This presentation premiered at WaterSmart Innovations

watersmartinnovations.com
A WATER BUDGET APPROACH FOR ASSESSING URBAN RESIDENTIAL IRRIGATION PERFORMANCE

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CP Khedun        J Nations      C Bastidas
OVERVIEW

- Overwatering lawns and landscapes wastes water
- Causes of overwatering
- Interventions to reduce overwatering
- Developing water budgets
- Assessing irrigation performance
- Next steps
CAUSES OF OVERWATERING

- Overwatering lawns and landscapes wastes water
  - 40-60% of single-family residential water use is outdoor
  - 50% is wasted due to overwatering (EPA)

- Causes
  - Continuing to run sprinklers after rainfall provides all of turf needs
  - Running irrigation system too long
  - Running irrigation system too often
  - Poor irrigation system design
  -Leaks

- Interventions targeting outdoor water use

Source: EPA WaterSense
Hurricane Harvey provided all of your lawn water needs last week and then some. Please turn your sprinklers off.

Past Rainfall: Weekly

Rainfall past 24 hours: 0 inches.
Rainfall past 7 days: 0 inches.
Rainfall last week (Sep 03, 2017 to Sep 10, 2017): 0 inches.
9/11/2017

Your lawn needs water this week.

Rainfall past 24 hours: 0 inches.
Rainfall past 7 days: 0 inches.
Rainfall last week (Sep 03, 2017 to Sep 10, 2017): 0 inches.

Click HERE for suggested generic Irrigation Run Times

SUGGESTED SPRINKLER SYSTEM RUN TIMES
Sprinkler Head type

- **Multi-stream**: 40 minutes per day, twice a week.
- **Rotator**: 30 minutes per day, twice a week.
- **Pop-up**: 15 minutes per day, twice a week.
- **Shrub spray**: 15 minutes per day, twice a week.
A message from Brazos Valley WaterSmart

Dear Ronald Kaiser,

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](http://bvwatersmart.tamu.edu).

*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](http://bvwatersmart.tamu.edu). Thank you for helping us conserve water.

---

**INTERVENTION 2: WEEKLY EMAILS**

When watering is required:

A message from Brazos Valley WaterSmart

Dear Ronald Kaiser,

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](http://bvwatersmart.tamu.edu).

*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](http://bvwatersmart.tamu.edu). Thank you for helping us conserve water.
Dear Ronald Kaiser,

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.
**Impact of Weekly Emails on Total Outdoor Water Use**

**Random Sample of 30 Customers from 390 Subscribers**

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (gal)</td>
<td>2,455,000</td>
<td>2,553,000</td>
<td>2,544,000</td>
<td>1,572,000</td>
</tr>
</tbody>
</table>
INTERVENTION 3: IRRIGATION SEMINARS
INTERVENTION 4: IRRIGATION SYSTEM CHECK-UPS

- Voluntary
- Free to homeowner
- Informed through
  - Utility bill insert
  - High water bill
  - Friend/Neighbor referral
  - Irrigation seminar
  - Study letter
- 779 since 2010
INTERVENTION 5: WATER BUDGETS

- Compares
  - How much lawn needs
  - How much is being watered

- Focusing on single-family residential landscape

- Causes of Overwatering
  - Continuing to run sprinklers after rainfall provides all of turf needs
  - Running irrigation system too long
  - Running irrigation system too often
  - Poor irrigation system design
  -Leaks

YOUR LAWN’S WATER BUDGET IN 2016

The table below gives your estimated irrigation budget and estimated outdoor water use for 2016. We determine your budget based on:

- the size of your lawn,
- College Station weather conditions, and
- your neighborhood rainfall from our many College Station rainfall sensors.

Did you know? Your grass typically needs about half as much water in April, May, and October than it does in June, July, August, and September. Your lawn needs even less if the weather is cool and rainy. Your water budget goes up when the weather is hot and dry, and then goes down when the weather is cool and wet.

<table>
<thead>
<tr>
<th>Month</th>
<th>Your Estimated Irrigation Budget (gallons)</th>
<th>How Much Water You Applied (gallons)</th>
<th>Amount You Over-irrigated (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>5,800</td>
<td>17,700</td>
<td>11,800</td>
</tr>
<tr>
<td>April</td>
<td>5,300</td>
<td>9,700</td>
<td>4,400</td>
</tr>
<tr>
<td>May</td>
<td>12,700</td>
<td>5,900</td>
<td>0</td>
</tr>
<tr>
<td>June</td>
<td>17,700</td>
<td>21,200</td>
<td>3,500</td>
</tr>
<tr>
<td>July</td>
<td>7,800</td>
<td>16,900</td>
<td>9,100</td>
</tr>
<tr>
<td>August</td>
<td>11,300</td>
<td>15,700</td>
<td>4,400</td>
</tr>
<tr>
<td>September</td>
<td>7,100</td>
<td>19,600</td>
<td>12,500</td>
</tr>
<tr>
<td>November</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>67,700</td>
<td>106,700</td>
<td>45,700</td>
</tr>
</tbody>
</table>

If you are over your estimated irrigation budget, please call Water Services at (979) 764-3660 to schedule a FREE LANDSCAPE IRRIGATION CHECKUP.

HOW MANY GALLONS IS ONE INCH OF WATER ON MY LAWN?

This table is an estimate of the number of gallons of water you use for each 1/2-inch of water applied based on the size of your lawn.

<table>
<thead>
<tr>
<th>Amount (in)</th>
<th>Volume (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>2,100</td>
</tr>
<tr>
<td>1</td>
<td>4,300</td>
</tr>
<tr>
<td>1.5</td>
<td>6,500</td>
</tr>
</tbody>
</table>

Irrigable Area (sq. feet): 7,000

To learn about irrigation runtimes and how to adjust your sprinkler heads, please visit www.BVWaterSmart.tamu.edu
Budgets sent to 5,565 lots in 2012-2015

23% of total residential customers

40% of total residential water use
ANATOMY OF A WATER BUDGET

<table>
<thead>
<tr>
<th>Irrigation needs (gal)</th>
<th>Potential Evapotranspiration (in)</th>
<th>Irrigation Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q = {K_c \times PET - P} \times A \times 0.62$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Landscape/Crop Coefficient
- Rainfall (in)
- Unit Conversion (gal/ft²)
A SAMPLE IRRIGATION AREA

- Sample lot
  - Parcel Area: 21,780 ft$^2$
  - Living Area: 2,377 ft$^2$
  - Building Area: 4,083 ft$^2$
  - Driveway Area: 2,440 ft$^2$
  - Irrigation Area: 15,257 ft$^2$
## Calculating Irrigation Landscape Area

<table>
<thead>
<tr>
<th>Appraised Lot Area (ft²)</th>
<th>4,000-5,999</th>
<th>6,000-7,999</th>
<th>8,000-9,999</th>
<th>10,000-11,999</th>
<th>12,000-13,999</th>
<th>14,000-17,999</th>
<th>18,000-23,999</th>
<th>24,000-29,999</th>
<th>30,000-59,999</th>
<th>60,000-89,999</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-999</td>
<td>0.66</td>
<td>0.69</td>
<td>0.76</td>
<td>0.82</td>
<td>0.84</td>
<td>0.87</td>
<td>0.87</td>
<td>0.94</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>1,000-1,499</td>
<td>0.55</td>
<td>0.60</td>
<td>0.66</td>
<td>0.72</td>
<td>0.75</td>
<td>0.78</td>
<td>0.83</td>
<td>0.86</td>
<td>0.91</td>
<td>0.92</td>
</tr>
<tr>
<td>1,500-1,999</td>
<td>0.50</td>
<td>0.56</td>
<td>0.62</td>
<td>0.67</td>
<td>0.71</td>
<td>0.76</td>
<td>0.80</td>
<td>0.84</td>
<td>0.87</td>
<td>0.90</td>
</tr>
<tr>
<td>2,000-2,499</td>
<td>0.53</td>
<td>0.53</td>
<td>0.57</td>
<td>0.61</td>
<td>0.65</td>
<td>0.70</td>
<td>0.76</td>
<td>0.81</td>
<td>0.86</td>
<td>0.90</td>
</tr>
<tr>
<td>2,500-2,999</td>
<td>0.49</td>
<td>0.56</td>
<td>0.57</td>
<td>0.58</td>
<td>0.60</td>
<td>0.66</td>
<td>0.73</td>
<td>0.77</td>
<td>0.84</td>
<td>0.89</td>
</tr>
<tr>
<td>3,000-3,499</td>
<td>0.52</td>
<td>0.53</td>
<td>0.55</td>
<td>0.58</td>
<td>0.61</td>
<td>0.70</td>
<td>0.75</td>
<td>0.83</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>3,500-3,999</td>
<td>0.54</td>
<td>0.53</td>
<td>0.56</td>
<td>0.60</td>
<td>0.67</td>
<td>0.72</td>
<td>0.80</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000-4,999</td>
<td>0.60</td>
<td>0.61</td>
<td>0.66</td>
<td>0.67</td>
<td>0.75</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000-8,999</td>
<td>0.50</td>
<td>0.60</td>
<td>0.61</td>
<td>0.64</td>
<td>0.74</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CALCULATING OVERWATERING

- April: Indoor consumption - 8, Irrigation within budget - 5, Excess irrigation - 3
- May: Indoor consumption - 10, Irrigation within budget - 5, Excess irrigation - 5
- June: Indoor consumption - 12, Irrigation within budget - 5, Excess irrigation - 5
- July: Indoor consumption - 12, Irrigation within budget - 20, Excess irrigation - 5
- August: Indoor consumption - 10, Irrigation within budget - 35, Excess irrigation - 5
- September: Indoor consumption - 10, Irrigation within budget - 15, Excess irrigation - 5

Water use (1000 gallons/month)

- Indoor consumption
- Irrigation within budget
- Excess irrigation
- Budget volume
ASSESSING IRRIGATION PERFORMANCE

- Performance can be assessed by comparing actual water use with plant irrigation requirements or water budget volumes.

- Criteria
  - Quantity of overwatering per household
  - How frequently per irrigation season overwatering occurred
  - Quantity relative to lot characteristics

- Objective
  - Determine characteristics explaining why overwatering might be higher in some homes relative to others.
## Irrigation Performance Versus Lot Size

Based on averaged results for 2008-2016 for 5,565 lots

<table>
<thead>
<tr>
<th>2017 Assessed Lot Size</th>
<th>Number of Accounts</th>
<th>Percentage of Accounts</th>
<th>Average Landscape Area (ft²)</th>
<th>2008-2016 Total Overwatering – Percentage</th>
<th>Average Annual Overwatering per Account (gallons)</th>
<th>Average Overwatering per Unit Area (inches)</th>
<th>Average Number of Months Overwatered per Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,000 ft² - 5,999 ft²</td>
<td>2910</td>
<td>20%</td>
<td>2,571</td>
<td>0.8%</td>
<td>22,345</td>
<td>13.2</td>
<td>3.4</td>
</tr>
<tr>
<td>6,000 ft² - 7,999 ft²</td>
<td>2480</td>
<td>17%</td>
<td>4,040</td>
<td>10.5%</td>
<td>16,694</td>
<td>6.6</td>
<td>2.5</td>
</tr>
<tr>
<td>8,000 ft² - 9,999 ft²</td>
<td>1545</td>
<td>11%</td>
<td>5,521</td>
<td>16.4%</td>
<td>19,170</td>
<td>5.2</td>
<td>2.4</td>
</tr>
<tr>
<td>10,000 ft² - 11,999 ft²</td>
<td>1377</td>
<td>10%</td>
<td>6,934</td>
<td>19.7%</td>
<td>23,963</td>
<td>5.1</td>
<td>2.5</td>
</tr>
<tr>
<td>12,000 ft² - 13,999 ft²</td>
<td>756</td>
<td>5%</td>
<td>8,357</td>
<td>16.0%</td>
<td>28,468</td>
<td>5.0</td>
<td>2.5</td>
</tr>
<tr>
<td>14,000 ft² - 17,999 ft²</td>
<td>322</td>
<td>2%</td>
<td>10,627</td>
<td>14.8%</td>
<td>31,068</td>
<td>4.3</td>
<td>2.4</td>
</tr>
<tr>
<td>18,000 ft² - 23,999 ft²</td>
<td>374</td>
<td>3%</td>
<td>14,870</td>
<td>10.6%</td>
<td>37,956</td>
<td>3.7</td>
<td>2.3</td>
</tr>
<tr>
<td>24,000 ft² - 29,999 ft²</td>
<td>99</td>
<td>1%</td>
<td>19,434</td>
<td>7.3%</td>
<td>48,082</td>
<td>3.6</td>
<td>2.2</td>
</tr>
<tr>
<td>30,000 ft² - 59,999 ft²</td>
<td>0</td>
<td>0%</td>
<td>29,658</td>
<td>3.8%</td>
<td>47,002</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>60,000 ft² - 89,999 ft²</td>
<td>0</td>
<td>0%</td>
<td>62,322</td>
<td>0.1%</td>
<td>20,791</td>
<td>0.5</td>
<td>1.2</td>
</tr>
</tbody>
</table>
## Irrigation Performance versus Home Age

Based on averaged results for 2008-2016 for 5,565 lots

<table>
<thead>
<tr>
<th>Year Built</th>
<th>Number of Accounts</th>
<th>Percentage of Accounts</th>
<th>Average Landscape Area (ft²)</th>
<th>2008-2016 Total Overwatering – Percentage</th>
<th>Average Annual Overwatering per Account (gallons)</th>
<th>Average Overwatering per Unit Area (inches)</th>
<th>Average Number of Months Overwatered per Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951-1960</td>
<td>1</td>
<td>0.02%</td>
<td>15,706</td>
<td>0.0%</td>
<td>7,958</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>1961-1970</td>
<td>97</td>
<td>1.74%</td>
<td>11,463</td>
<td>1.2%</td>
<td>18,285</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>1971-1980</td>
<td>413</td>
<td>7.42%</td>
<td>11,664</td>
<td>3.9%</td>
<td>13,521</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>1981-1990</td>
<td>728</td>
<td>13.08%</td>
<td>9,308</td>
<td>11.8%</td>
<td>23,063</td>
<td>4.0</td>
<td>2.2</td>
</tr>
<tr>
<td>1991-2000</td>
<td>1944</td>
<td>34.93%</td>
<td>8,706</td>
<td>37.1%</td>
<td>27,260</td>
<td>5.0</td>
<td>2.4</td>
</tr>
<tr>
<td>2001-2010</td>
<td>2353</td>
<td>42.28%</td>
<td>7,145</td>
<td>45.4%</td>
<td>27,531</td>
<td>6.2</td>
<td>2.7</td>
</tr>
<tr>
<td>≥2011</td>
<td>29</td>
<td>0.52%</td>
<td>6,862</td>
<td>0.6%</td>
<td>27,969</td>
<td>7.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td>5,565</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Irrigation Performance versus Home Value

Based on averaged results for 2008-2016 for 5,565 lots

<table>
<thead>
<tr>
<th>2017 Assessed Home Value</th>
<th>Number of Accounts</th>
<th>Percentage of Accounts</th>
<th>Average Landscape Area (ft²)</th>
<th>2008-2016 Total Overwatering – Percentage</th>
<th>Average Annual Overwatering per Account (gallons)</th>
<th>Average Overwatering per Unit Area (inches)</th>
<th>Average Number of Months Overwatered per Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>$50,000 to $99,999</td>
<td>7</td>
<td>0%</td>
<td>12,497</td>
<td>0.03%</td>
<td>6,909</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>$100,000 to $149,999</td>
<td>963</td>
<td>7%</td>
<td>6,737</td>
<td>7.24%</td>
<td>10,733</td>
<td>2.7</td>
<td>1.7</td>
</tr>
<tr>
<td>$150,000 to $199,999</td>
<td>1617</td>
<td>11%</td>
<td>6,570</td>
<td>18.98%</td>
<td>16,750</td>
<td>4.3</td>
<td>2.2</td>
</tr>
<tr>
<td>$200,000 to $299,999</td>
<td>1854</td>
<td>13%</td>
<td>7,968</td>
<td>38.19%</td>
<td>29,399</td>
<td>6.3</td>
<td>2.8</td>
</tr>
<tr>
<td>$300,000 to $499,999</td>
<td>693</td>
<td>5%</td>
<td>11,429</td>
<td>19.31%</td>
<td>39,766</td>
<td>6.5</td>
<td>2.8</td>
</tr>
<tr>
<td>$500,000 to $999,999</td>
<td>428</td>
<td>3%</td>
<td>15,788</td>
<td>15.88%</td>
<td>52,969</td>
<td>6.2</td>
<td>2.7</td>
</tr>
<tr>
<td>$1,000,000 or more</td>
<td>3</td>
<td>0%</td>
<td>21,286</td>
<td>0.38%</td>
<td>178,820</td>
<td>15.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Median Value</td>
<td>$210,930</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
COMPARING QUANTITY OVERWATERED VERSUS HOW OFTEN OVERWATERING OCCURRED

- Based on average of overwatering and number of months over budget (rounded) for 2008-2016

- Cells show count of lots within category

<table>
<thead>
<tr>
<th>Months Over Budget</th>
<th>Total Amount Overwatered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,500 or less</td>
</tr>
<tr>
<td>1</td>
<td>262</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

*5,543 lots overwatered*
COMPARING QUANTITY OVERWATERED VERSUS HOW OFTEN OVERWATERING OCCURRED

- Based on average of overwatering and number of months over budget (rounded) for 2008-2016
- Cells show percent of total overwatering represented by lots within category

<table>
<thead>
<tr>
<th>Months Over Budget</th>
<th>2,500 or less</th>
<th>2,500 to 9,999</th>
<th>10,000 to 24,999</th>
<th>25,000 to 49,999</th>
<th>50,000 or more</th>
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<td>1</td>
<td>0.28%</td>
<td>1.42%</td>
<td>0.35%</td>
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<tr>
<td>2</td>
<td>0.03%</td>
<td>3.10%</td>
<td>8.34%</td>
<td>4.60%</td>
<td>1.04%</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.18%</td>
<td>11.12%</td>
<td>14.93%</td>
<td>5.83%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>2.56%</td>
<td>16.52%</td>
<td>12.59%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>0.14%</td>
<td>3.73%</td>
<td>9.53%</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>0.02%</td>
<td>0.46%</td>
<td>3.12%</td>
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</tbody>
</table>
SUMMARY OF FINDINGS

- Overwatering is common, but quantity and frequency varies!
- Overwatering tended to be higher among lots that were larger, newer, and more expensive.
- Smaller homes tended to overwater more often and more per unit area.
  - However, these tended to be smaller volumes and were much greater quantities relative to the size of the landscape.
- Newer homes, irrespective of market value, tended to overwater more often and more per unit area.
  - Inclusion of irrigation systems with automatic irrigation controllers.
**Summary of Findings**

<table>
<thead>
<tr>
<th>Quantity Overwatered</th>
<th>Frequency of Overwatering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Seldom</td>
</tr>
<tr>
<td></td>
<td>Least concern</td>
</tr>
<tr>
<td>Medium</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Often</td>
</tr>
<tr>
<td></td>
<td>Most concern</td>
</tr>
</tbody>
</table>

- **Low Overwatering:** Seldom, Least concern
- **Medium Overwatering:** Average
- **High Overwatering:** Often, Most concern

Leak? Log error?
LIMITATIONS OF ANALYSIS

- Monthly budget calculations did not account for when rain falls relative to the start or end of the month
- Weather data was obtained from a single weather station—rainfall varies!
- Weather station switched locations over the analysis period
- Landscape area methodology may overestimate area that is actually being irrigated
- Landscape contains numerous plant species with varying water needs
- Possible errors in water billing data logged by City
WHAT WE ARE CURRENTLY WORKING ON

- Statistical analysis to determine the impact of the interventions on water use
- Better understanding of irrigation performance across single-family residential water customers using a weekly time step
- Using rainfall from nearest weather station
- BV WaterSmart: estimating irrigation budget monthly and comparing to monthly water bill
ACKNOWLEDGEMENTS

- University Council on Water Resources
- City of College Station – Water Services
  - Dave Coleman, Water Services Director
  - Jennifer Nations, Water Conservation Coordinator
- Brazos Central Appraisal District
- David Smith, Brazos Valley WaterSmart
Thank You
REFERENCES


RAINFALL VARIES....

- May 26, 2016

5.2 in

7.4 in

4.2 in

4.46 in
RAINFALL VARIES....

- August 20, 2016

0.8 in

- SPW_1

0 in

- Well 4

1.2 in

- Burgess

2.0 in

- Carter Creek

LEGEND

Weather Station Owner

- Bryan
- College Station
- Wixon Valley
RAINFALL VARIES....

- Hurricane Harvey

**Legend**
- Weather Station Owner
  - Bryan
  - College Station
  - Wixon Valley
  - City Boundary

18.9 in
18.8 in
17 in
17.9 in
18 in
18.8 in
18.9 in
20 in
21.1 in
23.1 in