THE UNIVERSITY OF ARIZONA

Water Resources Research Center

Utility Guide to Rainwater and Stormwater Harvesting

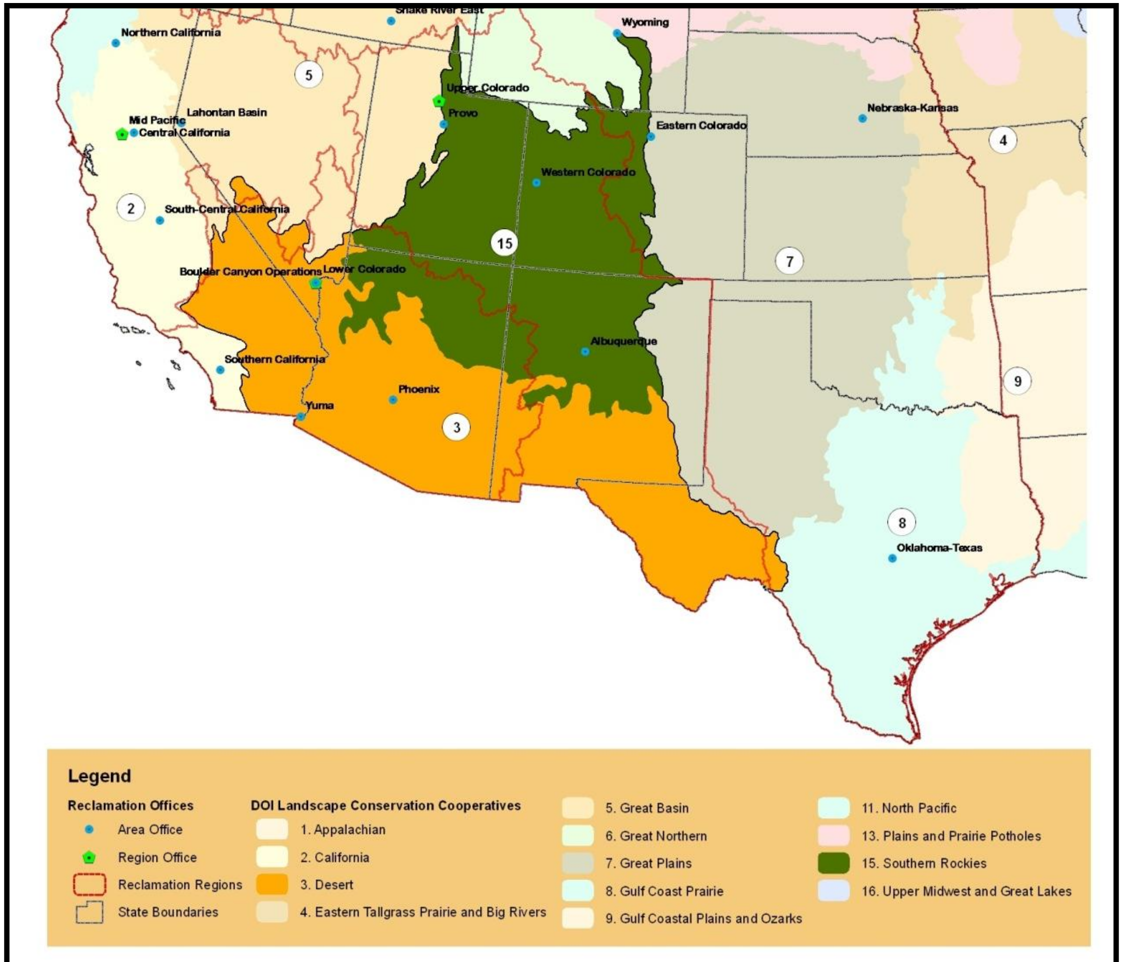
A project funded by the U.S. Bureau of Reclamation Landscape Conservation Cooperative, WaterSMART Program

Project conducted by University of Arizona WRRC, with input and assistance from Technical Advisory Committee, Water Harvesting and Landscape Consultants, and Regional Water Providers

LID Basics and Beyond, Feb. 5, 2013

Jenna Cleveland

Geographic Focus Area



Focus area of water harvesting assessment assistance:

"Desert Landscape Conservation Cooperative" (Desert LCC) of the Department of Interior, shown as orange area on map

Project Process and Influence

Water Management Challenges

Expand water supply, improve water quality

Optimize and delay infrastructure investments

Save energy

Enhance the (urban) environment

Reduce/manage stormwater

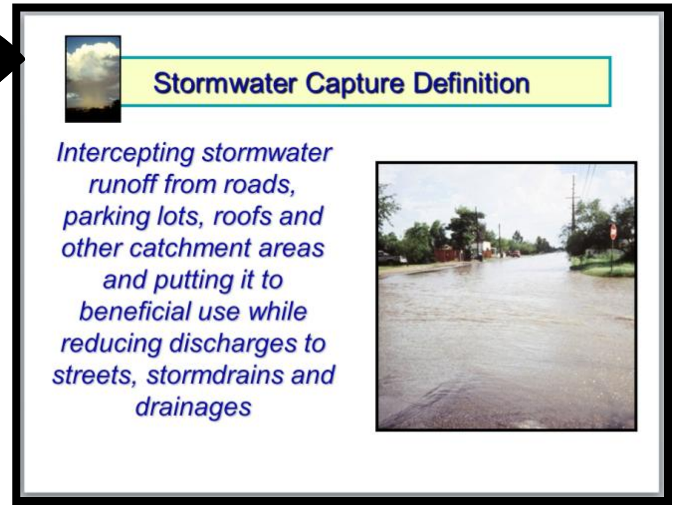
Comply with regulations

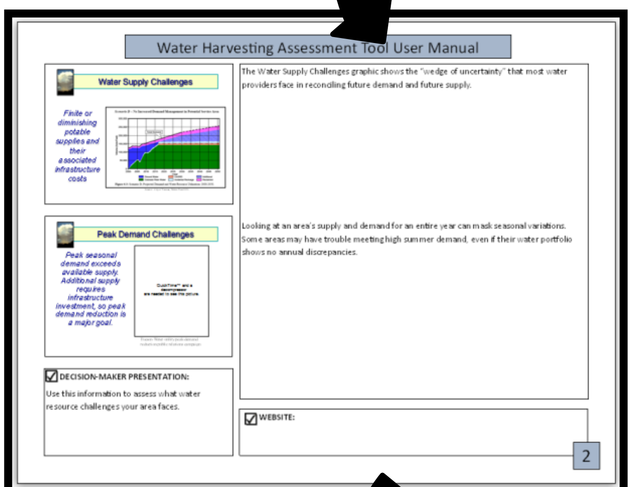
Do the right thing (public perception)

Water harvesting can be your solution

Multiple benefits at multiple scales

Tools Provided to Users



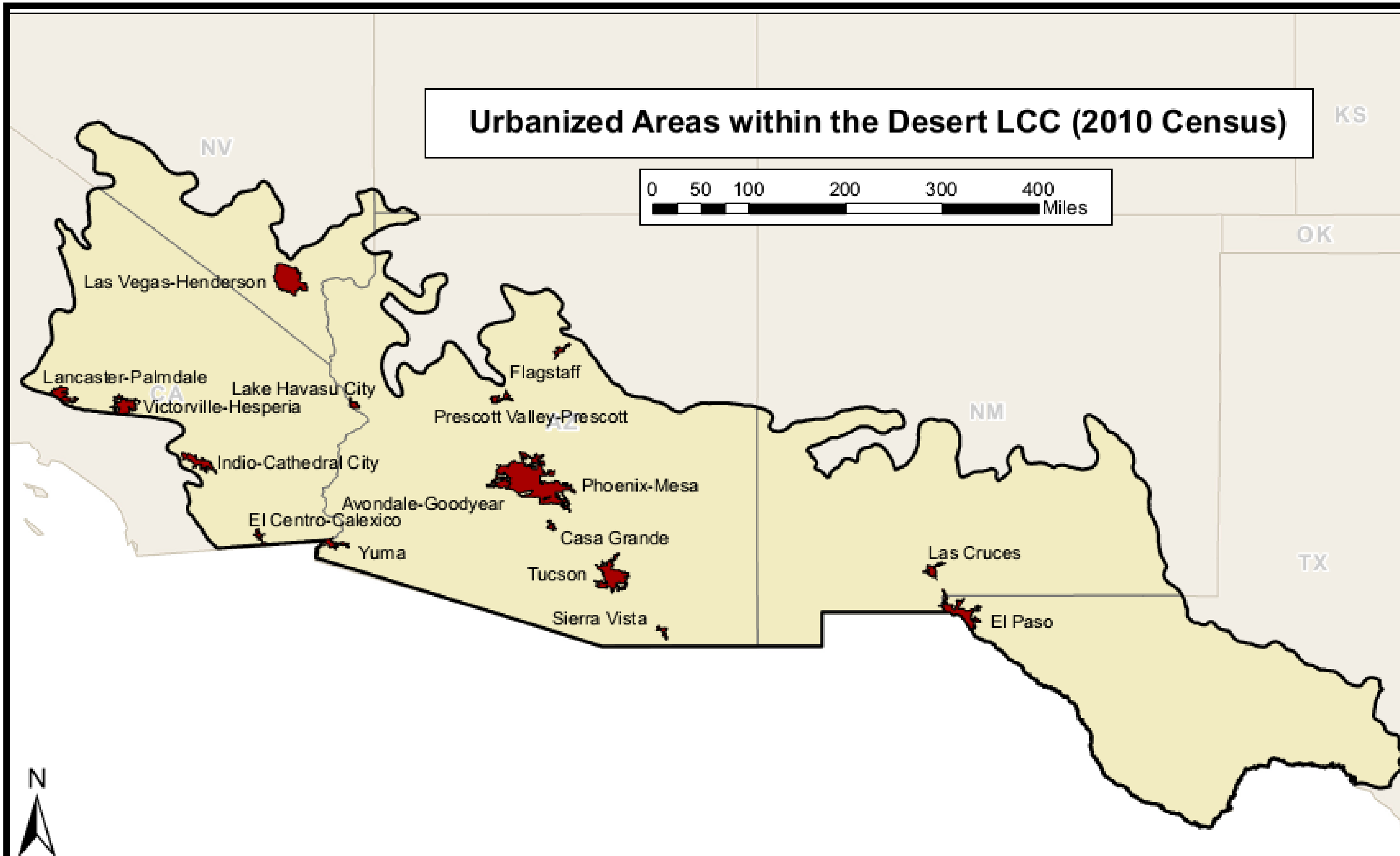


Project Goals

To assist public utilities, agencies, and other water managers to:

- *Evaluate the suitability of using rainwater and stormwater harvesting as an adaptive response to climate change*
- *Design multiple benefits from water harvesting into programs*
- *Communicate about water harvesting strategies to decision makers and the community*

Population Centers > 50,000



Water Harvesting Focus

- Harvest both rainfall and stormwater runoff
- Store water in soils: Passive Water Harvesting
- Store water in tanks: Active Water Harvesting
- Focus on urban & suburban settings
- Show strategies for residential, commercial, right-of-way, and stormwater management sites
- Harvest water to support vegetation
- Harvest water to provide many other benefits

Intended Users

- Water utilities
- Jurisdictions
- Stormwater management agencies
- Flood-control agencies
- Drought management groups
- Water conservation officers
- Others who manage and make decisions about water resources

Discussion: Water/stormwater decision makers

- What entities make or affect water policy in your area?
- Who is at the table now?
- Who might usefully be added to the discussion?
- Who will you want to communicate water harvesting analysis results and recommendations to?

Example Workbook Page

Water Harvesting Assessment Tool User Manual

Discussion: Water/stormwater decision makers

- What entities make or affect water policy in your area?
- Who is at the table now?
- Who might usefully be added to the discussion?
- Who will you want to communicate water harvesting analysis results and recommendations to?

1. What entities make or affect water policy in your area?

2. Who is at the table now?

3. Who might usefully be added to the discussion?

4. Who will you want to communicate water harvesting analysis results and recommendations to? Politicians? The community? Board members?

☑ DECISION-MAKER PRESENTATION:

☑ WEBSITE:

Water Harvesting Definition

A strategy to conserve potable water and manage stormwater to improve the safety, comfort, aesthetics and sustainability of the urban and suburban environment.

Active Water Harvesting Definition

Capturing rainwater in an above-ground or below-ground tank (cistern) and storing it for later beneficial use

Passive Water Harvesting Definition

Shaping the earth to collect and store water in the soil and put it to beneficial use to support vegetation growth

Stormwater Capture Definition

Intercepting stormwater runoff from roads, parking lots, roofs and other catchment areas and putting it to beneficial use while reducing discharges to streets, stormdrains and drainages

Low Impact Development (LID) and Green Infrastructure (GI) Definition

EPA: LID is an approach to land development or redevelopment that works with nature to manage stormwater as close to its source as possible. GI refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate, or reuse stormwater on the site where it is generated

Water-Related Challenges

Water resource and stormwater managers face many water-related challenges that water harvesting and stormwater capture strategies can help address.

WHICH OF THE FOLLOWING CHALLENGES DO YOU FACE?

Water Supply Challenges

Finite or diminishing potable supplies and their associated infrastructure costs

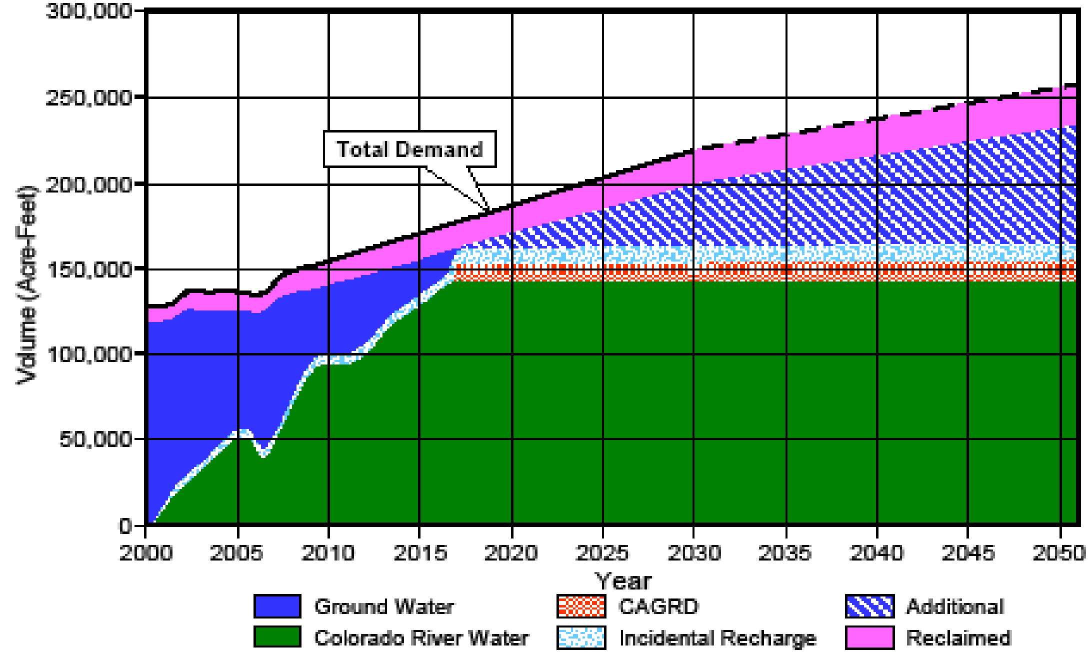


Figure 6-3: Scenario D, Projected Demand and Water Resource Utilization: 2000-2050.

Source: City of Tucson, Water Plan 2050

Peak Demand Challenges

Peak seasonal demand exceeds available supply. Additional supply requires infrastructure investment, so peak demand reduction is a major goal.

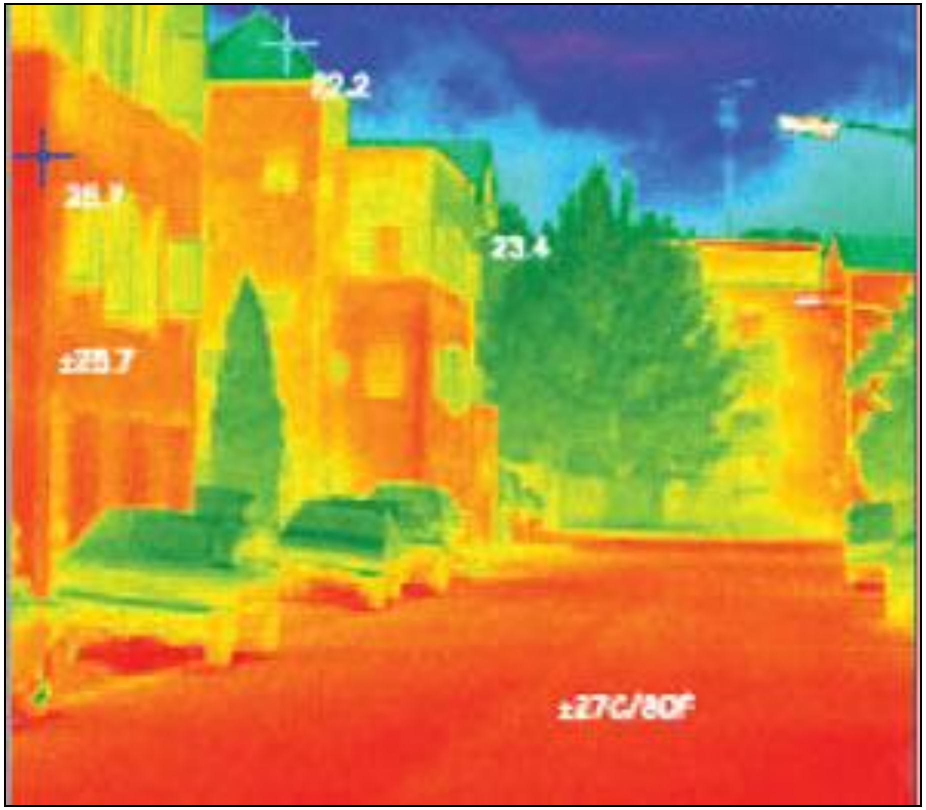
Tucson Water utility peak demand reduction public relations campaign

Limits of Traditional Landscape Water Conservation Strategies

Xeriscape landscapes can reduce plant canopy, leaving urban environments unshaded

Pressures on water resources to address heat island & climate impacts

The urban heat island effect refers to higher temperatures that built-up areas experience in comparison to rural areas. This is especially noticeable at night. Trees and vegetation help mitigate this. Requires more water to increase urban vegetation.



http://www.urban-climate-energy.com/urbanHeatIsland.htm

Example Workbook Page

Water Harvesting Assessment Tool User Manual

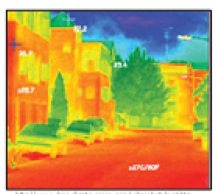
Limits of Traditional Landscape Water Conservation Strategies

Xeroscape landscape reduces plant canopy & landscape aesthetics, with unshaded urban environments

Xeriscape often relies on large gravel expanses planted sparingly with cacti and other extremely drought-tolerant plants. This technique removes shade from yards and sidewalk and increases the amount of hardscape-like materials. Though a valid water conservation strategy, xeriscape landscapes can actually contribute to a warmer urban environment.

Pressures on water resources to address heat island & climate impacts

The urban heat island effect refers to higher temperatures that built up areas experience in comparison to rural areas. This is especially noticeable at night. Trees and vegetation help mitigate this. Requires more water to increase urban vegetation.



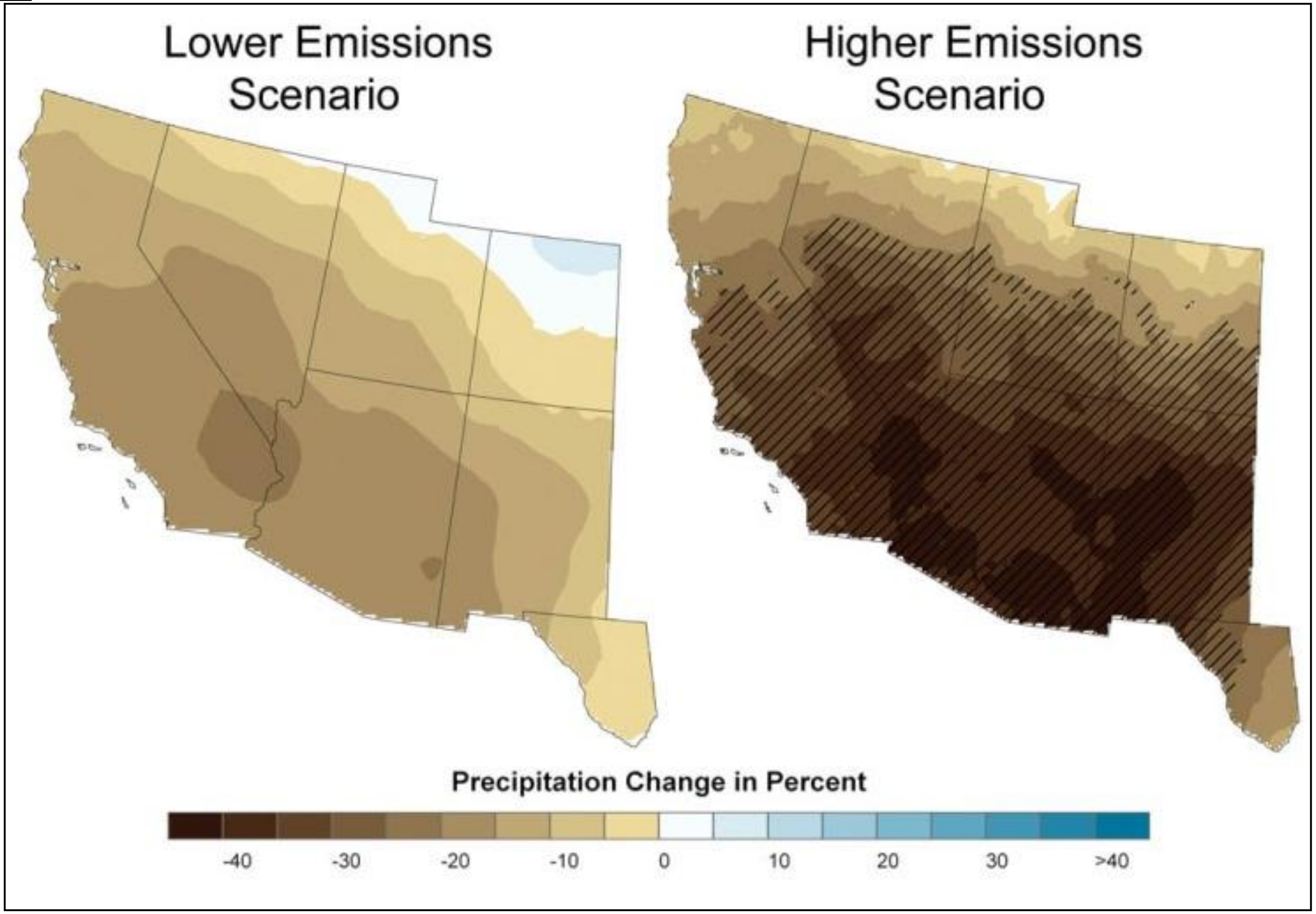
The urban heat island (UHI) effect is the documented increase in temperatures within cities as compared with surrounding suburbs or natural areas. As the graphic in the slide shows, the built environment retains heat throughout the day and releases it very slowly at night. This means that nighttime temperatures within the urban core are substantially higher than more vegetated areas. The UHI can negatively affect quality of life for residents, and can even increase the incidence of heat-related illness and death.

☑ DECISION-MAKER PRESENTATION:

Use this information to assess what water resource challenges your area faces.

☑ WEBSITE:

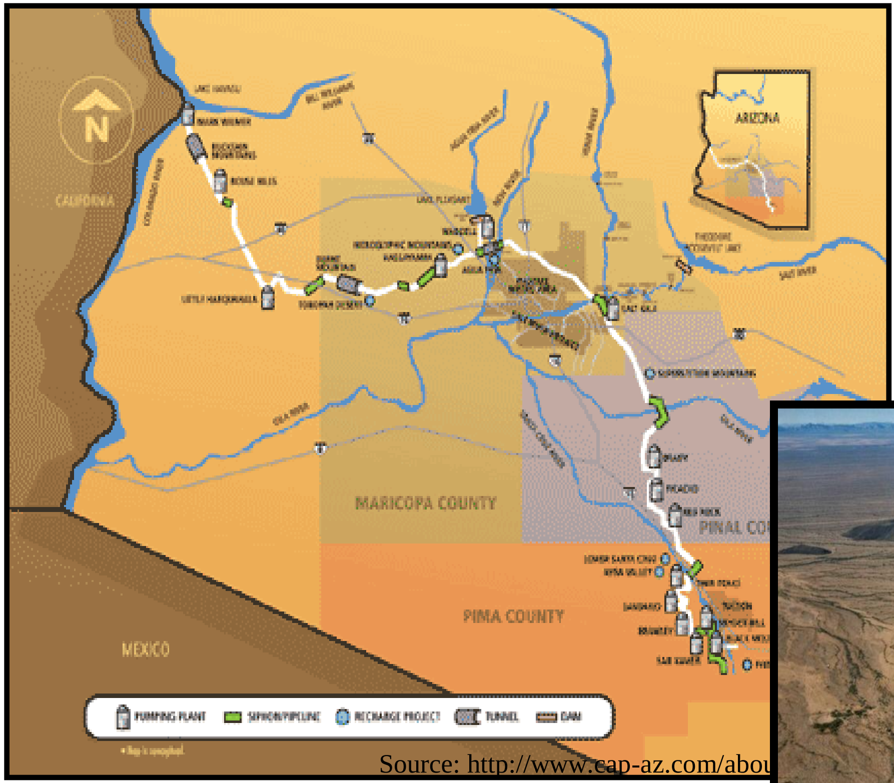
Climate Change Predictions- Precip



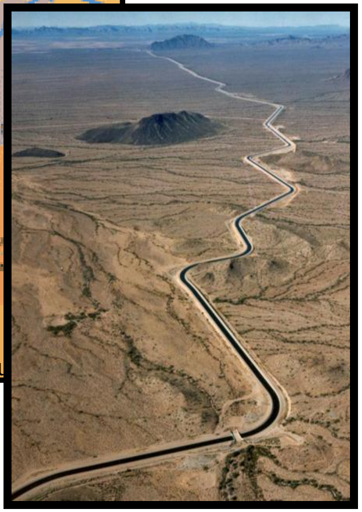
http://www.epa.gov/climatechange/impacts-adaptation/southwest.html

Increasing Energy Costs of Water

Energy costs for well pumping, canal lifts, and water treatment are increasing

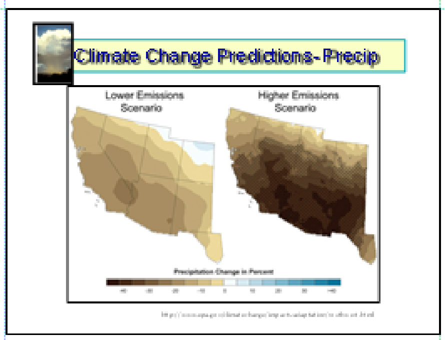


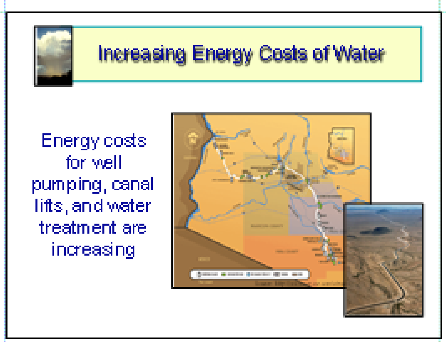
Source: http://www.cap-az.com/abou



Example Workbook Page

Water Harvesting Assessment Tool User Manual





Use this information to assess what water resource challenges your area faces.

Expected impacts from climate change on Southwestern communities include:

- **Impacts on stormwater and water supply:** Fewer, but potentially stronger rainfall events, flashier peak flood flow, reduced natural groundwater recharge, longer periods of drought
- **Impacts on land and air:** Higher air temperatures day and night, higher soil surface temperatures, lower humidity, decreased soil moisture
- **Impacts on vegetation:** Increased stress due to heat and drought resulting in higher mortality, higher susceptibility to stress-induced disease, reduced canopy cover
- **Impacts on people:** Exacerbated discomfort and health impacts as heat island effect increases, higher water bills to maintain vegetation, longer residence of mosquitoes and other pests, increased dust and associated disease vectors in air

For access further studies regarding these topics, go to wrrc.arizona.edu/DWHI______

Stormwater Quantity Challenges

Urban runoff flooding streets, causing safety concerns, overwhelming stormdrains, exceeding flood control capacity of rivers

Stormwater Quality Challenges

Need to reduce contaminants in stormwater discharges to meet federal and state water quality discharge permit requirements

Discussion: water-related challenges you face

- What long-term or peak seasonal water supply challenges are your water providers preparing for?
- Is xeriscape a common landscaping practice in your area?
- How have your urbanized areas experienced UHI effects?
- What do you know about climate change projections for your area?
- Have you undertaken climate change mitigation planning to date?
- What impacts might climate change have on your supply and demand?
- What percentage of your water providers’ costs come from energy supplies?
- What stormwater nuisances frequently impact your community?

Water-Harvesting Benefits

Water harvesting and stormwater capture strategies can address many water-related challenges.

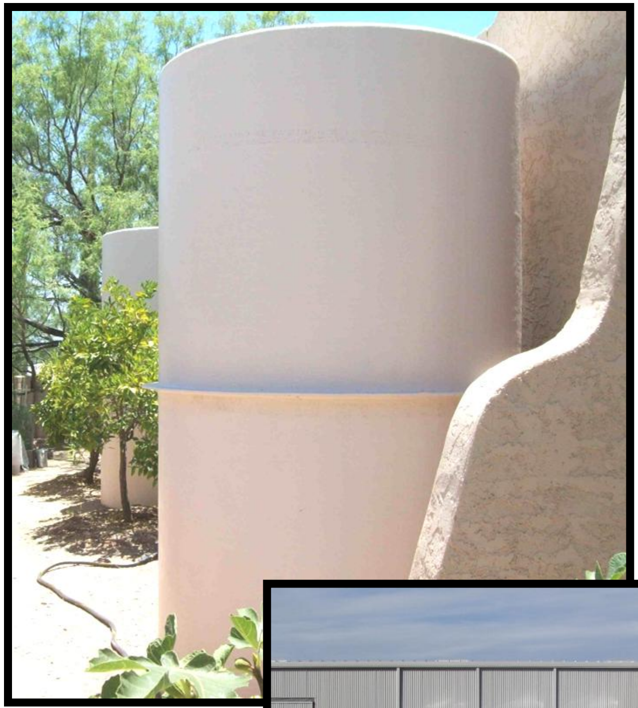
WHICH OF THESE BENEFITS COULD HELP ADDRESS YOUR WATER-RESOURCES CHALLENGES?

Benefit: Reduce overall potable water demand

Replace potable water irrigation with rainwater-supplied passive and active irrigation to delay or defray expensive new supplies or advanced treatment. Buffer systems until new sources can be found or treated.

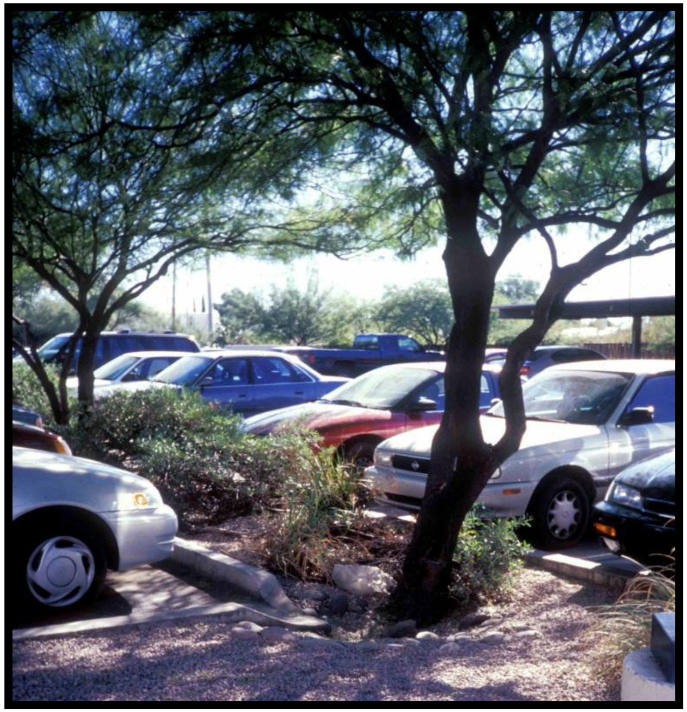
Benefit: Reduce peak potable demand

Use large tanks to prolong the time period when harvested rainwater can meet landscape demand to reduce seasonal peak demand



Benefit: Reduce urban heat island effect

Utilize tree canopies to reduce air temperature and sun exposure in hot desert environments and increase comfort of people, cars, and buildings.



Benefit: Decrease energy use

Shade the west, north and east side of buildings using tanks and plants to reduce energy demand for cooling in hot desert environments. Leave south side open to sun for passive solar heating to reduce winter energy demand.

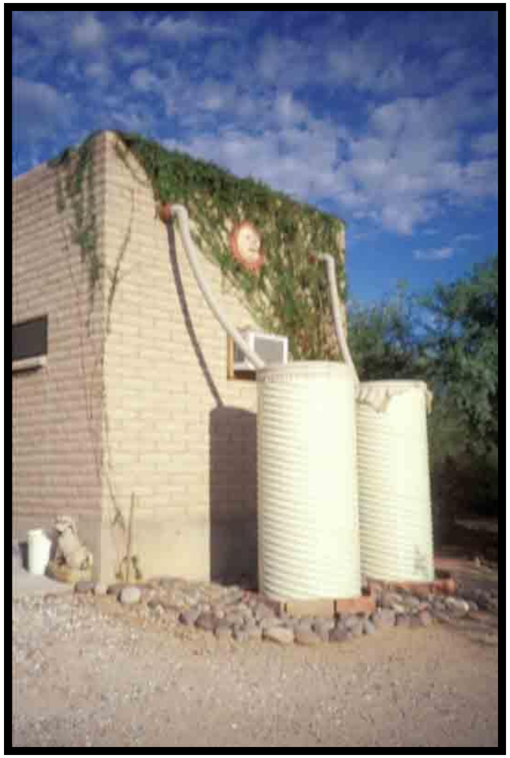
Reduce the use of treated, potable water for outdoor irrigation

http://imagesus.homeaway.com

http://www.home-water-works.org

Benefit: Reduce quantity of stormwater runoff

Using porous paving, multi-purpose detention basin, large tanks and soil storage areas to reduce stormwater flow volumes.
Reduce street flooding and traffic disruption
Reduce peak discharges to waterways
Reduce cost to expand stormwater infrastructure



Benefit: Improve stormwater quality

Capture and infiltrate the first flush of stormwater runoff from streets and parking lots into soils to sequester contaminants present in urban runoff and allow biological action to break contaminants down.

Reduce soil erosion.

High-nitrogen, low-salt rainwater improves soil quality and encourages plant growth. Plants in water harvesting basins drop leaves to basins below to build organic soils, encourage soil microbial life, and cools soil temperatures.

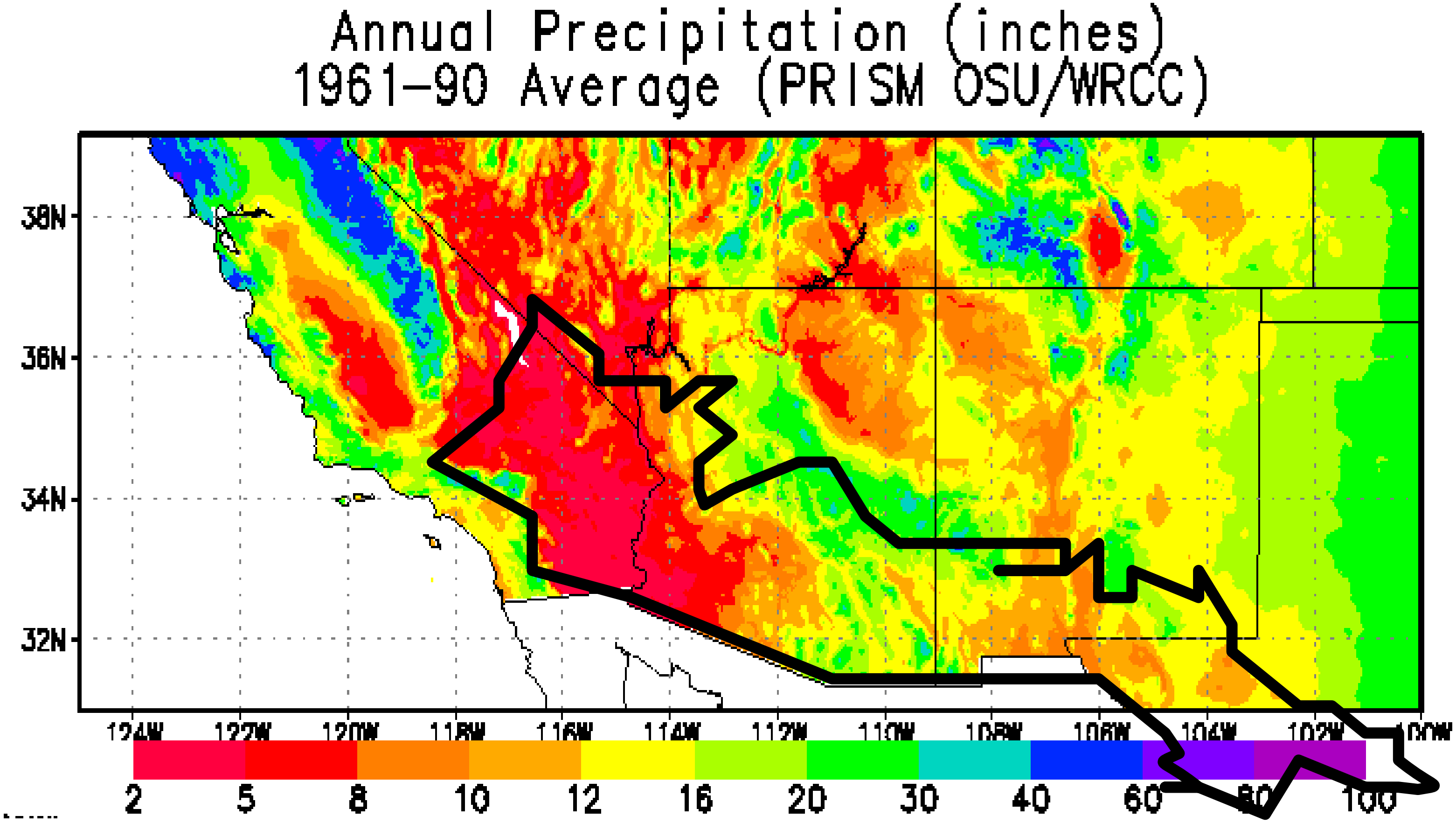
Benefit: Increase Property Values

Studies have shown that trees increase property value. In addition, shoppers are willing to pay more for products in a shaded commercial area. The Tucson Audubon Society estimates that birding and watchable wildlife generates $1.5 billion per year in Arizona.

Discussion: What benefits would assist your area?

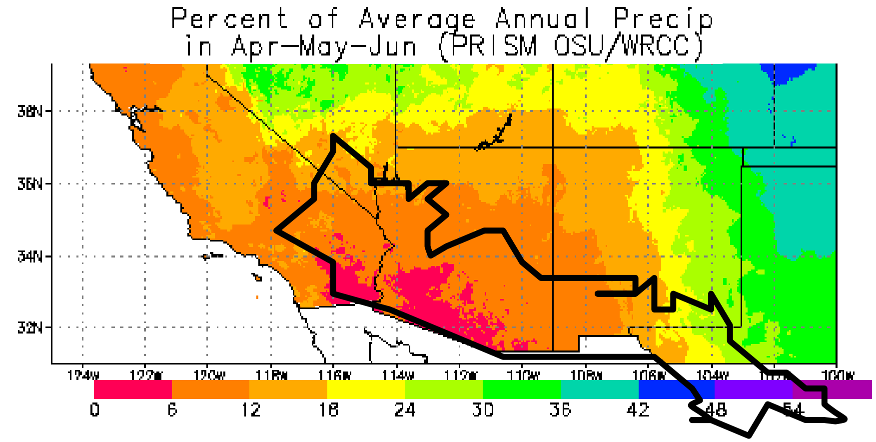
- Which of these benefits would have the greatest impact in your community, given the challenges you previously identified?
- Which benefits are most relevant to your community's weather and climate?
- How could you market these benefits?

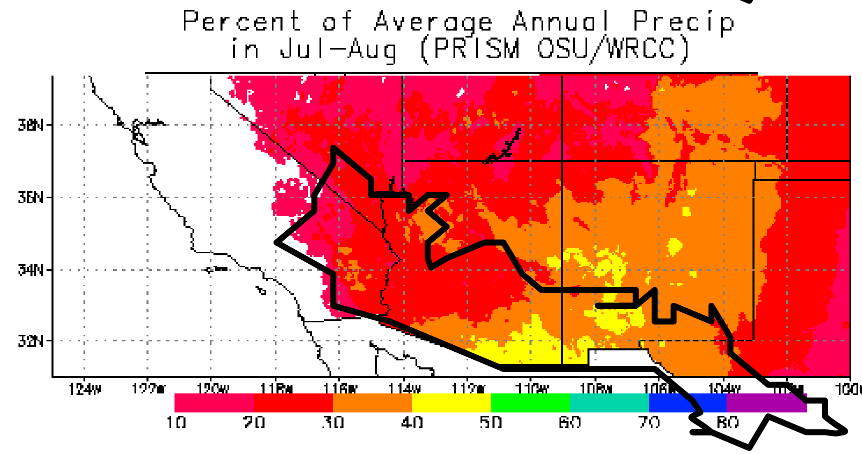
Average annual rainfall

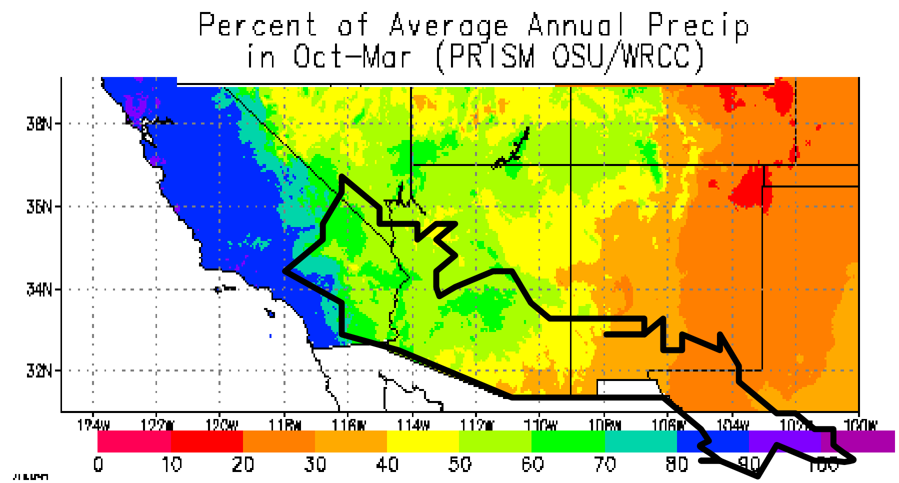


Source: www.wrcc.dri.edu/precip.html

Percent of Annual Rainfall by Season



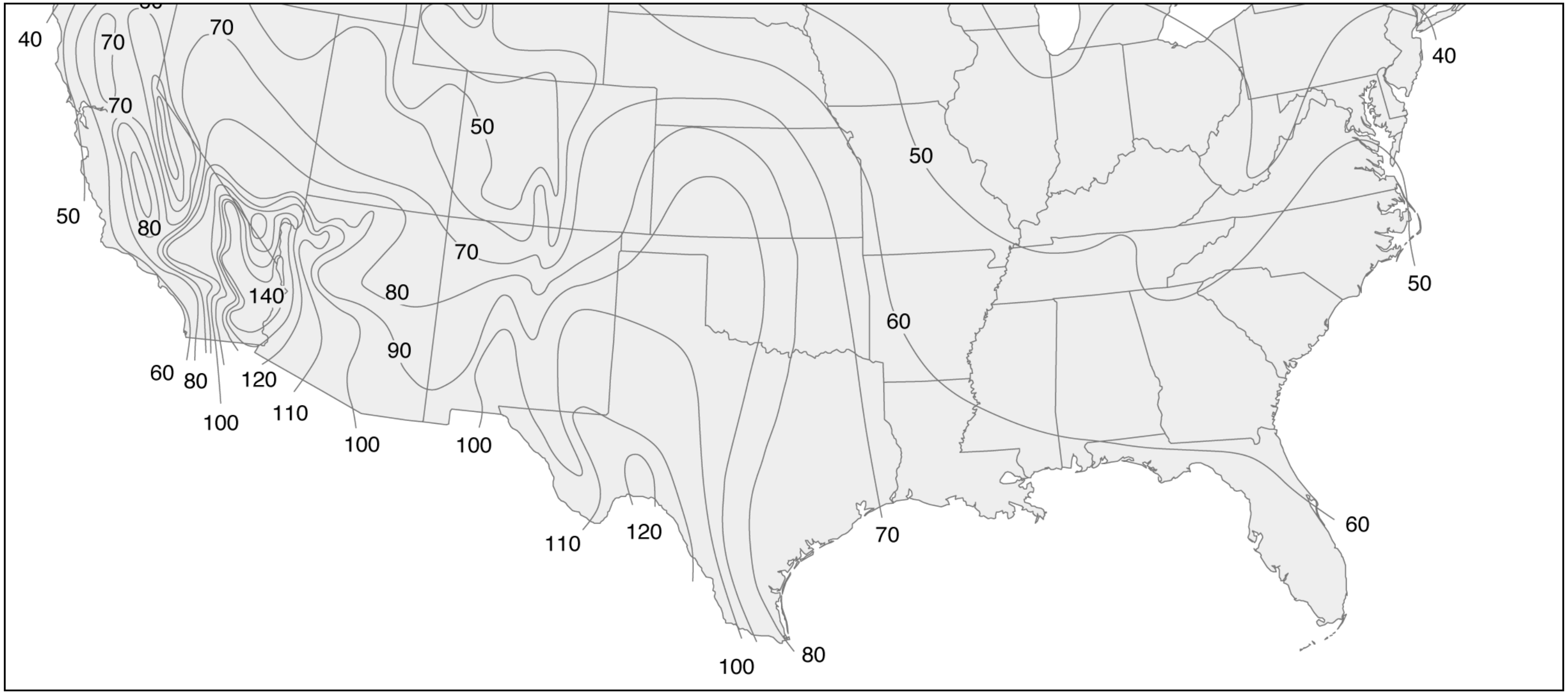




Source: www.wrcc.dri.edu/precip.html

Evaporation Rates

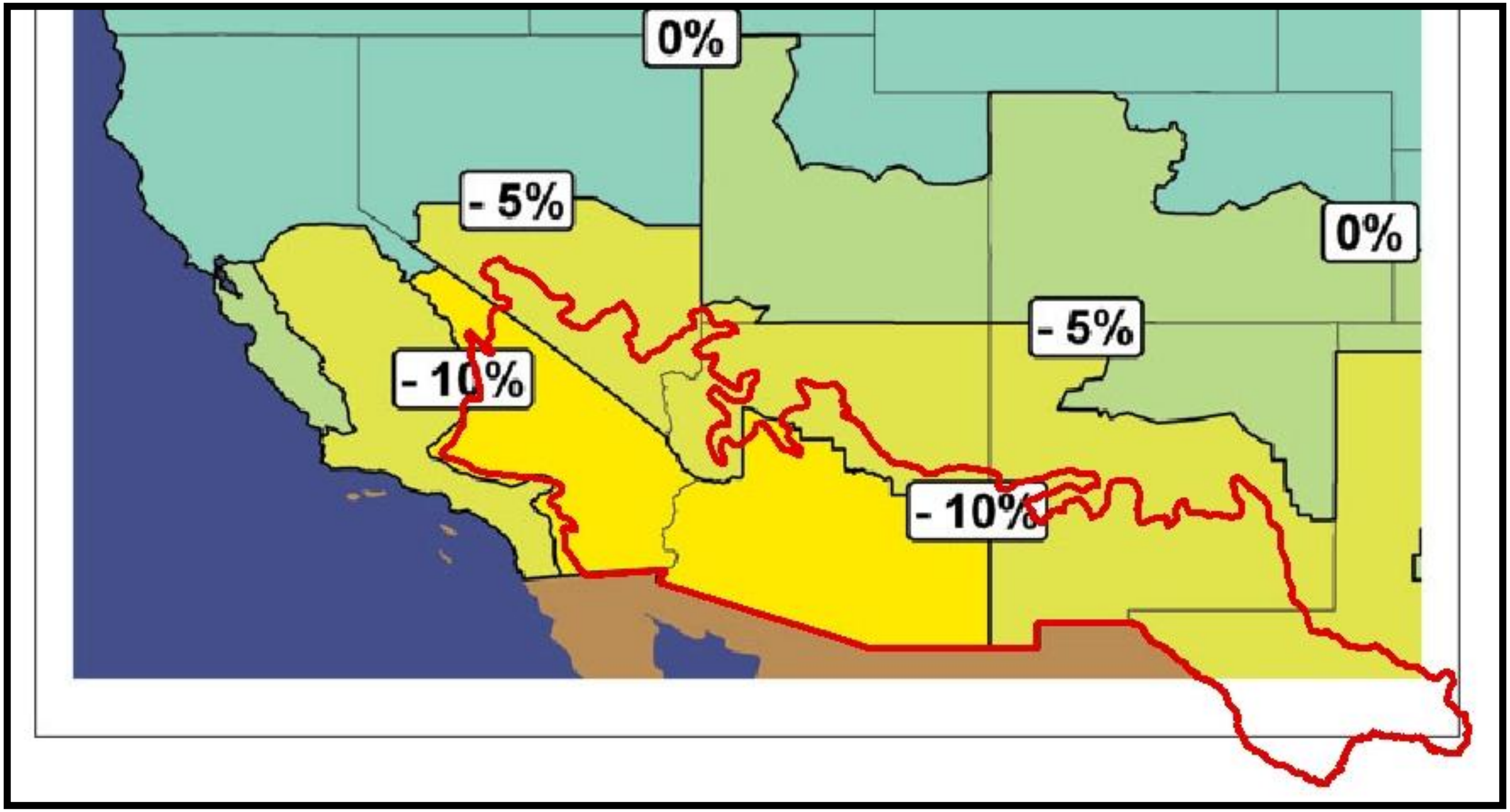
Average annual potential evaporation rates



http://www.moreaqua.com/markets.html

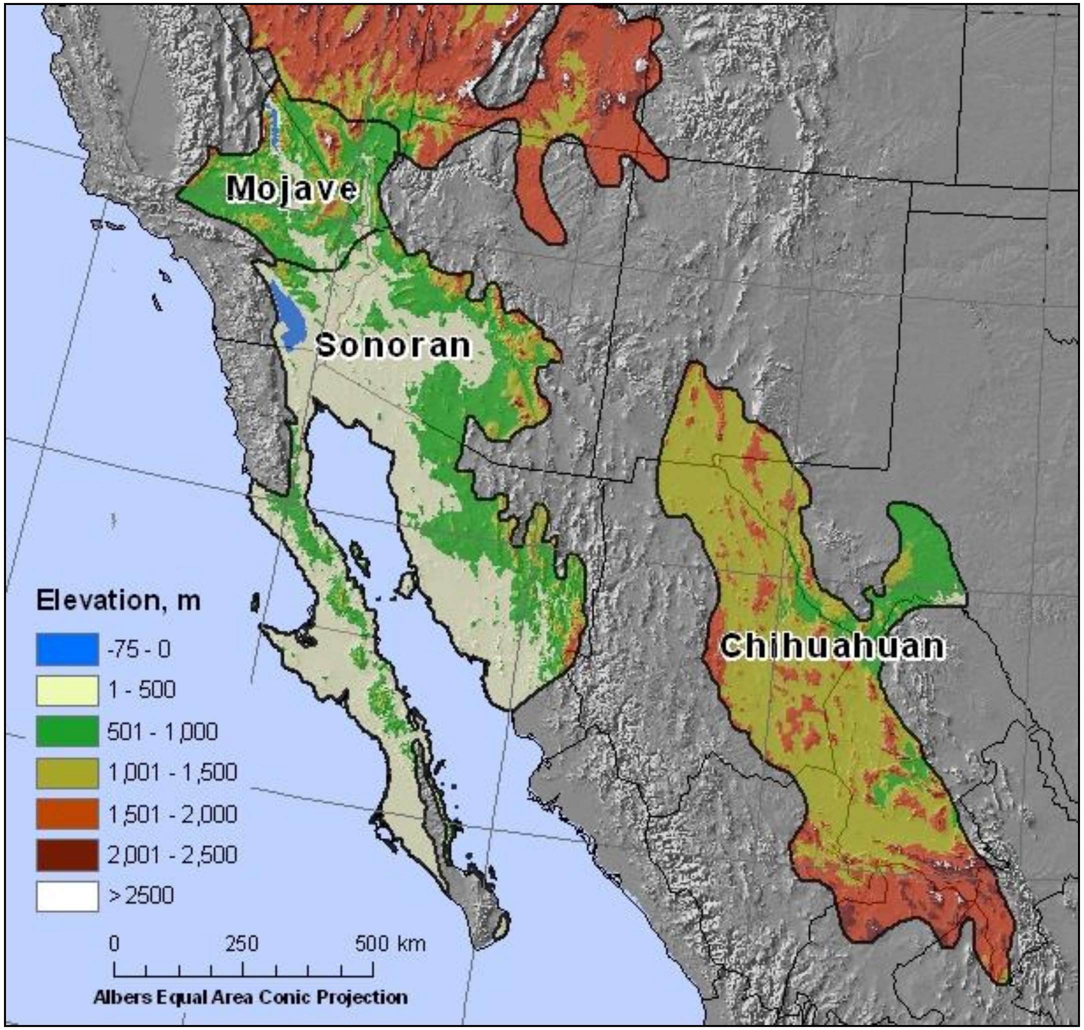
Predicted Precipitation Decreases

Changes in Annual Precipitation Averaged for 2091 to 2100



http://www.southwestclimatechange.org/node/790

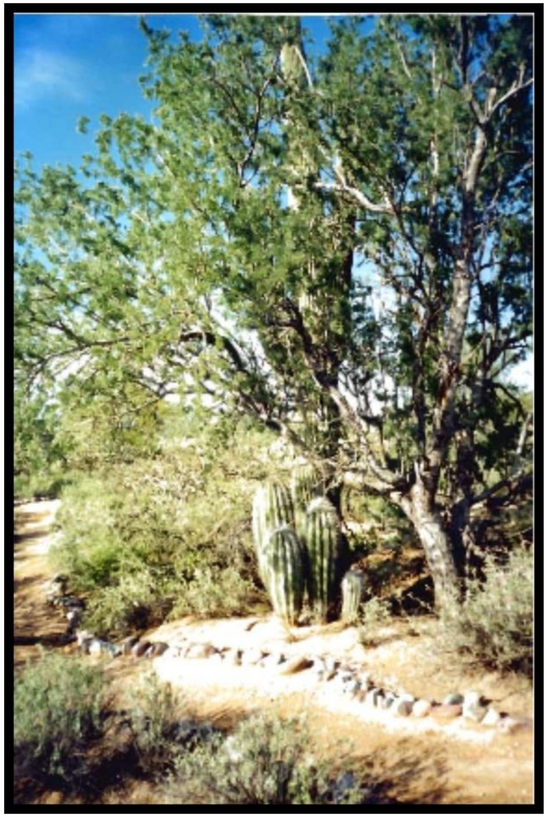
Desert LCC Deserts



http://www.eoearth.org/article/Deserts_of_North_America

Importance of using native and drought-adapted species

Low-water-use native plants can be supported entirely on rainwater once established, are adapted to local rainfall patterns, and respond better to drought periods than low-water use nonnative plants. However, in some areas the native plant palette is very limited.



Determining Water Harvesting Potential

Step 1: Graph average monthly rainfall

Step 2: Subtract 50% of monthly rainfall to address the following:

- **high and low rainfall events**
- **localized rainfall variability**
- **potential rainfall decrease due to climate change**
- **Runoff coefficient for hardscape**

Step 3: Graph resulting “effective” rainfall

Determining Water Harvesting Potential

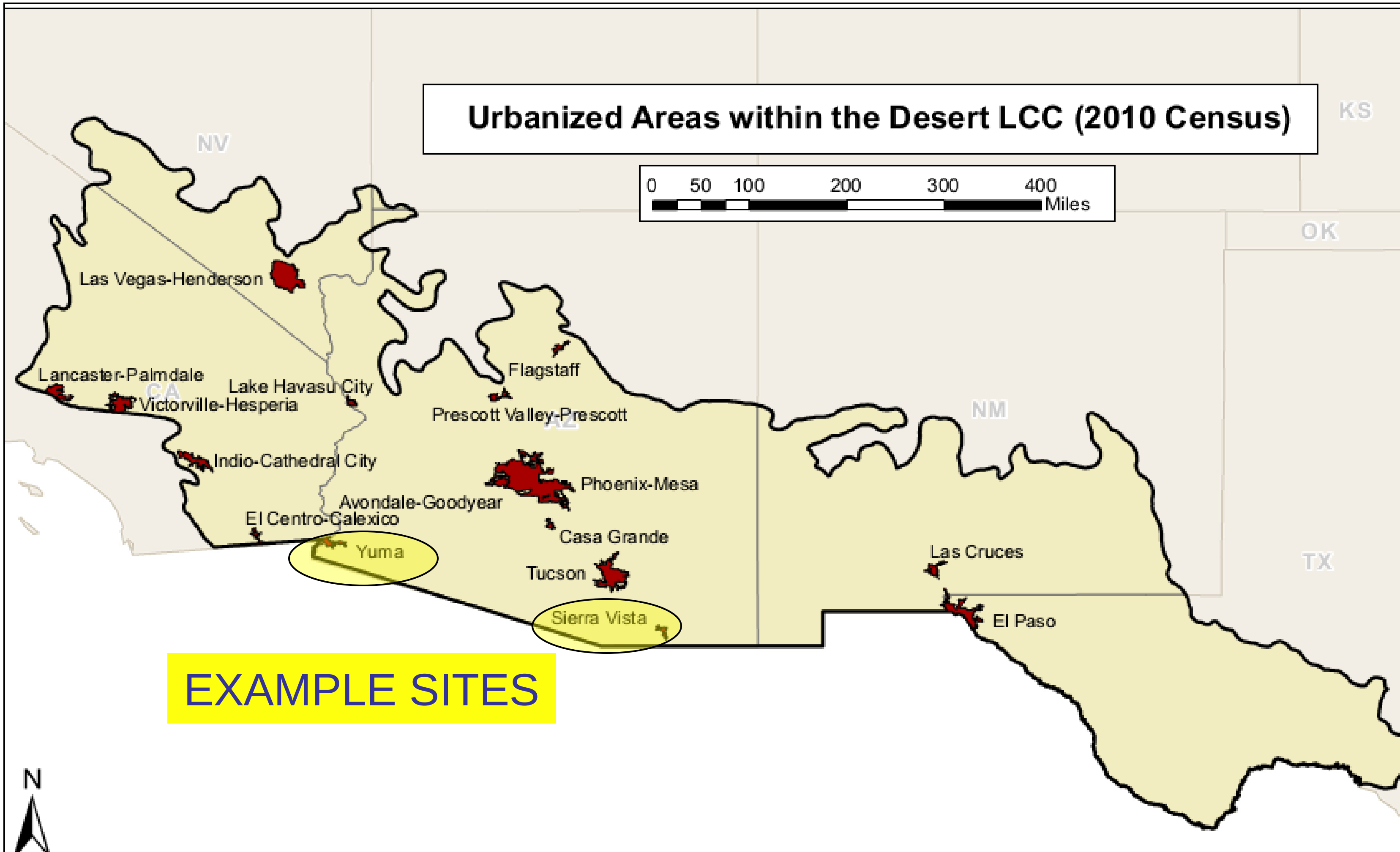
Step 4: Compare effective rainfall to monthly low-water-use plant water demand

Step 5: Pick the minimum ratio of hardscape catchment area to plant canopy area that is needed to harvest enough rainwater to exceed plant water demand ≥6 months/year

This ratio utilizes rainwater and optimizes vegetation area to:

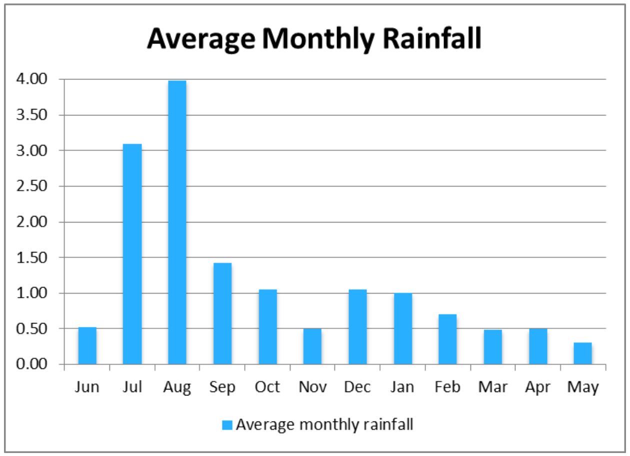
- *Offset potable water demand significantly for ≥ 6 months/year, saving associated water, energy & infrastructure costs*
- *Reduce stormwater discharge*
- *Improve stormwater quality*
- *Increase shade*
- *Cool urban environments*
- *Improve aesthetics*
- *Increase property values*
- *And provide many more benefits*

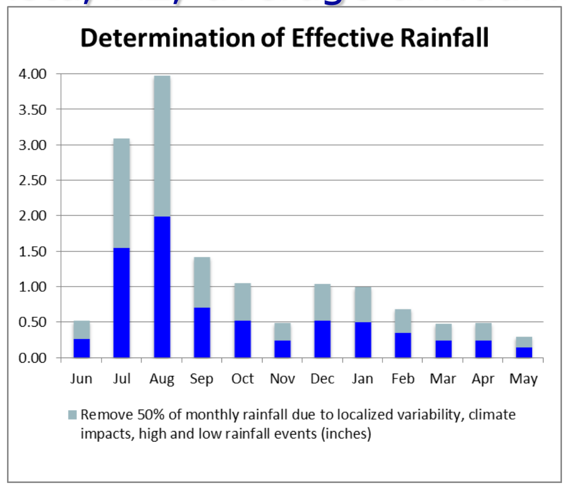
Population Centers > 50,000

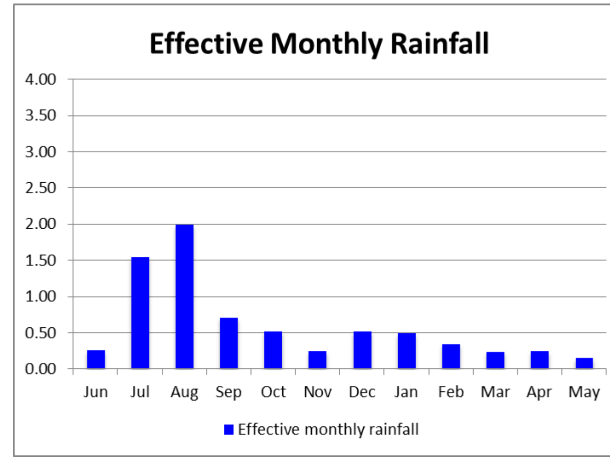


Reduce Average Monthly Rainfall 50% to Determine "Effective" Monthly Rainfall

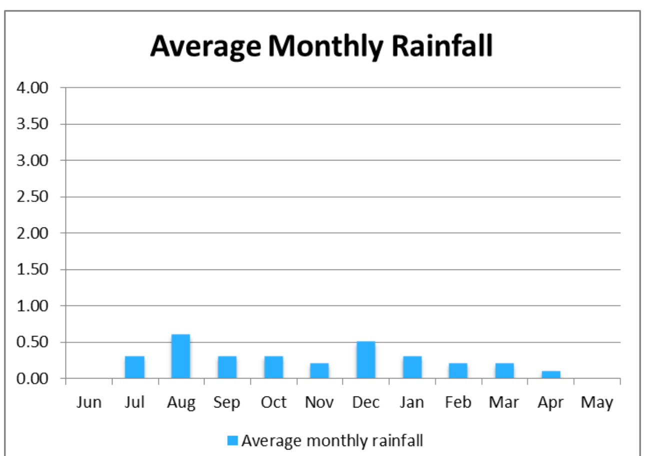
Example: Sierra Vista, AZ, average annual rainfall 14.6 inches

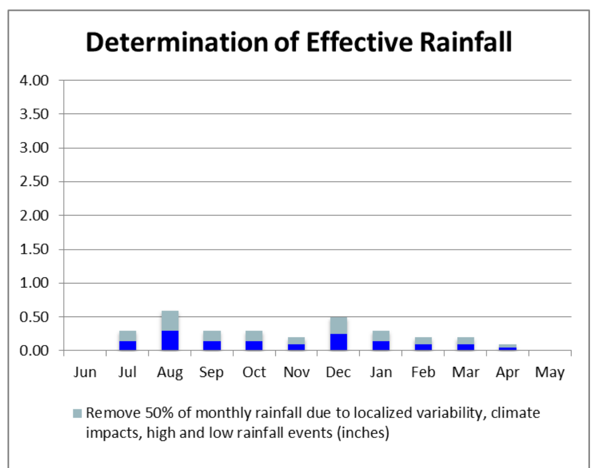


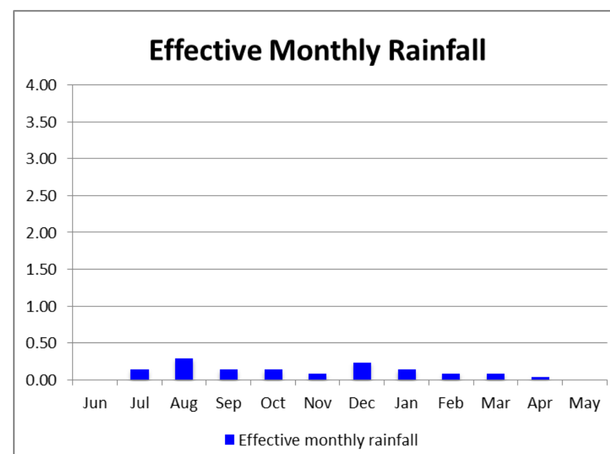




Example: Yuma, AZ, average annual rainfall 3.0 inches

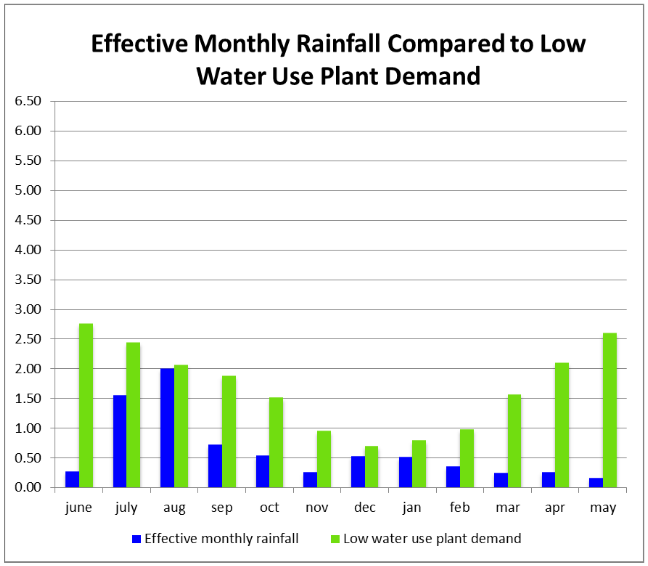


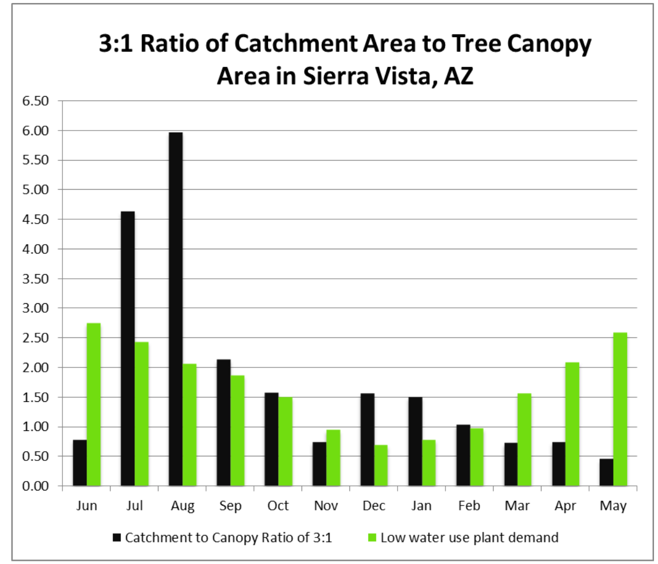




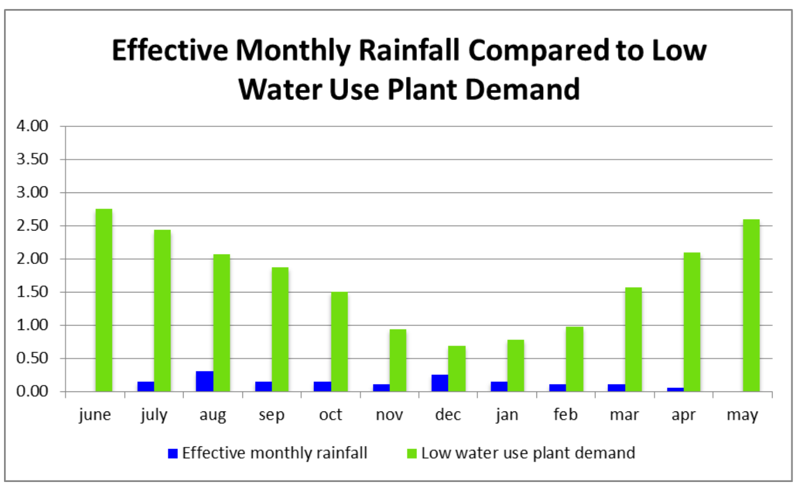
Effective Monthly Rainfall Compared to Plant Water Demand, and Optimal Catchment Ratio

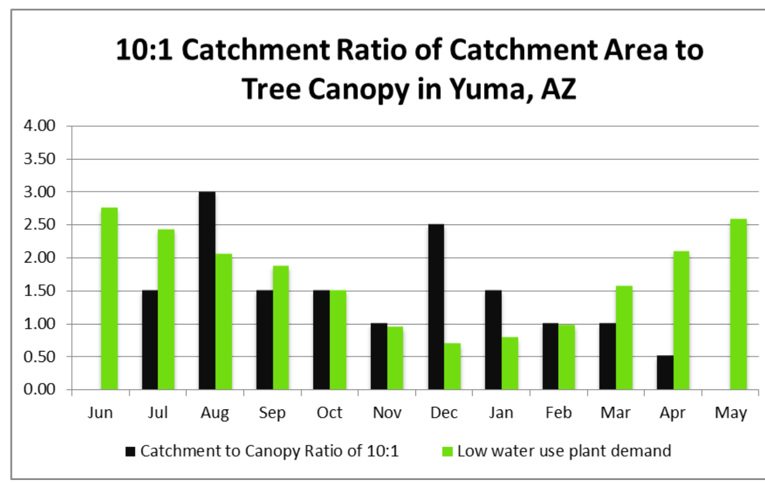
Example Sierra Vista, AZ



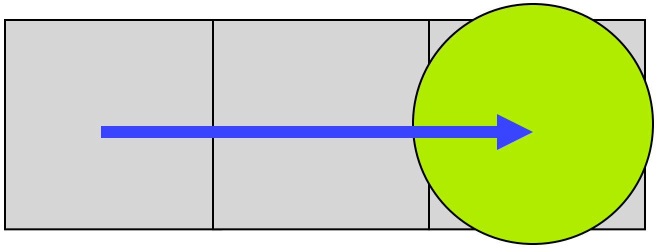


Example Yuma, AZ

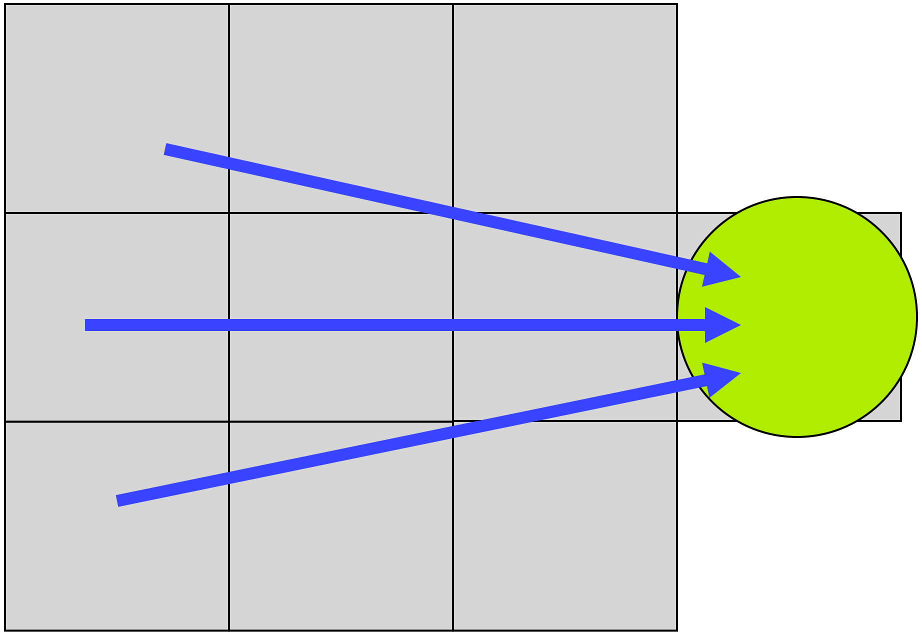




Schematic illustrations of Catchment-Canopy Ratios

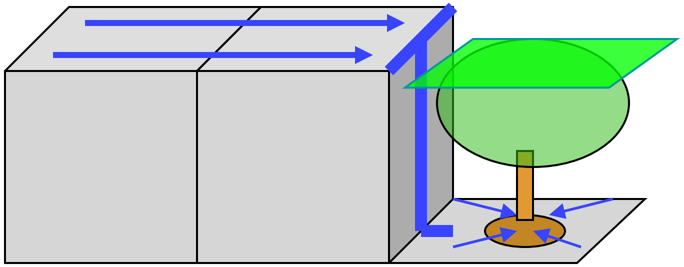


Example: Sierra Vista AZ, Schematic 3:1 ratio of catchment area to canopy area. Note the ground under the canopy area is part of the catchment area.

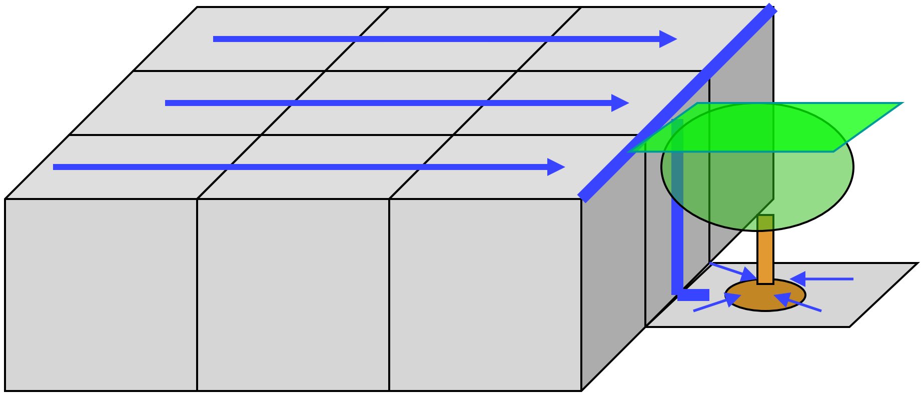


Example: Yuma AZ, Schematic 10:1 ratio of catchment area to canopy area. Note the ground under the canopy area is part of the catchment area.

Illustrations of Water Harvesting Systems using Catchment-Canopy Ratios



Example: Sierra Vista AZ, 3:1 ratio of catchment area to tree canopy area (as seen from overhead)



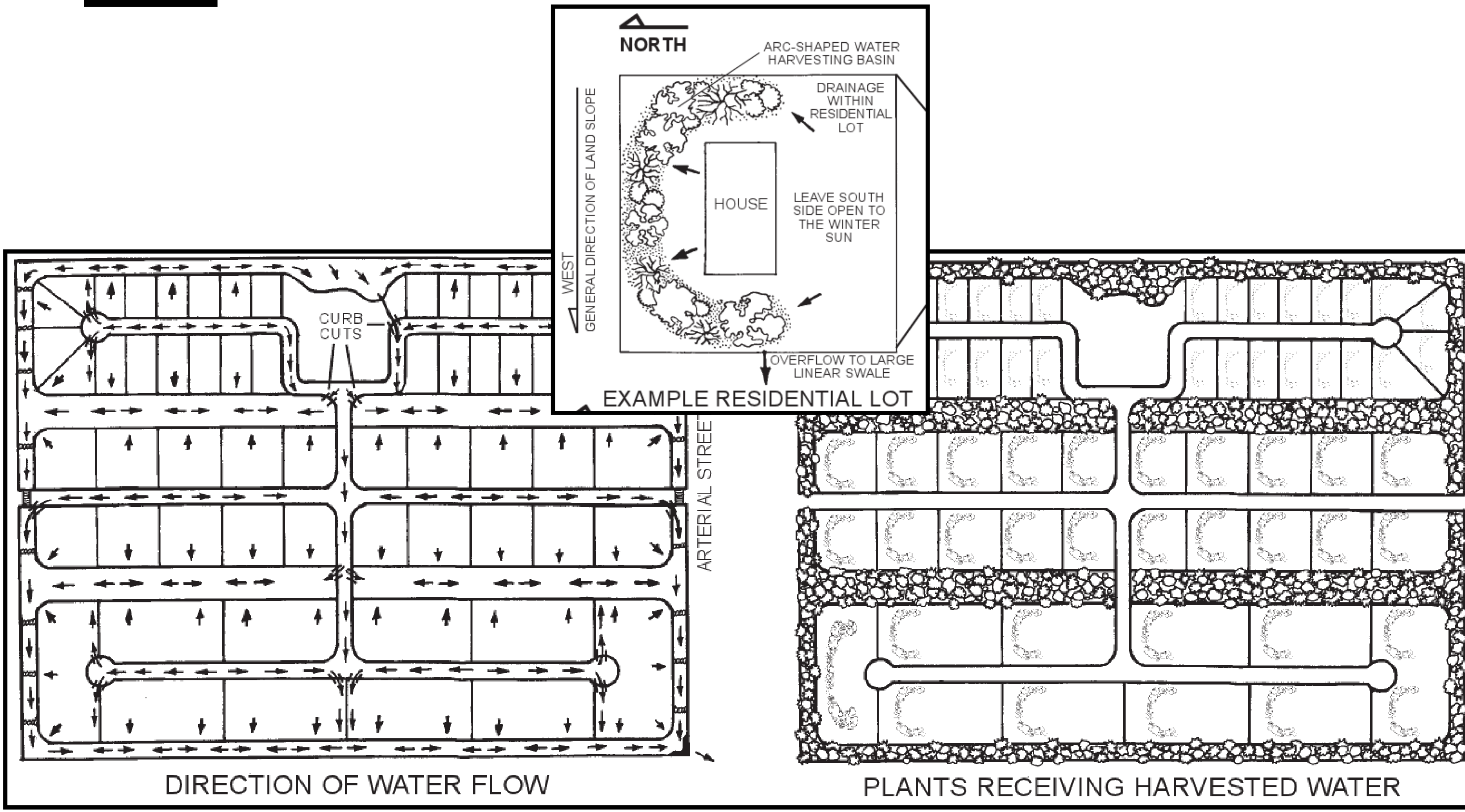
Example: Yuma, AZ, 10:1 ratio of catchment area to tree canopy area (as seen from overhead)

Example Residential Sites

Multi-family residential:
90-80% hardscape, 10-30% canopy
Runoff coefficient = 90%
Runoff:canopy ratio = 16:1 to 4:1

High density residential:
70-40% hardscape, 5-30% canopy
Runoff coefficient = 80%
Runoff:canopy ratio = 11:1 to 2:1

Subdivision Water Harvesting



City of Tucson Water Harvesting Guidance Manual

Example Residential Sites, cont.

Medium density residential:
40-20% hardscape, 10-50% canopy
Runoff coefficient = 70%
Runoff:canopy ratio = 3:1 to 0.3:1

Low density residential:
25-10% hardscape, 20-50% canopy
Runoff coefficient = 50%
Runoff:canopy ratio range =0.6:1 to 0.1:1

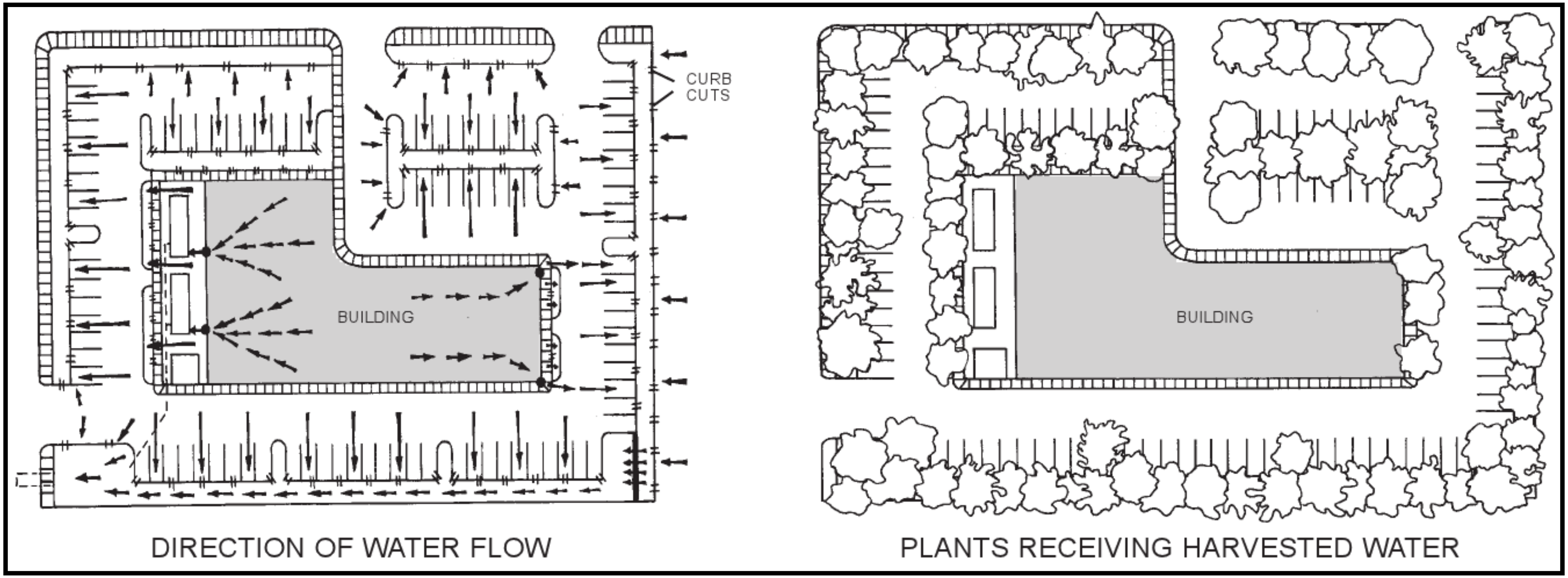
Example Commercial Sites

Large-scale commercial:
98-90% hardscape, 2-10% canopy
Runoff coefficient = 85%
Runoff:canopy ratio = 42:1 to 8:1

Small-scale commercial:
90-80% hardscape, 4-20% canopy
Runoff coefficient = 80%
Runoff:canopy ratio range = 18:1 to 3:1

Commercial Water Harvesting

Break commercial properties into multiple subwatersheds draining toward planted depressions to meet parking lot tree, landscape buffer and retention/detention requirements in the same areas



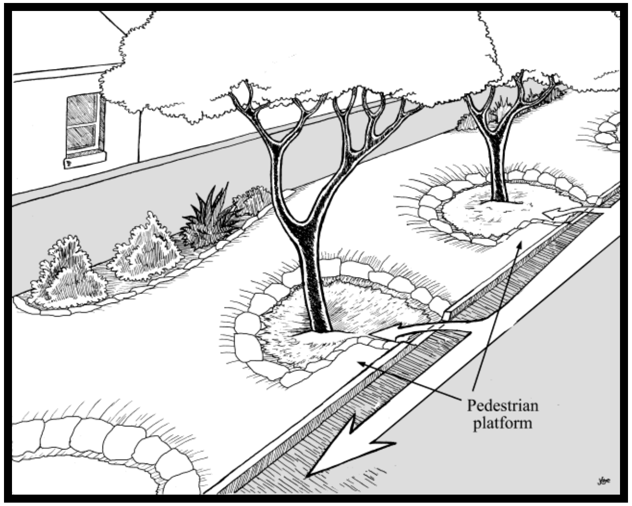
City of Tucson Water Harvesting Guidance Manual

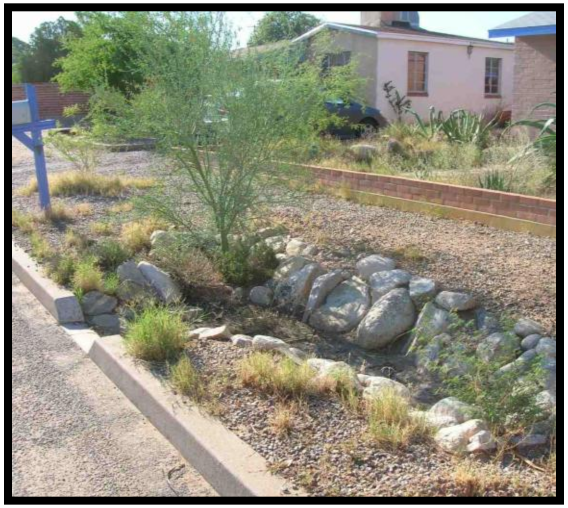
Commercial Water Harvesting

Commercial property retrofit adding passive water harvesting at Oracle Rd. Target, Tucson, AZ

Public Right-of-Way

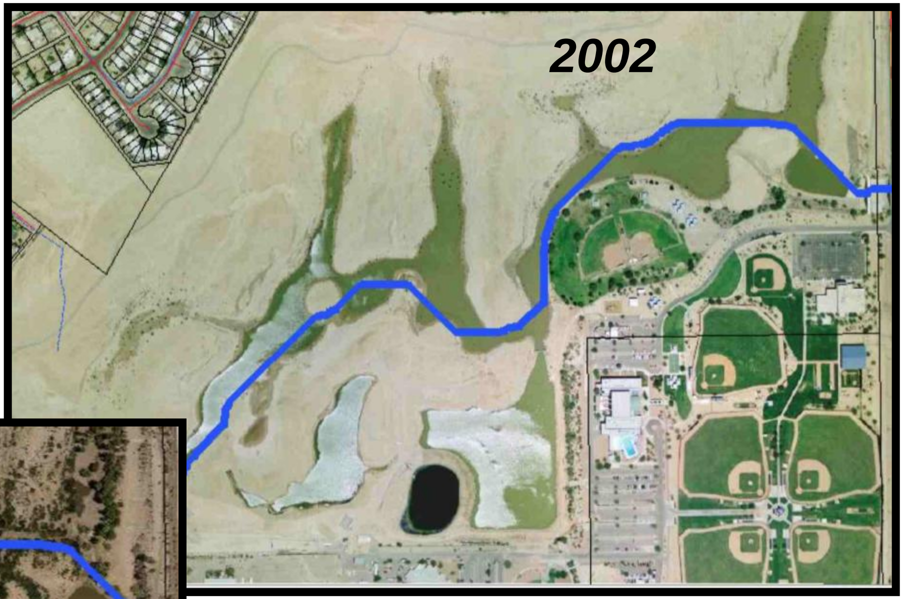
Curb Cuts in public Right-of-Way using street stormwater runoff to support shade trees





Large-Scale Stormwater Capture

Kino Environmental Restoration Project (KERP)



Discussion: Water Harvesting Potential

- What impact would meeting plant water demand 6 months of the year have?
- What is already occurring in your area with water harvesting? At what scales?
- Do the example sites presented here look similar to sites in your community?
- Is Low Impact Development being incorporated into design? What upcoming requirements do you face?
- What are your retention/detention requirements?

Discussion: Impediments

- What are the prevailing water rights affecting your area? Do you have a policy on the use of “developed” water?
- What possible code impediments might exist?
- Are mosquitos a concern in your community?
- Would politicians and the community be accepting of water harvesting practices?
- Is maintenance a concern?

Continuum of Options

Provide Education and Guidance

Remove Impediments

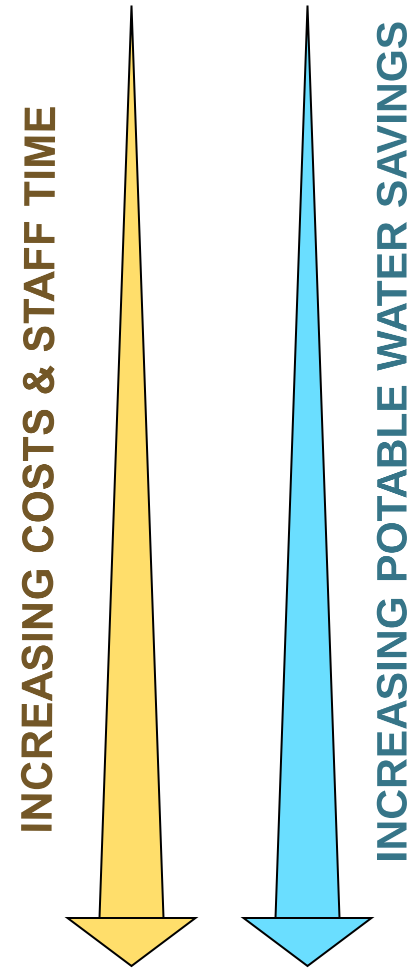
Quantify Water Harvesting Potential

Lead By Example at Public Sites

Regulate Qualitatively

Create Financial Incentives

Regulate Quantitatively



Continuum of Options

USE MULTIPLE APPROACHES FOR WATER-SAVING SYNERGY

Provide Education and Guidance

Remove Impediments

Quantify Water Harvesting Potential

Lead By Example at Public Sites

Regulate Qualitatively

Create Financial Incentives

Regulate Quantitatively

Water Harvesting Makes a Difference!

Feedback? Questions?

jlzcleveland@email.arizona.edu

wrrc.arizona.edu/DWHI