Estimating Rainwater Runoff and Storage Needs

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Variables that determine how much water can be collected and stored

- Roof area
- Roof material
- Rainfall amount
- Rainfall intensity
- Arid, semi-arid or humid area
- Is water needed for indoor use, outdoor use or both?
- Space availability for tank or cistern, and
- How much money are you willing to spend?

How much water can you collect ?

Engineering Formula (for math-lovers):

RWH (Gallons) = Rainfall Collection Efficiency x Rainfall(in)/12 x Roof Area (sq. ft.) x 7.48 gal/sq. ft

How much water can you collect ?

- A simpler way to estimate… (Rule of thumb):

  0.6 gallon / inch of rainfall / sq. ft. of roof area
  or
  Approx. 600 gallons of water can be collected per inch of rainfall, per 1,000 sq. ft. of roof area

Minimum information needed

Rainfall (inches)

Roof Area (sq. ft.)

Water demand / requirements…

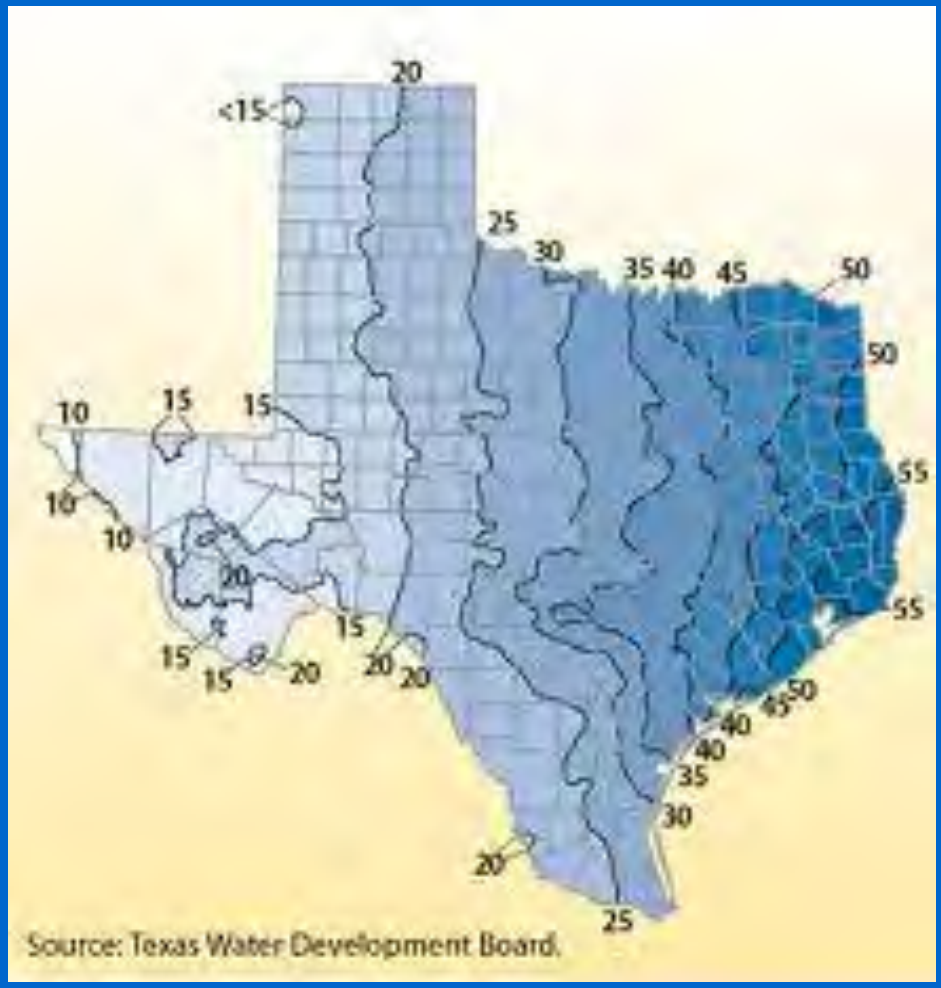
Is the water needed for indoor use, outdoor use or both ?

Runoff Estimates

- Methodology using Texas data as an example…
- Start with rainfall …

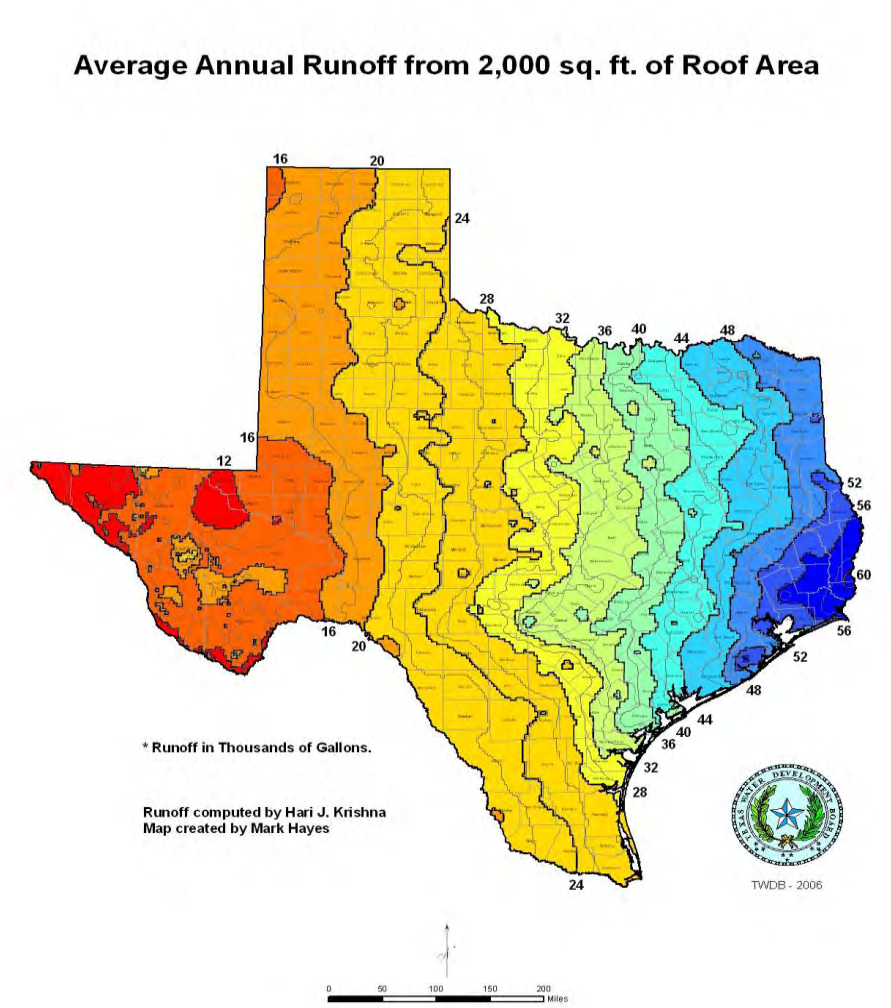
- Similar techniques can be used for Colorado

Average Annual Rainfall Map of Texas



Source: Texas Water Development Board.

Rainwater Harvesting Map of Texas (Krishna,2006)



Rainwater Volumes

- At a typical home in Austin, with a 2,000 sq. ft. roof area, you can collect about 35,000 gallons/year
- In the Houston area, you can collect up to 50,000 gallons/year from a typical home

Tank Sizing - How much of storage should we plan for?

- Several different methods available…

- Expected water needs / demands, and
- How long do you need the water to last in the tank..
- This depends on how long of a dry (rainless) period you're likely to experience between storms…

Consecutive days without rainfall in Texas (Krishna,2003)

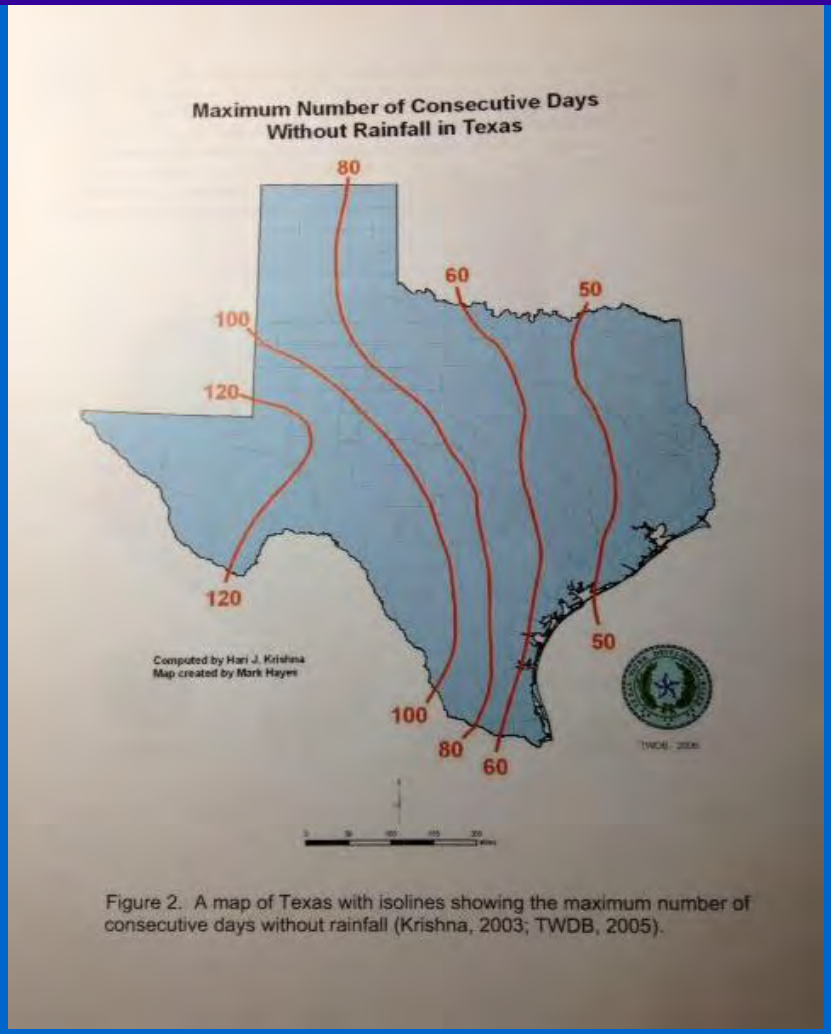


Figure 2. A map of Texas with isolines showing the maximum number of consecutive days without rainfall (Krishna, 2003; TWDB, 2005).

RWH for Indoor Use

- In Central Texas - Assuming a use of 30 gal/per person/day and 2 people at home, water should last for at least 60 days…

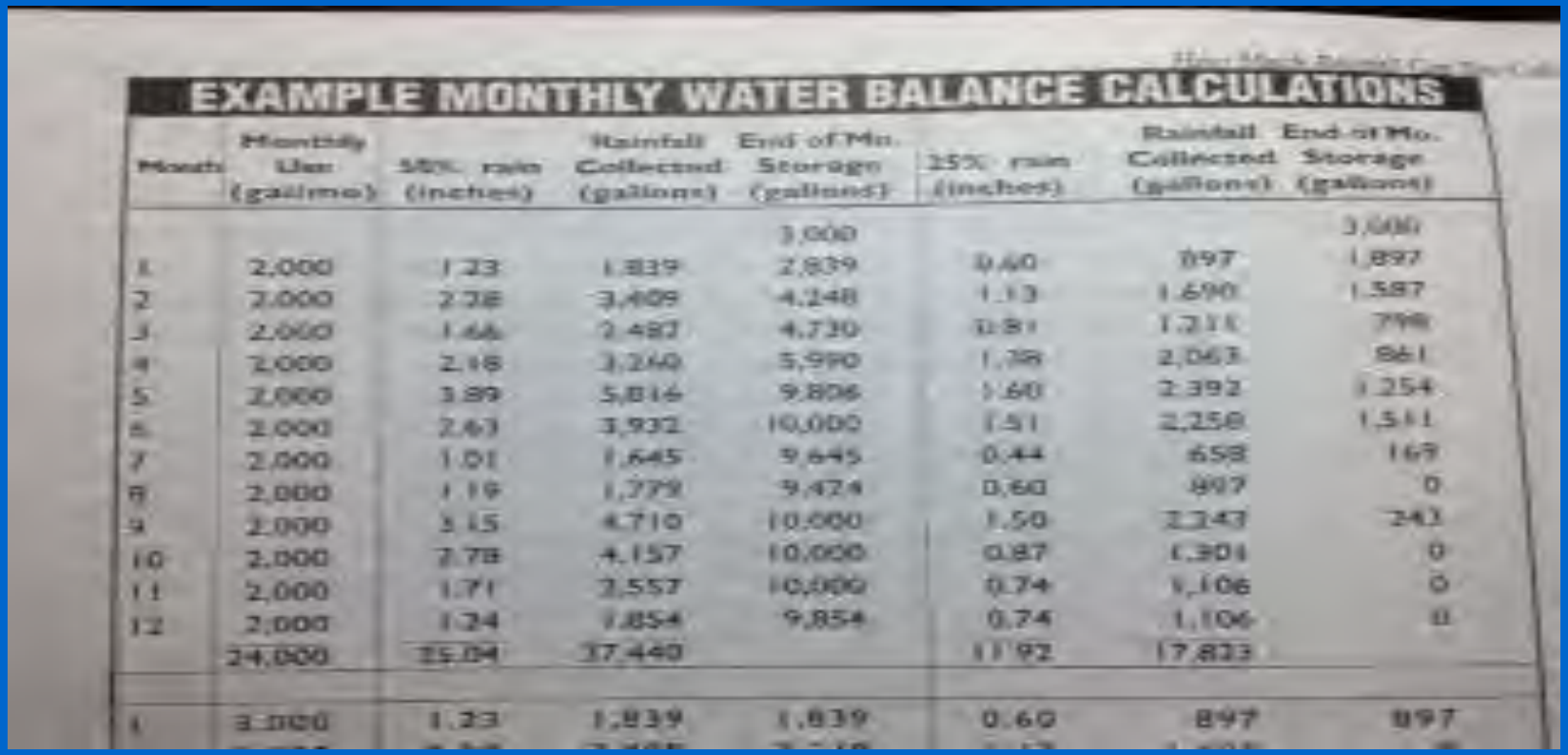
60 gal/day for 60 days = 3,600 gallon tank is the minimum to satisfy indoor needs in the Central Texas area.

Rainfall reliability

- The less rainfall amount that you use in your calculations, the more reliable your estimates will be.
- For example, if only 50% of the average monthly rainfall data are used, it will provide a 95% reliability.
- In semi-arid areas, use 75% of the average rainfall in your calculations.

How much water can we use each month from the RWH system?

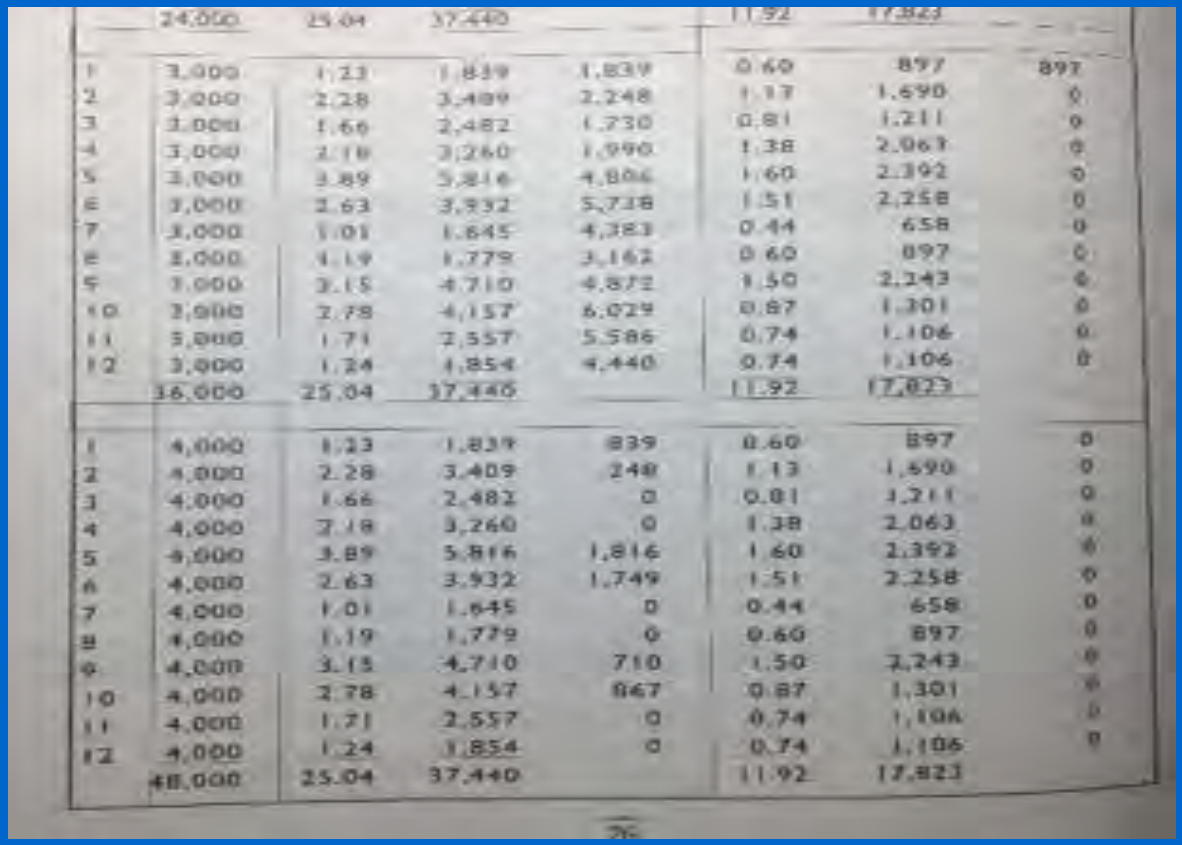
3,000 sq. ft. roof, 80% collection efficiency, 10,000 gal tank



EXAMPLE MONTHLY WATER BALANCE CALCULATIONS

Month	Monthly Use (gal/mo)	50% rain (inches)	Rainfall Collected (gallons)	End of Mo. Storage (gallons)	25% rain (inches)	Rainfall Collected (gallons)	End of Mo. Storage (gallons)
				3,000			3,000
1	2,000	1.23	1,839	2,839	0.60	897	1,897
2	2,000	2.28	3,409	4,248	1.13	1,690	1,587
3	2,000	1.66	2,482	4,730	0.81	1,211	798
4	2,000	2.16	3,240	5,990	1.38	2,063	861
5	2,000	3.89	5,816	9,806	1.60	2,392	1,254
6	2,000	2.63	3,932	10,000	1.51	2,258	1,511
7	2,000	1.01	1,645	9,645	0.44	658	169
8	2,000	1.19	1,779	9,424	0.60	897	0
9	2,000	3.15	4,710	10,000	1.50	2,243	243
10	2,000	2.78	4,157	10,000	0.87	1,301	0
11	2,000	1.71	2,557	10,000	0.74	1,106	0
12	2,000	1.24	1,854	9,854	0.74	1,106	0
	24,000	25.04	37,440		11.92	17,833	
1	3,000	1.23	1,839	1,839	0.60	897	897

Would the system support a use of 3,000 gal/month?



	24,000	25.04	37,440		11.92	17,823	
1	3,000	1.23	1,839	1,839	0.60	897	897
2	3,000	2.28	3,409	2,248	1.13	1,690	0
3	3,000	1.66	2,482	1,730	0.81	1,211	0
4	3,000	2.18	3,260	1,990	1.38	2,063	0
5	3,000	3.89	5,816	4,806	1.60	2,392	0
6	3,000	2.63	3,932	5,738	1.51	2,258	0
7	3,000	1.01	1,645	4,383	0.44	658	0
8	3,000	1.19	1,779	3,162	0.60	897	0
9	3,000	3.15	4,710	4,872	1.50	2,243	0
10	3,000	2.78	4,157	6,029	0.87	1,301	0
11	3,000	1.71	2,557	5,586	0.74	1,106	0
12	3,000	1.24	1,854	4,440	0.74	1,106	0
	36,000	25.04	37,440		11.92	17,823	
1	4,000	1.23	1,839	839	0.60	897	0
2	4,000	2.28	3,409	248	1.13	1,690	0
3	4,000	1.66	2,482	0	0.81	1,211	0
4	4,000	2.18	3,260	0	1.38	2,063	0
5	4,000	3.89	5,816	1,816	1.60	2,392	0
6	4,000	2.63	3,932	1,749	1.51	2,258	0
7	4,000	1.01	1,645	0	0.44	658	0
8	4,000	1.19	1,779	0	0.60	897	0
9	4,000	3.15	4,710	710	1.50	2,243	0
10	4,000	2.78	4,157	867	0.87	1,301	0
11	4,000	1.71	2,557	0	0.74	1,106	0
12	4,000	1.24	1,854	0	0.74	1,106	0
	48,000	25.04	37,440		11.92	17,823	

RWH System Sizing Calculator – TWDB website

- Sample Data (Change to suit your conditions)

Indoor use & some outdoor use

• Catchment Area (sq. ft.)	2,500
• Monthly Indoor Demand (gals)	3,000
• Outdoor Demand (gals)	150
• Water in Storage to begin (gal)	1,000
• Tank Size (gal)	10,000

Water Balance Calculations – Indoor and Outdoor Use

	Indoor demand	Irrigation	Total demand	Average rainfall	Collection surface size	Gallons/ft^2 collection coefficient	Efficiency factor	Rainfall collected (85% efficiency)	End of month storage (starting with water in storage)
January	3,000	0.0	3,000	1.97	2,500	0.62	0.85	2,595	595
February	3,000	0.0	3,000	2.40	2,500	0.62	0.85	3,162	757
March	3,000	150.0	3,150	2.91	2,500	0.62	0.85	3,834	1,441
April	3,000	150.0	3,150	3.81	2,500	0.62	0.85	5,020	3,311
May	3,000	150.0	3,150	5.01	2,500	0.62	0.85	6,601	6,762
June	3,000	150.0	3,150	3.12	2,500	0.62	0.85	4,111	7,722
July	3,000	150.0	3,150	2.04	2,500	0.62	0.85	2,688	7,260
August	3,000	150.0	3,150	2.07	2,500	0.62	0.85	2,727	6,837
September	3,000	150.0	3,150	2.67	2,500	0.62	0.85	3,518	7,205
October	3,000	150.0	3,150	3.76	2,500	0.62	0.85	4,954	9,009
November	3,000	0.0	3,000	2.70	2,500	0.62	0.85	3,557	9,566
December	3,000	0.0	3,000	2.64	2,500	0.62	0.85	3,478	10,000

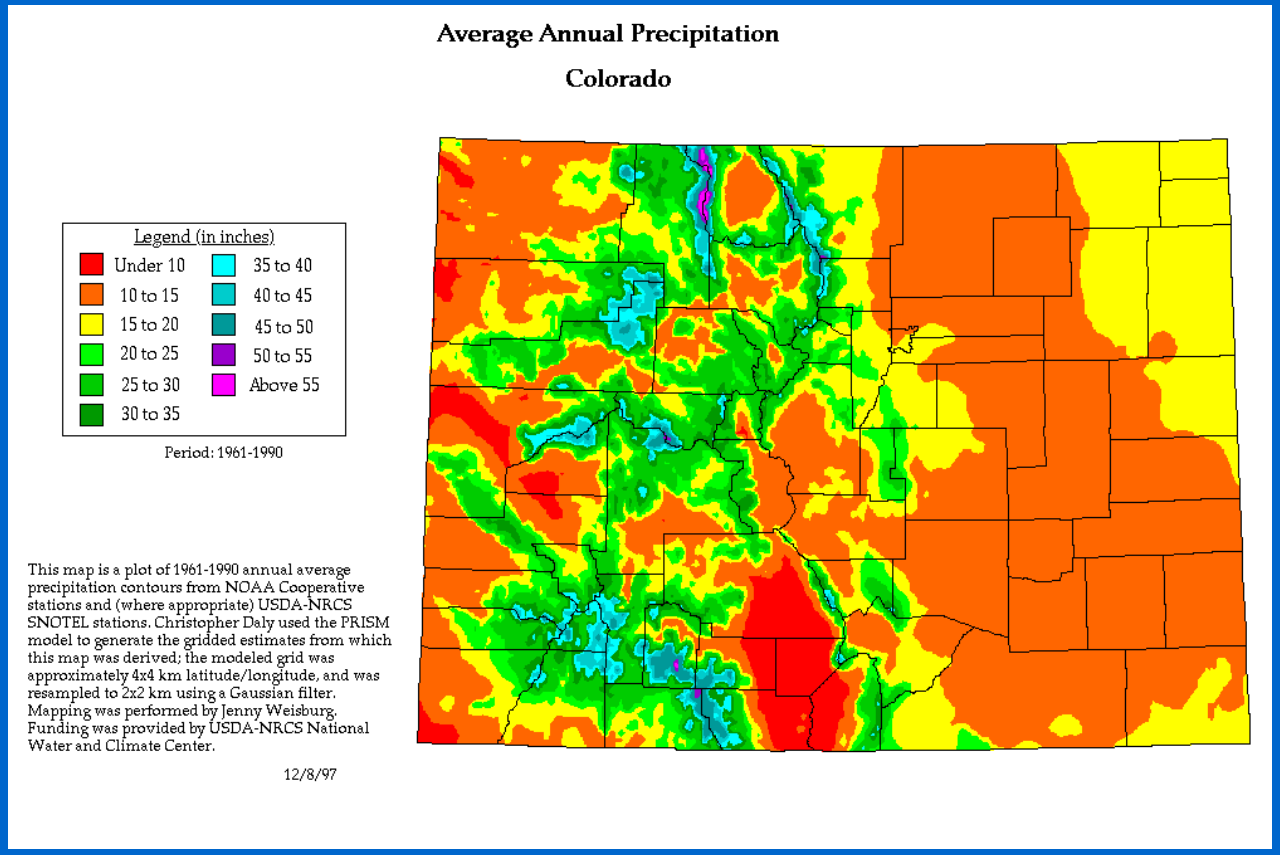
Calculations using plant ET data and harvested rainwater (TWDB)

RESULTS:

Calculations completed for Austin, TX

	SUPPLY					DEMAND							
Month	**Average monthly rainfall (in.)**	**Average monthly rainfall (gal. per sq.ft.)**	**Potential volume of water from collection area (gal.)**	**Estimated monthly supply to collection tank (gal.)**	**Comment**	**Average monthly evapotrans-piration (in.)**	**Average plant water needs (in.)**	**Average plant water needs (gal. per sq.ft.)**	**Monthly outdoor demand (gal.)**	**Potential volume of water from rainfall directly on irrigated area (gal.)**	**Monthly indoor demand (gal.)**	**Total monthly demand (gal.)**	**Estimated volume of rainwater used for month (gal.)**
December	2.53	1.57	502	477	Supply > tank capacity.	2.21	1.33	0.82	0	314	0	0	0
January	2.21	1.37	438	417	Supply > tank capacity.	2.27	1.36	0.84	0	274	0	0	0
February	2.02	1.25	401	381	Supply > tank capacity.	2.72	1.63	1.01	0	250	0	0	0
March	2.36	1.46	468	445	Supply > tank capacity.	4.34	2.60	1.61	323	293	0	30	30
April	2.63	1.63	522	496	Supply > tank capacity.	5.27	3.16	1.96	392	326	0	66	66
May	5.12	3.17	1,016	965	Supply > tank capacity.	6.39	3.83	2.38	475	635	0	0	0
June	3.42	2.12	679	645	Supply > tank capacity.	7.15	4.29	2.66	532	424	0	108	108
July	2.03	1.26	403	383	Supply > tank capacity.	7.22	4.33	2.69	537	252	0	285	200
August	2.51	1.56	498	473	Supply > tank capacity.	7.25	4.35	2.70	539	311	0	228	200
September	2.88	1.79	571	543	Supply > tank capacity.	5.57	3.34	2.07	414	357	0	57	57
October	3.99	2.47	792	752	Supply > tank capacity.	4.38	2.63	1.63	326	495	0	0	0
November	3.02	1.87	599	569	Supply > tank capacity.	2.74	1.64	1.02	0	374	0	0	0
Annual	***34.72***			***6,546***		***57.51***	***34.51***					***774***	***661***

Average Annual Rainfall Map of Colorado



RWH Map for Colorado

- Based on the rainfall map, a RWH map similar to that used in Texas can be developed for Colorado too !

Average Monthly Rainfall, Castle Rock, CO

(Inches)

- **Jan 0.55**
  Feb 0.53
- **Mar 1.50**
  Apr 1.87
  May 2.42
  Jun 1.92
  Jul 2.37
  Aug 2.16
  Sep 1.24
  Oct 1.09
- **Nov 0.98**
  Dec 0.71
- **Total 17.34” of rainfall**
- **plus 60” of snow (~ 6” of rainfall)**

RWH Potential in Douglas County, CO

- Based on 17” of average annual rainfall plus 6” of precipitation from snowmelt and using a 75% reliability index,

  0.75 x 23”x 600 gal/1000 sq. ft x 2

  = 20,400 gallons of water can be collected annually from a 2,000 sq. ft. roof.

What is the cost of a RWH system?

What is the cost of a RWH system?

- Depends on the size of the system
- < $500 - over $10,000

Complete system for a typical home: Guttering, 10,000 gallon cistern, roof washer, pump, filters, and UV light
Approx. cost $ 9,000

(long-term savings on water bills)

How will RWH affect streamflow?

Effect of RWH on streamflow - Texas

- If 10% of the total roof area in Texas is used to harvest rainwater, it would generate 120,000 ac. ft. of water annually.
- That is only 0.03% of the total rainfall received in the state.
- Little or no effect of RWH on streamflow !

Food for thought…

The Potential for Rainwater to save precious municipal water

- If RWH is used for just 15% of residential landscape irrigation in the US, it would save over a billion gallons of treated municipal water each day(1,120,000 ac. ft per year).

- If just 4 percent of the homes in the US could use rainwater for all applications, over a billion gallons of treated municipal water could be saved each day.

Rainwater Harvesting can save money for cities

- The capital costs needed by US cities and water utilities for expanding and building new water treatment and distribution systems over the next 20 years is projected to be $325 billion

- At least some of that enormous cost can be saved through rainwater harvesting.

Acknowledgment

Texas Water Development Board
Austin, Texas

Texas Water Development Board Publications

Thank You !

Questions ?