



THE BVWATERSMART PROGRAM — INCREASING THE EFFICIENCY OF OUTDOOR WATER USE

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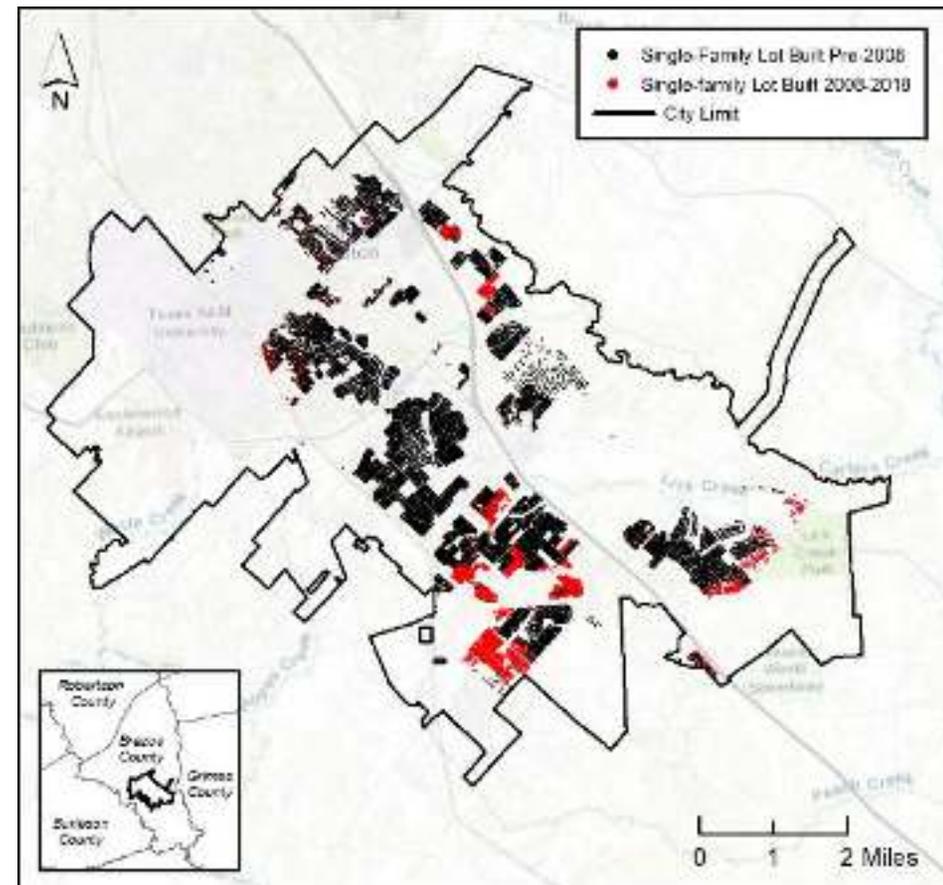
JD Nations



**WATER MANAGEMENT &
HYDROLOGICAL SCIENCE**

Profile of College Station Water Users

- Over 40,000 customers: 2,000 commercial, 17,000 multi-family, 21,000 single-family
- Residential water use is 70% of the total
- About 24% growth in single-family customers from 2008 to 2018



Why Focus on Residential Outdoor Water Use?

- **50%** of all residential water is used outdoors for lawn/landscape irrigation
- Studies indicate that **30-50%** of residential water is wasted due to overwatering



Source: EPA WaterSense

Sources of Water Waste



Poor system design



Failure to shut irrigation system off after rainfall

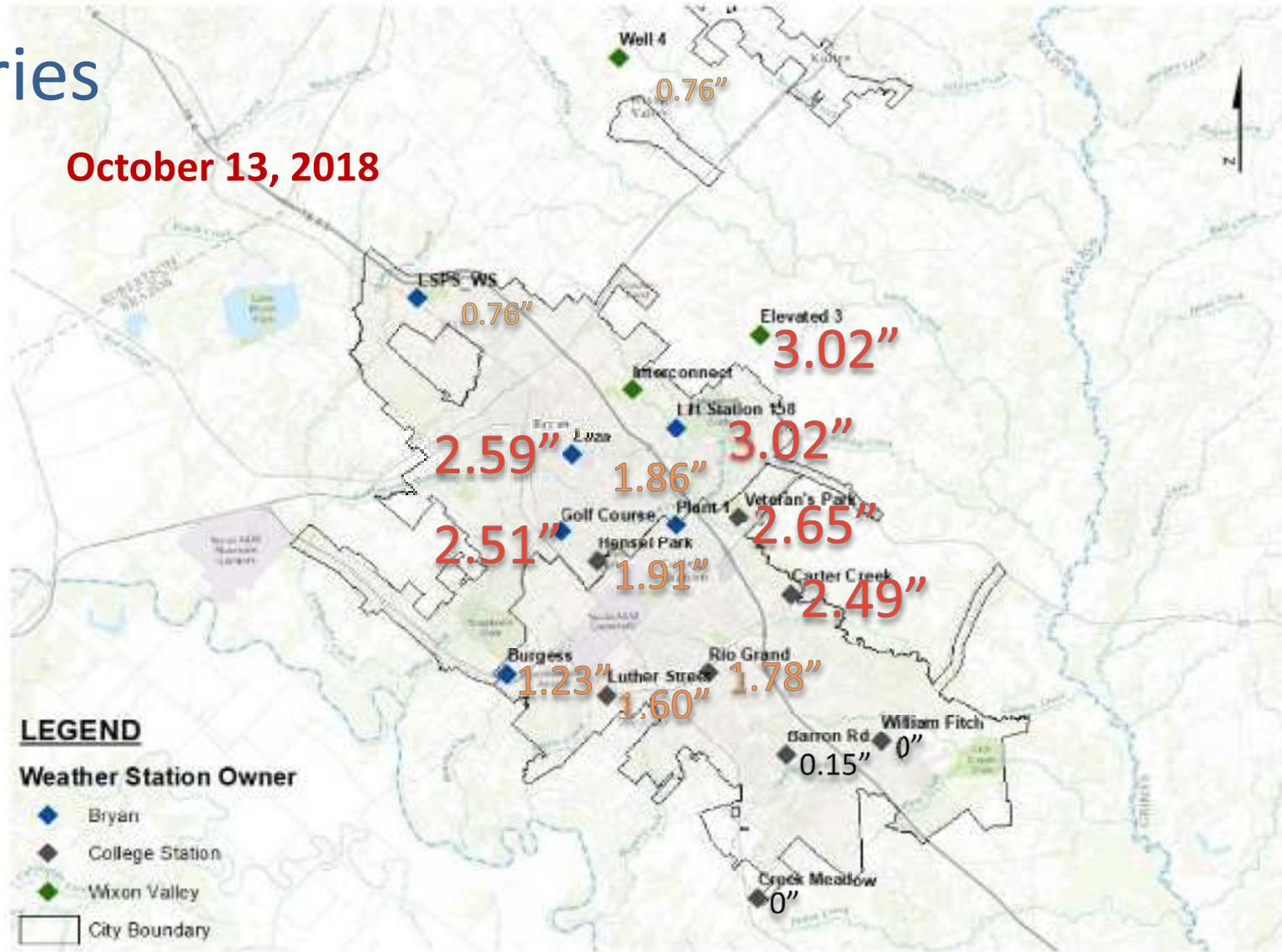
Watering too long or too often



Leaks

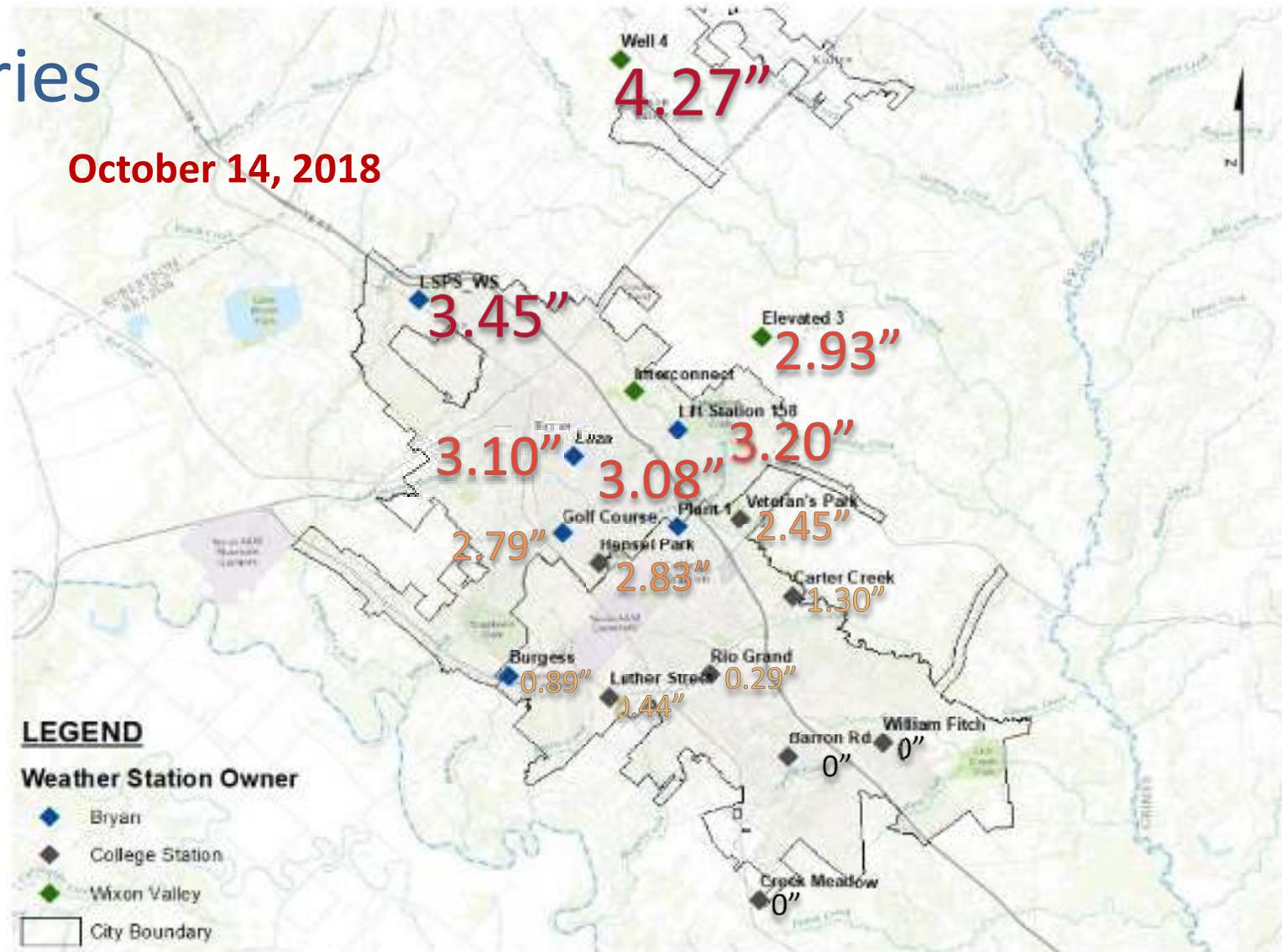
Rainfall varies

October 13, 2018



Rainfall varies

October 14, 2018



Educational Interventions to Reduce Overwatering



Provide water budgets to homeowners



BVWaterSmart website and network



Weekly watering notifications



Free irrigation system inspections



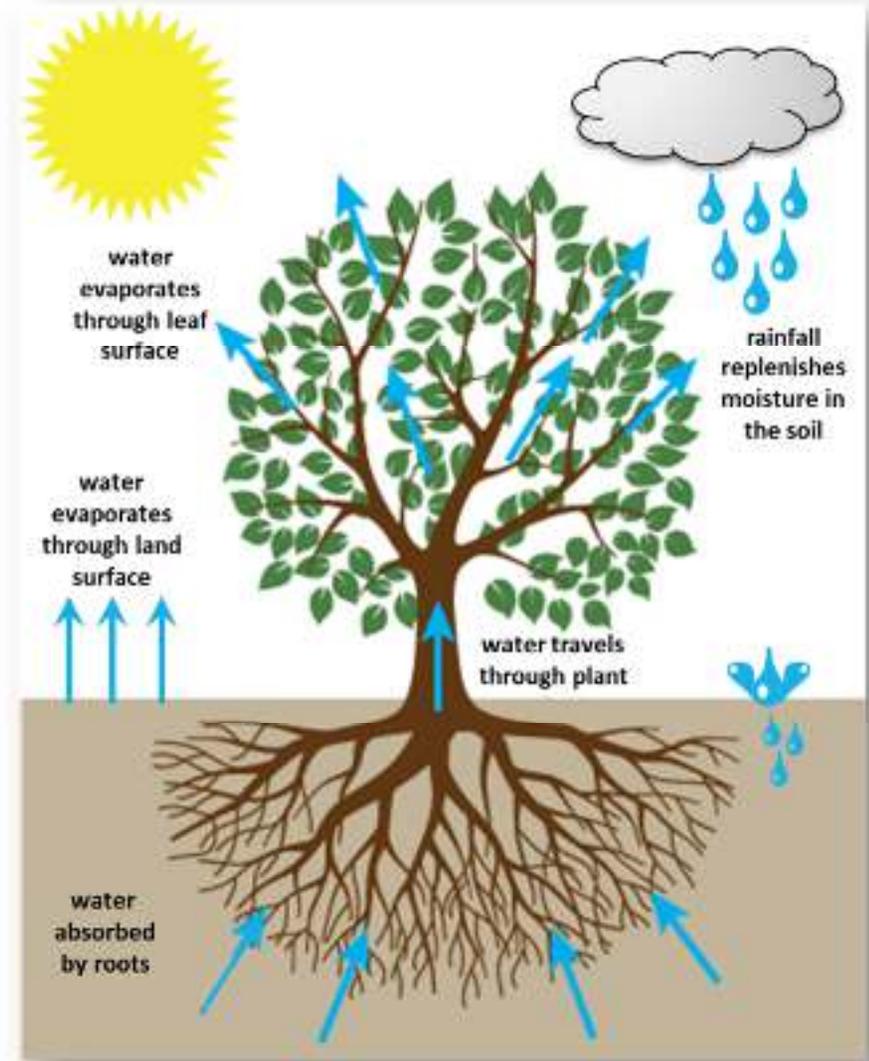
Water conservation workshops

Residential Water Budgets for 15,000 Customers

$$B = \frac{1}{DU} \{k_L \times ET_0 - P\} \times A_{Irr} \times 0.62$$

Irrigation needs (gal) | Landscape/Crop Coefficient | Rainfall (in) | Irrigable Area (ft²) | Unit Conversion (gal/ft²)

Reference Evapotranspiration (in) | Sprinkler Distribution Uniformity



A Sample Irrigation Area

■ Sample lot

- Parcel Area: 21,780 ft²
- Living Area: 2,377 ft²
- Building Area: 4,083 ft²
- Driveway Area: 2,440 ft²
- Irrigation Area: 15,257 ft²



YOUR 2017 ESTIMATED IRRIGATION BUDGET AND OUTDOOR WATER USE

The table below gives your estimated irrigation budget and outdoor water use for 2017. Your estimated outdoor water budget is the amount of water needed to keep your lawn and landscaping healthy. We determine your budget based on:

	Your Estimated Irrigation Budget (gallons)	Amount of Water You Applied (gallons)	Amount You Over-irrigated (gallons)
January			
February	Your lawn is sleeping. It does not need to be irrigated.		
March			
April	6,400	26,200	19,800
May	16,100	45,900	29,800
June	12,500	28,900	16,400
July	22,800	50,900	28,100
August	15,300	37,400	22,100
September	16,000	35,700	19,700
October	16,500	31,000	14,500
November			
December	Your lawn is sleeping. It does not need to be irrigated.		
Total amount you over-irrigated in Summer 2016			150,400

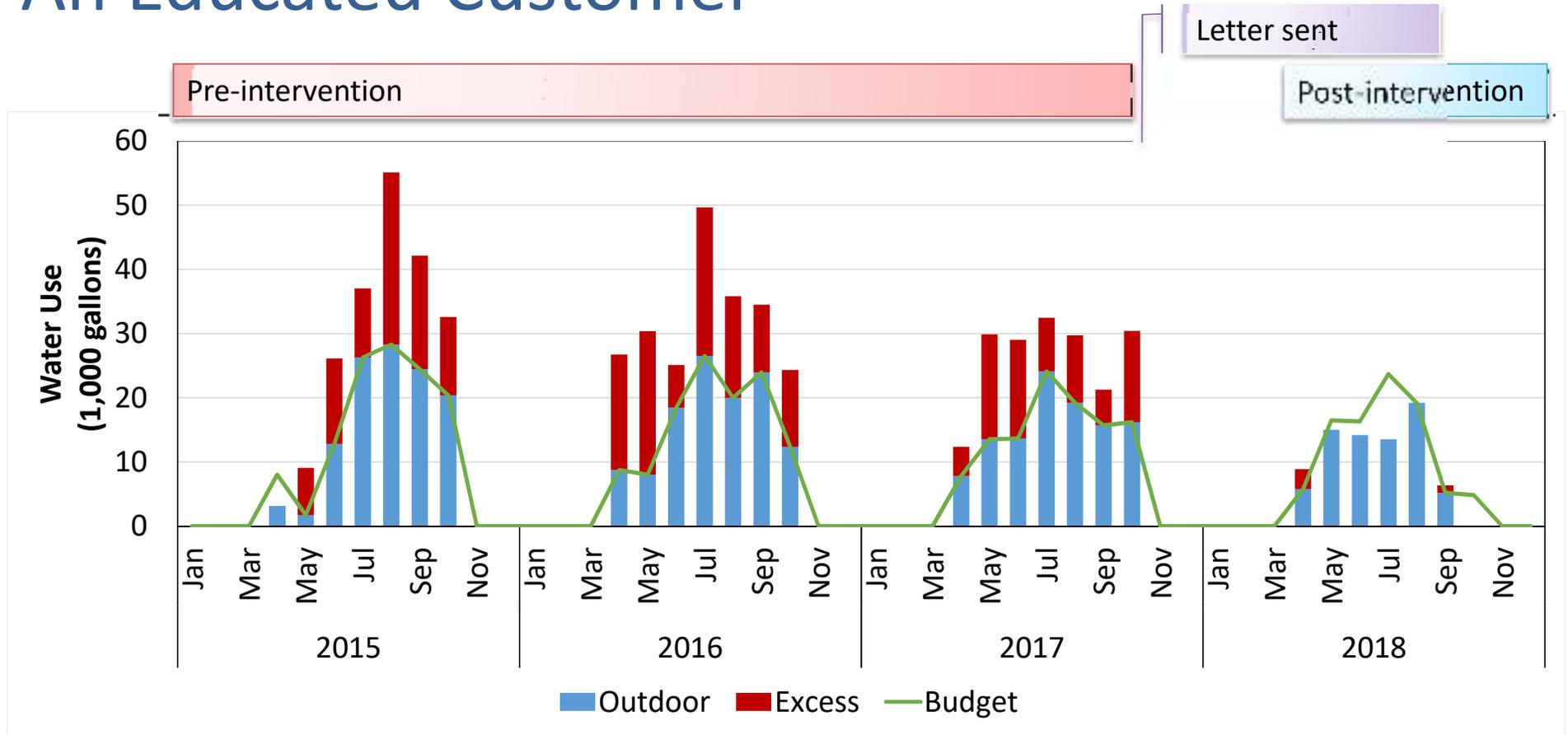
based on the size of your lawn
irrigable area (sq. feet)

12,700

1	7,900
1.5	11,800

To learn about irrigation runtimes and how to adjust your sprinklerheads,
go to lwatersmart.tamu.edu

An Educated Customer

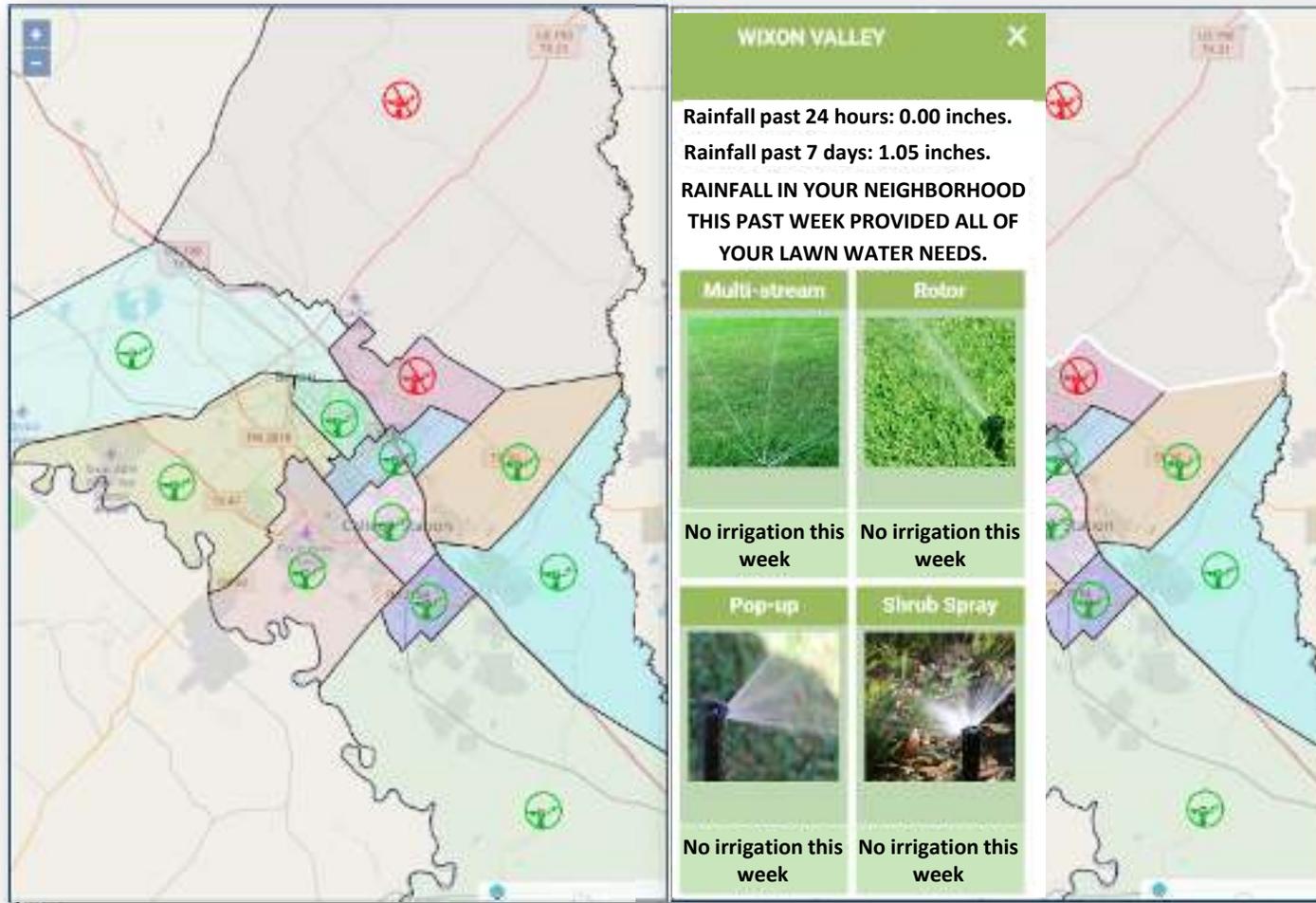




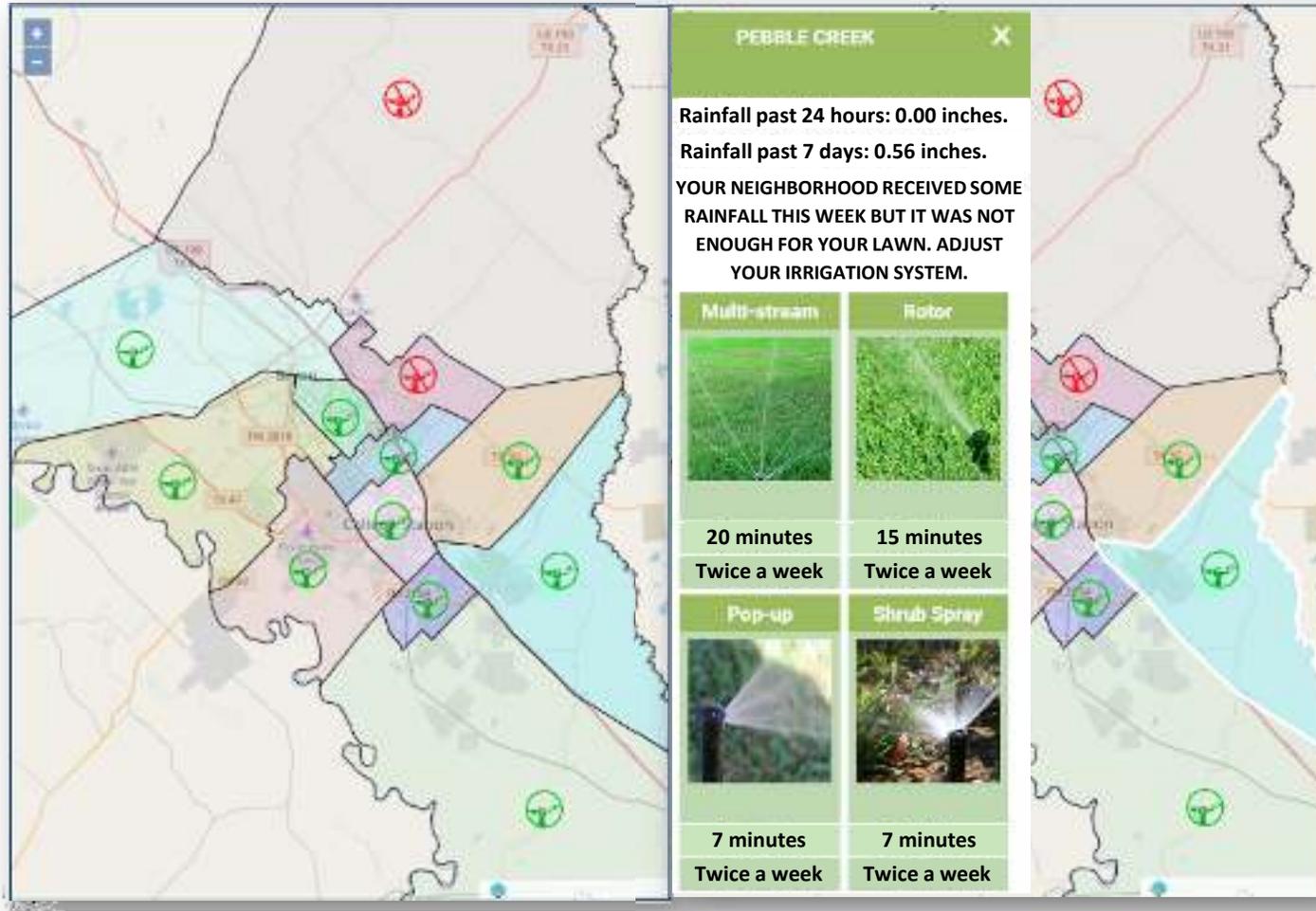
BVWaterSmart Website and Network

<http://bvwatersmart.tamu.edu>

Real-Time Watering Recommendations from BVWaterSmart.tamu.edu



Real-Time Watering Recommendations from BVWaterSmart.tamu.edu



The screenshot displays a map of the Pebble Creek area with various colored zones. A pop-up window is centered over a specific zone, providing the following information:

PEBBLE CREEK X

Rainfall past 24 hours: 0.00 inches.
Rainfall past 7 days: 0.56 inches.

YOUR NEIGHBORHOOD RECEIVED SOME RAINFALL THIS WEEK BUT IT WAS NOT ENOUGH FOR YOUR LAWN. ADJUST YOUR IRRIGATION SYSTEM.

Multi-stream	Rotor
	
20 minutes Twice a week	15 minutes Twice a week
Pop-up	Shrub Spray
	
7 minutes Twice a week	7 minutes Twice a week



Weekly Watering Notifications

Weekly Watering Notifications

■ When watering is needed

A message from Brazos Valley WaterSmart

Dear [Your Name],

Your lawn needs water this week.

Recommended sprinkler system run times:

Multi-stream rotors : 40 minutes per day, twice a week.

Rotors : 30 minutes per day, twice a week.

Pop-up sprays : 15 minutes per day, twice a week.

Shrub sprays : 15 minutes per day, twice a week.

If you need more information about sprinkler types see our [website](#).

This is based on rainfall of 0.11 inches for the week of Jul 30, 2017 to Aug 06, 2017.

If the forecast for the upcoming week is rainy, please consider turning off your sprinklers.

At any time, for the latest rainfall totals please visit <http://bvwatersmart.tamu.edu>.

Thank you for helping us conserve water.

■ When watering is not needed

A message from Brazos Valley WaterSmart

Dear [Your Name],

Rainfall in your neighborhood this past week provided all of your lawn water needs.

This is based on rainfall of 1.66 inches for the week of Aug 06, 2017 to Aug 13, 2017.

If the forecast for the upcoming week is rainy, please consider turning off your sprinklers.

At any time, for the latest rainfall totals please visit <http://bvwatersmart.tamu.edu>.

Thank you for helping us conserve water.



Free Irrigation System Inspections

Free Irrigation System Check-Ups

- Free service provided by College Station Water Services
- Voluntary
- Customers are informed through
 - Utility bill insert
 - Friend/neighbor referral
 - Irrigation seminar
 - Study letter
- 974 completed since 2010

Sign up for FREE weekly watering recommendations! <http://www.waterman.texas.edu>



Irrigation System Check-Up Report



Know your water. <http://www.waterman.texas.edu>

9-17-10 08:00:00 Rain Sensor: Y / B

<http://www.csta.gov/water> Backflow preventer: 000 000 000 000

Performed By	Customer Name	Date	Time
			8:00 AM
Controller Model	Address	LOT#	Small Address
HUNZ 1960-21J			

Station #	Sprinkler Type	Plan Type	Current Run Time	Current Days	Suggested Run Time	Suggested Days	Area being irrigated
1	P	F	10	SU/TH/SA	5 min / 3x	Tu / Sa	Lower back in front of house
2	K	I	41	SU/TH/SA	10 min / 2x	Tu / Sa	front yard surf, sun
3	P	F	10	SU/TH/SA	5 min / 3x	Tu / Sa	Lower back along rest of house
4	P	I	10	SU/TH/SA	5 min / 3x	Tu / Sa	small area to right of driveway
5	K	I	22	SU/TH/SA	10 min / 2x	Tu / Sa	backyard turf closer to house
6	P	T	28	SU/TH/SA	12 min / 2x	Tu / Sa	turf along rear of back yard, sun
7	K	I	43	SU/TH/SA	12 min / 2x	Tu / Sa	turf in middle of back yard, sun

Station #	Problems Observed
1	Change nozzle on end of leader, 1/2" nozzle to 3/4" nozzle. Adjustable Nozzle (ANN) in red zone - spray pattern.
2	Replace the 2 Sand spig by heads next to street on either side of mailbox with rotors.
3	Leak on flood spray head under back window.
4	Replace full circle nozzle with half circle nozzle on middle of driveway. Also - 2 heads didn't rotate.
5	Replace rotor next to fence - not spraying all the way to next rotor. Check knot over in one spot.
6	No problems observed.
7	No problems observed.

COMMENTS: Overall the irrigation system and landscape are in good condition.
 The irrigation controller is currently set to come on for three cycles on Tuesday, Thursday and Saturday for the three given.
 This is less frequent for early spring/summer.
 Based on the plant water requirements for this time of year, and the application rates of each station, we recommend irrigating on Tuesday and/or Saturday for the suggested run times listed. Controller was changed to Tue/Sat at check-up.
 There is a large wet area towards back fence. Unclear if this is due to standing water from recent rain or if there is a leak on an irrigation line.
 Consider installing a rain shut off device to prohibit unnecessary irrigation during and directly after significant rainfall events. A rain sensor will keep the irrigation system from running on wet the sensor device has dried.
 Sign up for free weekly watering recommendations! <http://www.waterman.texas.edu>



Water Conservation Workshops

Water Conservation Workshops for Homeowners





MINING WATER CONSUMPTION BILLING DATA FOR TARGETED EDUCATION AND WATER CONSERVATION INTERVENTIONS

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Data and Methodology

■ Dataset

- 15,000 single-family residential customers
- 2008 to 2018



2 million data points

■ Water metering and billing is cyclic

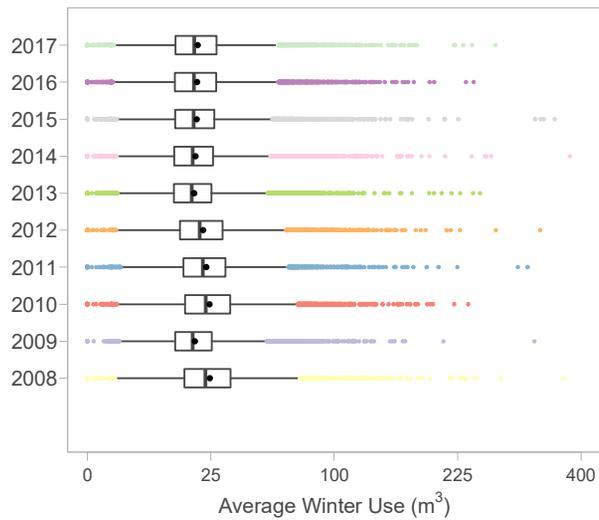
- Each customer's billing data was converted to daily consumption
- Re-aggregated into monthly totals

■ Methodology

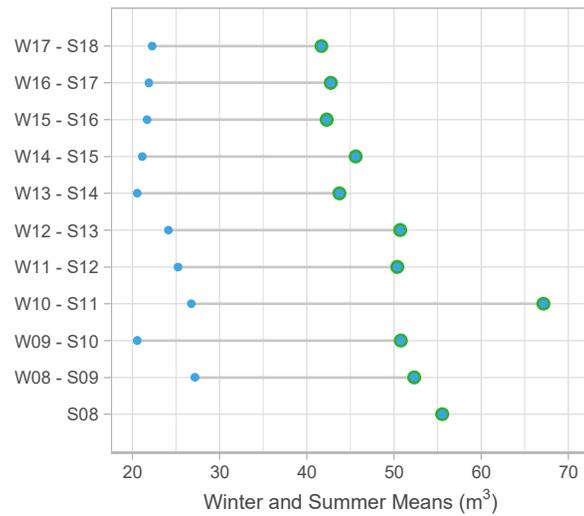
- Histograms and Kernel density estimation
- Graphically illustrate the ***effect of climate*** and ***educational efforts*** on water consumption pattern
- Pair-wise Welch *t*-test and Kolmogorov-Smirnov (KS) test to identify the years that had **similar mean summer consumption** and the **same distribution of consumption**

Winter versus Summer Use

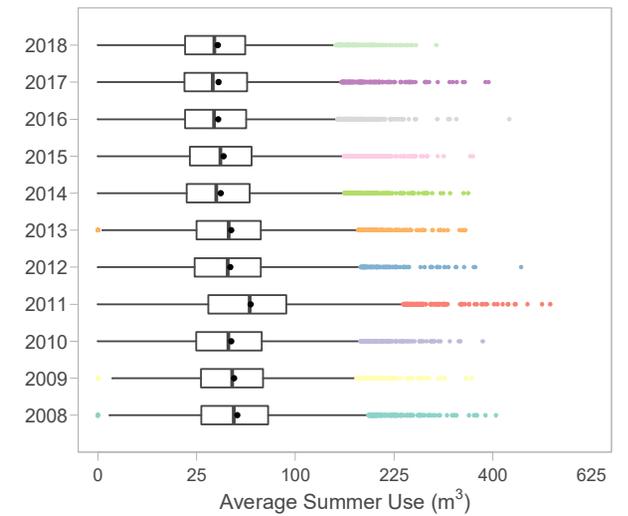
Average winter use



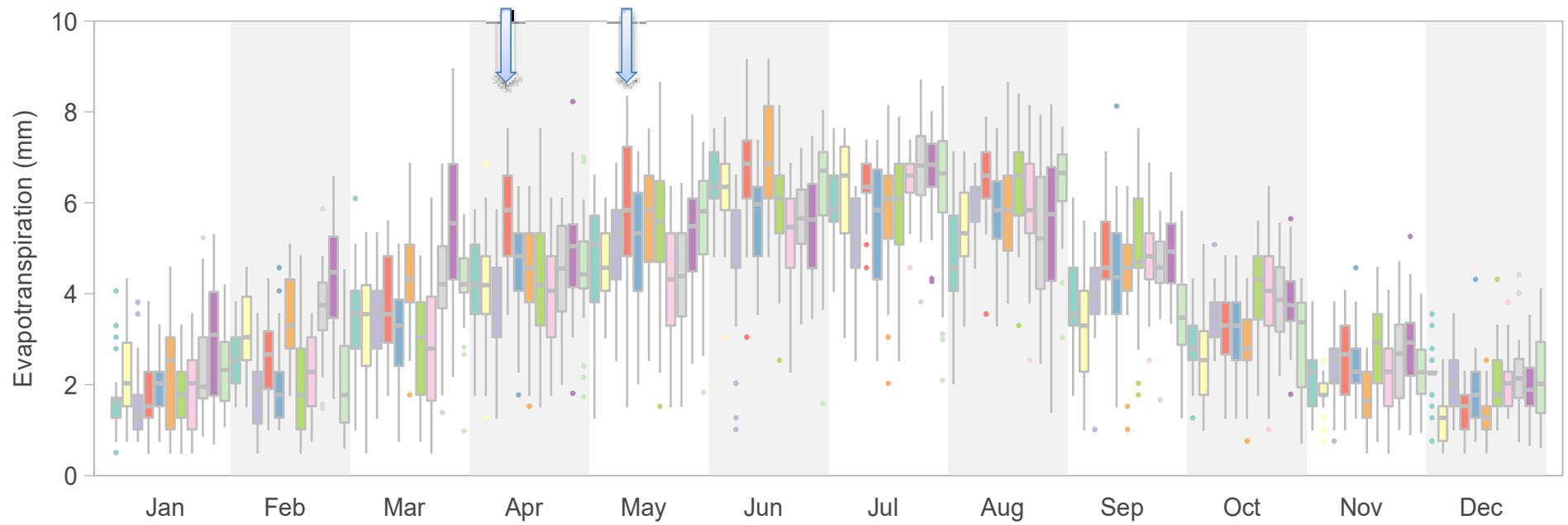
SFR-wide mean change from winter to summer



Average summer use



Weather Patterns



Average Summer Use (m³) [1 m³ = 264 Gallons]

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<i>n</i>	12,004	12,351	12,677	12,942	13,137	13,316	13,657	14,009	142,04	14,321	14,738
Mean (m ³)	55.9	52.7	51.1	67.6	50.8	51.1	44.0	45.7	42.4	42.9	41.7
SD (m ³)	38.9	34.5	35.3	48.2	36.2	35.7	32.9	32.9	31.9	33.5	30.4
Sum (m ³)	671,000	651,000	648,000	875,000	667,000	681,000	601,000	640,000	602,000	614,000	615,000

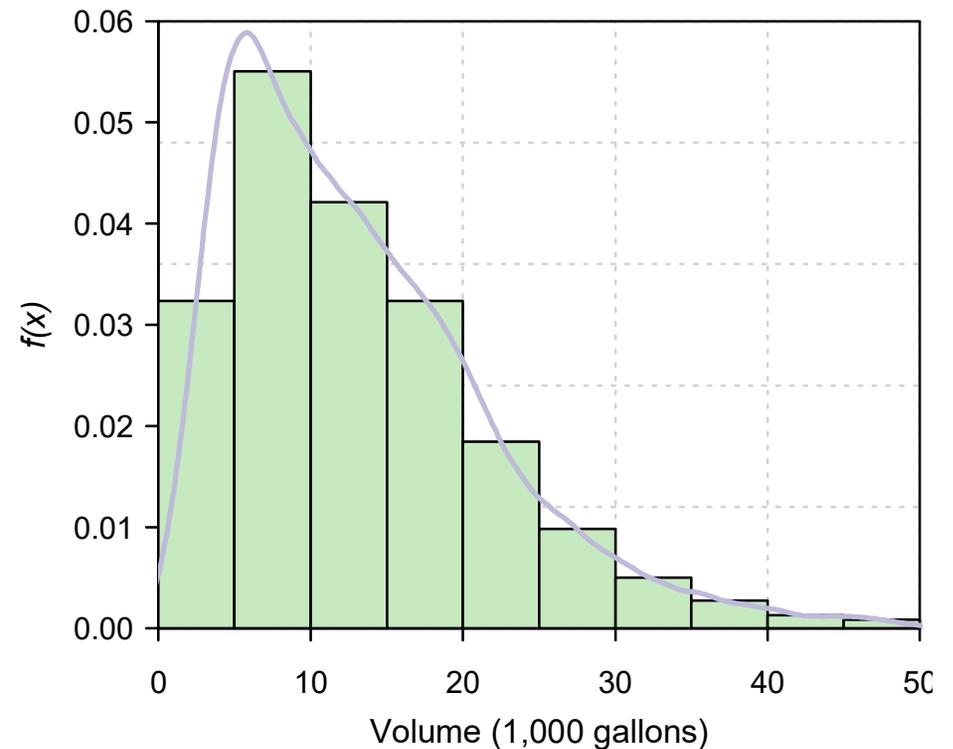
Note:

Average summer use for each SFR, $\bar{U}^s = \sum_{m=1}^7 U_m^s / 7$, where *m* is for month of April to October

Sum = $\sum_{i=1}^n \bar{U}^s_i$, where *n* is the number of SFRs

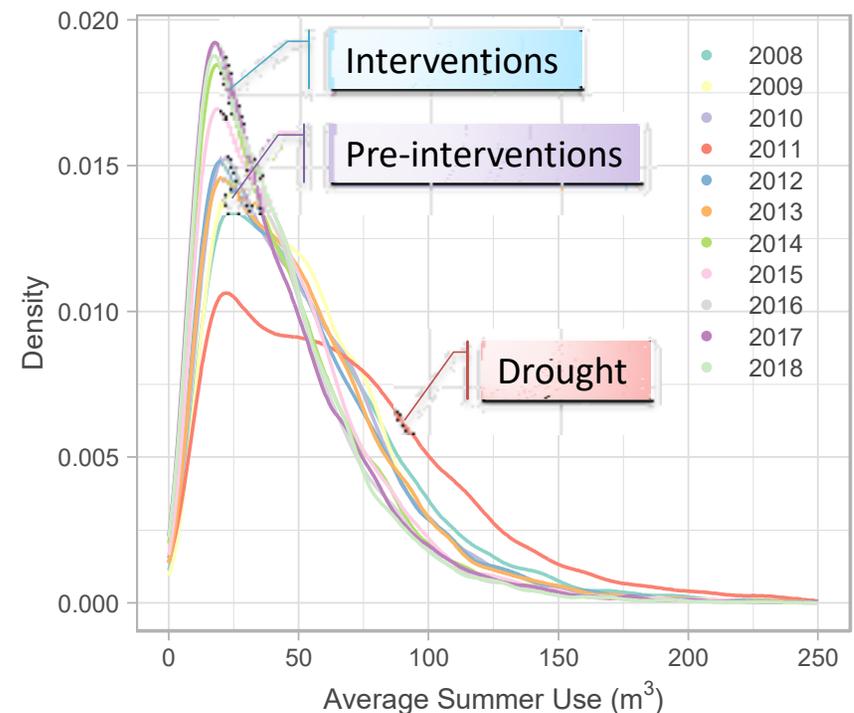
Kernel Density Estimation

- A non-parametric way to estimate the probability density function of a random variable
- Kernel density estimation is a fundamental data smoothing problem
 - Inferences about the population is made based on the sample
- Allows us to compare the distribution across the years



Drought and Effect of Educational Interventions

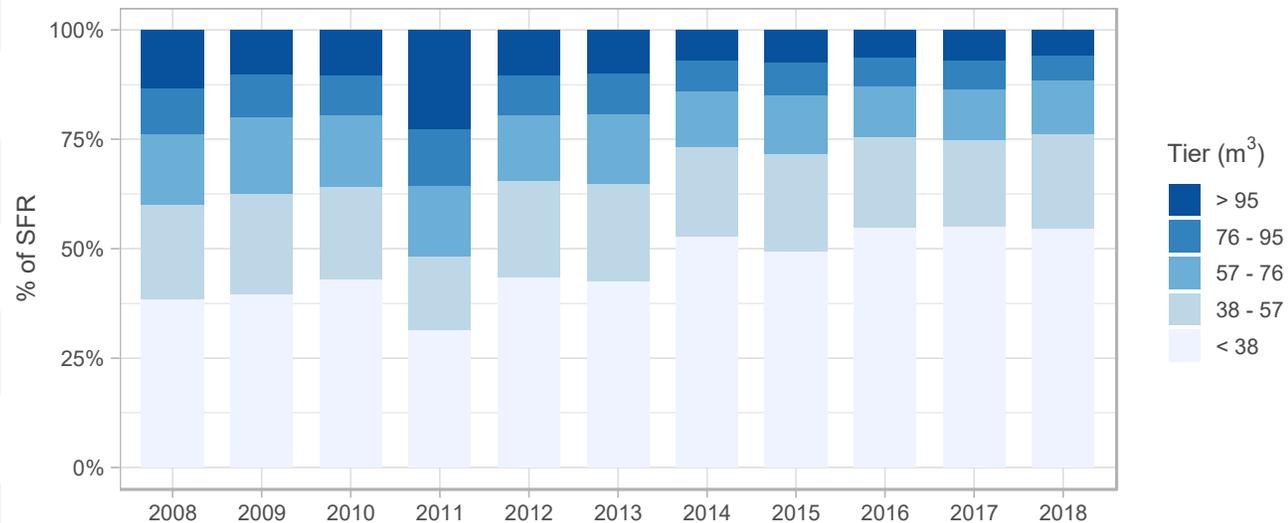
- Drought
 - More customers used more water
- Pre-interventions
 - Set it and forget it
 - Consumption profile remains the same irrespective of weather
- Effect of educational interventions
 - More customers using less water



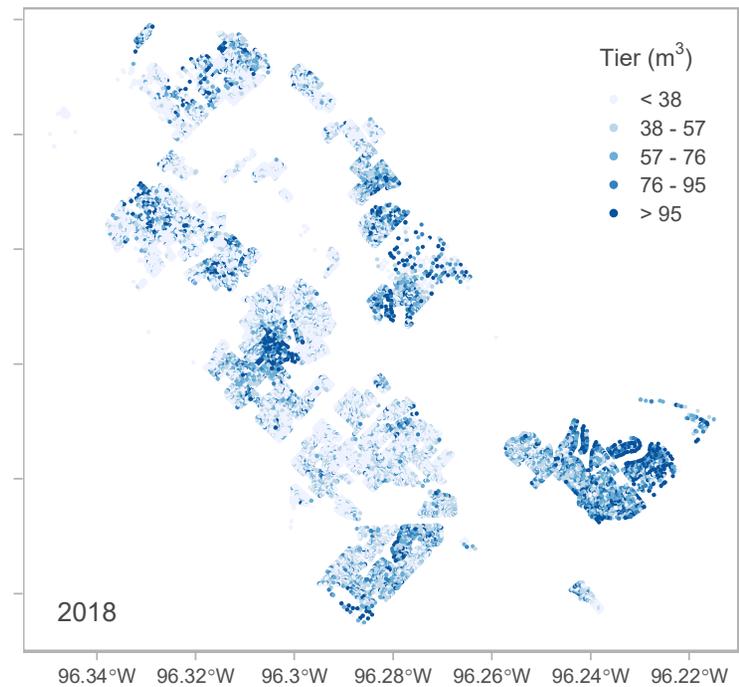
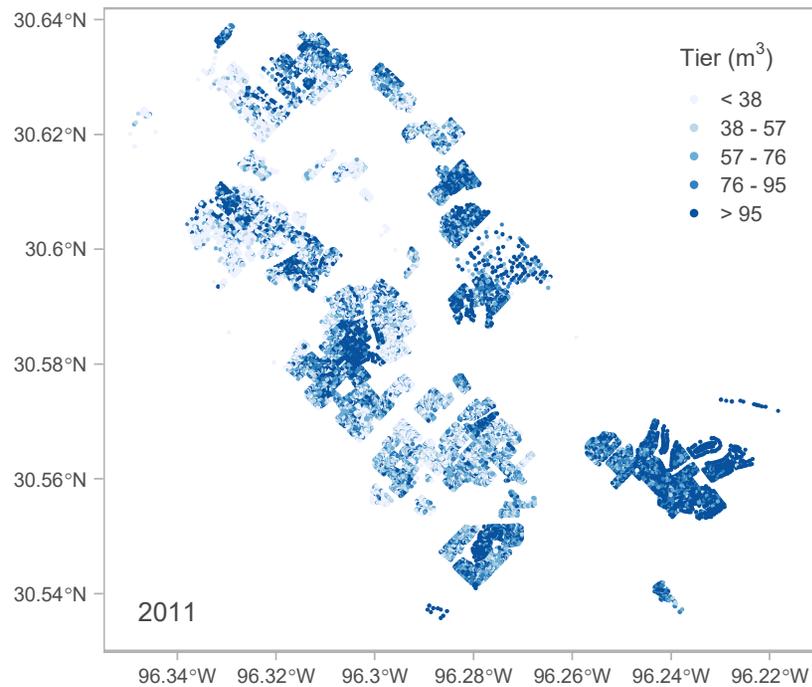
% of Customers in Different Usage Categories

Residential Rate Structure

Tier (gallons)	Tier (m ³)	Rate / 1,000 Gallons
0 – 10,000	< 38	\$2.75
11,000 – 15,000	38 – 57	\$3.60
16,000 – 20,000	57 – 76	\$4.40
21,000 – 25,000	76 – 95	\$5.20
26,000 – above	> 95	\$6.05
Meter Fee		\$12.40



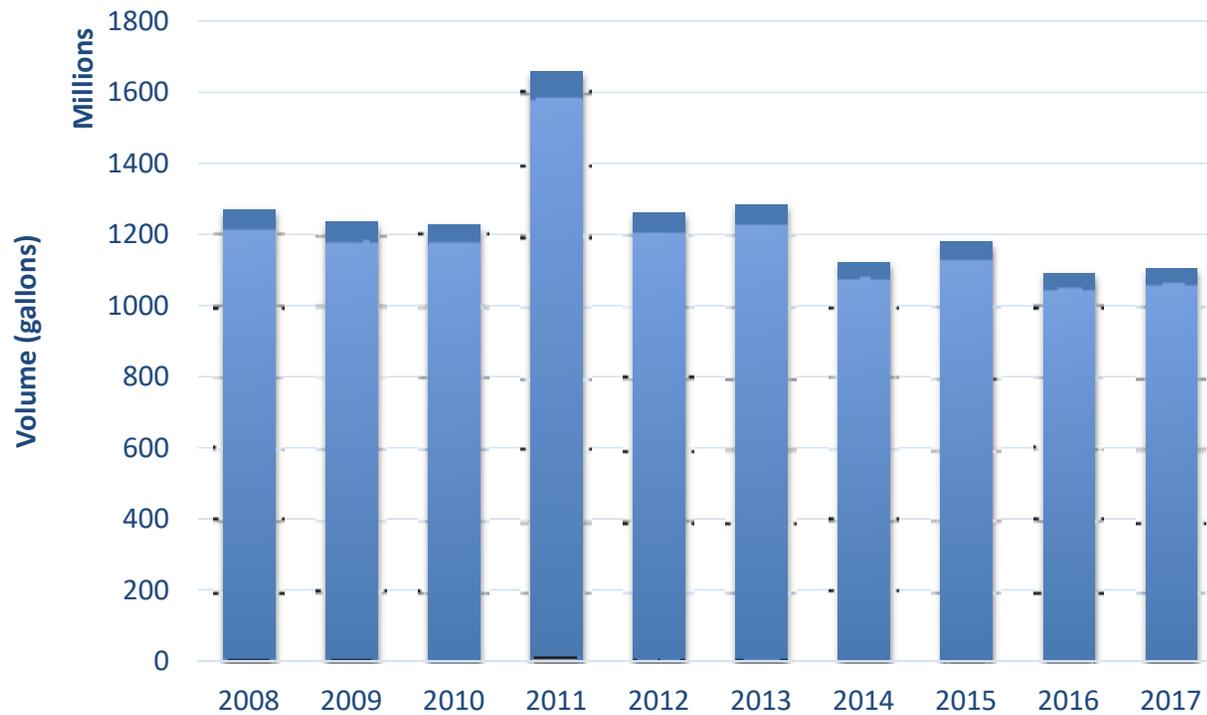
SFRs with Average Monthly Summer Use Each Tier





Impact of *BVWaterSmart*

Total Amount of Water Saved



Summer consumption
2012 *minus* 2017

157 Million
Gallons



BVWaterSmart: A Conservation Success Story

- Five interventions improved efficient irrigation by reducing use
 - Cumulative reduction in use since 2010 of just over **630,000,000 gallons**
 - 85% came from 5,500 homeowners that received interventions
 - This is equivalent to about **2 month total city water use**
 - As a result of savings, **College Station water use remained about same in 2018 as in 2010 while population has grown by 26%**
 - Website visitors have tripled since 2016 to more than **8,000 in 2018** and have visited site more than **300,000 times**
 - Nearly 1,000 irrigation check-up since 2018—a Master's study of 170 check-up revealed a savings of **11.5 million gallons** between 2010 and 2013
 - Energy savings to City from reductions in use since 2010 is more than **\$150,000**

Acknowledgements

- Brazos Valley Groundwater District
- City of College Station – Water Services
- Brazos Central Appraisal District
- David Smith
- Texas Center for Applied Technology





Thank You