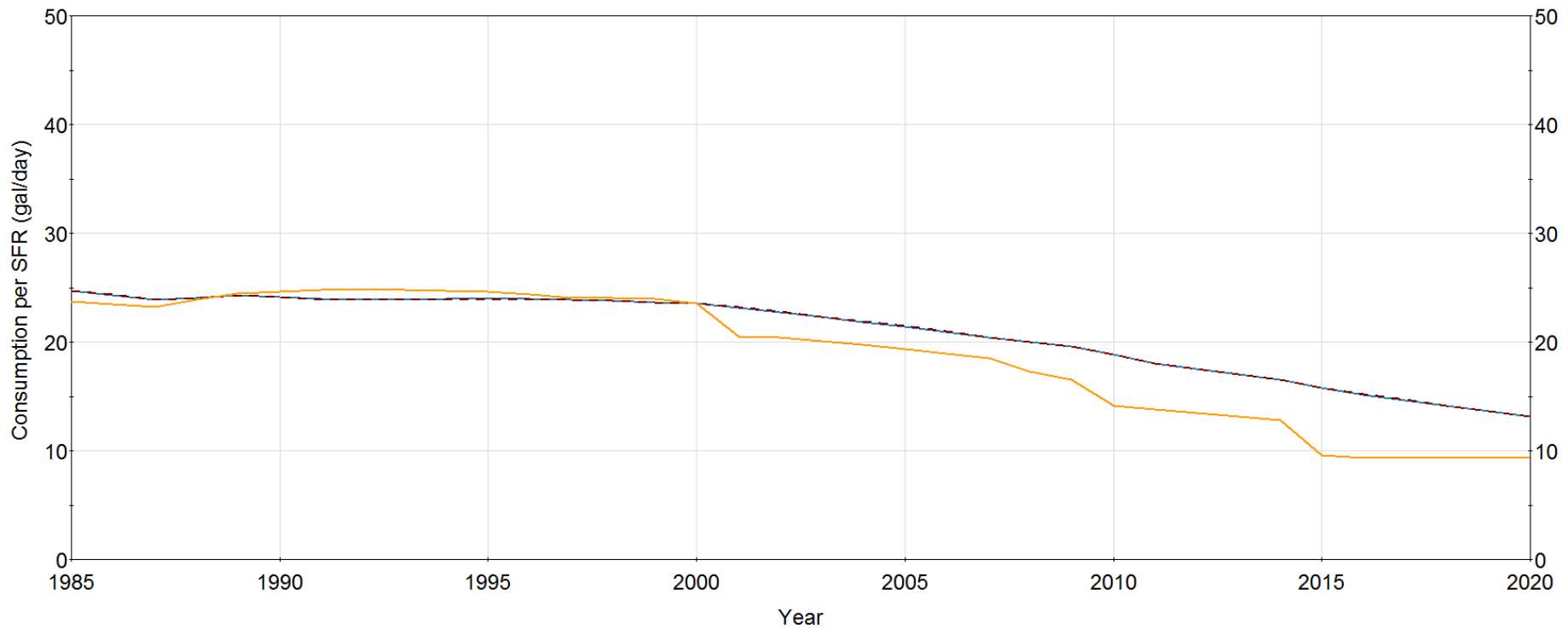
Users Guide Assumptions Efficiency Standards Scenarios Information Sources

Washing Machine Water Factors

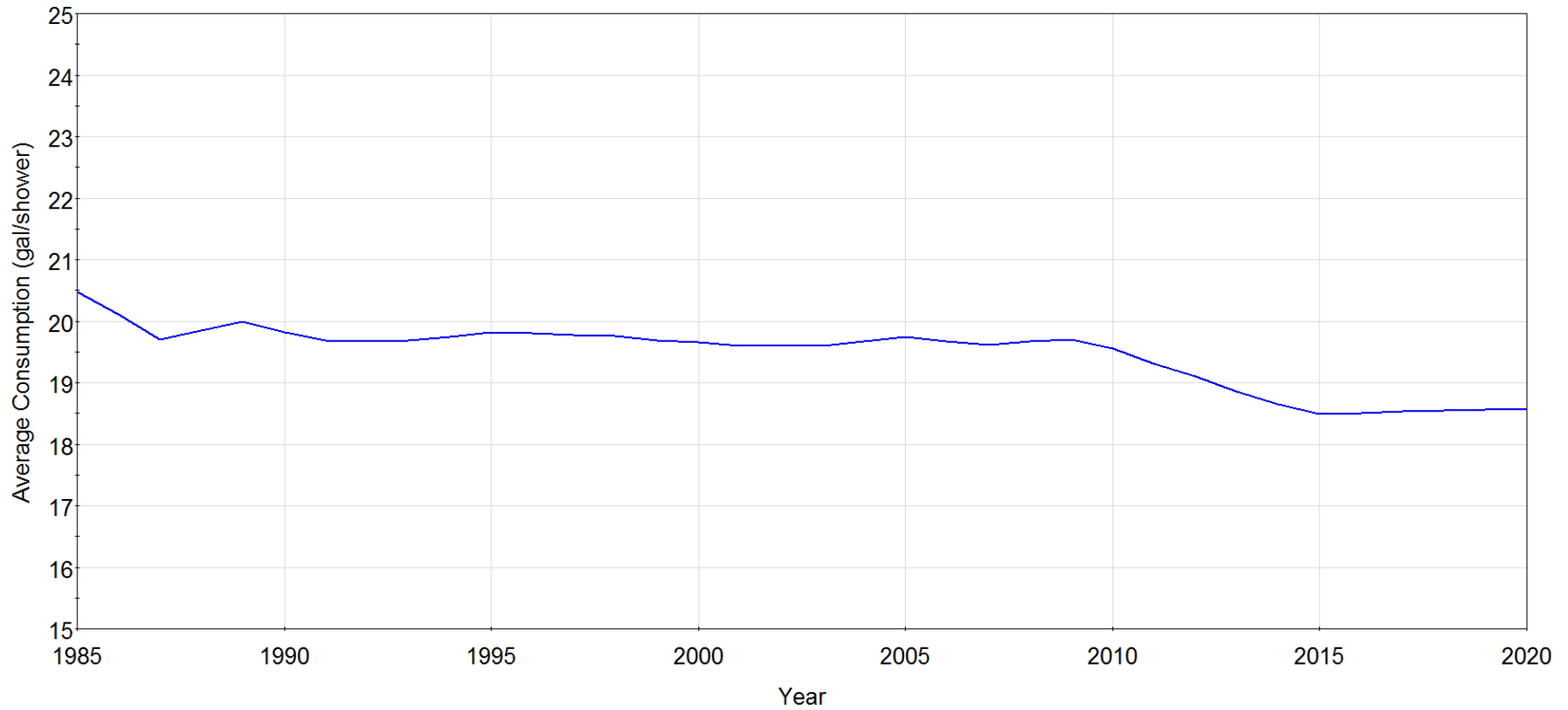
Code and Industry Efficiency Standards



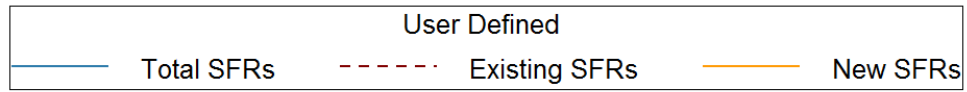
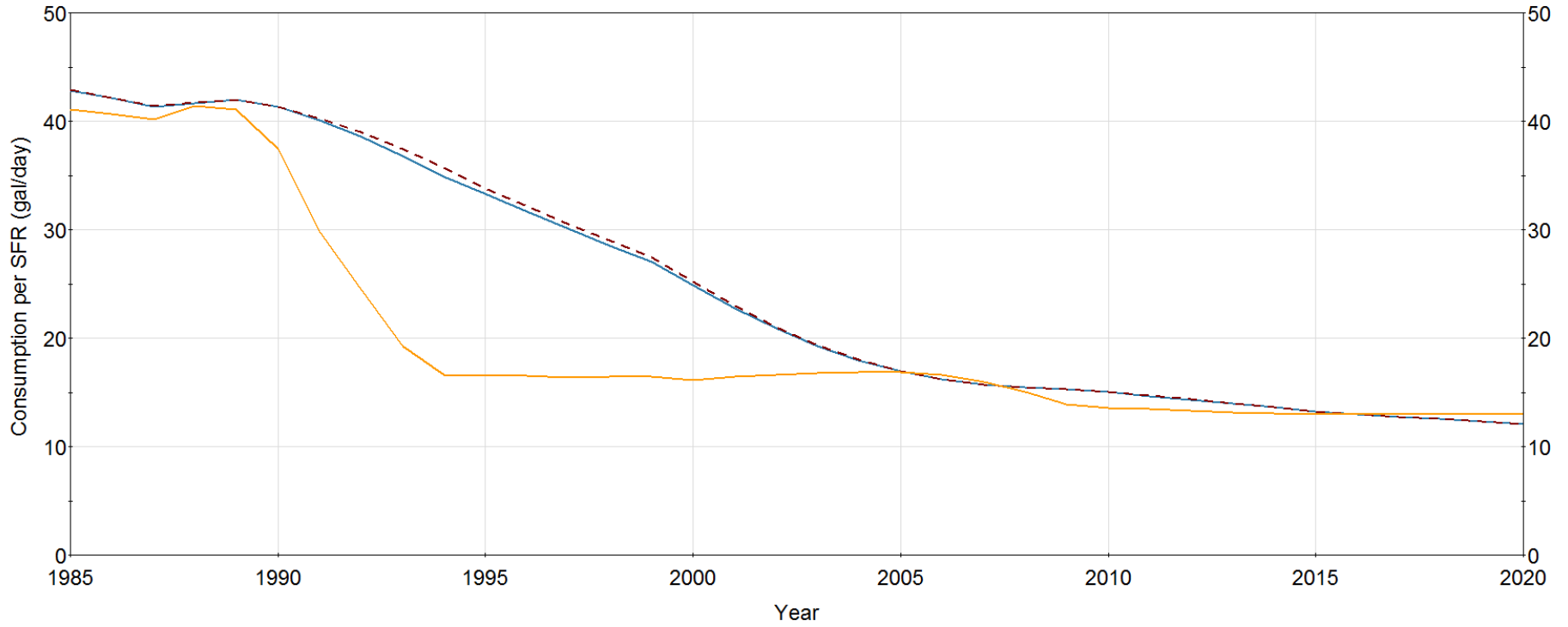
Clothes Washer Water Consumption per SFR



Average Water Consumption per Shower



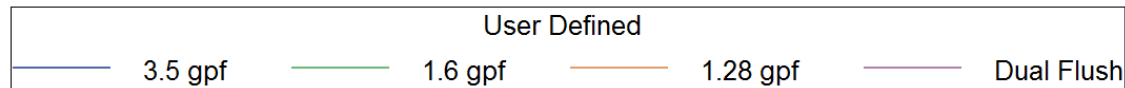
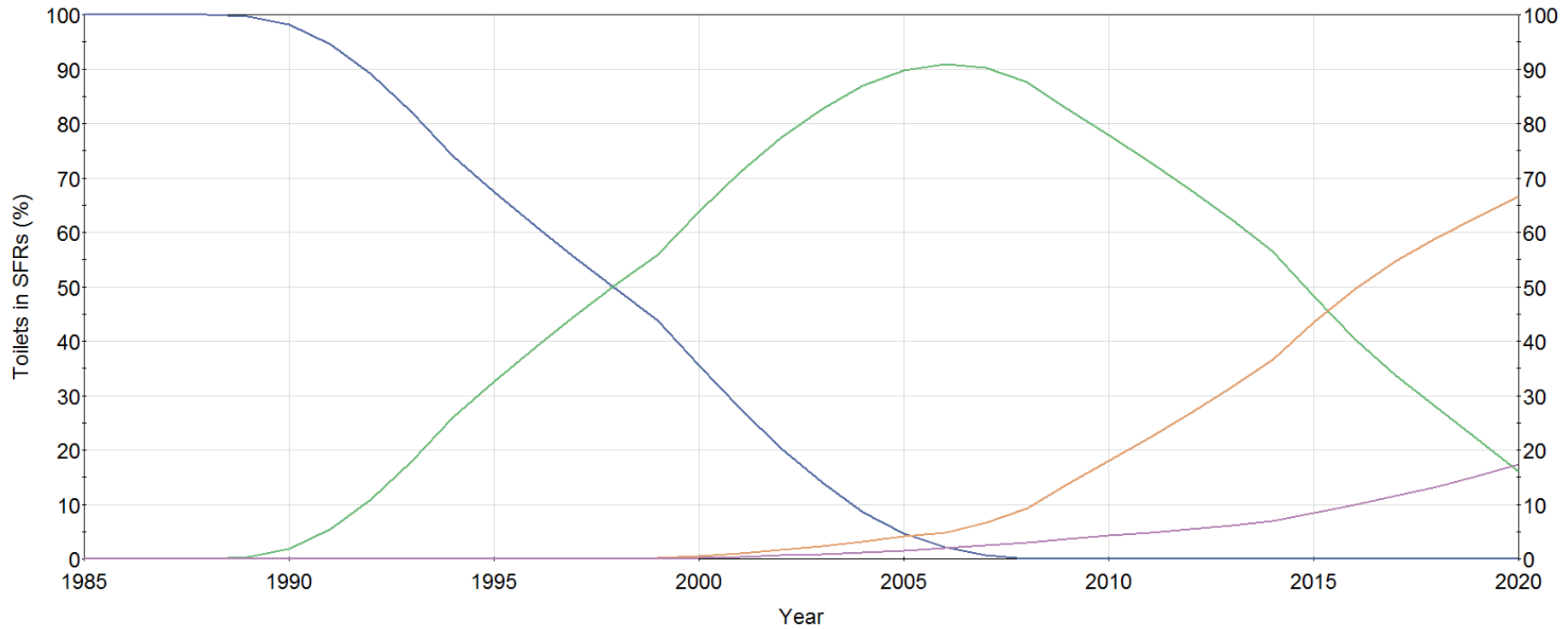
Toilet Water Consumption per SFR



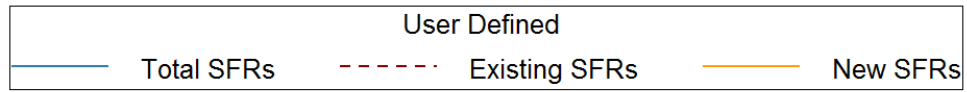
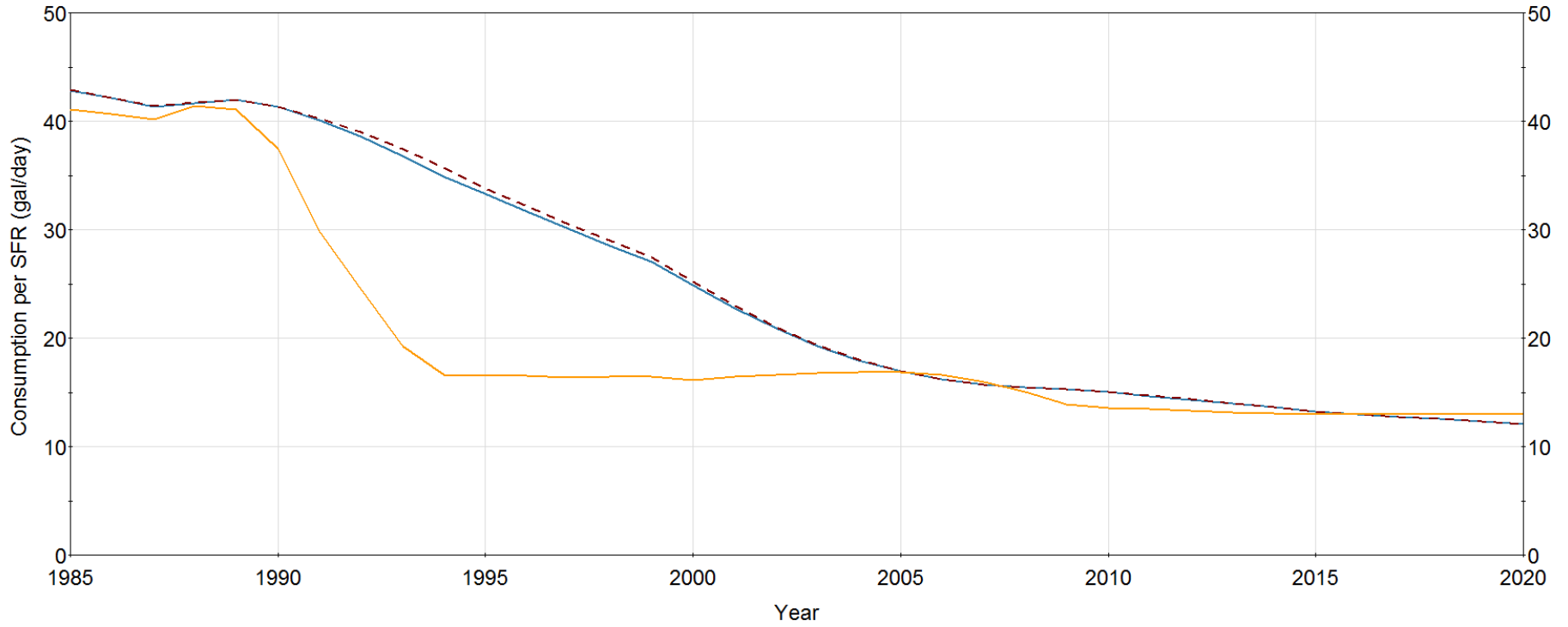
National voluntary standards and state mandatory standards are having impacts:

- Dishwashers – 76 of 80 models sold by Best Buy meet the voluntary Energy Star standard;
- Toilets – 17 of 19 models sold in Home Depot and 22 of 23 models sold in Lowe's meet or exceed the CalGreen and Texas 1.28 gpf standard

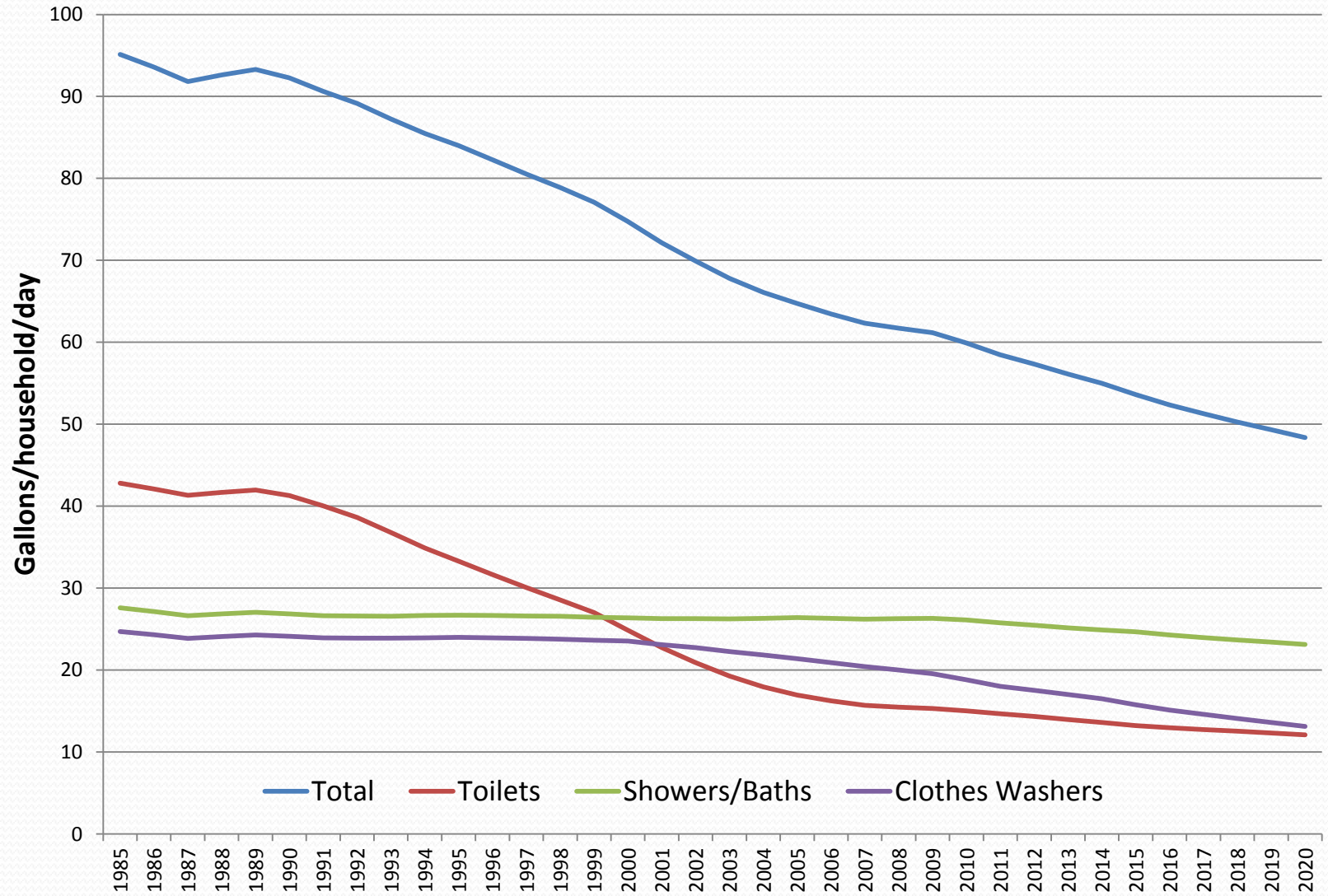
Toilet Penetration Rate



Toilet Water Consumption per SFR



Pima County Indoor Demand Trends



What are the limits to efficiency?

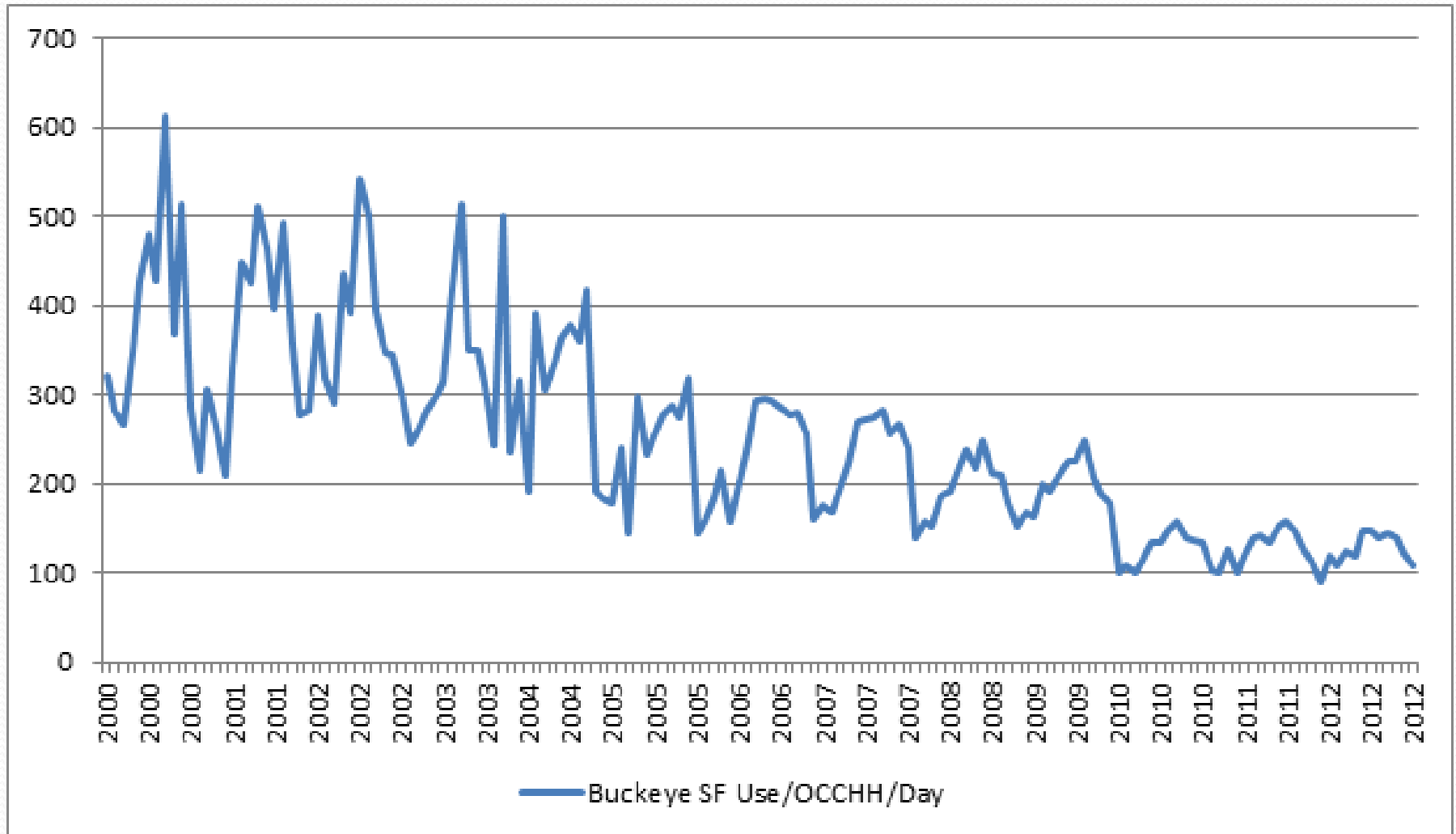
- Toilets – from 5 gallons to 3.5 to 1.6 to 1.28 to 1 (dual)
- Shower heads – from 4 gallons/min to 2.5 to 2.0 to 1.5
- Clothes washers – from 40 gallons/load to 27 to 23...

New clothes washing technology may reduce water usage to under 8 gallons/load.

New home construction situation

- Post-bubble shakeout left only 7 national builders
- Four of them claim their homes are “sustainable”, “green”, and/or efficient
- Two of them appear to be serious
- New homes will continue to be more water-efficient, both indoors and outdoors
- Market forces will decide how hard builders push the trend; government not currently having any real effect

Buckeye, AZ – example of hypergrowth



Recap and Conclusions - 1

Three factors are driving declines in domestic demand:

- Adding new, water-efficient houses to existing housing stock
- Active conservation efforts – program-related
- “Passive conservation” driven by changes in tastes and preferences and more efficient devices

In most cases, active conservation is the third-most important factor, but it often gets all the credit/blame.

Recap and Conclusions - 2

Average consumption forecast for Pima County:

Indoor

- Toilets: gradual decline, levelling off
- Clothes Washers: accelerating decline
- Showers: frequency slightly up, baths down (aging pop.)

Outdoor

- Pools: gradual decline
- Evap Coolers: gradual exponential decline
- Turf: front yards all but gone, backyard likely decline

Overall: gradual decline

Recap and Conclusions - 3

- We are far past peak cooler
- We are well past peak lawn
- We appear to be near peak pool
- Largest component of indoor demand is now showers/baths. This is the logical place to focus conservation efforts. If...

Recap and Conclusions - 4

- Water demand is no longer tightly tied to population, economic output, conservation efforts, or quality of life...
- ...and the downward trends are expected to continue through the end of the decade and beyond.

Issues created:

Unanticipated declines in municipal water demand have created issues, including:

Fiscal Consequences

- revenues drop more than expenses
- conservation-oriented rate designs exacerbate the problem
- budgeting uncertainties

Operational Issues

- reuse of reclaimed water
- longer “water age” impacts residual disinfectant levels and disinfection by-products
- uncertainties as to available unused system capacity for wastewater plants

Planning Challenges

- optimal timing of capital improvements
- acquisition of new supplies
- rate setting
- design of water conservation programs

Public Perception Issues

- water conservation blamed for rate hikes
- people feel they are being punished for conserving

Final thoughts – beware water misers

We need to change our water budget conversations

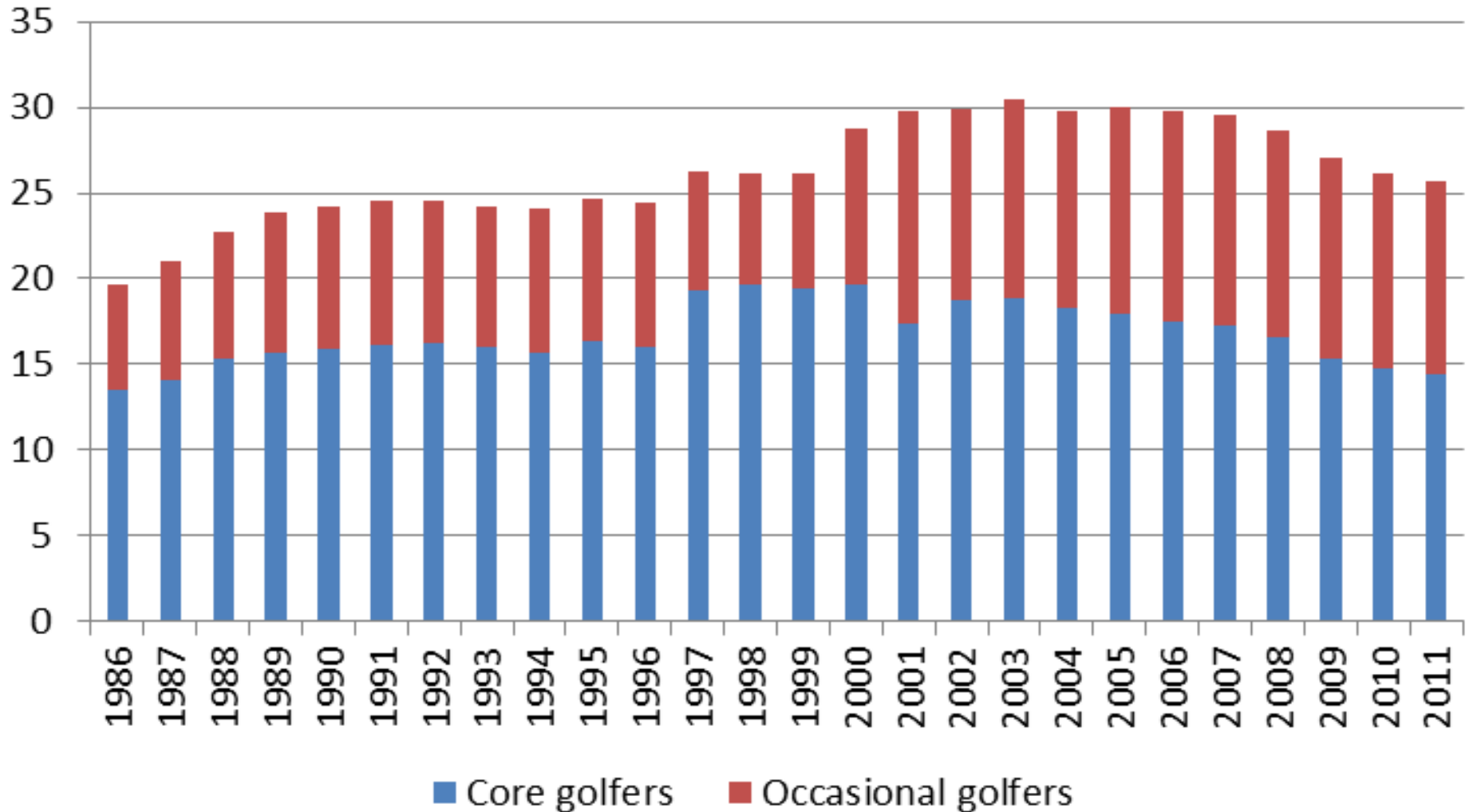
From: “How can we further reduce demand?”

To:

“How can we best use the water that we have to maximize our quality of life and protect future generations?”



Fewer golfers are playing less frequently



...creating a need to repurpose closed courses.

