



**DANIEL
CUNNINGHAM**

*Project Manager
Horticulturist*

@TXPlantGuy



#WaterUDoing *for Texas Horticulture ?*

What can you do to save blue in
The Green Industry ?

Texas Research Foundation

Texas Agricultural Research Experiment Station

The Renner Station

County Cooperative Extension Center

Texas Co-Op Extension

Texas AgriLife Research Center

Texas A&M Dallas

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Urban Solutions Center

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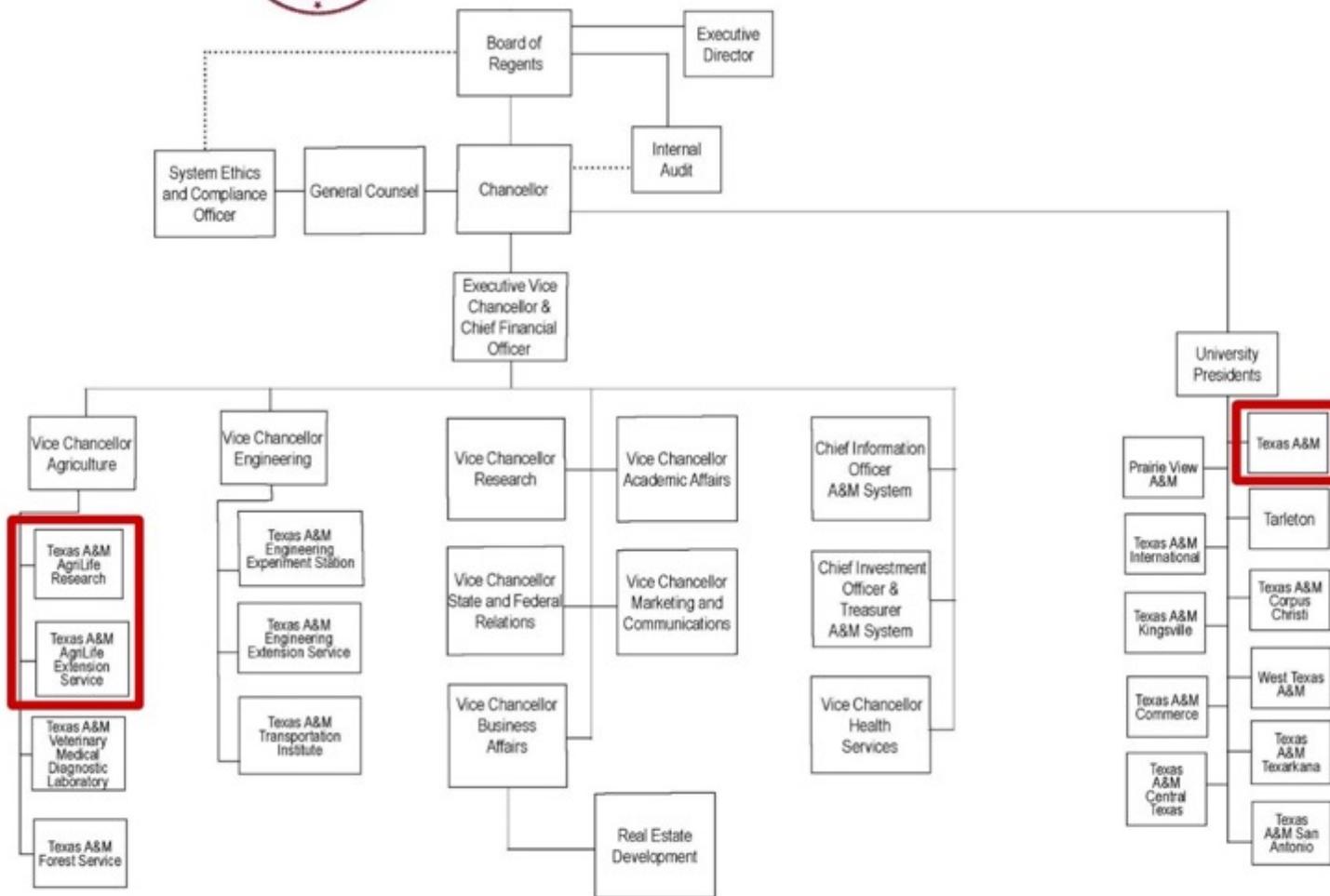
At Dallas





The Texas A&M University System

ORGANIZATIONAL CHART



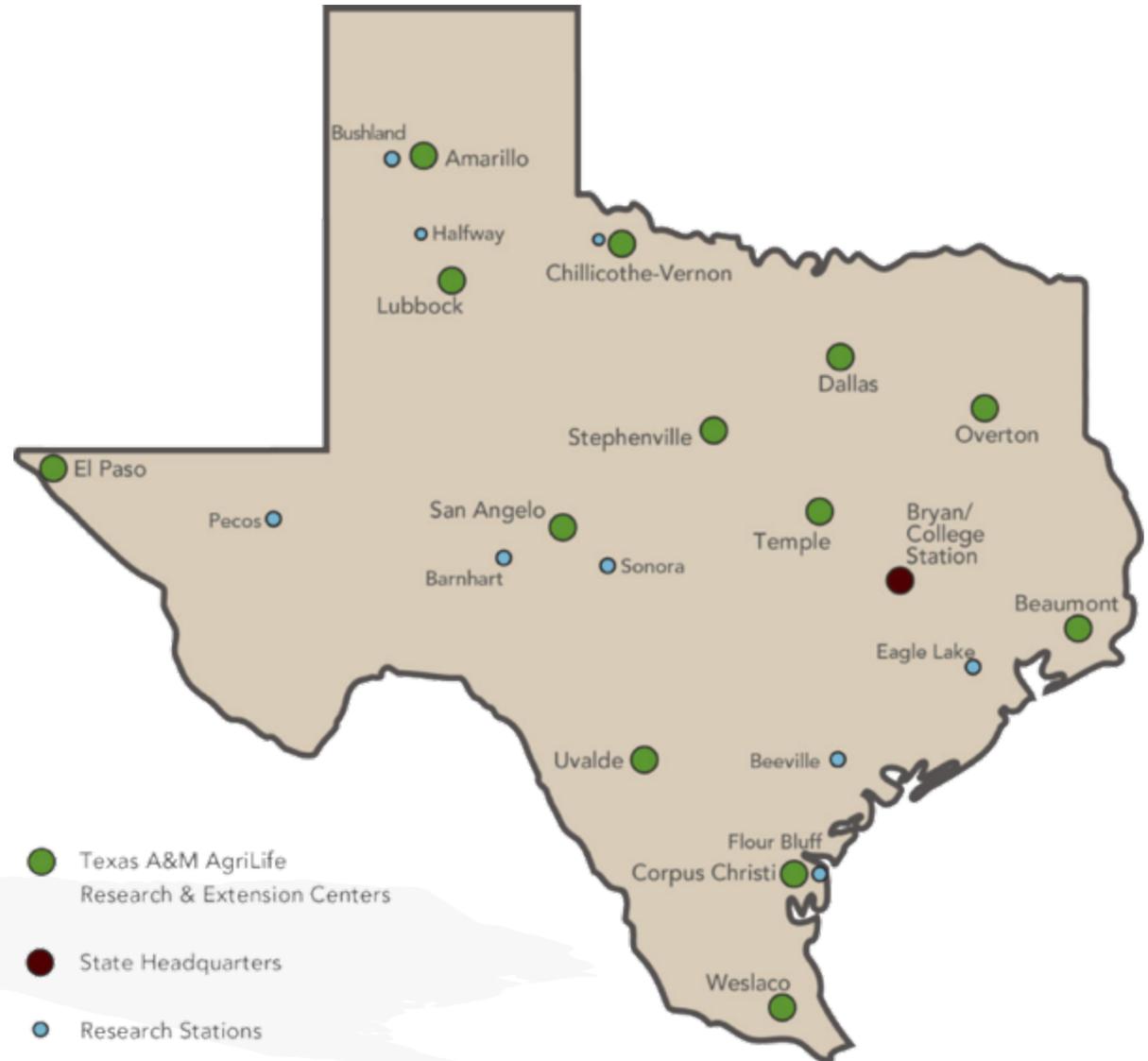


TEXAS A&M
AGRILIFE
RESEARCH



TEXAS A&M
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EXTENSION

13 research and extension centers across Texas



RESEARCH

1. Water University
2. Plant Virology
3. Turfgrass Breeding
4. Plant Genomics
5. Plant Abiotic Stress
6. Plant Biotic Stress
7. Freshwater Mussels

EXTENSION

1. Family and Community Health
2. Urban Entomology
3. School IPM
4. Agricultural Entomology
5. Ecological Engineering
6. Texas 4-H Urban Outreach
7. Texas 4-H
8. Urban Municipal Parks
9. Agricultural Business Management

TEXAS A&M
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RESEARCH

WATER
UNIVERSITY

WaterUniversity.tamu.edu

**RESEARCH, PUBLIC OUTREACH
AND CONTINUING EDUCATION**

**WATER USE
EFFICIENCY
IN THE URBAN ENVIRONMENT**

THE WATER UNIVERSITY TEAM



**CLINT
WOLFE**
Program Leader



**PATRICK
DICKINSON**



**DANIEL
CUNNINGHAM**



**DR. DOTTY
WOODSON**

ABOUT 50%

Of any urban area is covered by lawns and landscaping.

TURFGRASS

Is the largest irrigated crop in the US

ABOUT 50%

Of any urban area is covered by lawns and landscaping.

ABOUT 30%

Of all water used by the average U.S. home is used outside.



MISSION

Shape perception

Change behavior





TEXAS A&M AGRILIFE RESEARCH | WATER UNIVERSITY

- Home
- About
- Plants
- Turfgrass
- Soil
- Irrigation
- Rainwater Harvesting
- Design
- WaterSense Demonstrations
- Stream Trailer

Courses



Plant Database

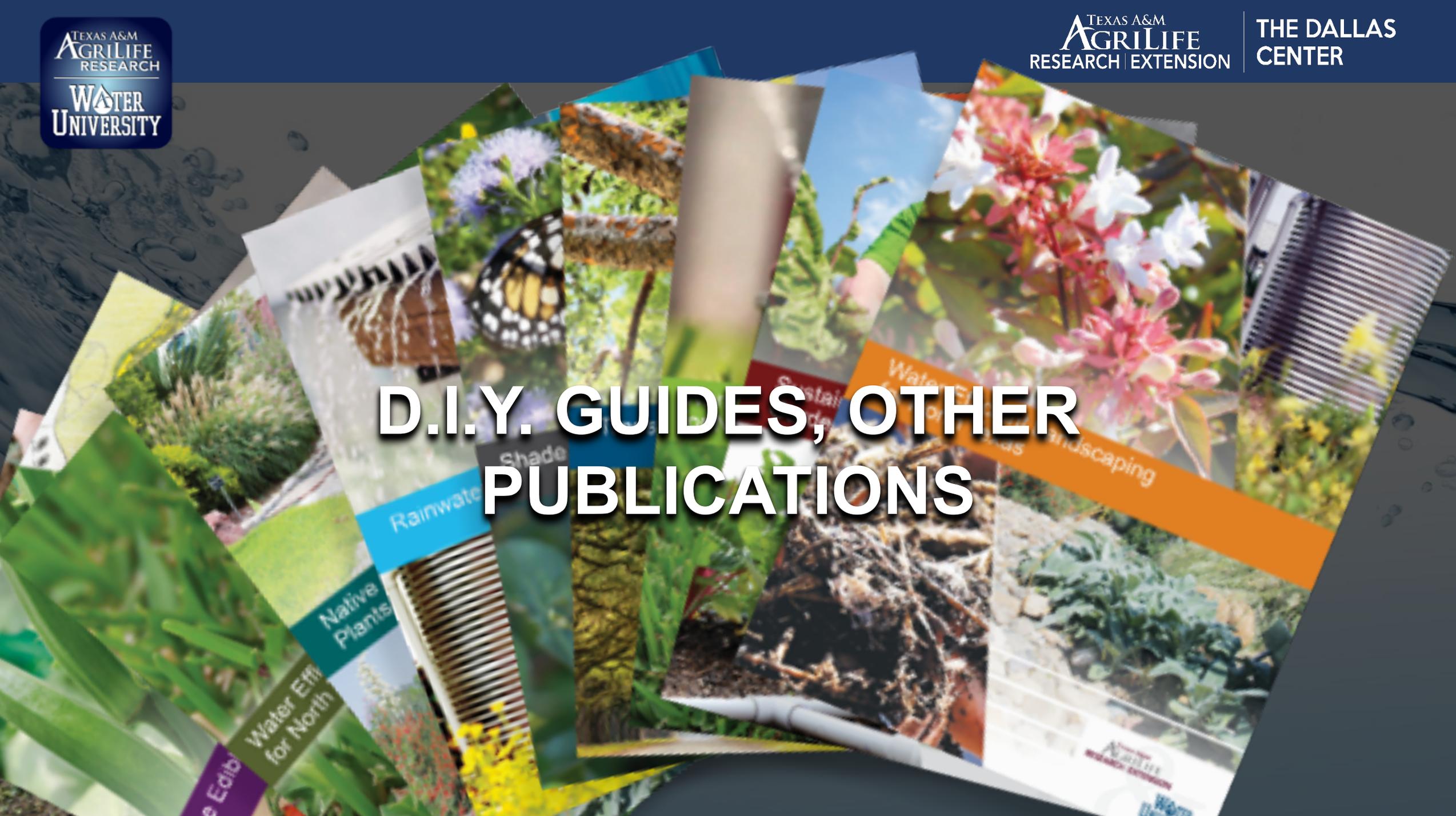


ULandscapeIt



Publications





D.I.Y. GUIDES, OTHER PUBLICATIONS

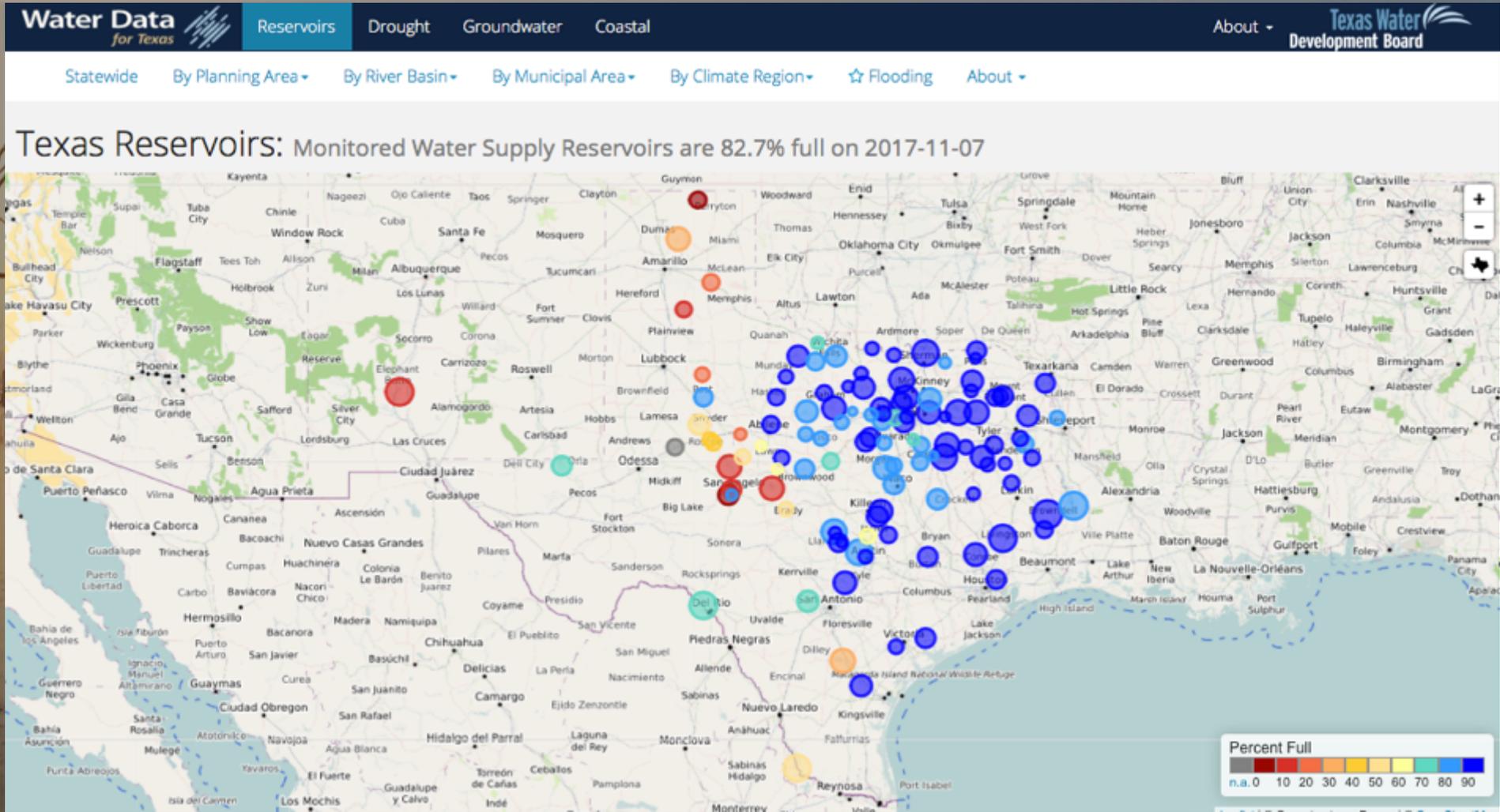


@AgriLife Water University



@TXPlantGuy





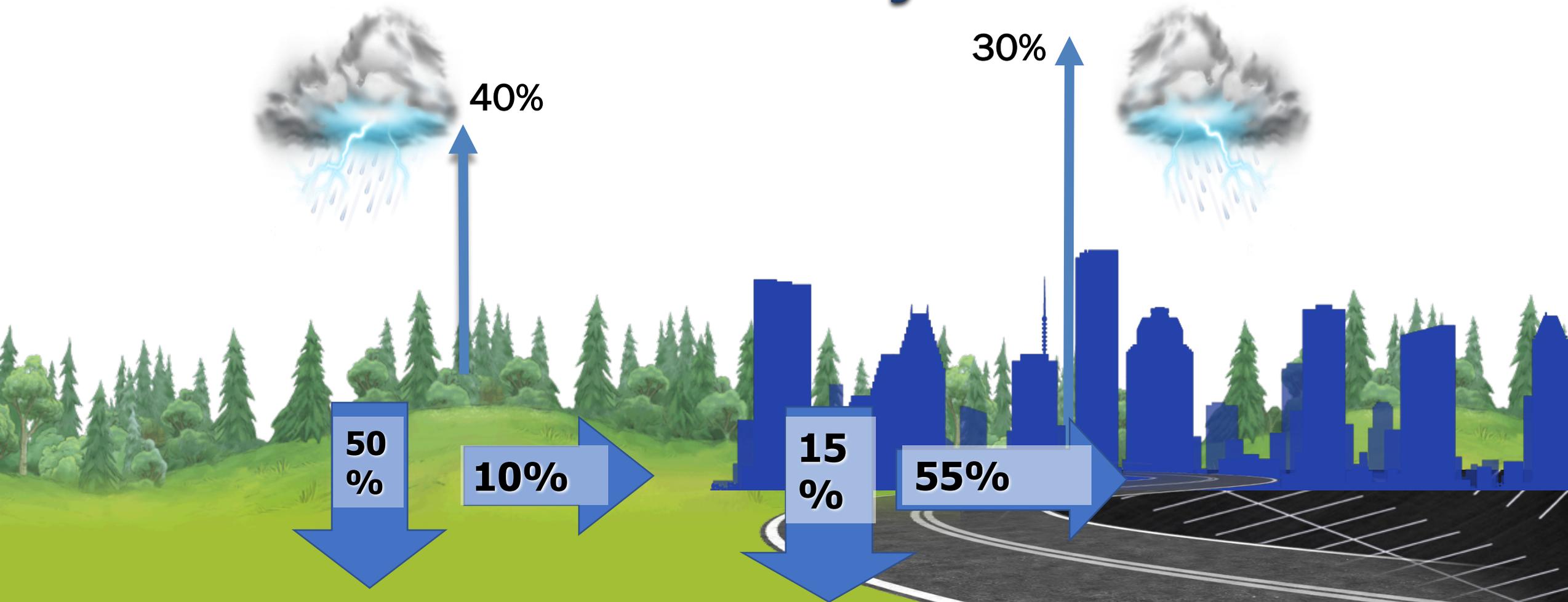
Texas' existing water supplies

(that can be relied on in the event of drought)

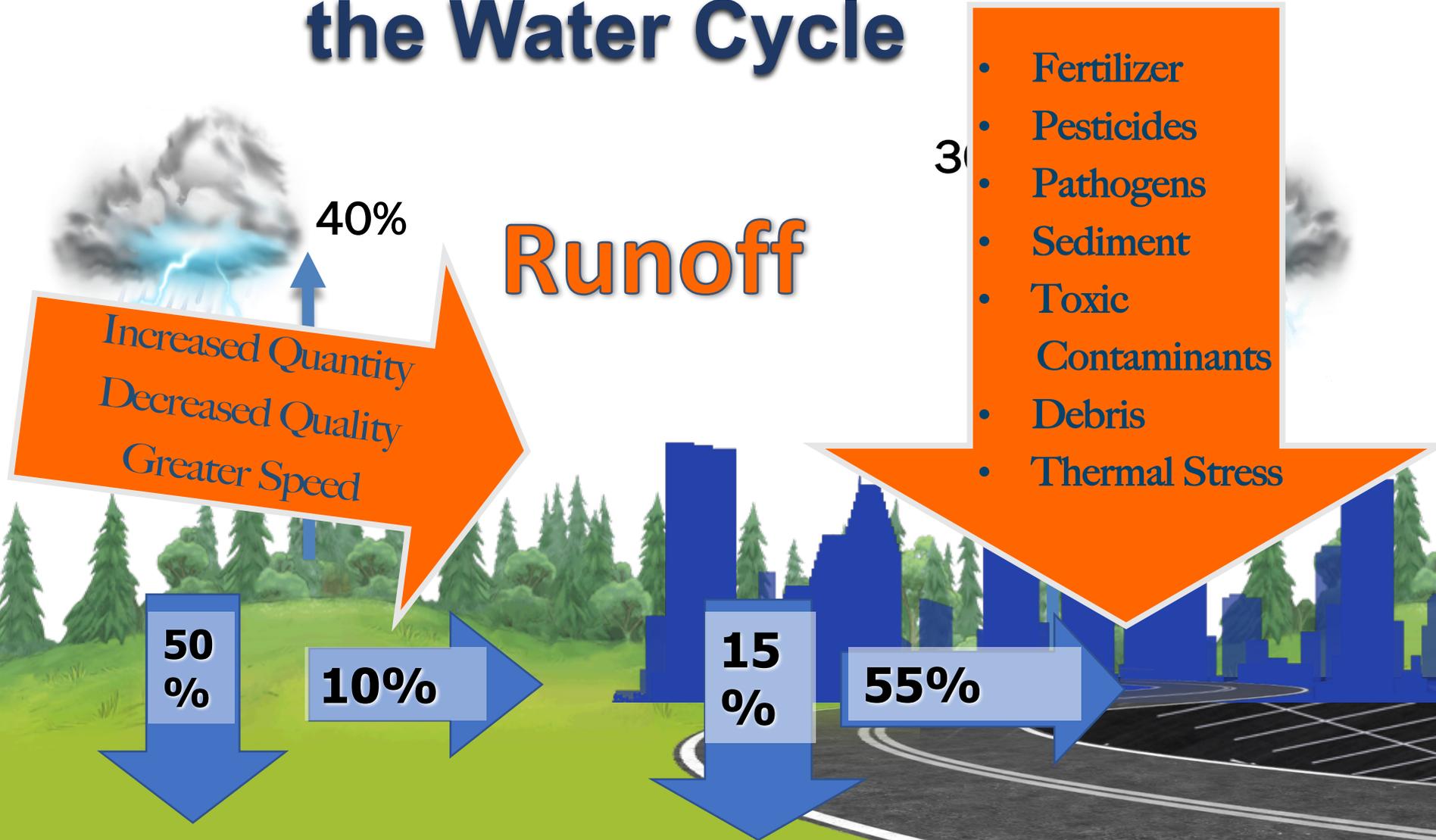
Expected decline by approximately 11% (2020 - 2070)

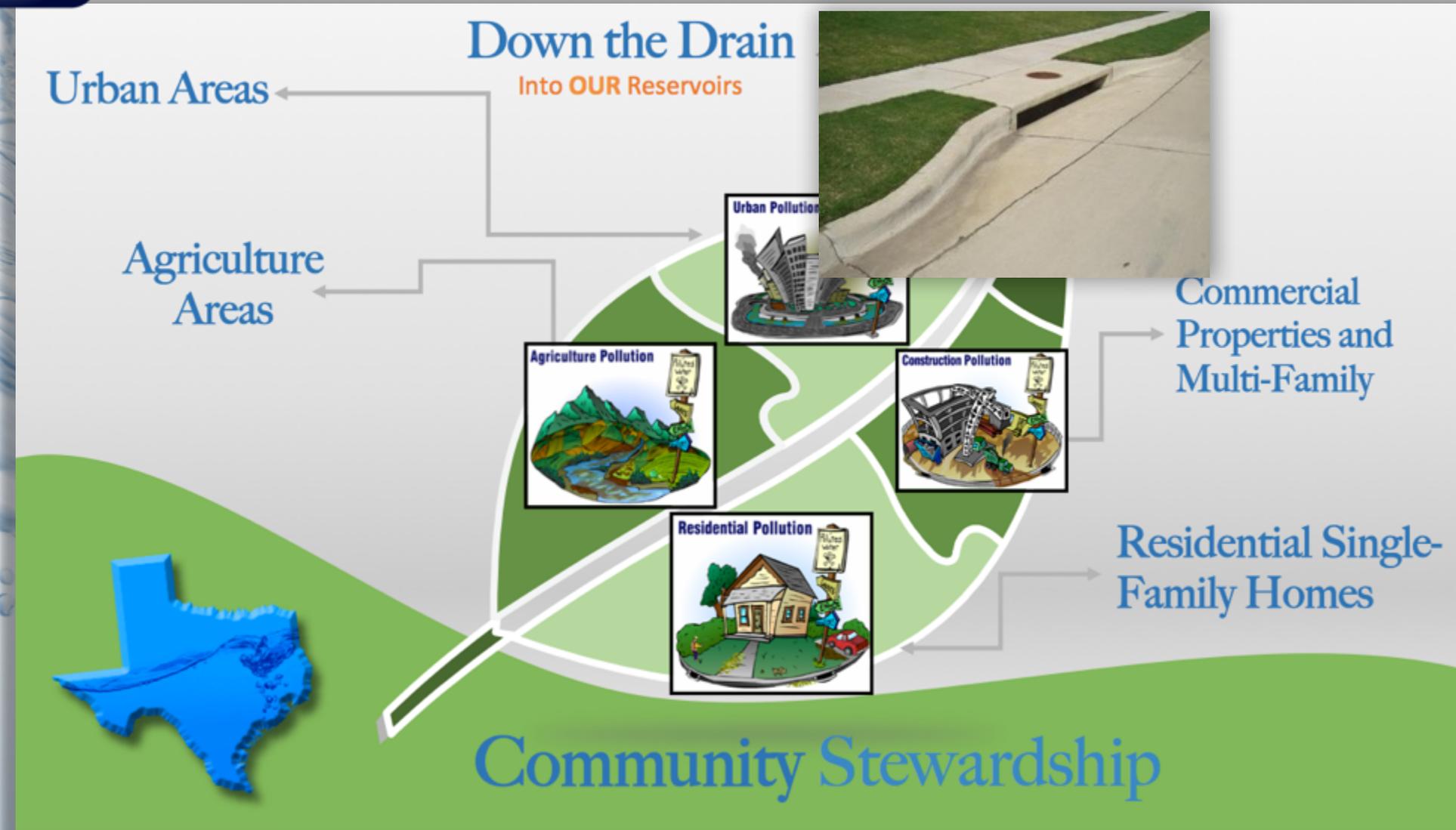
15.2 million to 13.6 million acre-feet

Development Impacts the Water Cycle



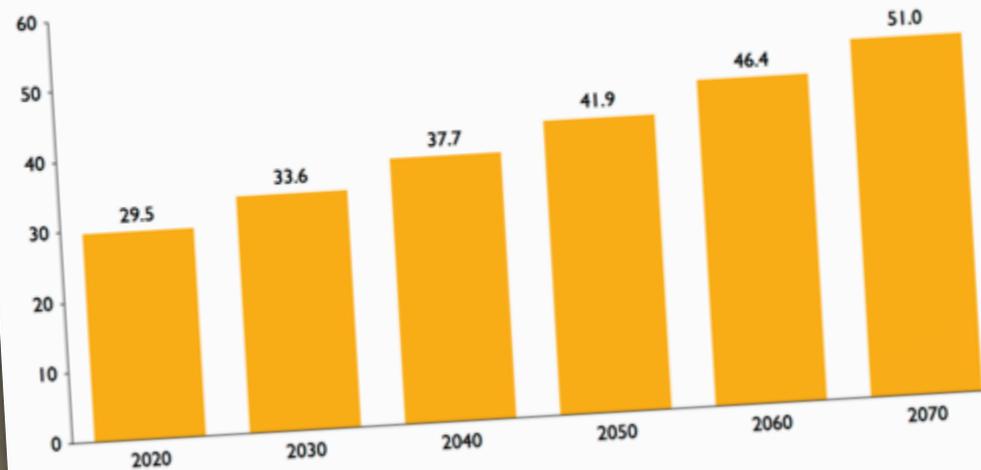
Development Impacts the Water Cycle





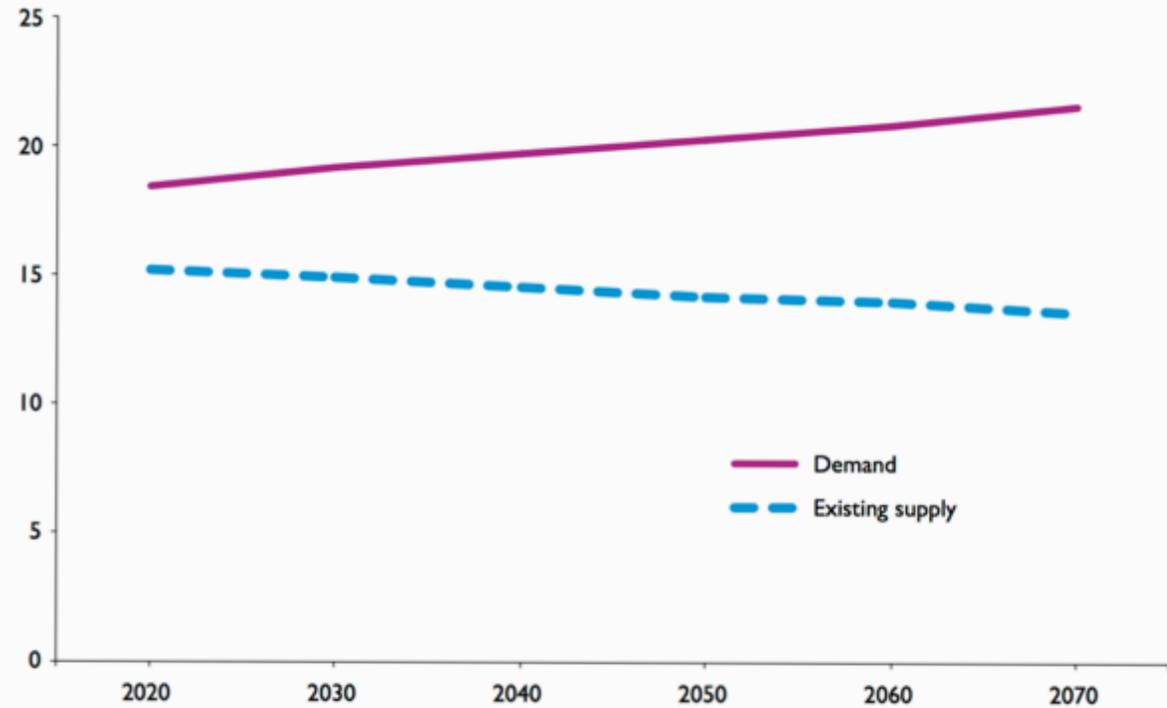
Increase 70% by 2070
(29.5 million to 51 million by 2030)
***TWDB Projections**

Figure ES.2 - Projected population in Texas (millions)



Water supply expected to decrease (from 15.2 million acre feet to 13.6)

Figure ES.3 - Projected annual water demand and existing water supply in Texas (millions of acre-feet)



U.S. Drought Monitor Texas

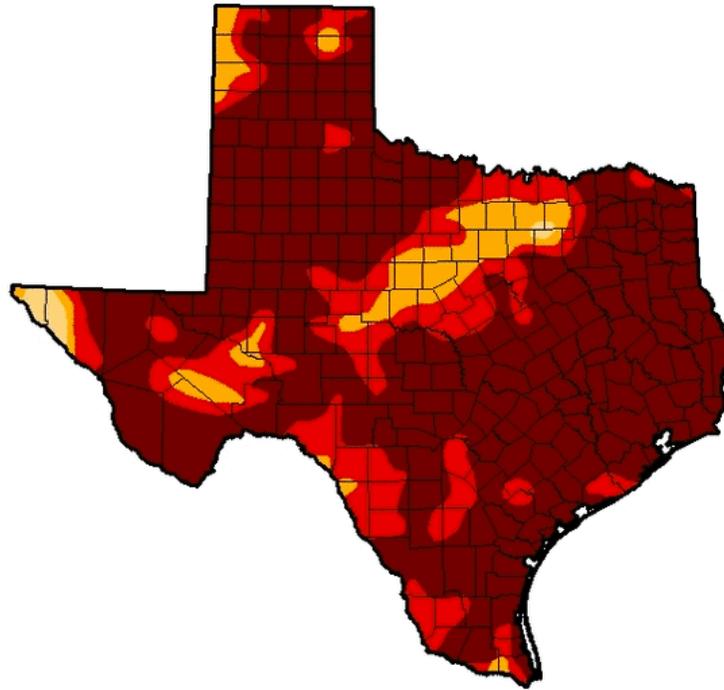
October 11, 2011

(Released Thursday, Oct. 13, 2011)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	99.15	91.96	73.13
Last Week <i>10/4/2011</i>	0.00	100.00	100.00	99.16	96.99	87.99
3 Months Ago <i>7/12/2011</i>	0.00	100.00	97.43	95.78	90.97	71.66
Start of Calendar Year <i>1/4/2011</i>	13.55	86.45	66.68	36.30	13.04	0.00
Start of Water Year <i>9/27/2011</i>	0.00	100.00	100.00	99.16	96.65	85.75
One Year Ago <i>10/12/2010</i>	72.27	27.73	3.79	1.03	0.02	0.00



Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:

Richard Tinker
 CPC/NOAA/NWS/NCEP



<http://droughtmonitor.unl.edu/>

Potential water shortage?

4.8 million acre-feet per year in 2020

8.9 million acre-feet per year in 2070

(in *drought of record* conditions)

Texas 2017 State Water Plan

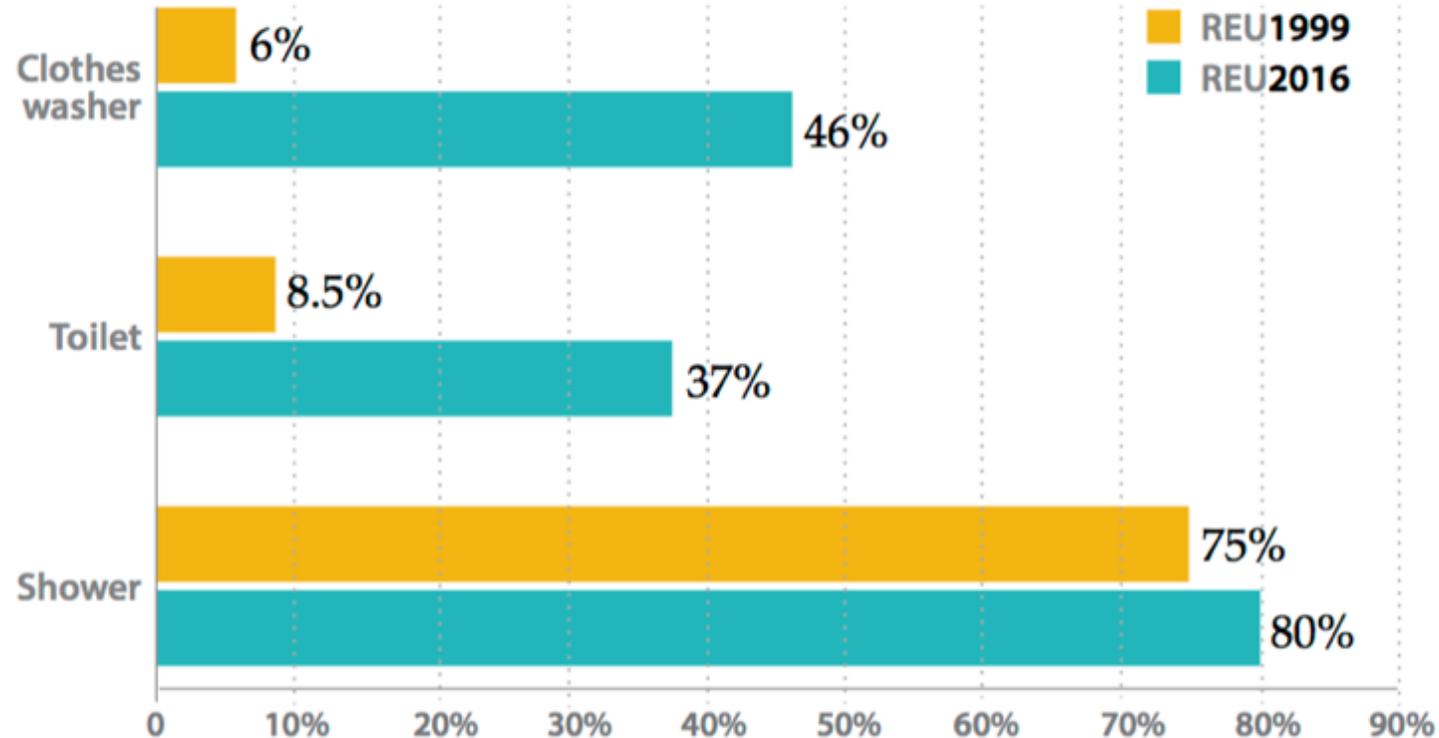
Conservation & Reuse strategies –

Increased from 34% to 45 % of total future water volume!

Indoor Use

Figure 6. Percent of homes meeting efficiency criteria, REU1999 and REU2016

Efficiency criteria include: clothes washers <30 gal/load, toilets <2.0 gal/flush, showers <2.5 gal/minute.



Outdoor Use

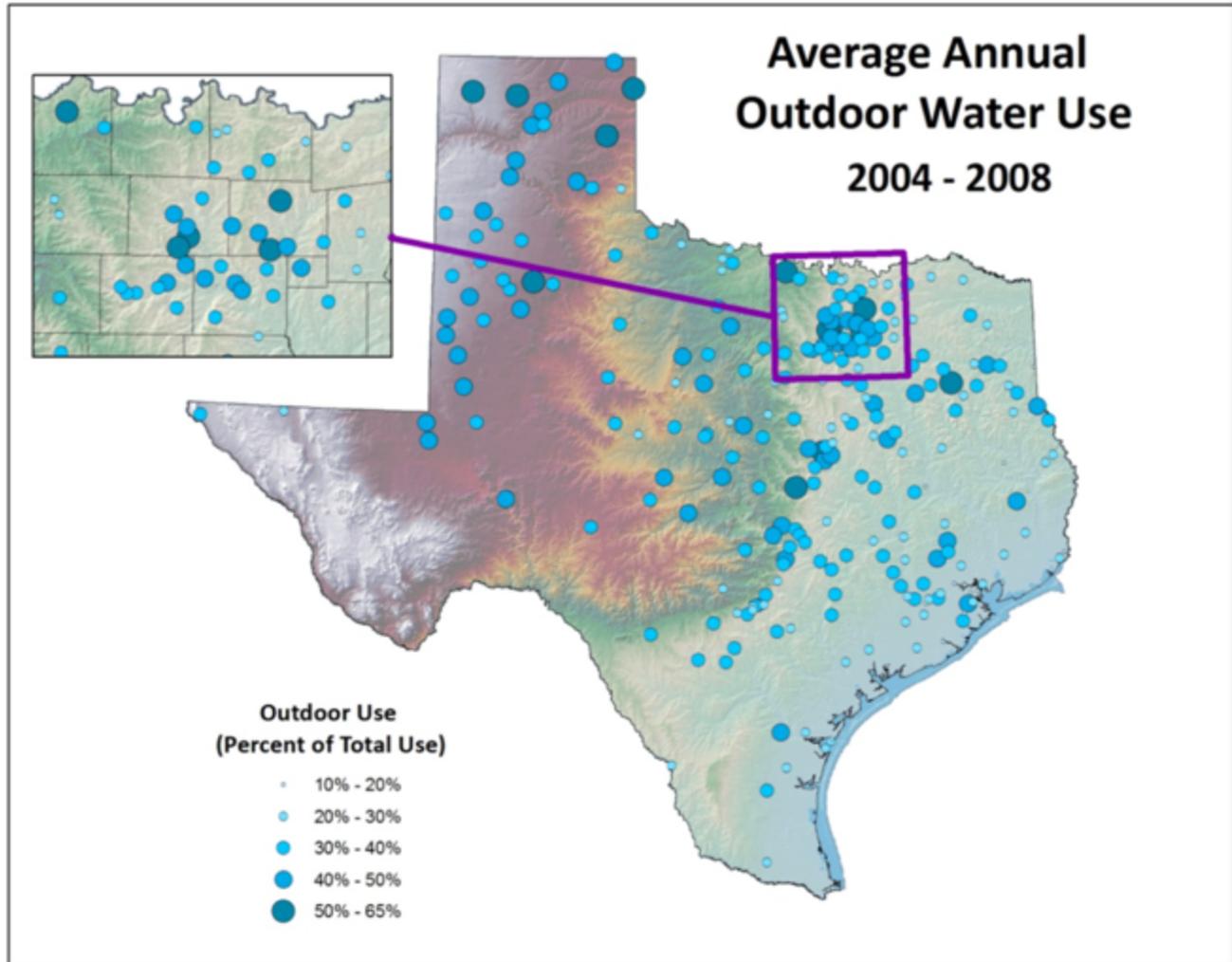


Table 3: Annual average water use by city for 2004 through 2011.

	City	Indoor use (gallons)	Outdoor use (gallons)	Outdoor use as a percentage of total use	Gallons per household per day for indoor use (gallons)	Gallons per household per day for outdoor use (gallons)
1	Amarillo	4,203,333,000	3,110,188,125	42	194	143
2	Arlington	6,579,447,000	3,806,411,375	36	198	114
3	Austin	11,532,894,150	5,879,032,288	33	176	89
4	College Station*	1,510,618,286	922,872,143	38	-	-
5	Corpus Christi	4,983,501,000	1,839,473,375	26	179	66
6	Dallas	16,293,358,200	11,668,235,723	41	173	125
7	El Paso	12,676,702,014	6,231,936,280	33	220	105
8	Fort Worth	11,576,921,511	6,819,864,226	37	166	97
9	Garland	4,398,659,640	2,234,119,198	33	198	100
10	Houston	22,287,783,000	5,629,024,250	20	148	37
11	Katy	281,554,500	202,737,375	40	188	135
12	Laredo	5,013,600,000	1,707,862,500	25	265	93
13	Lubbock	4,332,784,500	2,341,568,000	36	177	96
14	Odessa	2,327,562,000	1,358,331,500	37	205	119
15	Pflugerville	558,544,200	393,038,375	39	219	152
16	San Antonio**	23,242,411,406	7,713,879,696	25	202	67
17	Tyler	1,682,887,500	1,937,568,750	53	171	195
	City average			35	192	108
	City median			36	191	102
	Statewide average			31	181	86

Clients are asking for:

Outdoor living spaces that

- Are environmentally sustainable
- Reduce water costs
- Are lower maintenance

88% Rainwater Harvesting or Graywater Harvesting

86% Native plants/Adapted Plants

77% Pervious Paving

75% Edible Landscaping

73% Rain Gardens

72% Drip/ Efficient Irrigation

72% Reduced Lawn Area



Conservation-

Saving resources **Water, Soil, Energy, Air Quality**

- Preserving and enhancing habitat and ecological functions of the watershed

Permeability-

Disconnecting impermeable surfaces

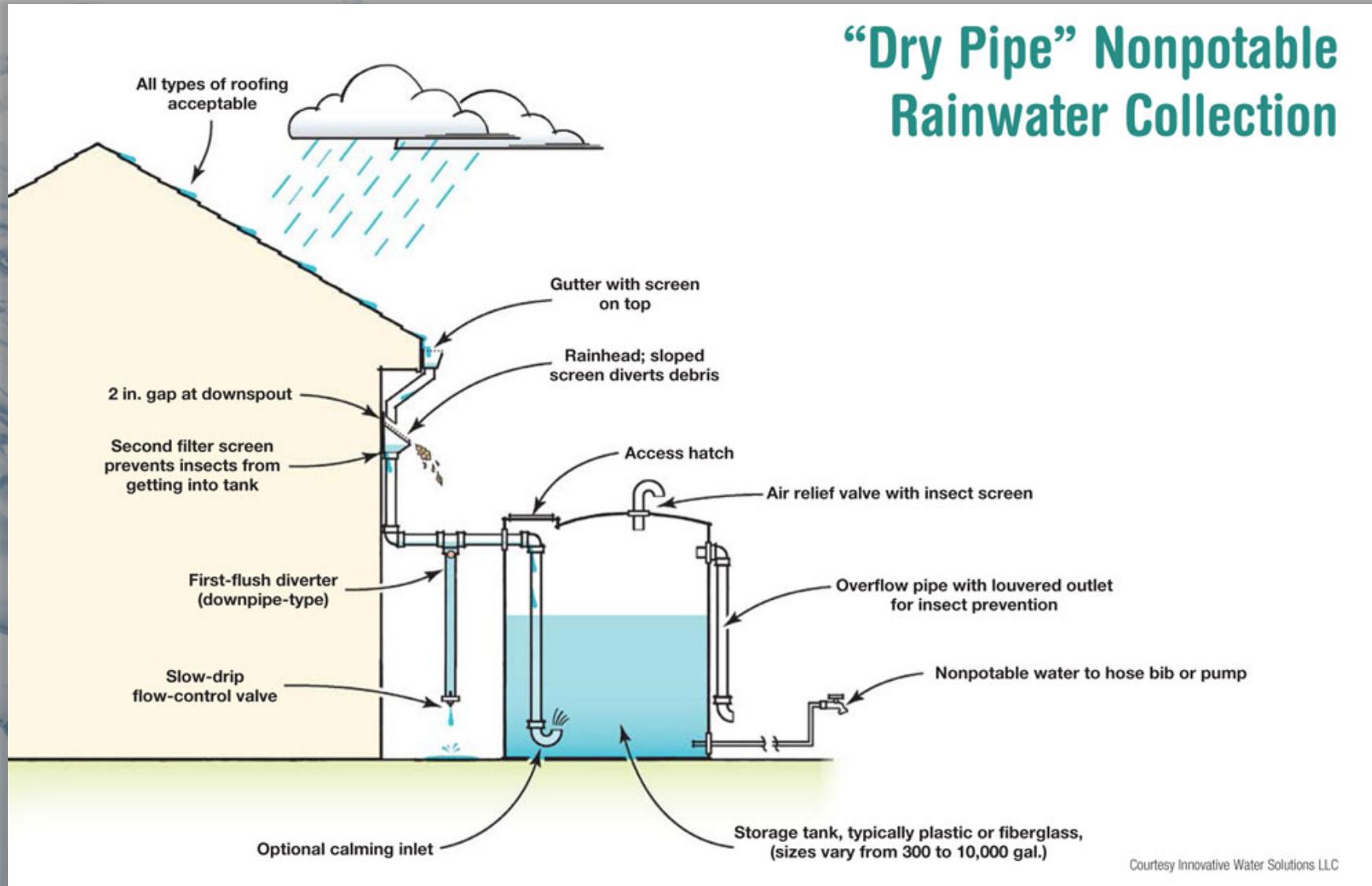
- Breaking up hard surfaces to allow water to spread out and sink into the ground
- Creating soil that is biologically active and holds on to water

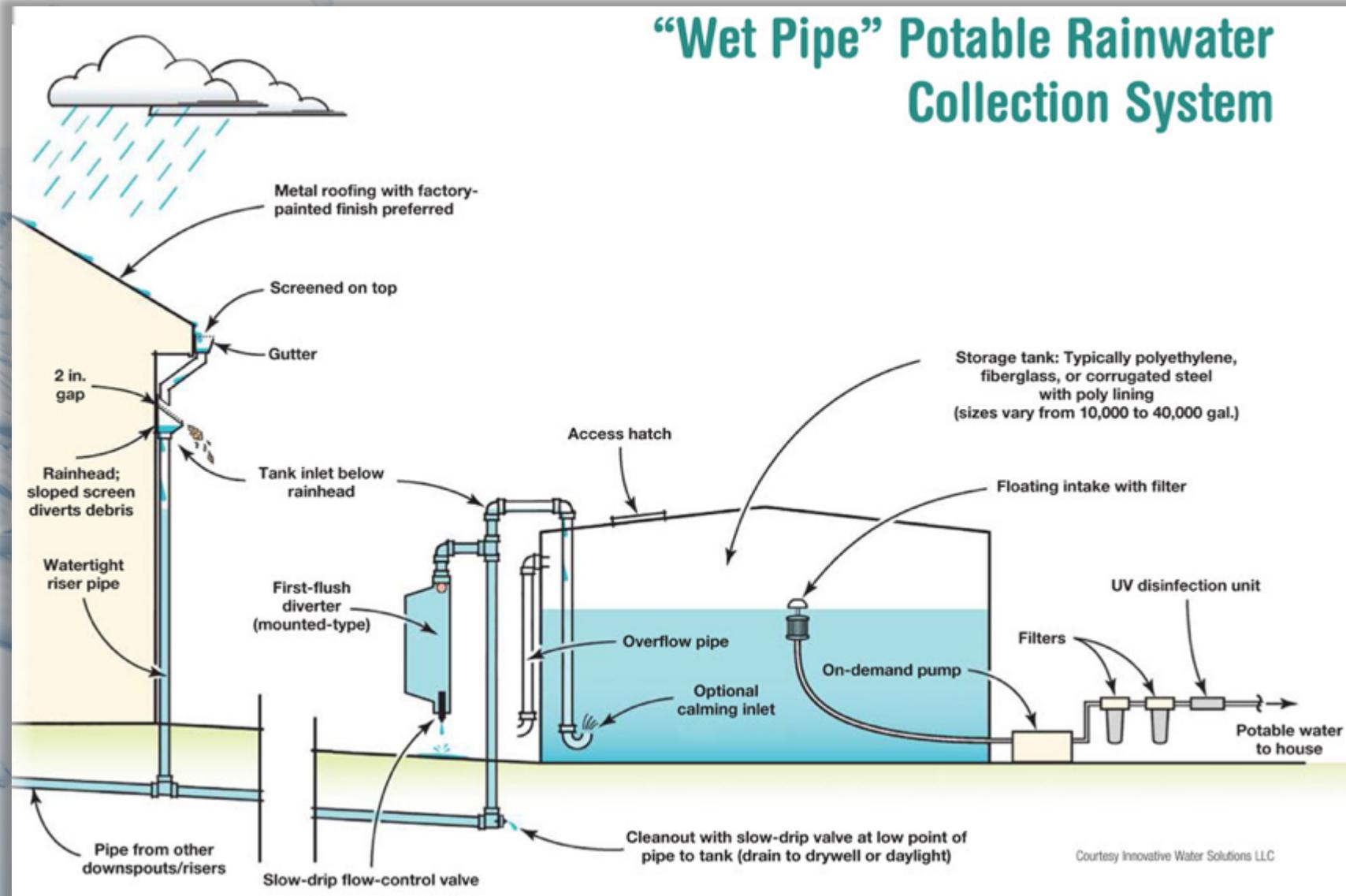
Retention-

Holding water on the property for the benefit of Soil, Plants, and Habitat

- Rather than allowing it to Run Off into the storm system
- Grading to capture water and allow it to sink throughout the landscape
- **Elimination of Runoff**

“Dry Pipe” Nonpotable Rainwater Collection



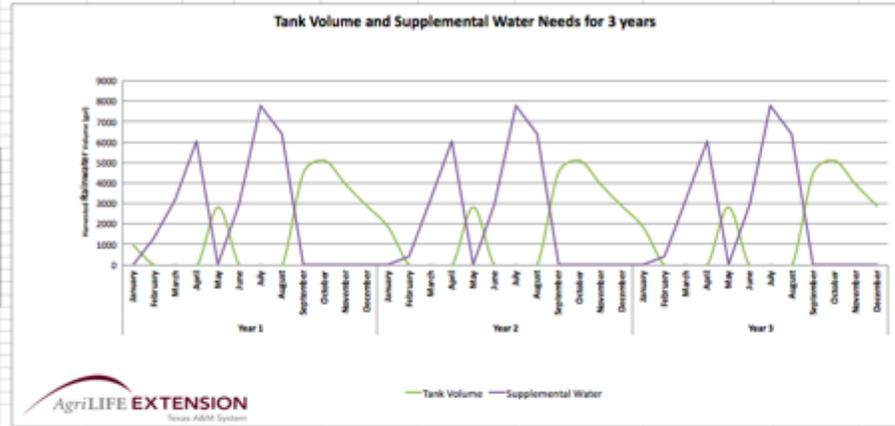


RainwaterHarvesting.tamu.edu

Texas AgrLife Extension Service Rainwater Harvesting Calculator

To use the calculator fill in all highlighted input values.

Input Values		
Catchment area (sq ft)	12500	
Collection efficiency (%)	91	
Initial tank volume (gal)	20000	
Tank size (gal)	40000	
Plant water use coeff	0.3	
Irrigated area (sq ft)	10,000	
Monthly indoor demand (gal)	0	
Avg. monthly rainfall (in)		
Jan	0.75	1.28
Feb	0.69	2.03
Mar	1.24	4.41
Apr	1.28	5.53
May	3.21	6.59
Jun	2.14	7.79
Jul	1.84	7.63
Aug	1.86	7.2
Sep	2.75	3.68
Oct	1.57	0.73
Nov	0.83	2.01
Dec	0.74	2.33
Total	18.76	59.28
Avg. PET (in)		
Jan	0	0
Feb	0	0
Mar	0	0
Apr	0	0
May	0	0
Jun	0	0
Jul	0	0
Aug	0	0
Sep	0	0
Oct	0	0
Nov	0	0
Dec	0	0
Total	0	0
AC Coefficient (gal)		
Jan	0	0
Feb	0	0
Mar	0	0
Apr	0	0
May	0	0
Jun	0	0
Jul	0	0
Aug	0	0
Sep	0	0
Oct	0	0
Nov	0	0
Dec	0	0
Total	0	0
Yearly Percent Average Rainfall (%)		
Year 1	100%	
Year 2	100%	
Year 3	100%	



AgriLIFE EXTENSION
Texas A&M System

Calculations

Year	Month	Supply	Demand	Tank Volume	Supplemental Water
Year 1	January	9549	6588	960	0
	February	9106	7973	0	1308
	March	9174	12363	0	3190
	April	9470	15508	0	6034
	May	22268	19438	2840	0
	June	15832	21671	0	2999
	July	13813	21391	0	7778
	August	13761	20185	0	6421
	September	20049	15531	4518	0
	October	12355	11747	5126	0
	November	6140	7917	3949	0
	December	5475	6532	2891	0
Year 2	January	9549	6588	1852	0
	February	9106	7973	0	413
	March	9174	12363	0	3190
	April	9470	15508	0	6034
	May	22268	19438	2840	0
	June	15832	21671	0	2999
	July	13813	21391	0	7778
	August	13761	20185	0	6421
	September	20049	15531	4518	0
	October	12355	11747	5126	0
	November	6140	7917	3949	0
	December	5475	6532	2891	0
Year 3	January	9549	6588	1852	0
	February	9106	7973	0	413
	March	9174	12363	0	3190
	April	9470	15508	0	6034
	May	22268	19438	2840	0
	June	15832	21671	0	2999
	July	13813	21391	0	7778
	August	13761	20185	0	6421
	September	20049	15531	4518	0
	October	12355	11747	5126	0
	November	6140	7917	3949	0
	December	5475	6532	2891	0

	Evapotranspiration (inches)	Plant water use Coefficient	Plant water needs in inches	Gallons per square foot	Square Footage of Landscaping	Total Landscaping water Demand in gallons
January	2.26	0.3	0.71	0.44	18000	6588
February	2.65	0.3	0.79	0.48	18000	7973
March	4.41	0.3	1.32	0.82	18000	12363
April	5.53	0.3	1.66	1.02	18000	15503
May	6.53	0.3	2.08	1.26	18000	19428
June	7.73	0.3	2.32	1.44	18000	21671
July	7.63	0.3	2.29	1.43	18000	21391
August	7.2	0.3	2.16	1.35	18000	20185
September	3.68	0.3	1.08	0.64	18000	15531
October	0.73	0.3	0.28	0.18	18000	11747
November	2.01	0.3	0.69	0.48	18000	7917
December	2.33	0.3	0.72	0.44	18000	6532

permadesign.com/calculator



Welcome to PermaDesign's FREE Roofwater Calculator

USE IT TO INSTANTLY ESTIMATE THE WATER RESOURCES THAT YOUR ROOF COLLECTS IN AN AVERAGE YEAR.

Help

1. Find your property ?

1710 N. FM 3053, Overton, TX 75684

Locate Site

2. Outline surfaces ?

Draw

Edit

3. Manage surfaces ?

Surface Name	Area	Volume	
Surface 1	30108	831734	-
Surface 2	1270	35084	-
Surface 3	2939	81190	-
Total Harvest	34317	948008	

Select display units: Sq Feet/Gallons



Google

Map data ©2017 Google Imagery ©2017, DigitalGlobe, Texas Orthoimagery Program 20 m Terms of Use Report a map error

4. Save Report ?

Print

5. Share Site ?

Like 60

Tweet

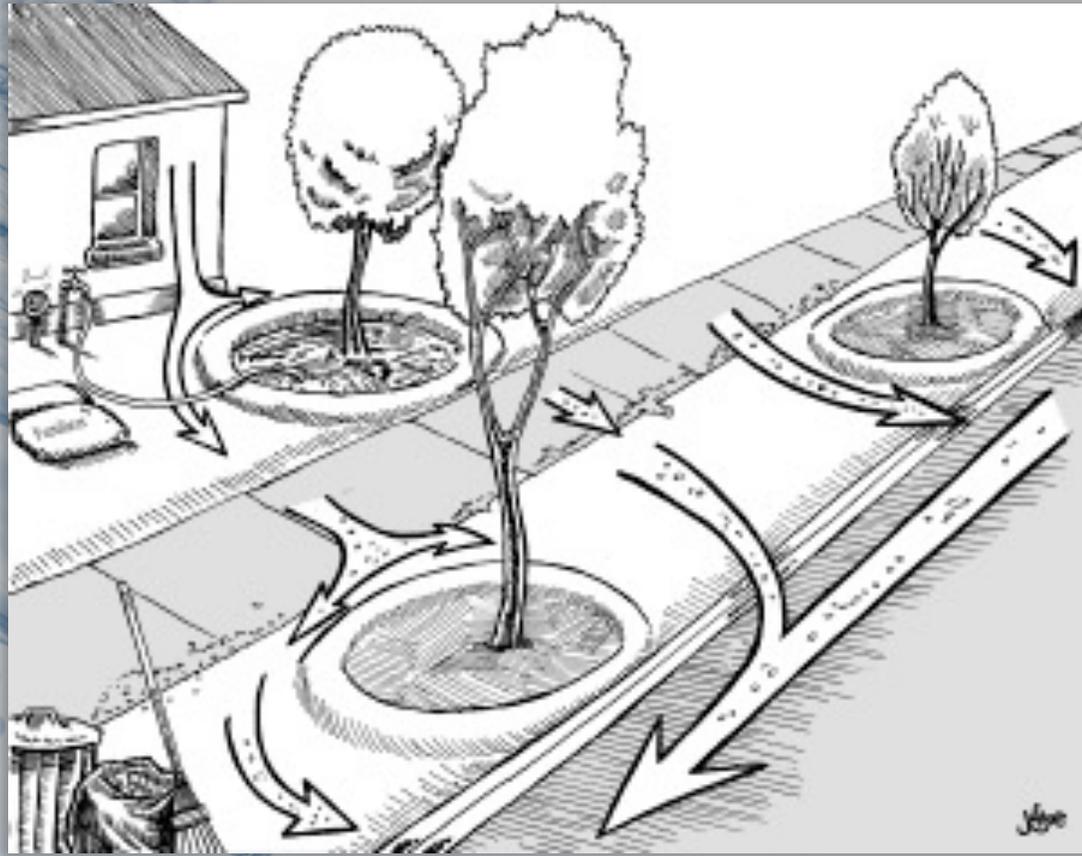
G+

6. Learn more about roofwater

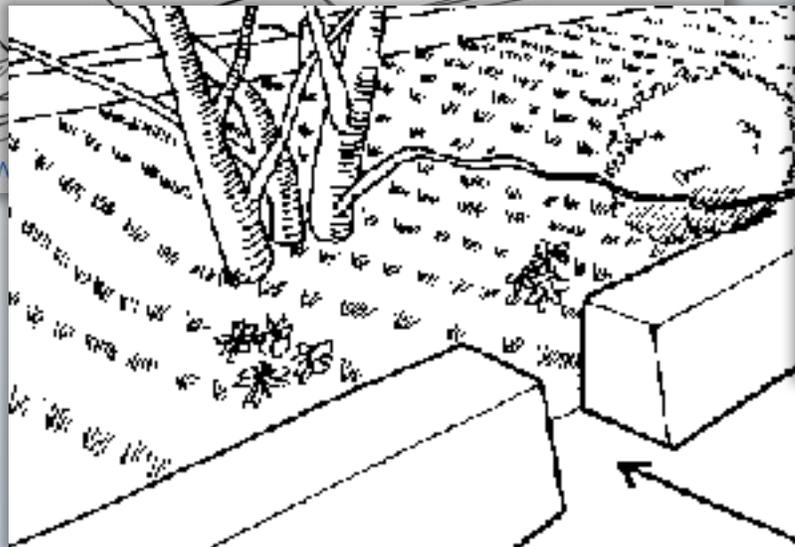
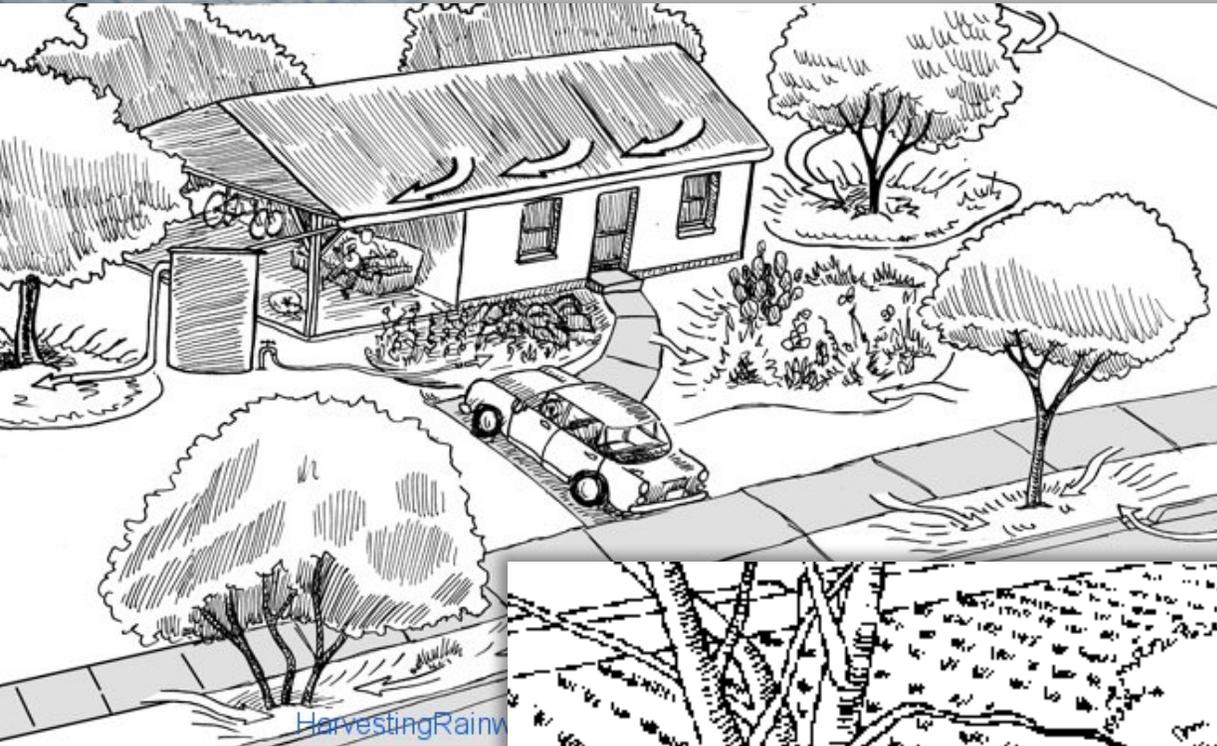
Click here.

But a Cistern Only Holds So Much...

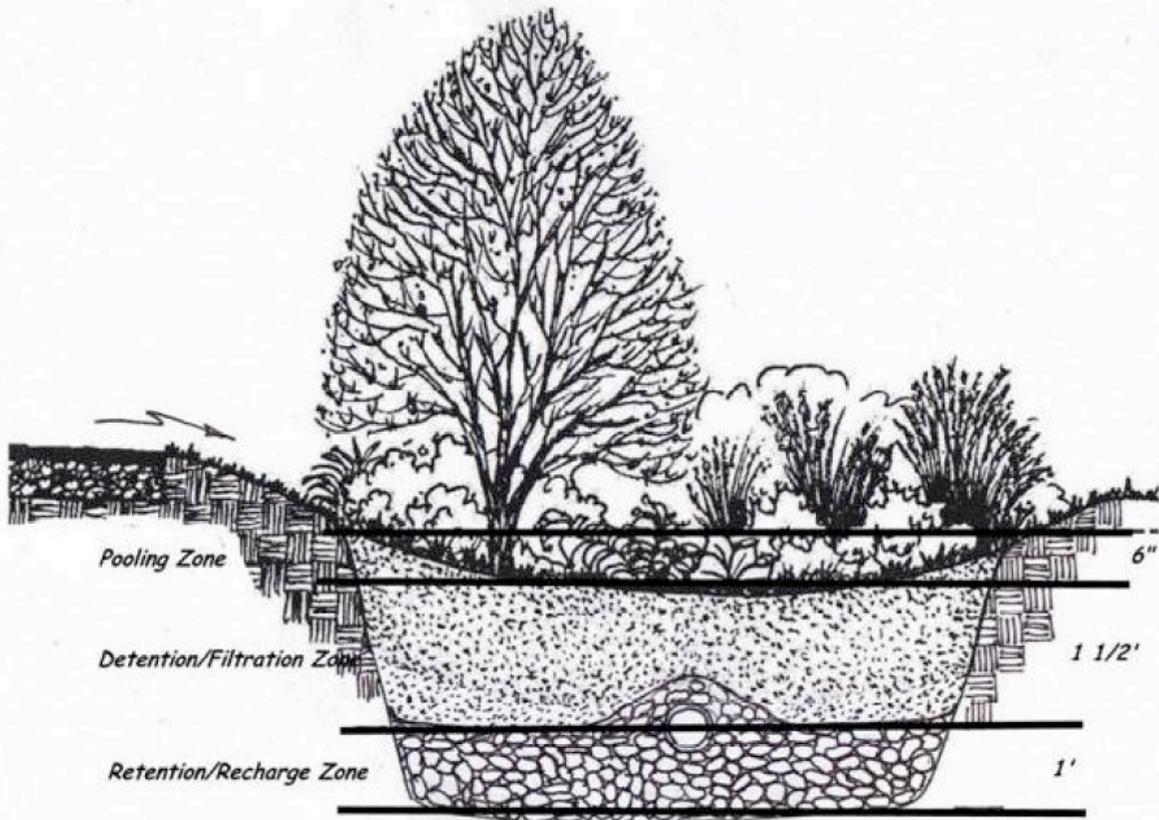




Green Infrastructure

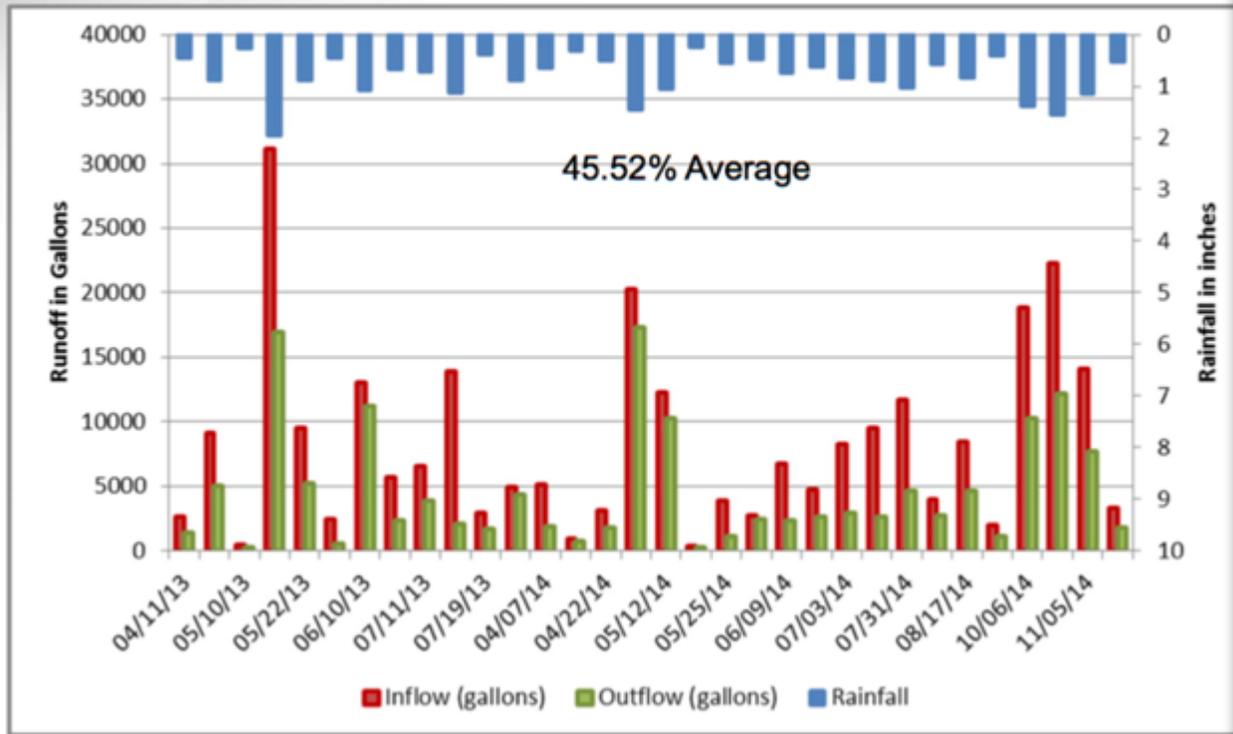


Rain Gardens



Rain Gardens

Volume Reduction



Load Reduction

Contaminant	Inflow (lbs)	Outflow (lbs)	% reduction
NO3	94070	20268	78%
NH4	15102	5192	66%
TKN	177932	63353	64%
Orthophosphate	3190	2056	36%
Total Phosphorus	9082	5320	41%
TSS	2020645	341401	83%

Lawns



Commonly over watered

- **Creates the stigma “water hogs”**

Overuse can lead to Water Pollution

- **Fertilizers**
- **Pesticides,**
- **Other chemicals**
(If managed the wrong way)

Reduce Turf Areas?



1/3 Turfgrass



1/3 Native/ Adapted
Perennials



1/3 Pervious Hardscape

EPA WaterSense



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WaterSense / The WaterSense Water Budget Tool



The WaterSense Water Budget Tool

The WaterSense Water Budget Tool can be used to comply with section 109 of the New Home Specification (PDF) (19pg, 250K, About PDF) or to ensure a suitability for the amount of water applied to a landscape based on local climate data.

Check out the WaterSense Interactive Water Budget Tool



- WaterSense Landscape Water Budget Tool Version 1.02 (XLS, 102K) - Excel version of the Water Budget Tool on July 24, 2014. This version includes updates to the tool's calculations and user interface.

Help Using the Water Budget Tool

- Water Budget Quick Start Guide (PDF) (4 pg, 853K, About PDF)—See how to use the tool.
- Water Budget Approach (PDF) (14 pg, 482K, About PDF)—Contains information on how the tool was developed.
- Water Budget Data Finder—Provides the local climate data necessary to complete the tool.

Additional Information

For more information regarding the development of the tool or the WaterSense New Home Specification, please visit the New Homes Specification page.

Español 中文: 繁體版 中文: 简体版 Tiếng Việt 한국어

Search EPA.gov

This worksheet determines the monthly landscape water requirement (LWR) for a site based on its peak watering month. The monthly LWR is the water requirement specific to the designed landscape. The sum of the LWRs for each hydrozone equals the site LWR. The following formula is used to calculate the LWR for each hydrozone:

$$LWR_H = \frac{1}{DU_H} \times [(ET_r \times K_e) - R_n] \times A \times C_n$$

Where:
 LWR_H = Landscape water requirement for the hydrozone (gallons/month)
 DU_H = Lower quarter distribution uniformity
 ET_r = Local reference evapotranspiration (inches/month)
 K_e = Landscape coefficients for the type of plant in that hydrozone (dimensionless)

This worksheet determines if the designed landscape meets the water budget.

If the landscape water requirement is LESS than the landscape water allowance, then the water budget criterion is met.
 If the landscape water requirement is GREATER than the landscape water allowance, then the landscape and/or irrigation system needs to be redesigned to use less water.

STEP 3A - REVIEW THE LWA AND LWR FROM PART 1 AND PART 2

LWA **89,944** (gallons/month) LWR **58,050** (gallons/month)

STEP 3B - REVIEW THE TOTAL AREA OF TURFGRASS* IN THE DESIGNED LANDSCAPE FROM STEP 2B

The designed landscape contains **13,333** square feet of turfgrass.* This is **50%** of the landscaped area.

*This includes the area of any pools, spas, and/or water features, designated by WaterSense to be counted as turfgrass.

OUTPUT - DOES THE DESIGNED LANDSCAPE MEET THE WATER BUDGET?

YES If YES, then the water budget criterion is met.

If NO, then the landscape and/or irrigation system needs to be redesigned to use less water.

The designed landscape water requirement is a **55%** reduction in water use from the baseline calculated in Part 1.

MORE TECHNICAL?

Click here if you are part of the media, an educator, manufacturer, professional or promotional partner.

Table 5. Appropriate Irrigation Types - Landscaped Areas without Irrigation Systems

IF THE PLANT TYPE OR LANDSCAPE FEATURE IS:	THEN THE IRRIGATION TYPE SHALL BE:		
	Drip - Standard	Fixed Spray	No Irrigation
Trees, Shrubs, or Groundcover with Low Water Requirements (K _e < 0.2)	x		
Trees, Shrubs, or Groundcover with Medium or High Water Requirements (K _e > 0.2)		x	
Turfgrass with Low, Medium, or High Water Requirements (K _e > 0.2)		x	
Chimney, Rock, or Water Features		x	
Chemical Hardscapes			x
Decorative Structures			x

Next Step

OUTPUT - WATER REQUIREMENT FOR THE SITE
58,050 Monthly landscape water requirement (gallons/month) based on the site's peak watering month



Drought Tolerance

Heat Tolerance

Less Water

Less Fertilizer

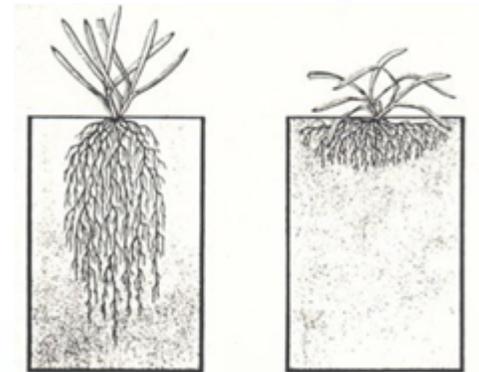
Less Pesticides

***Native=Hardy & from Texas**

***Adapted=Hardy & introduced to landscapes**

Best Management Practices

- Water only when needed
- Water deeply to promote deep and healthy roots
- Water slowly for better absorption. Use drip wherever possible and the Cycle & Soak method
- Maintain a 2" to 4" mulch layer
- Design for efficiency
- Install per state (and local) specifications
- Water without creating runoff
- Check irrigation system monthly



*The best results come when there's
collaboration between landscape AND irrigation disciplines !!*

Site Inventory

- *Wind*
- *Structures*
- *Hardscape*

- *Hydrozones*
 - ***Soil Type***
 - ***Sun Exposure (Full sun – Full shade)***
 - ***Reflected Light***
 - ***Plant Material-Water Requirements and Root Depth***
 - *Turfgrass Variety*
 - *Annual Color*
 - *Herbaceous Perennials*
 - *Ground Cover*
 - *Trees/Shrubs/Woody Perennials*

Water Requirements

- *How much water is needed for each Plant?*
- *Does the water budget allow for enough water?*
- *Watering Window-Water restrictions?*
- *ET-Evapotranspiration*

Water Source

- *Municipal Water*
- *Alternative Water Sources*
 - *Rainwater Harvesting*
 - *Graywater*
 - *AC Condensate*

The purpose of an irrigation system?

To support the health and viability of managed landscapes by delivering supplemental water when rainfall is minimal

*It all comes down to better WATER MANAGEMENT!
(as simple as turning the water off)*

- *Establishment*
- *Maintenance-Repair/Monitor*
- *Adjust for maturity*

Most Efficient Irrigation Method

- ***90% efficient compared to 60% or less with other systems***
- ***Easily installed and equipment readily available***
- ***Typically exempt from water restrictions imposed during drought***
- ***Reduces water loss due to evaporation***
- ***Reduces water loss and contamination due to runoff***
- ***Reduces leaching of water and nutrients below the root zone***
- ***Saves Water and Money***



Drip Irrigation



Rain and Freeze Sensors



Gutter mount



Surface mount



Pole mount

- *Increase efficiency of spray irrigation by replacing spray nozzle with multi-stream rotors.*
- *More than 60% more efficient than regular nozzles.*





TEXAS COMMISSION
ON ENVIRONMENTAL QUALITY

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Beneficial Re-Use of Graywater

Definition for and beneficial re-uses of graywater from private residences, and commercial, industrial, institutional, and agricultural facilities.

HOT New Sources of Water for Re-use

The TCEQ is developing standards similar to those that exist for graywater for additional water sources you may re-use (alternative on-site water). Sources include rainwater, air-conditioning condensate, foundation drain water, storm water, cooling tower blowdown, swimming pool backwash and drain water, reverse osmosis reject water, or other sources of water that the TCEQ deems appropriate. (per House Bill 1902, 84th Texas Legislature)

The TCEQ has initiated rulemaking to implement [this bill](#) that will amend Title 30, Texas Administrative Code, Chapters **210** and **285**. You can keep track of proceedings by searching the [TCEQ Rule Projects database](#) for HB 1902: Graywater and Alternate On-site Water Reuse.

HOT UPDATE Draft Rules Scheduled for Commission Action.

The TCEQ has developed draft amendments to Chapters 210 and 285 to implement HB 1902. The draft rules are scheduled for consideration at the commission meeting on July 6, 2016 to publish the rules for public comment. Backup materials for this meeting will be available on June 17, 2016. If approved for publication, the draft rules will be published in the Texas Register on July 22, 2016 for public review and comment.

Stakeholder meeting

- [Meeting agenda](#)
- [Audio-recording](#) of the meeting
-

What is Graywater?

Graywater is wastewater from clothes-washing machines, showers, bathtubs, hand-washing lavatories, and sinks that are not used for disposal of hazardous or toxic ingredients. The term does not include wastewater that has come in contact with toilet waste; or from the washing of material, including diapers, soiled with human excreta; or from sinks used for food preparation or disposal.

What can I use Graywater for?

Residential Uses of Graywater:

Graywater at private residences is limited to 400 gallons per day for all combined uses:

- around the foundation of new housing to minimize foundation movement or cracking
- gardening
- composting
- landscaping



WATER #DOING?

For The

The **Green** Industry

Water Management Challenges

- *Adequate Water Supply*
- *Filtering Water*
- *Fertilizer Injection*
- *Pathogens*
- *Chemical Runoff?*
- *Sustainable Profitability*

- Capillary Mats
- Ebb and Flow Benches
- Flood Floors

Advantages

- Save Labor Time
- Save Water? *Fertilizer?*
 - Circulated systems
- Space Efficiency (*flexible*)
- Uniform Growth
- Less Foliar Disease

Challenges

- Cost Effectiveness
- Retrofit?
- Learning Curve for Success
- Salts (*Fertilizer concentrations*)
- Disease and Insects

Mist Nozzles, Impact Sprinklers, Booms

- Drawback...
- Overhead irrigation = Foliar disease?

Increase Water Efficiency

- Correct timing
- Automation
- Saucers/ Trays underneath?
(capture excess through capillary action)
- Dense plantings?

Technology

- **Drippers**
 - **Peat, Coir, Perlite**
- **Spray type emitters**
 - **Course media (bark etc)**

Considerations

- ***Pressure compensated**
- **Time of installation**
- **Cost**

Uncertainty about the cost of water treatment is the greatest potential barrier to adoption of irrigation treatment and recycling

- *Initial water source*
- *Cost of production losses from quality issues*
- *Cost of treatment*

Water Education Alliance for Horticulture

CLEAN WATER³
REDUCE • REMEDIATE • RECYCLE

WEAH

home water problems training tools research ask an expert feedback about search

WaterEducationAlliance.org

**Be Proactive
 Consider All Options
 What Works For Other Folks?**

**Reduce Overwatering
 Reduce Storm Runoff**

- **Design**
- **Maintenance**
- **Scheduling**

Treat or Recycle Runoff?

aggie-horticulture.tamu.edu

The screenshot shows a web page from the Texas A&M AgriLife Extension website. The page title is "Ornamental Production" and the sub-header is "Treating and Recycling Irrigation Runoff". The page content includes an introduction to the problem of runoff, a list of common permit features, and a table of labs conducting runoff analysis. A sidebar on the right contains a navigation menu with various links related to greenhouse management.

Ornamental Production

Treating and Recycling Irrigation Runoff

The potential contamination of surface and groundwater from runoff presents a major challenge for the greenhouse industry. Growers rely heavily on the use of fertilizers and pesticides, as well as water, to produce quality crops. As a result, these operations can pose a threat to our natural water resources. Collecting, treating and recycling greenhouse effluent is one of the best solutions to this environmental problem.

Many states now require a water discharge permit to control irrigation runoff. These permits regulate the level of discharge that flows into surface and groundwater reserves. In many situations quantitative discharge standards are vague and each case is based by the best professional judgment of the regulatory agency.

Although these permits differ somewhat from state-to-state, there are some common features:

- Usually 3-5 years in duration
- Must retain all irrigation runoff
- Must retain all or part of storm runoff (usually first 2")
- Must dispose of irrigation runoff
- No pesticides discharged
- Nitrate and Ammonia discharge < 2ppm
- Discharge pH between 6 and 9
- Acceptable level of suspended solids

Monitoring is very important in the overall process of treating greenhouse runoff. Knowing what contaminants are present and their relative concentrations, is the basic information required for developing a management plan. Nitrates, salts, pesticides and pathogenic organisms are the principal contaminants to be on the lookout for. Many of the tests for these materials are quite expensive to run. Also, sampling technique, handling and analytical methodology can impact the results and interpretation. Table 1 provides a list of labs that are currently conducting runoff analysis.

Name	Address	City, State, Zip	Phone
Millipore	P.O. Box 255	Bedford, Mass 01730	(617) 275-9200
HACA Company	P.O. Box 389	Loveland, CO 80539	(800) 227-4224
National Testing Laboratories	6151 Wilson Mills Rd.	Cleveland, OH 44143	(216) 449-2524

Minimizing Runoff

The best method of managing runoff is to utilize production practices which reduce volume. Obviously, the less runoff you have to deal with, the less of a problem it creates. In addition, these techniques are usually much more economical to implement than large scale treatment and disposal procedures. The following are some basics to consider:

Utilize Efficient Irrigation Systems

Ornamentals Home

Texas Greenhouse Management Handbook

- Greenhouse Structures
- Greenhouse Heating Requirements
- Growing Media
- Growing Media & pH
- Fertilizing Greenhouse Crops
- Diagnosing Nutritional Deficiencies
- Irrigating Greenhouse Crops
- Monitoring the Quality of Irrigation Water
- Treating Irrigation Water
- Managing Soluble Salts
- Treating and Recycling Irrigation Runoff**
- Air, Water And Media... Putting Them All Together
- Additional References for Greenhouse Management

The Texas Poinsettia Producers Guide

A Reference Guide to Plant Care, Handling and Merchandising

Test Your System - Aggie Catch Can Test

Proper design= Efficiency

- Pumps
- Lines
- Emitters
- Water Pressure

Overwatering
Under watering
Increasing Distribution Uniformity



Ellison Chair in International Floriculture



Blog

Benefits of Plants

Marketing & Economics

Water Resources

Sustainability

Executive Academy for Growth & Leadership (EAGL)

Water Resources

The Big Picture — Water Issues & Policy Resources

Water Management Practices (BMP's)

Water Conservation Practices

Water Auditing Tools For Growers

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Additional Resources and Standards



ARCSA/ASPE 78: Stormwater Harvesting System Design for Direct End-Use Applications

First Public Review Draft
Approved for public review by WG 78 on January 16, 2015

PLUMBING ENGINEERING & DESIGN STANDARD

ARCSA/ASPE/ANSI 63-2013: Rainwater Catchment Systems