This presentation premiered at WaterSmart Innovations

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INNOVATIONS

Irrigation water restrictions, not as good as you think

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WaterSmart Innovations October 2015

Irrigation water restrictions,

~~not as good as you think~~

better than I initially thought

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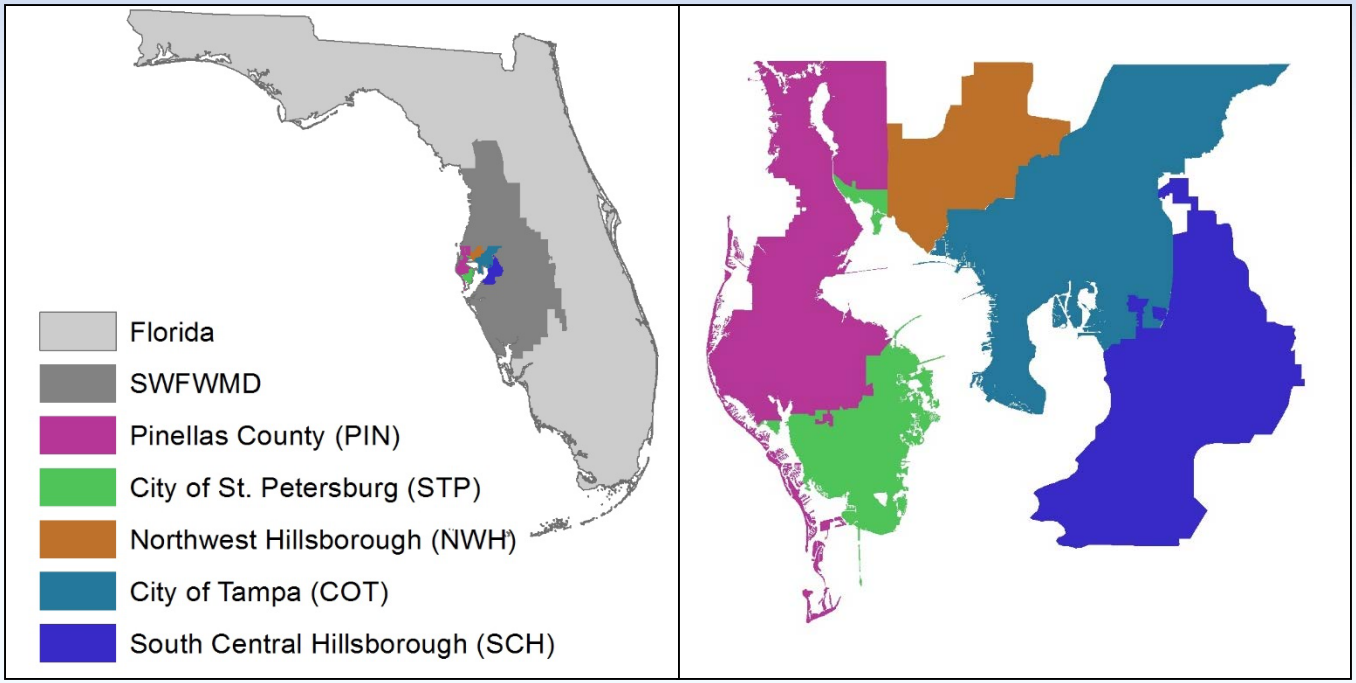
Study area



- Five member-government service areas of Tampa Bay Water within Southwest Florida Water Management District
- Long (> 20 year) history of water restrictions

The Southwest Florida Region
A LEADER IN Conservation

200 MILLION GALLONS PER DAY (GPD)

Estimated reduction in potable water demand due to conservation and source substitutions since 1987

2013 Conservation All-Stars

Lowest Per Capita GPD

50 Pinellas Park
55 Venice
56 Port Richey
65 Englewood
67 Gulf Port
68 North Port
69 Clearwater
70 Arcadia
72 Oldsmar
75 Sarasota Co.
75 Manatee Co.
77 Pinellas Co.
78 Dunedin
78 Sarasota
79 St. Petersburg

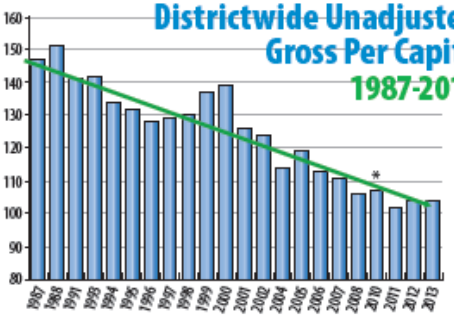
Compliance Per Capita

District average per capita* 107 gpd

Florida average per capita* 134 gpd

United States average per capita* 143 gpd

*2010 USGS Data



$100 Million+ Shared Investment

CFI Cooperative Funding Initiative
164 Projects
More Than $50 Million Project Costs

FARMS
163 Projects
More Than $57 Million Project Costs

District leak detection services have saved 6 mgd

250,000 toilet and 1/2 million shower and fixture retrofits saved 15 mgd

Florida Water Star℠ certified homes use up to 40% less water than typical homes

BUSINESSES IN THE REGION LEADING THE WAY

99% of water use permit holders in compliance (with their total quantities)

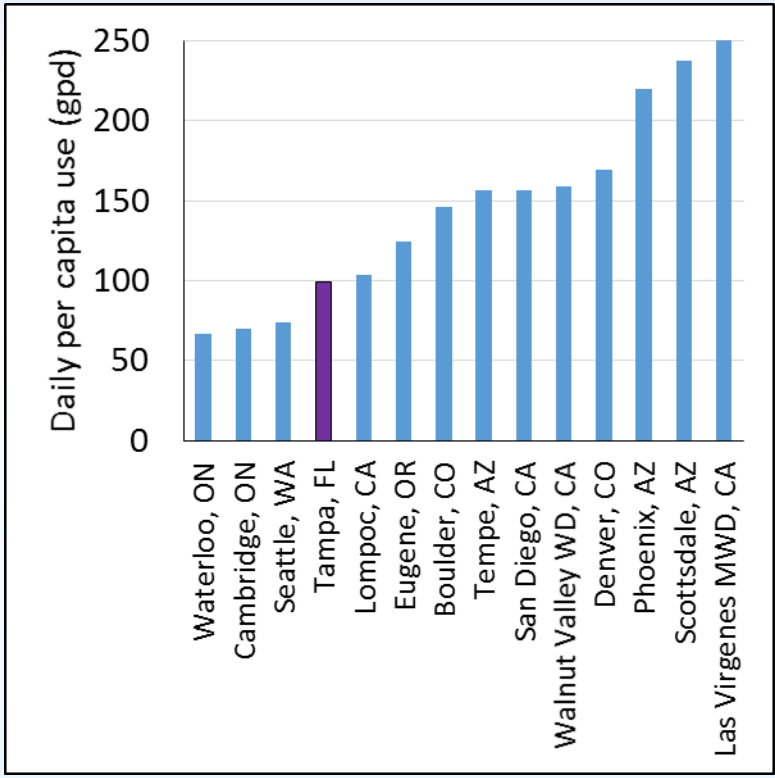
78% of large utilities adopted rate structures that promote greater conservation

WaterCHAMP hotels save 150 million gallons per year

rev 01/23/15

Southwest Florida Water Management District

For more information, WaterMatters.org/Conservation



Adapted by Mayer et al. 1999

Current SWFWMD restrictions

Automatic irrigation twice per week

Irrigating days determined by address

Hand watering not regulated

Exceptions for establishment

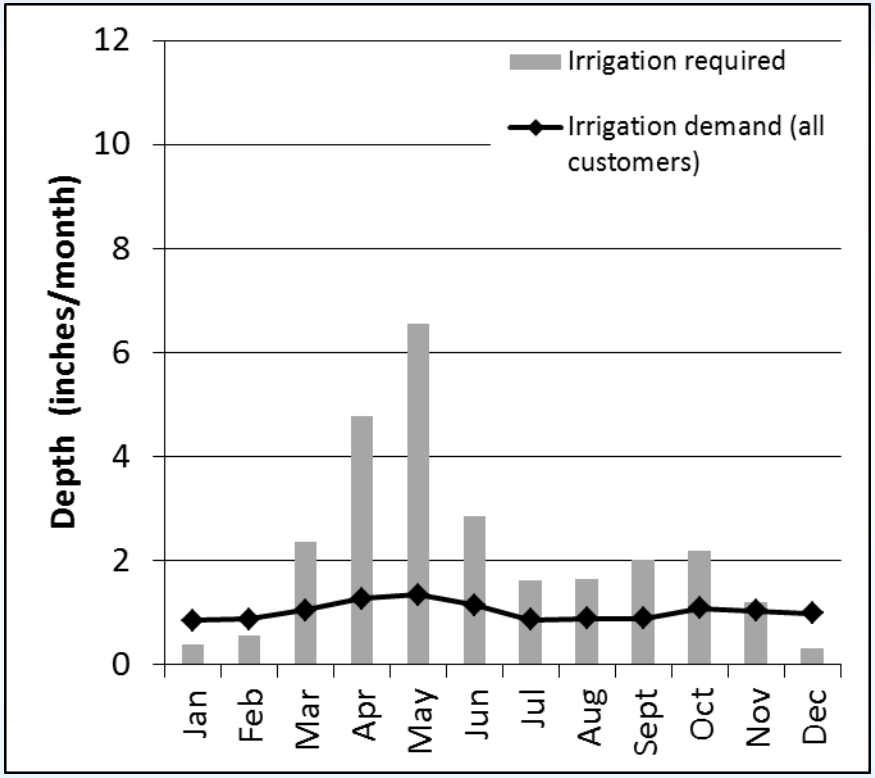
Lawn Watering Days and Times

- Lawn watering is limited to twice per week.
- Lawn watering days and times are as follows unless your city or county has a different schedule or stricter hours in effect:
  - Even addresses may water on Thursday and/or Sunday before 10 a.m. or after 4 p.m.
  - Odd addresses may water on Wednesday and/or Saturday before 10 a.m. or after 4 p.m.
  - Locations without a discernable address, such as rights-of-way and other common areas inside a subdivision, may water on Tuesday and/or Friday before 10 a.m. or after 4 p.m.
- Hand watering and micro-irrigation of plants (other than lawns) can be done on any day and any time.

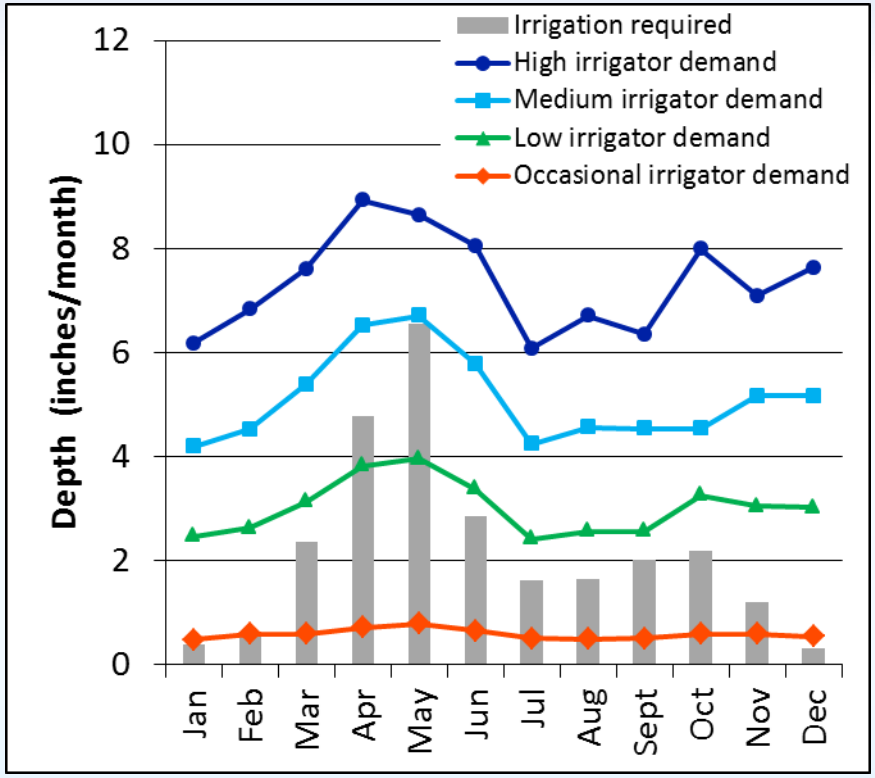
New Lawns and Plants

- New lawns and plants have a "30-30" establishment period.
- On the day of installation, watering is allowed on any day at any time.
- During the first 30 days, watering is allowed on any day during the allowable hours.
- During the second 30 days, watering is allowed three days per week: even-numbered addresses may water on Tuesday, Thursday and Sunday; odd-numbered addresses may water Monday, Wednesday and Saturday; and locations without a discernable address may water on Tuesday, Friday and Sunday.

Previous research: Irrigation demand and required

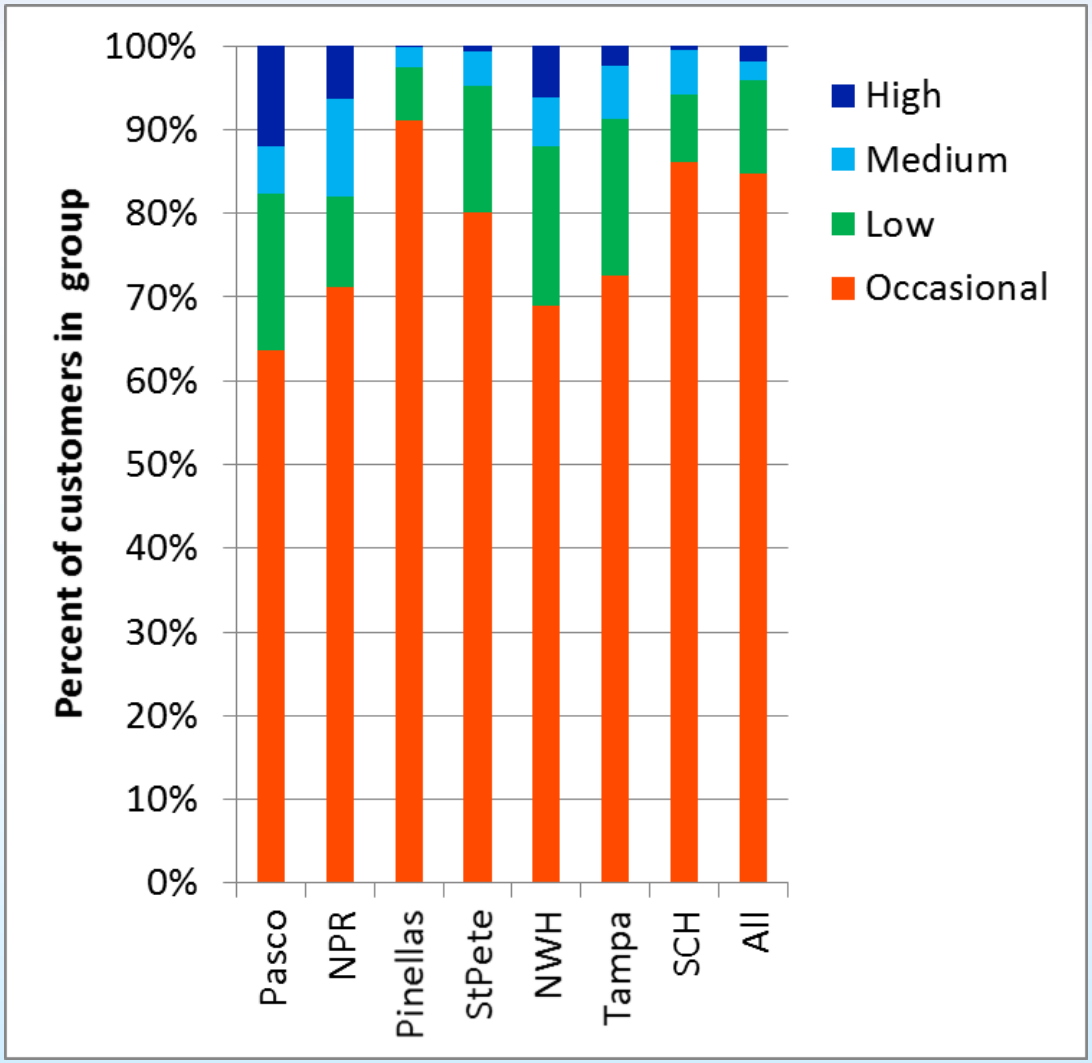


All customers combined

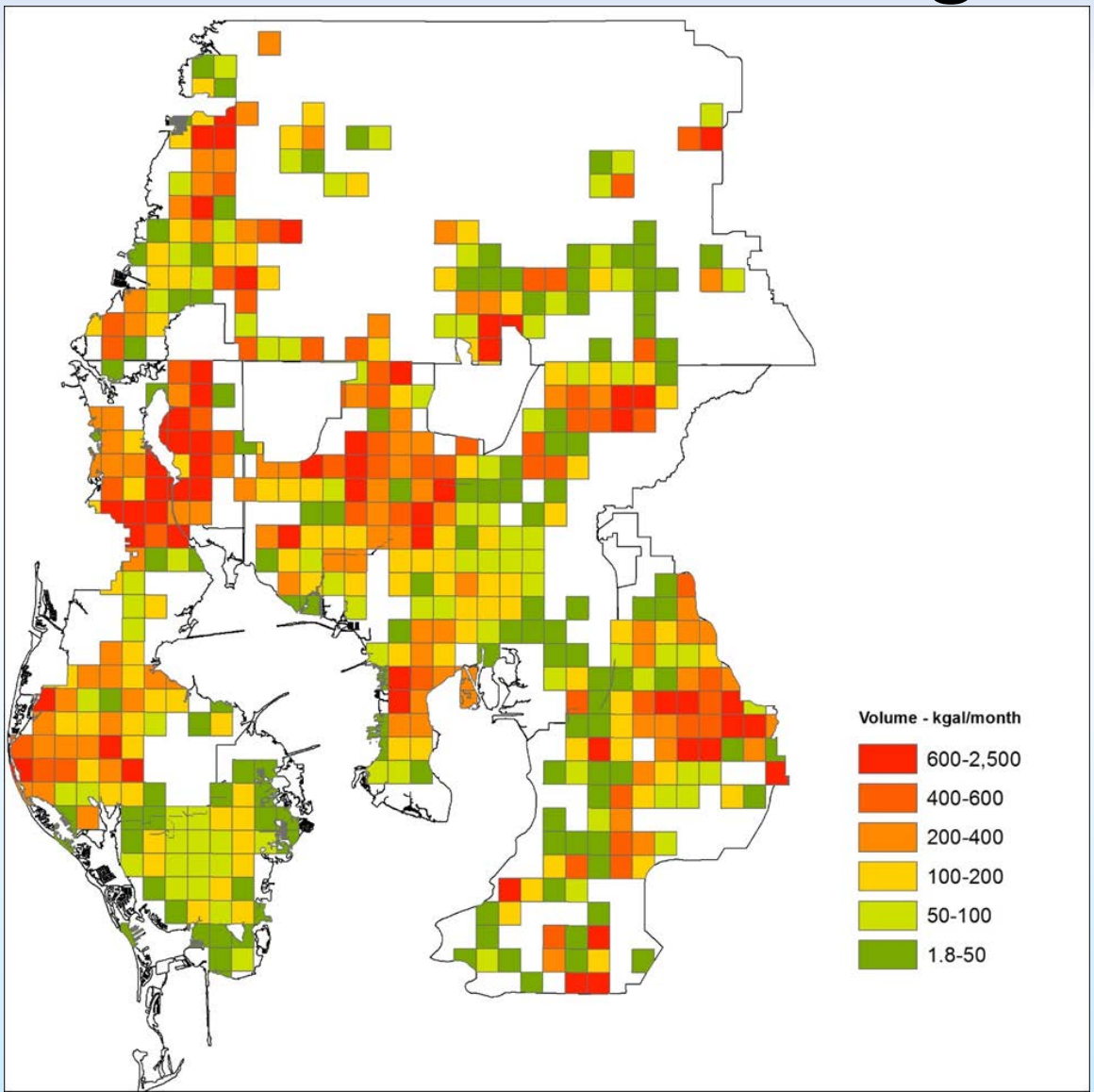


High, medium, low, and occasional irrigating groups

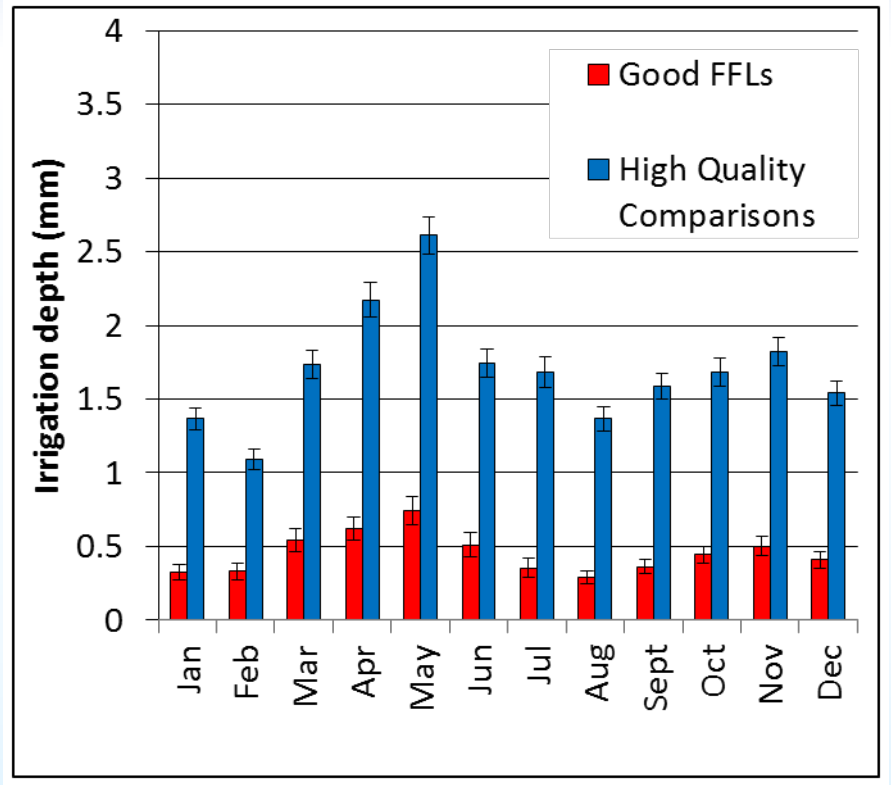
Previous research:
15% of customers regularly irrigate



Previous research: Spatial distribution of irrigators



Previous research: Florida-Friendly Landscapes (FFL)



- FFLs use 50% to 70% less irrigation than traditional landscapes

FFL

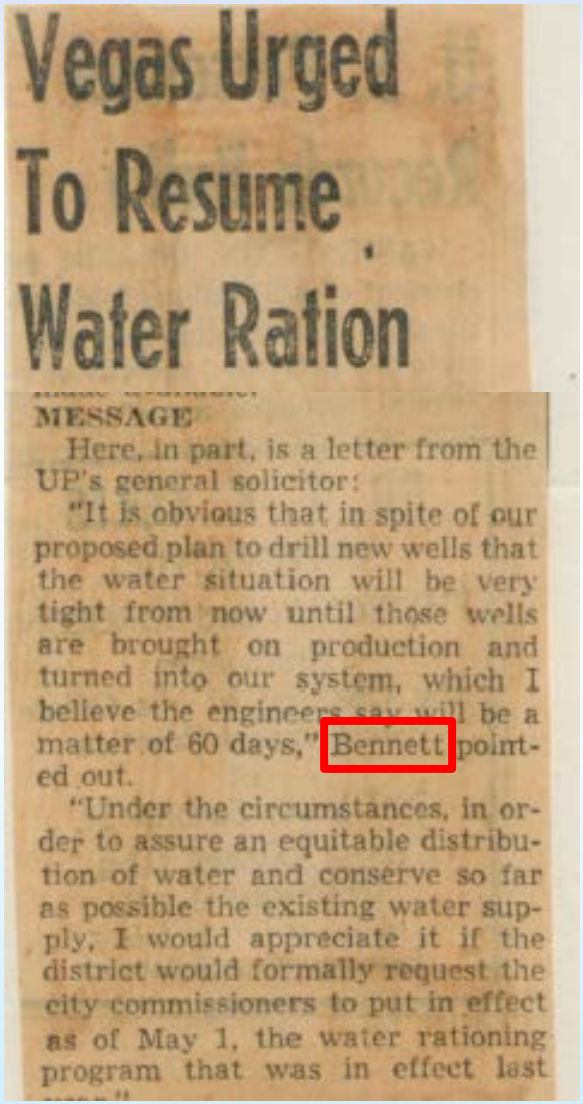
Traditional

Research questions

- Did increasing watering restrictions from 2 days/week to 1 day/week reduce the annual irrigation demand?
  - How did irrigation demand compare to required and expected irrigation
  - Was the change consistent among irrigating groups?
  - Was the change consistent among member governments?
  - What about that preliminary data?

Previous water restriction studies

Las Vegas, NV 1934-1959



Vegas Urged To Resume Water Ration

MESSAGE

Here, in part, is a letter from the UP's general solicitor:

"It is obvious that in spite of our proposed plan to drill new wells that the water situation will be very tight from now until those wells are brought on production and turned into our system, which I believe the engineers say will be a matter of 60 days," Bennett pointed out.

"Under the circumstances, in order to assure an equitable distribution of water and conserve so far as possible the existing water supply, I would appreciate it if the district would formally request the city commissioners to put in effect as of May 1, the water rationing program that was in effect last

Reno Evening Gazette April 21, 1954

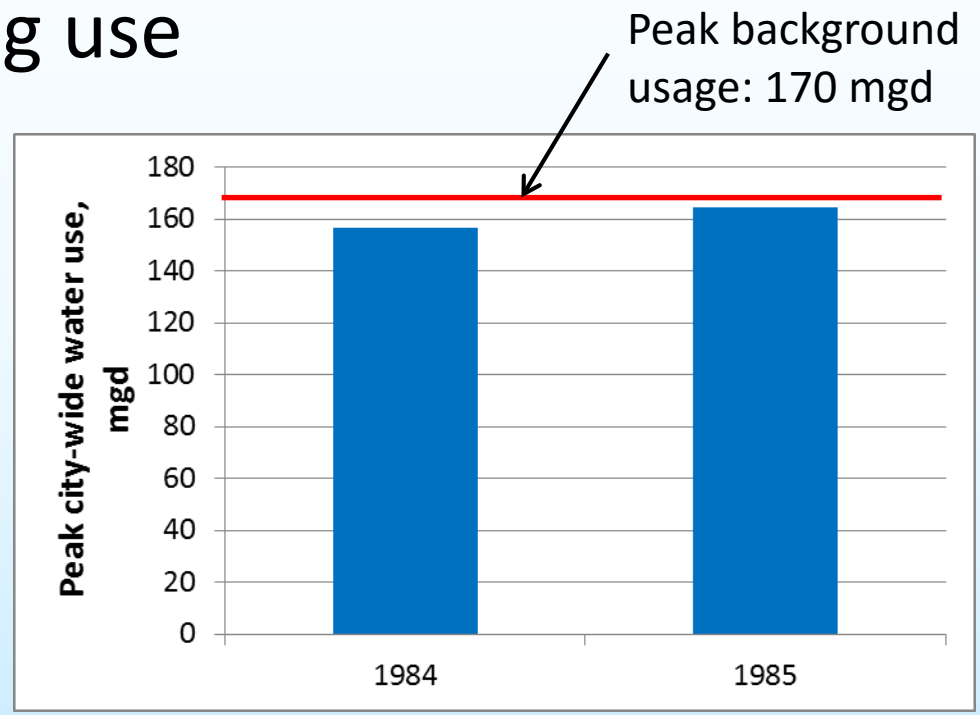
- Continuously running sprinklers → low system water pressure
- 1934: first restrictions
- 1947-1959: several short stretches of restrictions banning daytime watering
  - 1949: Second floor of hospital without water due to low pressure
  - 1954: Homeowners suspected of violating restrictions were arrested
- Water supplies increased with connection to Lake Mead

Fort Collins, CO
July 15-August 23, 1977

- 2 day/week restrictions
- Watering days initially based on geographic area
- Study demonstrated the importance of including current demand in evaluating effectiveness of restrictions
  - Water use decreased 41% below previous year
  - Water restrictions impact: 603 ac-ft reduction
  - Wet weather conditions impact: 659 ac-ft reduction

Austin, TX
Summers of 1984 and 1985

- Forecasting model used to predict when usage may trigger more stringent restrictions
- Predictions publicized→ affluent service zones reacted by increasing use
- Restrictions limited watering to once every 5 days



Colorado, May-August 2002

Municipal Water Provider	Watering Days per Week	Reduction Net Use (%)	Reduction Per Capita Use (%)*	Reduction Expected Use Per Capita (%)**
Thorton	2 ⅓ (voluntary)	-8	1	9
Aurora	2 ⅓	9	12	16
Denver Water	2 ⅓	7	10	13
Westminster	2 ⅓	4	7	14
Fort Collins	2	9	13	18
Boulder	2	24	24	27
Louisville	2	39	39	41
Lafayette	1	46	49	50

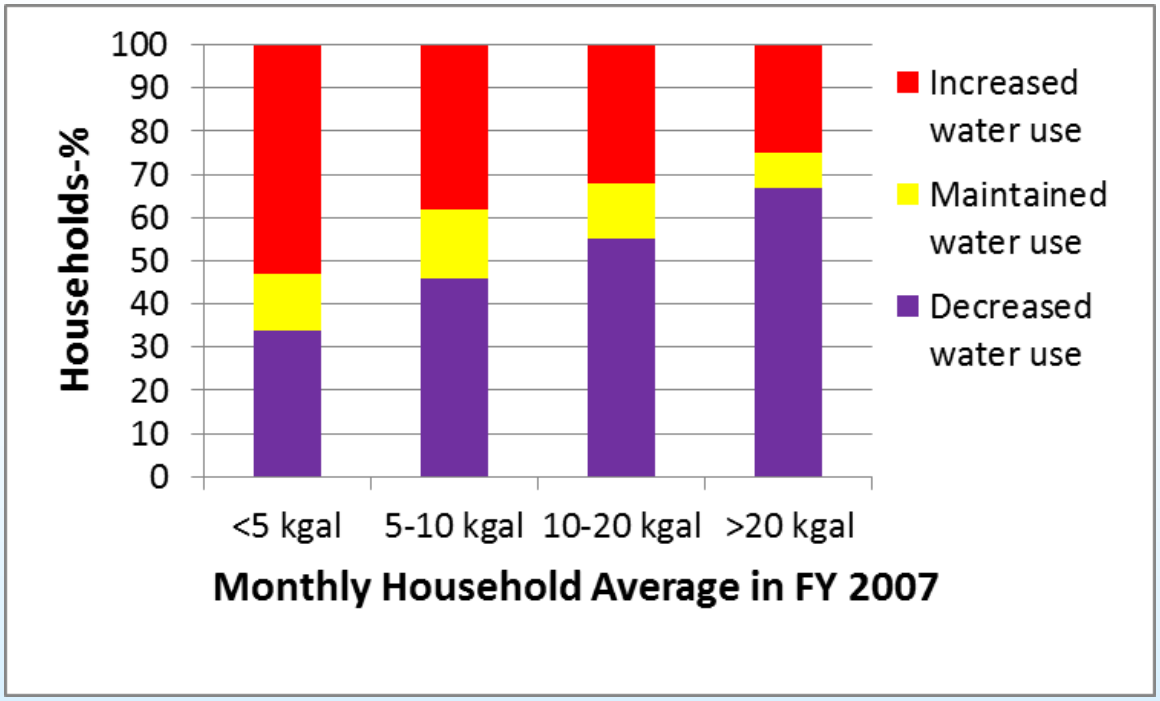
*Region experienced high population growth from previous (comparison years)

**Based on linear regression model of maximum daily temperature, daily precipitation, and previous day's water demand

- Restrictions well-publicized
- Cohesive restrictions would have been easier

North Carolina, 2006-2008

- Per capita water use increased 9% from July 2006-June 2007 to July 2007-June 2008, but:



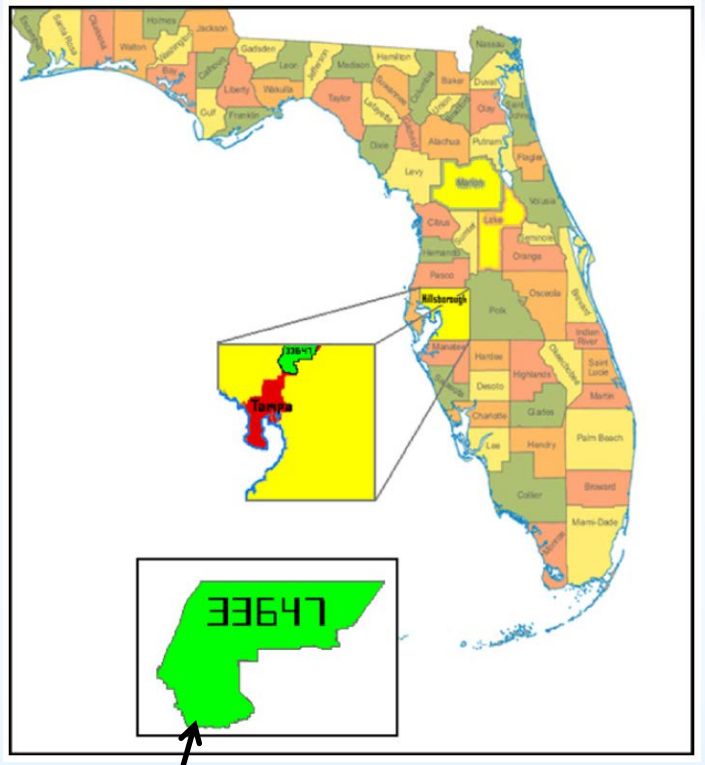
Wellington, Palm Beach County, Florida, 2009

- 2 day/week restrictions
- 165 homes (100 self-supply, 65 public supply)
- Water use: irrigation audits and daily visual inspections
- Observed irrigation: 1.3 events/week
- Use was 3.7 times the targeted use based on weekly rainfall and ET

Tampa, Florida, 2004-2008

Ozan and Alsharif (2013) study

- 225 homes in three neighborhoods
  - 30% of studied homes had received citation vs ~1.5% citation rate for all Tampa customers
- Analysis data
  - Monthly total water billing records
  - Twice a week: June 2004-May 2006
  - Once a week: June 2006-May 2008

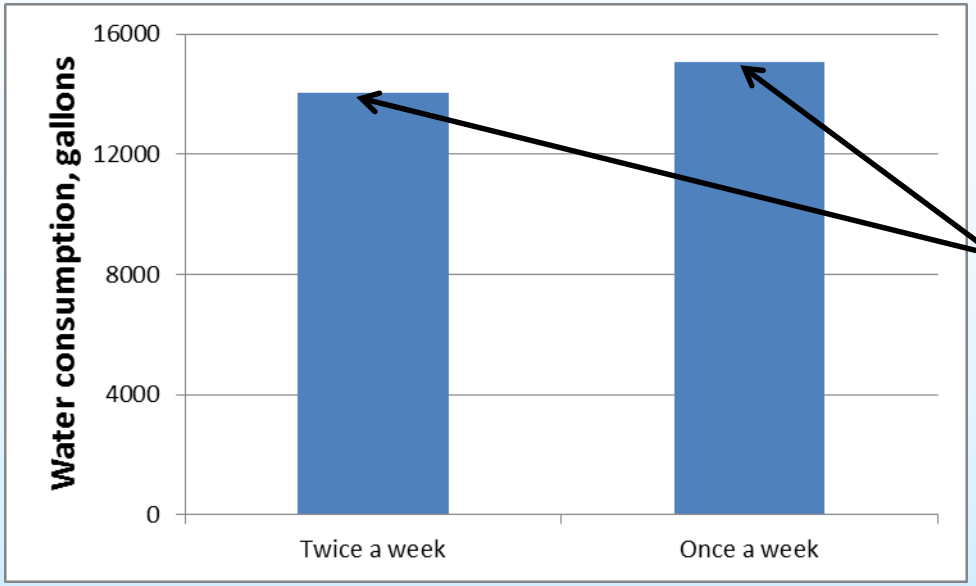


Ozan and Alsharif 2013

52% of irrigation violations in the city

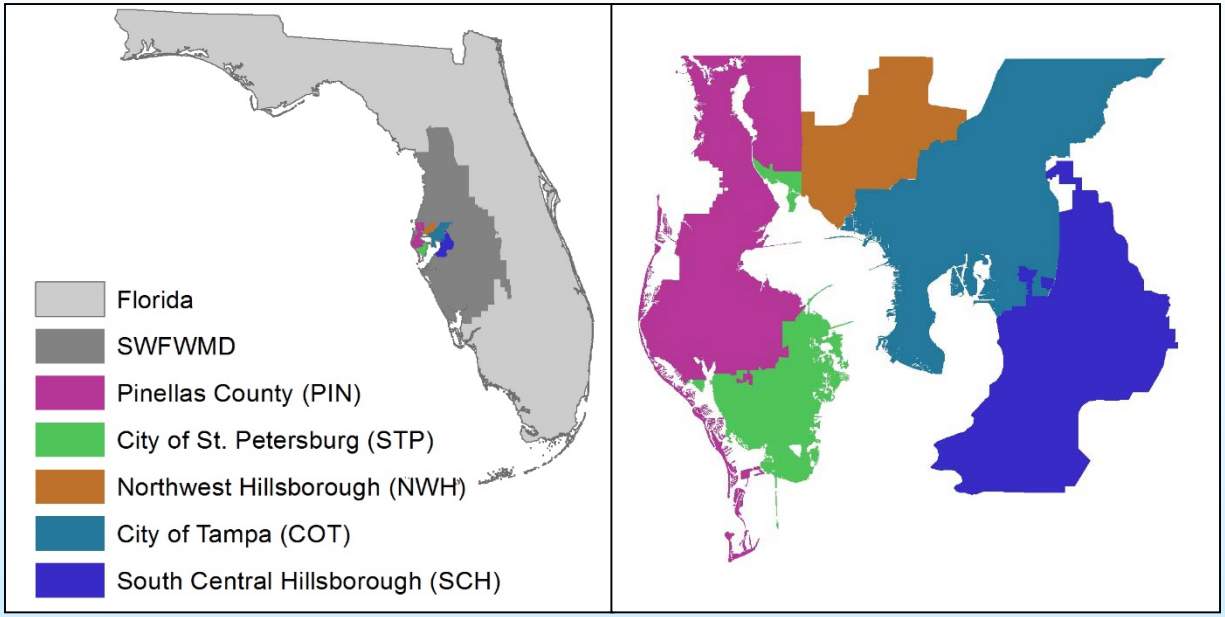
Tampa, Florida, 2004-2008

- Correlation between total water use and rainfall: -0.59
- Homeowners irrigate more during drought conditions despite watering restrictions



No significant difference

Impact of restrictions for Hillsborough and Pinellas County customers



Definitions

- Irrigation demand: What customers say the landscape needs, based on monthly billing data
- Irrigation required: What crop science says the landscape needs, based on daily soil-water balance for well-watered warm season turfgrass
- Irrigation expected: What the restrictions say a landscape can have, based on ½” irrigation per event and allowable irrigation days

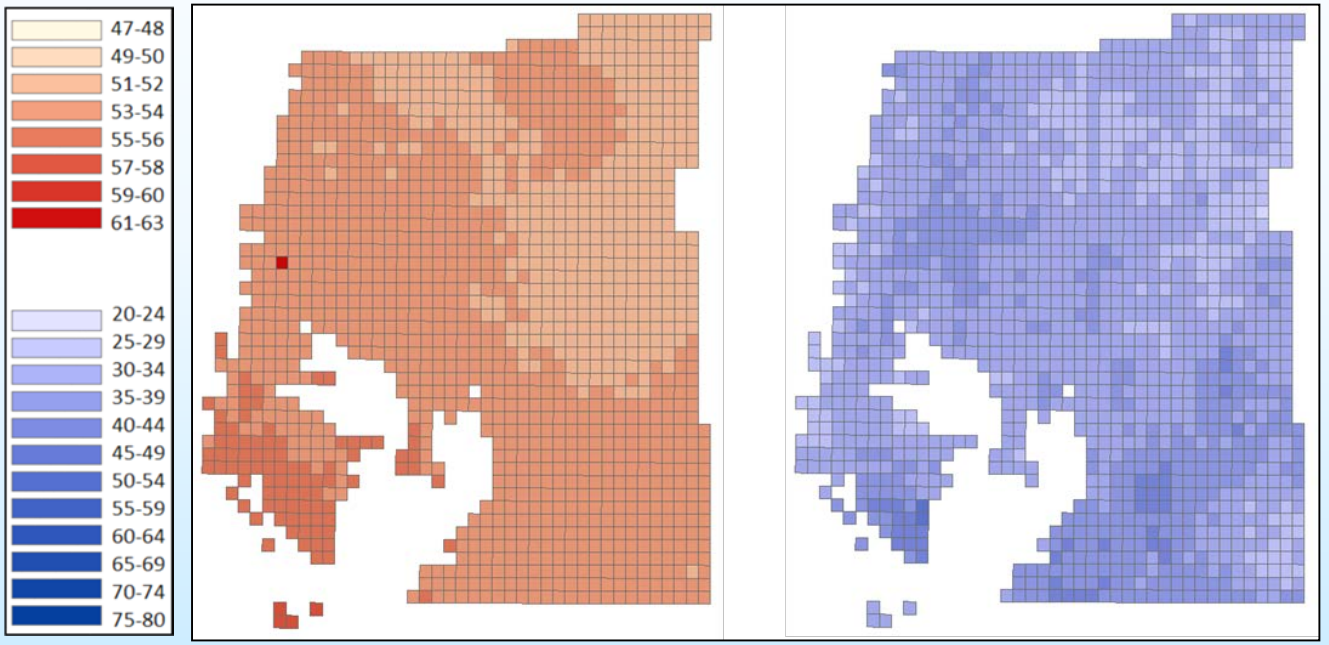
Irrigation demand

- Data inputs
  - Monthly billing data for single-family residential potable customers without access to reuse
  - Parcel data
  - Census data
- Demand calculation
  - Irrigation demand= Total water - Indoor water
    - Indoor water = (70 gpcd)(household size for census block)(days/month)
  - Irrigation depth = Irrigation demand/green area
    - Green area = total parcel area- building footprint area

Irrigation required

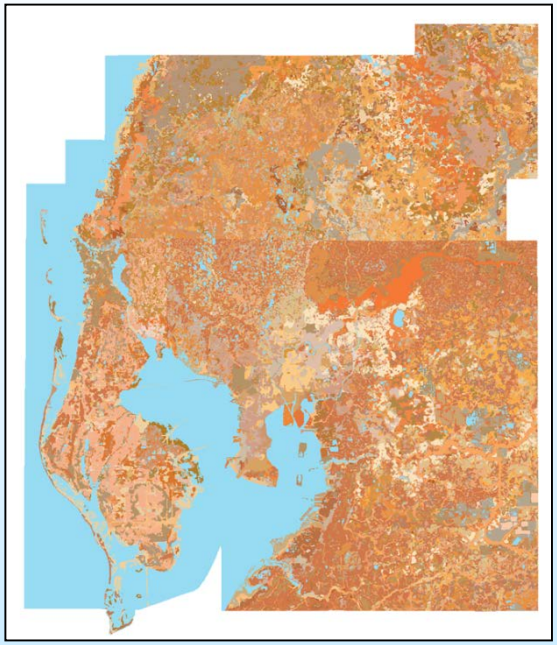
- Daily soil-water balance customized for weather and soil conditions at each parcel used to calculate monthly theoretical irrigation required
- Based on agricultural principles of well-watered crops

Annual ET_o (2000)

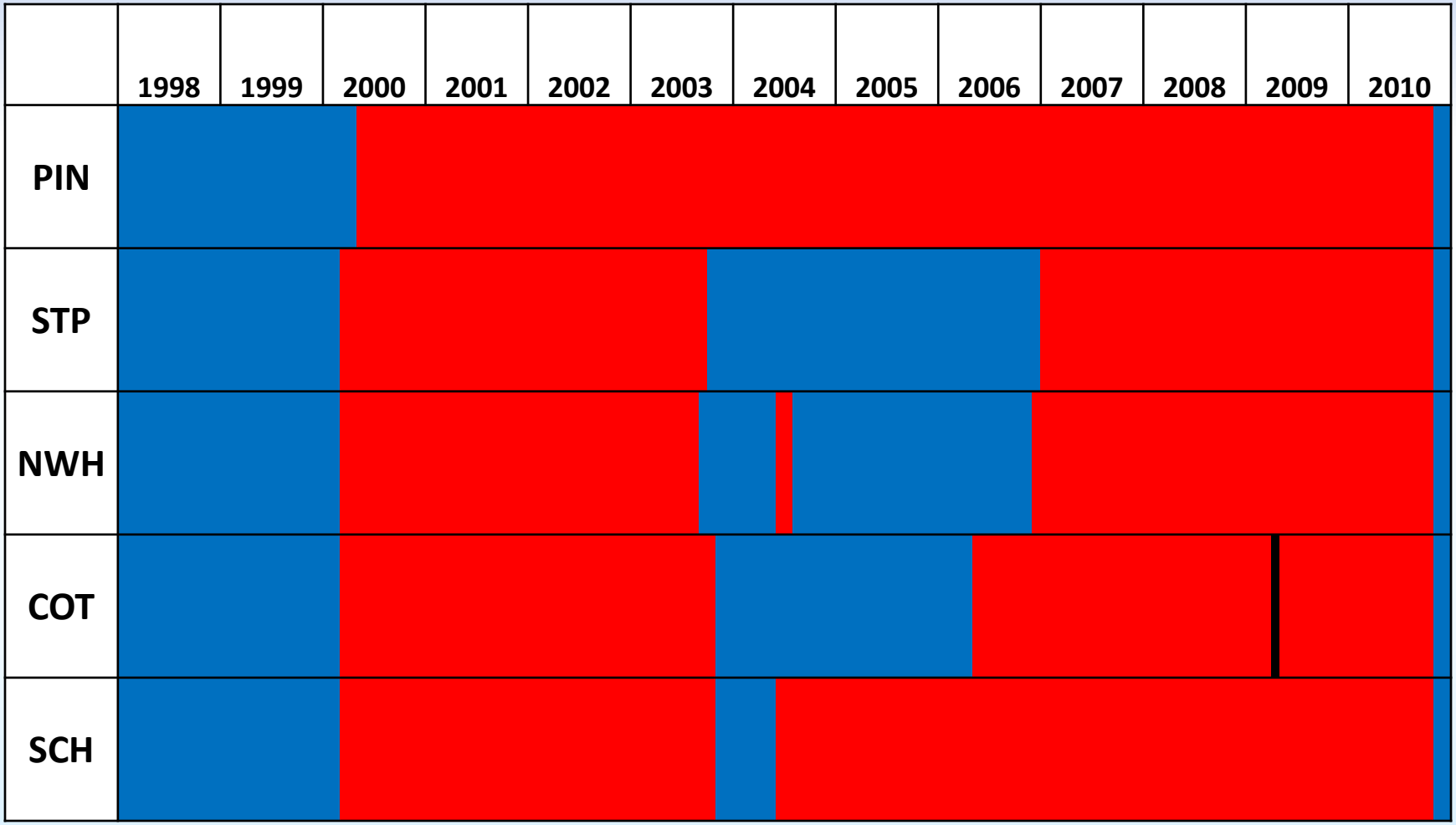


Annual Precipitation (2000)

Soil types



Historical Ordinances



Blue: 2 day/week Red: 1 day/week Black: 0 day/week

Customer selection

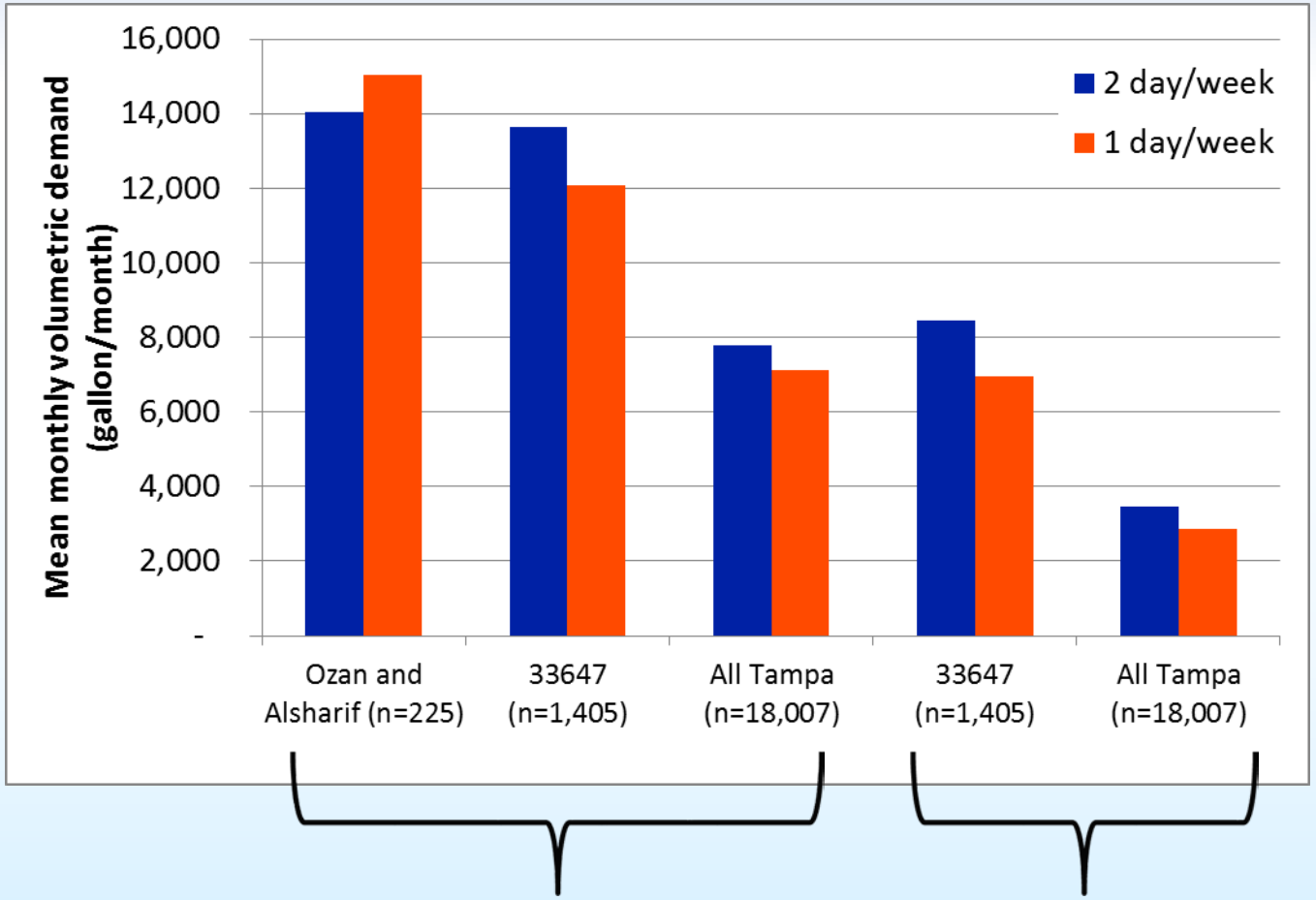
	98	99	00	01	02	03	04	05	06	07	08	09	10
Jan			✓				✓	✓					
Feb		✓	✓					✓	✓				
Mar		✓					✓	✓	✓				
Apr		✓					✓	✓	✓				
May		✓					✓	✓					
Jun		✓					✓	✓					
Jul		✓					✓	✓					
Aug		✓					✓	✓					
Sep		✓					✓						
Oct	✓	✓					✓						
Nov	✓	✓				✓		✓					
Dec	✓	✓				✓	✓						

+

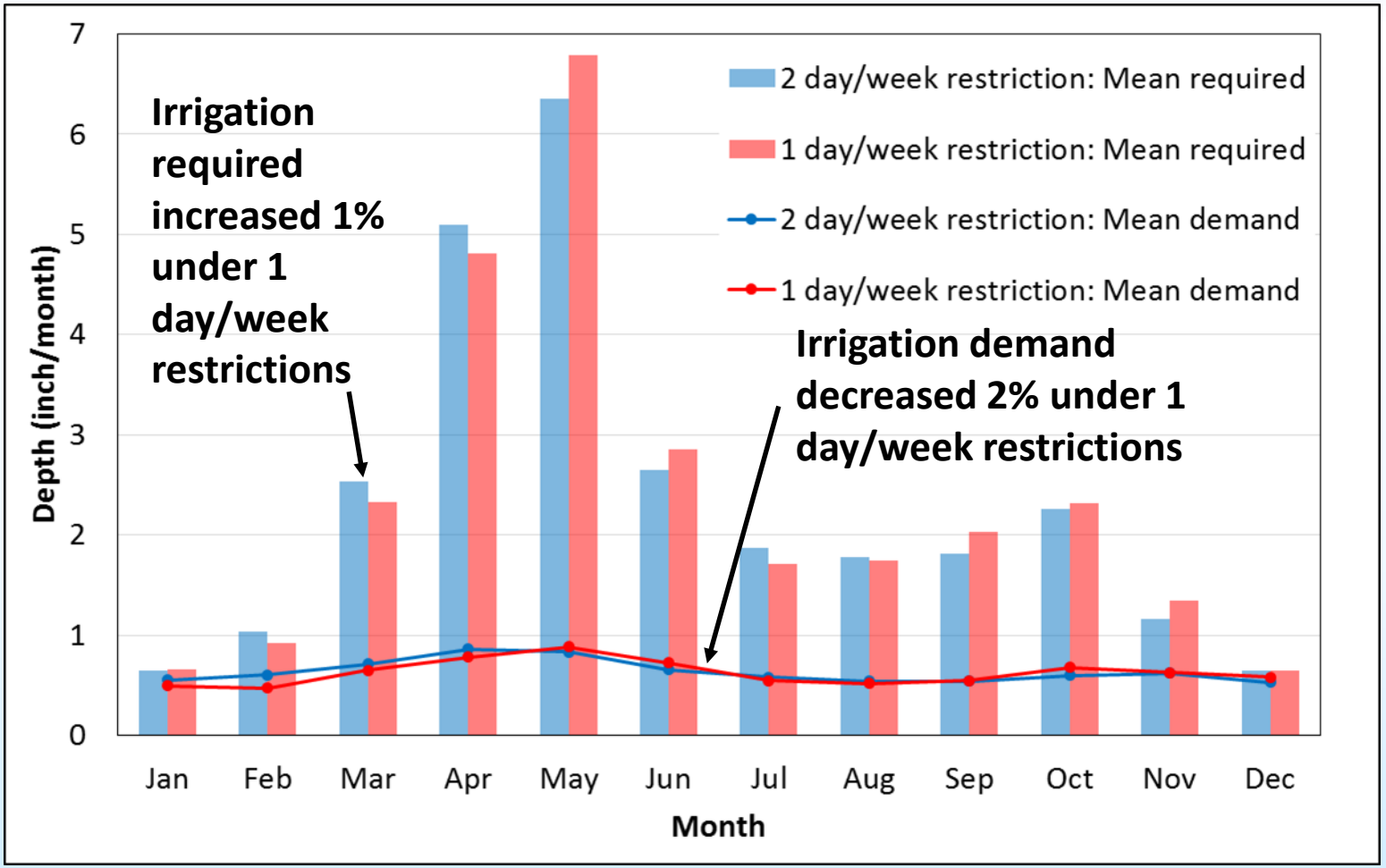
	98	99	00	01	02	03	04	05	06	07	08	09	10
Jan				✓	✓	✓				✓	✓		
Feb				✓							✓	✓	
Mar			✓	✓	✓	✓				✓	✓	✓	
Apr			✓	✓	✓	✓				✓	✓	✓	
May			✓	✓	✓	✓			✓	✓	✓	✓	
Jun			✓	✓	✓	✓			✓	✓	✓	✓	
Jul			✓	✓	✓	✓			✓	✓	✓	✓	
Aug			✓	✓		✓			✓	✓	✓	✓	
Sep			✓	✓	✓	✓			✓	✓	✓	✓	
Oct			✓	✓	✓	✓			✓	✓	✓	✓	
Nov			✓	✓	✓				✓	✓	✓	✓	
Dec			✓	✓	✓					✓	✓		

Member	Customers	Records
PIN	23,346	1,740,824
STP	41,556	4,283,525
NWH	14,446	1,204,114
COT	24,258	2,261,573
SCH	13,089	1,164,161
Total	**116,695**	**10,654,197**

Tampa volumetric water use

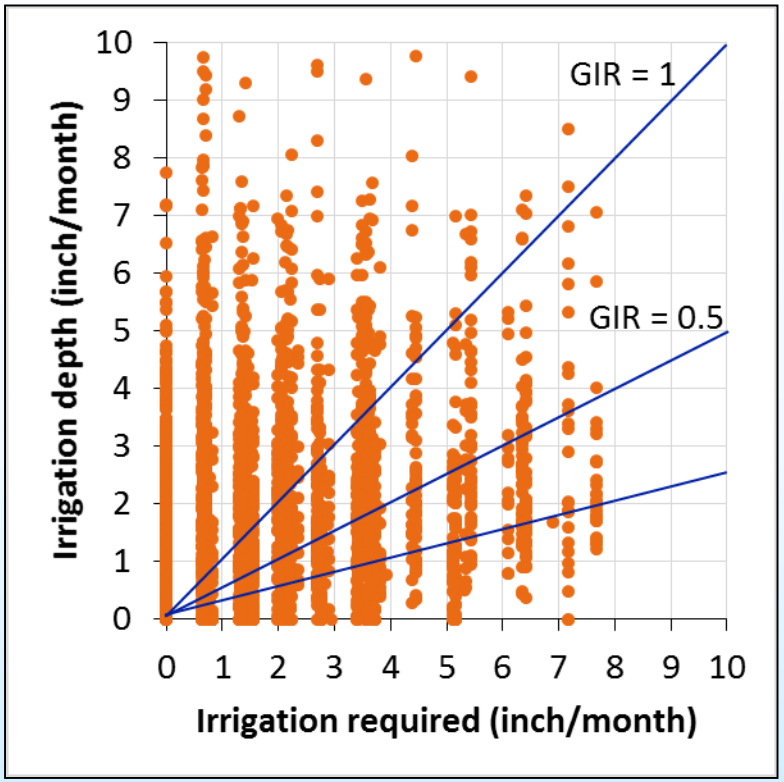


All customers:
2 day/week vs 1 day/week restrictions

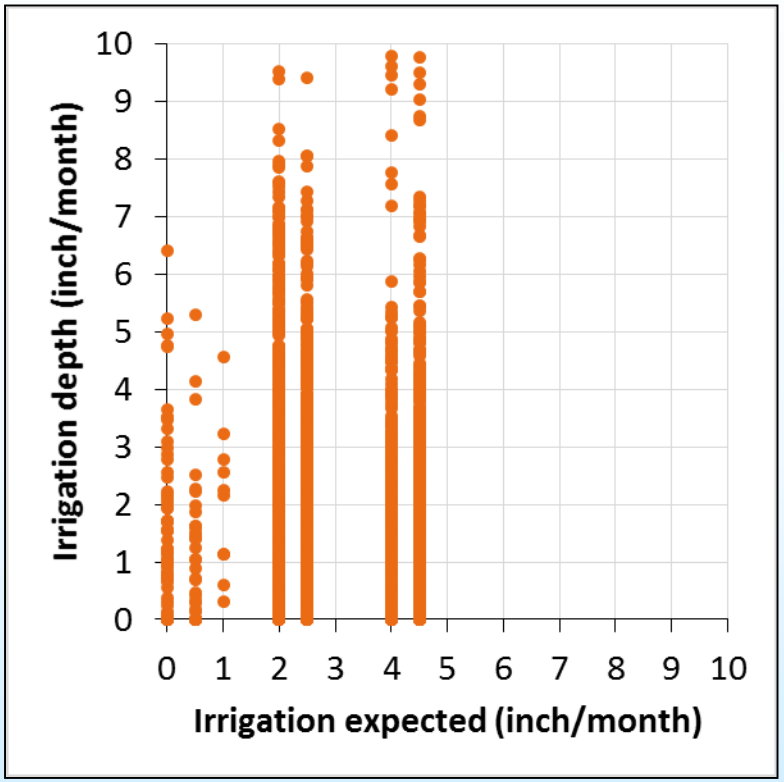


Response of demand to required and expected (zip 33647)

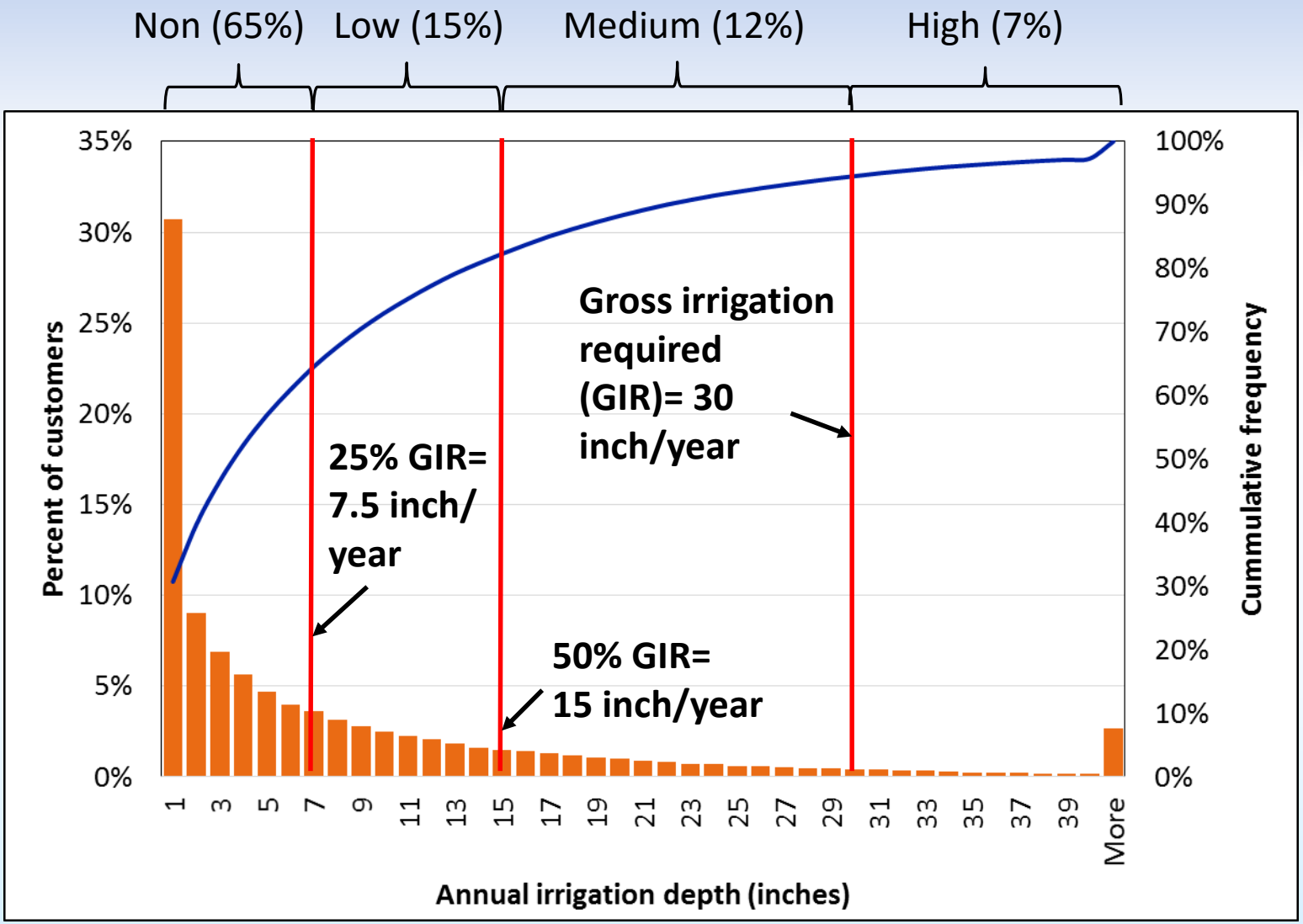
Irrigation required (soil water balance) vs irrigation demand



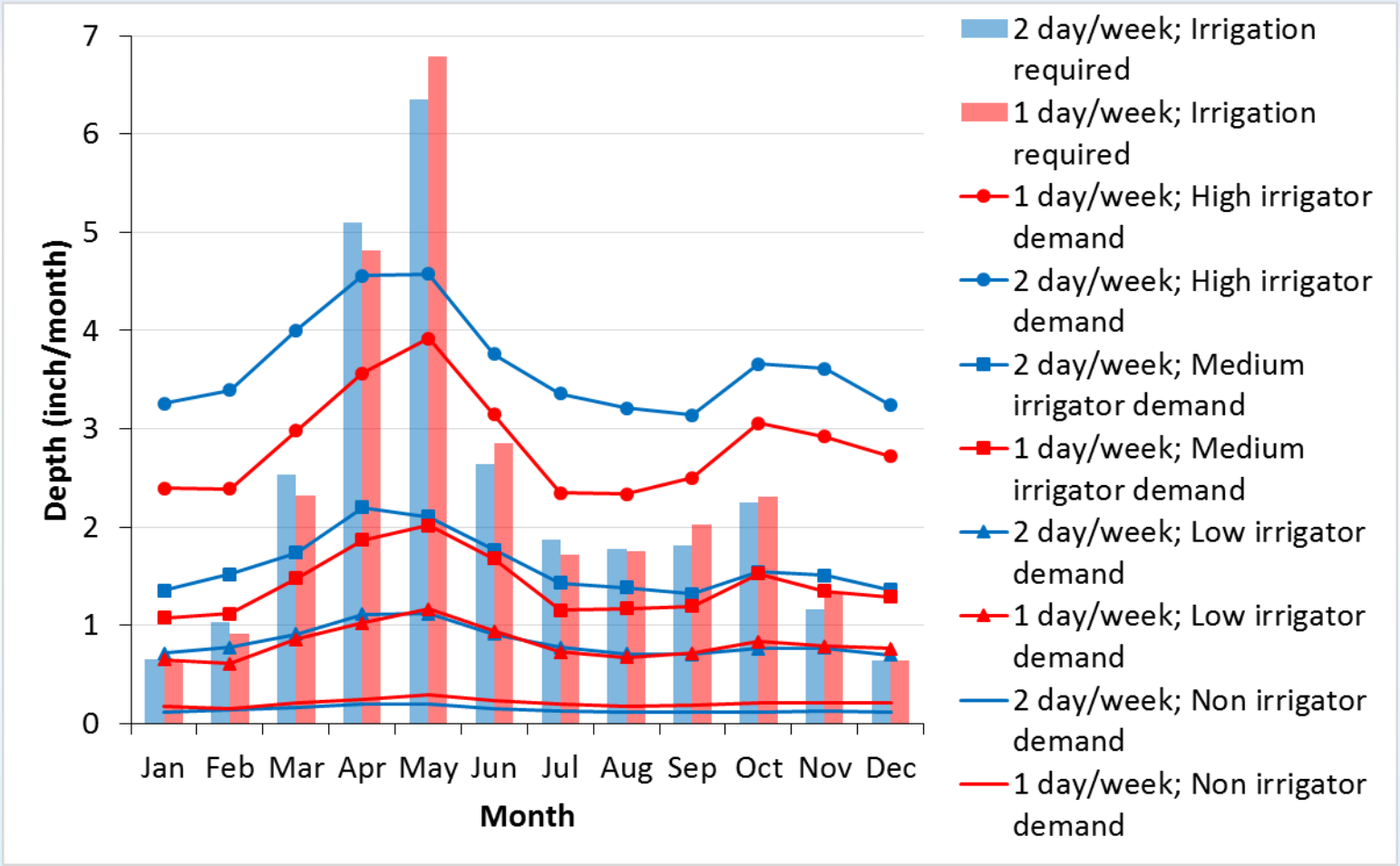
Irrigation expected (restriction ordinances) vs irrigation demand



Distribution of irrigation demand



Customer groups:
2 day/week vs 1 day/week restrictions



High: 22% decrease (9.5 inch/year)

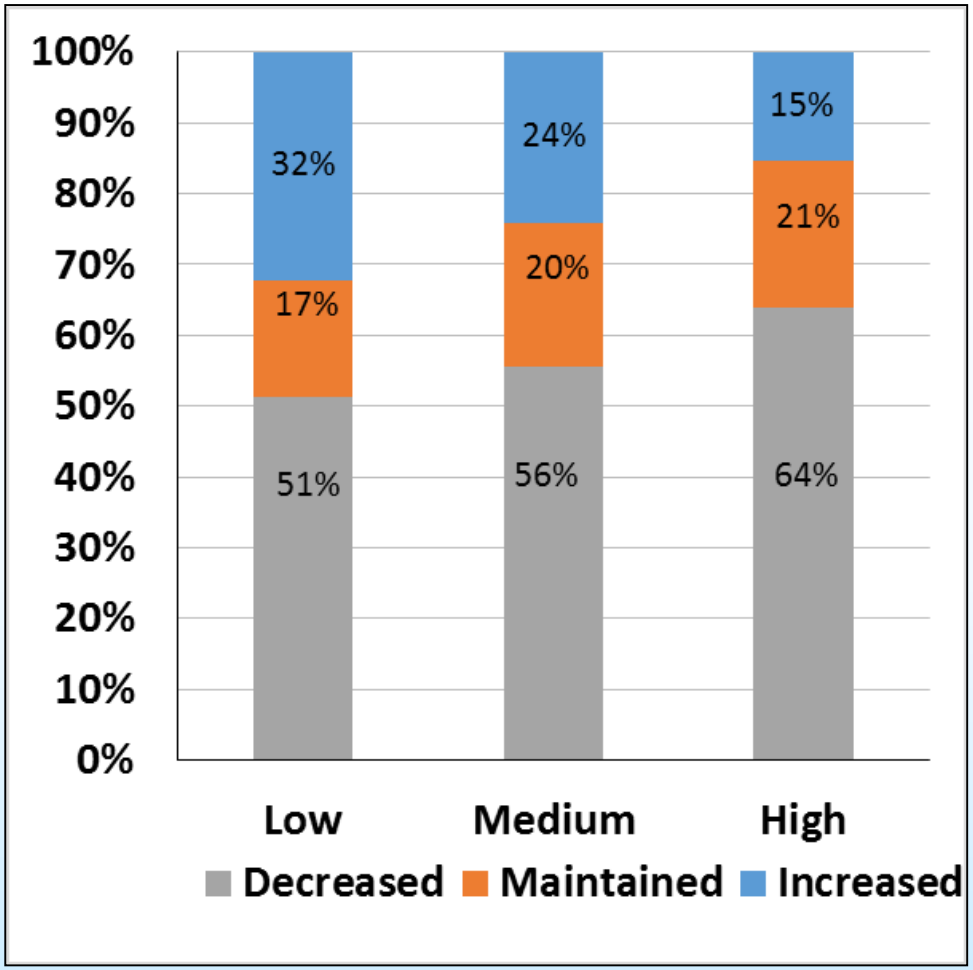
Med: 12% decrease (2.3 inch/year)

Low: 2% decrease (0.2 inch/year)

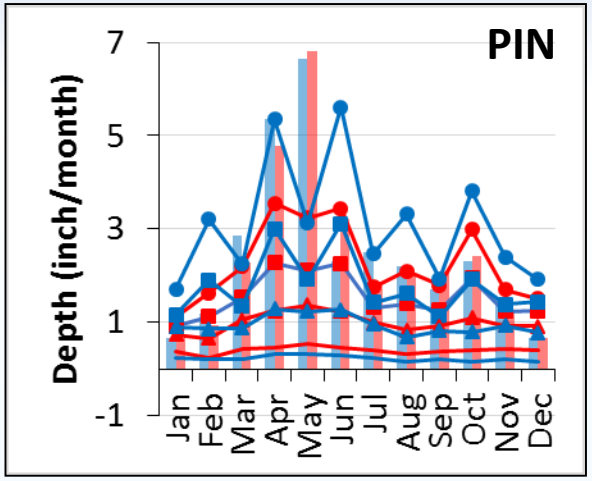
Non: 47% increase (0.8 inch/year)

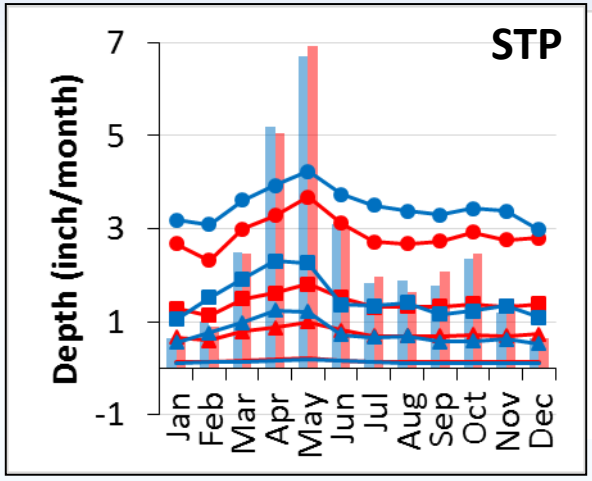
Change in irrigation by group

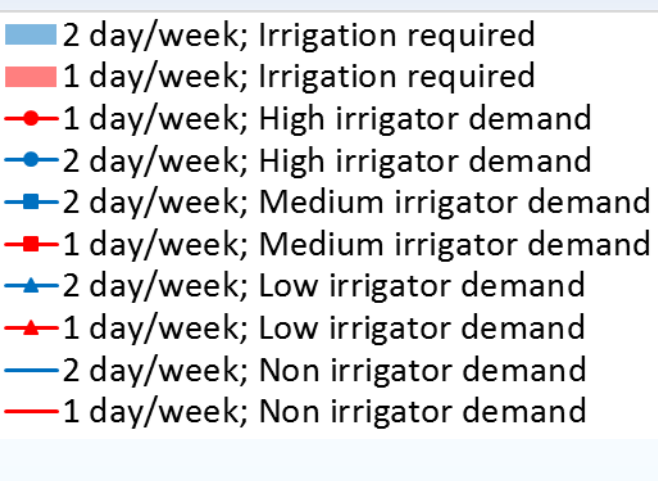
All irrigating customers
(PIN, STP, NWH, COT, and SCH; n = 40,413)

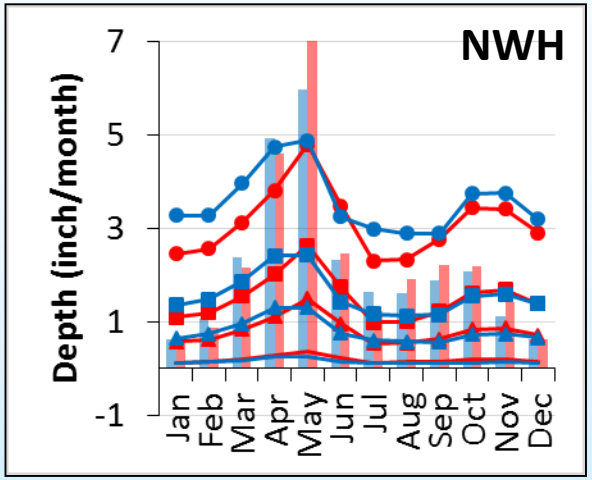


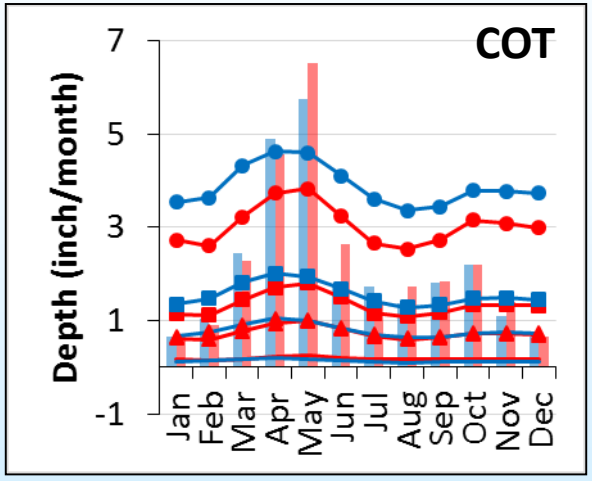
Member governments:
2 day/week vs 1 day/week restrictions

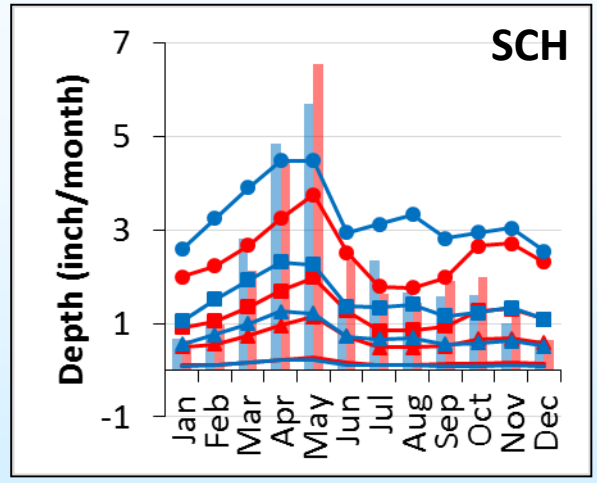




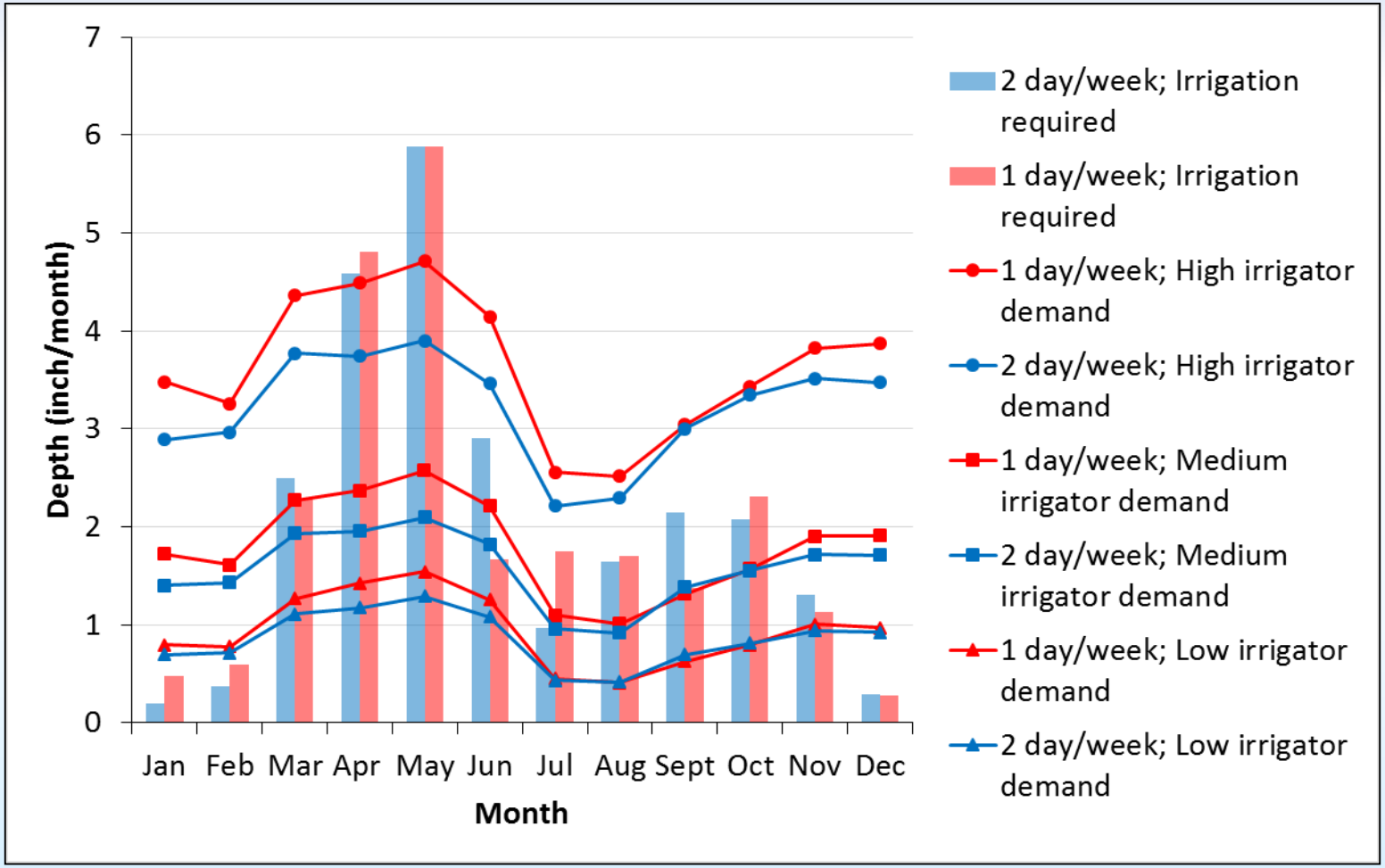








Tampa zip code 33647
2 day/week vs 1 day/week restrictions



High: 13% increase (5.1 inch/year)

Med: 14% increase (2.7 inch/year)

Low: 1 % increase (1 inch/year)

Summary and conclusions

- Majority (~65%) of single-family residential customers are not irrigating regularly
- 14% reduction in irrigation depth when restrictions change from 2 day/week to 1 day/week restrictions
- Customers with higher discretionary use tend to have greater response to restrictions
- Trends don’t hold for all customers (zip code 33647)

Acknowledgements

- Funding: Southwest Florida Water Management District and Tampa Bay Water
- Research team: Chuan Wang, Nikolay Bliznyuk, and Linda Young

References

- Anderson, R. L., Miller, T. A., & Washburn, M. C. (1980). WATER SAVINGS FROM LAWN WATERING RESTRICTIONS DURING A DROUGHT YEAR, FORT COLLINS, COLORADO1. *JAWRA Journal of the American Water Resources Association*, *16*(4), 642-645.
- Boyle, C. E., Eskaf, S., Wyatt Tiger, M., & Hughes, J. A. (2011). Emerging issues-Mining water billing data to inform policy and communication strategies. *Journal American Water Works Association*, *103*(11), 45.
- Kenney, D. S., Klein, R. A., & Clark, M. P. (2004). USE AND EFFECTIVENESS OF MUNICIPAL WATER RESTRICTIONS DURING DROUGHT IN COLORADO. *JAWRA Journal of the American Water Resources Association*, *40*(1), 77-87.
- Ozan, L. A., & Alsharif, K. A. (2012). The effectiveness of water irrigation policies for residential turfgrass. *Land Use Policy*.
- Shaw, D. T., & Maidment, D. R. (1987). INTERVENTION ANALYSIS OF WATER USE RESTRICTIONS, AUSTIN, TEXAS1. *JAWRA Journal of the American Water Resources Association*, *23*(6), 1037-1046.
- Whitcomb, J.B. (2006). Evaluation of Irrigation Restrictions in East-Central Florida. Prepared for Southwest Florida Water Management District.