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Water saving mechanisms, a policy analysis

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Water saving mechanisms, a policy analysis

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Dedication

To my grandparents Herbert and Margaret Schiffer, who taught me key life lessons.

Acknowledgements

I would like to thank and acknowledge: my Advisor Dr. Suzanne Pierce, my reader Mary Pearl, my alternate reader Judith Ayres, my family and my girlfriend Alison who have been supportive through this long process.

Abstract

Water saving mechanisms, a policy analysis

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Distributed water conservation provides significant benefits to overall water availability, particularly if adopted at a large scale. Conservation strategies, such as rainwater harvesting, xeriscaping, and permeable pavements are desirable because they conserve water, increase recharge near dwellings, and reduce dangerous stormwater runoff. Though conserving water is an admirable goal, justifying retrofits for water conservation mechanisms to existing structures is difficult because water prices are very low in much of the United States. However, stormwater regulations and the increasing implementation of stormwater utilities by cities enable other avenues of adoption for these practices.

This thesis reviews water conservation strategies, examines local and state policies, and presents a "model policy". The model policy design uses a comparative approach to identify useful incentives and aggregates best management and policy practices from several states to serve as a guide and accelerate implementation.

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Chapter 1: Background and Context of Water Conservation

It is estimated that 98,410,000,000 liters (26 billion gallons) of water are used daily in the United States and the U.S. Geological Survey reports an average per capita use between 302 and 379 liters (80 and 100 gallons) of water daily (Flowers, 2004). Furthermore, water and other natural resources are consumed at an increasing rate as the population of the United States continues to grow and expand into more arid territory (Census, 2010). Figure 1 shows the general demographic shifts towards the southwest (Yen, 2011).

Water management has traditionally involved the manipulation of water supplies, rather than modifying water demand. This has been completed with dams, water conveyance structures and the location and development of new supplies. However, these supply-based methods continually face economic, ecological, and hydrological concerns. For example, reduced surface water supplies can damage habitats for aquatic life, and the over pumping of groundwater resources can lead to land subsidence.

The effects of land subsidence are apparent in many areas, such as high profile cases in Houston, Texas and the San Joaquin Valley in California (Bolger, 2011). A long history of groundwater use in Houston led to localized subsidence, increased flood hazards, and affected the nearby Galveston Bay Estuary. In the San Joaquin Valley, excessive groundwater pumping to sustain agricultural water use has resulted in severe land subsidence, along with pesticide and fertilizer induced groundwater contamination problems that are considered drastic by some researchers (Botzan, 1999; Bolger 2011).

Globally, populations are shifting toward urban centers and intensifying water demand in these areas. Urban migration trends in the United States are exacerbating water resource circumstances because the major population shifts are also moving toward arid regions of the nation (Gleeson, 2012). The strategies and approaches to both supply and demand in urban centers is a significant concern for water resource governance and this thesis will focus on distributed water conservation efforts in urban environments, particularly xeriscaping, rainwater harvesting methods and pervious surfaces. It examines the benefits and risks of xeriscaping and rainwater harvesting methods, barriers to adoption, and how these measures have been implemented, via market or policy levers. Further, it identifies the "best practices" of adoption as part of a model policy design.

Policy implementation becomes important to water conservation practices because without mandated conservation measures, there is a risk that approaches, such as xeriscaping and rainwater harvesting, would be limited to a small water conservation conscious segment of a community. Deploying distributed water conservation strategies, such as xeriscaping or rainwater harvesting, is time, capital and effort intensive for individual property owners, though it remains significantly more economic when compared with large-scale infrastructure options. In order to achieve the cumulative benefits and reduced water use of these distributed conservation strategies, policy initiatives must be successfully converted into practice across large segments of a population.

DEFINING DISTRIBUTED WATER CONSERVATION METHODS

Rainwater harvesting

Rainwater harvesting is as simple as the name suggests, it means the act of capturing the rainwater that falls upon an area. Every house or building can serve as a potential catchment area for rainwater harvesting. There are benefits and risks to this concept; benefits include improved water quality and reduced surface or groundwater withdrawals, as well as limiting flooding during rainstorms (Kim et al, 2008). Negative aspects include diverting recharge from rainwater away from the natural systems, particularly rivers and streams, potentially causing impacts downstream or down gradient to the ecosystems or humans who rely on it.

Concerning water quality, rainwater is known for its purity and lack of dissolved minerals, which is referred to as "softness". The Texas Water Development Board (TWDB) notes, "Rainwater quality almost always exceeds that of ground or surface water" (TWDB, 2005). Rainwater is free from the contamination issues often faced by surface or groundwater such as sulfates or by-products of disinfectants, salts, minerals, and other natural and man-made contaminants. Plants do very well when irrigated by rainwater, as this is the water they evolved to use. Appliances operated using rainwater last longer than when subjected to the corrosion or scale effects of hard water (LCRA, 2009).

Recent research examined how five different roof types affected the water collected by rainwater harvesting (Kirisits, 2011). The study demonstrated that metal, concrete tile and cool roofs produce the highest quality for indoor domestic use. The study also showed that rainwater from asphalt fiberglass shingle roofs and, the increasingly popular, "green" roofs contain high levels of Dissolved Organic Carbon (DOC). Although other potential pollutants can be significantly lower on green roofs (turbidity and aluminum), the high DOCs are significant should these roof materials be used for potable rainwater collection. Water with DOC is not necessarily dangerous on its own, but when it is mixed with chlorine – a common product used to disinfect water – the two substances react to form byproducts that potentially cause cancer and other negative human health effects (Kirisitis, 2011).

Beyond water quality considerations, the mechanics of rainwater harvesting systems are relatively simple. Rainwater falls on a catchment area that is usually a surface such as a roof; the rain is captured before reaching the ground, and then conveyed to a storage area via rain gutters and pipes. One important aspect of rainwater harvesting that may be viewed as a minor risk, is that once rain contacts the catchment area it may absorb contaminants or transport materials (such as: tar, leaves and branches, or other detritus). To address debris and contamination risks, systems should incorporate a series or gratings or sieves to filter out the larger material and, possibly, a purification system to remove toxins. Concomitantly, as purification and mechanical components are added to a system the costs and complexity for installation and operation increases.

Central Texas typically has two periods of increased rainfall in the spring and fall of a normal year. The highest period of water use in Texas occurs during the hot summer months. This works well with the periodicity of rainfall patterns, because the spring rains (generally in April and May) may be stored and used during the peak demand period of summer. Rainwater collected during the fall of each year can be used to supplement the lower water demand months the rest of the year (Krishna, 2004). The Lower Colorado River Authority (LCRA) reported that a key benefit of rainwater harvesting is that it provides a reliable water source for Texas (LCRA, 2009).

One reason that rainwater harvesting is a popular tool for water use reduction is that a rough estimate of the water savings can be easily calculated. In a perfectly functioning system 2.34 liters, per 0.093 square meter per 2.54cm (0.62 gallons per square foot per inch) of rainfall can be collected (TWDB, 2005). However, no system is perfect, a reasonable assumption would be 75-90% efficiency meaning that 1.72-2.11 liters per square centimeter is more realistic (0.456-0.558 gallons per square foot per inch). This means that a house in Austin (which has an average rainfall of 81.28cm (32 inches) with a 92.9 square meters (1,000 square foot roof) would collect between 56,599-67,917 liters (14,952 and 17,942 gallons). of rainwater in a year.

To simplify this calculation, the TWDB created a map (shown in Figure 3) to provide a rough estimate of how much rainwater homeowners may be able to capture. It is based on a roof size of 185.8 square meters (2,000 square feet). To use the map a person chooses their location and, using the indicator contours on either side, the values are multiplied by 1,000 to calculate the estimated catchment value. For example, Austin is between 81.28cm and 91.44cm (32" and 36") average rainfall. From that range a home with 185.8 square meters (2,000 square feet) of roof area has capacity to collect between 121,133-136,274 liters (32,000 and 36,000 gallons) of water per year (TWDB, 2005).

Rainwater harvesting is optimal for uses in home gardening for several reasons. For example, in many cases pumps are not necessary to distribute the collected rainwater because the collection tanks are located such that the force of gravity is adequate to propel the water. One risk with the use of rainwater harvesting is the potential to reduce recharge to surface and groundwater, which may impact natural habitats or other water users. Most of the water used in rainwater harvesting is typically for outdoor watering, meaning it is not really removed from the environment; however, it is delayed in its release. Water is released in relatively small amounts over longer time periods to support garden plants with shallow root systems. A tradeoff though, is that plants with deep root systems, that require occasional drenching, may suffer. Combining rainwater harvesting with other water conservation measures, such as xeriscaping a low-water landscaping technique increases the overall benefits.

According to the TWDB (2012) rainwater collection provides additional benefits such as:

- The end use is located close to the source thereby eliminating the need for costly distribution systems.
- Rainwater provides a source of water when a more traditional source such as groundwater is unavailable or the quality unacceptable.

- The zero hardness of rainwater helps scales from building up on appliances and so extends the life of appliances.
- Rainwater is free of sodium.
- Rainwater is superior for landscape use and plants thrive on rainwater.
- Rainwater harvesting reduces flow to storm sewers and the threat of flooding.
- Rainwater harvesting helps utilities reduce peak demands during summer months.
- By harvesting rainwater, homeowners can reduce their utility bills.

Despite the benefits, rainwater harvesting has not yet been widely adopted. In part, this may be due to a poor legislative framework. For example in Texas, the state legislature, county governments, river authorities, and the Texas Commission on Environmental Quality have not yet defined acceptable guidelines for using rainwater as an approved water supply (Fieseler, 2009). Nevertheless in Texas, developers are obligated to show sufficient water resources for their development in order to build. This requirement provides an incentive to incorporate rainwater harvesting or collection strategies into land development projects.

Another issue is interconnection. Water managers in central Texas report that a major factor impeding implementation to rainwater harvesting is that some local water utilities refuse to provide water service to homeowners with a rainwater harvesting system (Fieseler, 2009). This is because it would be reasonably simple to divert the water from the pipe into the rainwater-harvesting tank before the pipe hits the meter, thereby allowing the owner to appropriate as much water as they wanted without paying for it.

The TWDB (Texas Water Development Board, 2012) identifies additional risks:

- Rainwater harvesting cannot be relied on as a long-term, drought-proof source of water supply, because rainfall events are highly unpredictable.
- The capital cost for a rainwater harvesting system is typically higher than the cost of obtaining water from a centralized distribution system. However, it is comparable to the cost of drilling and installing a new groundwater well.
- Rainwater harvesting systems require care and maintenance after installation, which may not be suitable for all homeowners.
- Providing a sanctuary for native wildlife, with the plants they have evolved to live amongst and or consume, which while beneficial for the wildlife, is not beneficial for water quality.
- Rainwater storage tanks may take up valuable space around homes.
- In Texas, rainwater harvesting systems are not subject to state building code and the absence of clear construction guidelines may discourage homeowners and developers from installing these systems.

For a normal single family home the cost of installing a rainwater harvesting system and range from $8,000 to $10,000. To offset the cost of rainwater technology many state agencies and municipalities offer financial assistance in the form of tax rebates (Texas Water Development Board, 2012).

Xeriscaping

A term coined in 1978 in Colorado to describe, “water wise” landscaping (Eagle et al, 2000) xeriscaping, derives from two words, “xeros” Greek for dry and “xcape” short for landscape (California Integrated Waste Management Board, 2008). The goal of xeriscaping is to make the area outside of a home as water efficient as possible. Conceptually, the process of xeriscaping is made up of eight key principles as described in the following sections include: *planning and design, soil analysis, practical turf areas, appropriate plant selection, improving the soil, use of mulches, efficient irrigation, and appropriate maintenance*.

1. ***Planning and design.*** The planning and design principle encompasses making a detailed drawing of all areas of the property that are vegetated. An important part of this is looking at seldom seen areas, such as the long narrow section of grass that may be on the sides of a house. This approach can reveal unused areas of property that may not be using water efficiently. (Colorado Water Wise, 2009)

2. Soil analysis. Step two of the xeriscaping process principles is soil analysis. It is important to know what kind of soil the owner has on their land, and if any improvements need to be made before other xeriscaping principles are employed. Testing for soil nutrient content and drainage (California Integrated Waste Management Board, 2008) saves water, and if there is very specific ground chemistry, such as basic, the owner can calibrate their selection of plants for ones that thrive in such an environment. Knowing the drainage will tell the owner how much mulch to put down later on as a water catcher. Furthermore, the nutrient content will let the owner know if there are any deeper problems. Many landowners think that if a plant is not growing it simply means it does not have enough water, although this is often the case, the problem could also lie in a lack of nutrients in the soil as well.

3. Practical turf areas. Step three is to create practical turf areas. For example, if the owner has a steep slope that is difficult to mow, it makes more sense to replace that with groundcover or perennials. On the other hand, traditionally when Americans think of landscaping it means a large expanse of green grass, such as Kentucky Blue Grass that use large amounts of water and is impractical to the homeowner or caretaker of the home. Another important consideration is foot traffic. Some drought resistant strains of grass such as Buffalo Grass or Blue Grama do not stand up well to heavy traffic. A land or property owner may think of putting down a footpath in these areas.

4. Appropriate plant selection. Step four is proper selection and grouping of plants.   Landowners should examine the microclimates on their property, sunny areas versus shady areas and choose species that work best in certain areas. It is also important to group plants by their watering needs, plant one area with plants that do not need as much, and one area with plants that are water intensive. This will make gardening and watering more efficient. Many xeriscaping guides state the need for “native” plants; however an important distinction needs to be made between drought resistant plants, Mediterranean plants and native plants. Not all native plants do well in drought conditions and some such as Mountain Cedar use huge amounts of water. Generally when guides instruct landowners to use native plants, they mean drought resistant plants, with good root systems that are not overly water consumptive. Some native plants have protection mechanisms that let them go dormant during periods of drought; this should be understood, and not mistaken for being "dead" (Green Builder, 2013). For variety, many species of plants that originate from the region near the Mediterranean Sea also fit into this category.

5. Improving the soil. Step five of the xeriscaping process involves soil improvement. The specific improvements depend on results of soil analysis. Sandy soil has excellent drainage, but poor water and nutrient retention. While silty or clay soil has excellent water retention, it is slow to absorb or release water. The best way to fix both is with the addition of organic material and tilling to mix it in.

6. Use of mulches. Step six is the addition of mulch material, which is related to soil improvement. Mulch is organic material of varying forms, such as wood chips, and, inorganic forms such as small rocks. Mulch is very important to xeriscaping because it limits evaporation and erosion, cools plant root zones, and, controls weed growth. Most landscaping authorities agree that 7.62-15.24 cm (3-6 inches) of mulch is optimal for xeriscaped beds. (Colorado Water Wise, 2009)

7. Efficient irrigation. Step seven is efficient irrigation that ideally would include an underground drip system. If that is not possible, a landowner should limit watering to early evening or morning hours to help limit evaporation. It is vital to check for leaks in the system. The most efficient use of water is to keep it low to the ground, to reduce losses due to wind such as those incurred with traditional fan sprinklers. Early gains can be made by changing the setting on a fan sprinkler to the largest droplets to limit losses to evaporation.

8. Appropriate maintenance. The final step of the xeriscaping process is maintenance. Vigilance needs to be exercised when performing dead-heading, aerating, pruning, mowing and fertilizing. Fertilizer should be applied in small amounts and in a delayed release format. This will help the garden over time, and avoid runoff to local waterways.

Xeriscaping has been proven to be effective in arid regions. For example, the Southern Nevada Water Authority (SNWA, 2005) conducted a five-year study on the effects of xeriscaping and found that the average household used 30% less water than a control group (SNWA, 2005). For an average family in the United States this results in an estimated savings of 363 399.5 liters (96,000 gallons) per year per residence as shown in Figure 5. (Sovocool, 2005).

The reductions were realized almost immediately after lawns were converted and stayed constant for the entire test period (shown in Figure 5). One factor that is important to consider with this data is that people who were already predisposed to save water were most likely to be the ones to volunteer for such a study (Sovocool, 2005).

Much of the water savings can be accounted for by examining the water use of turf versus xersiscaped land. Turf uses on average 276.33 liters per 0.093 square meters (73 gallons per square foot) annually while xeriscaped land uses an average of 65 liters per 0.093 square meters (17.2 gallon per square foot) (Sovocool, 2005).

A major barrier to implementation for xeriscaping is the effort and costs needed to install and maintain it. The graph below shows that people with at least 60% xeriscaped terrain save both time and money versus those who have turf. The average difference is 2.2 hours/month in labor and $206 per year in direct expenditures (shown in Figure 6) (Sovocool, 2005).

Las Vegas pays residents up to $1.50 per 0.093 square meters (square foot) to xeriscape, with the maximum payment of $50,000. So far the city has paid out over $25 million in rebates (Progressive Policy Institute, 2003).

This incentive has been very popular with local landscaping companies. SWNA runs classes for the contractors to certify them as xeriscaping knowledgeable, and then highlights the companies that participate on the SWNA website, to great effect. So much that, some of the 85 landscaping companies listed on the website asked to be removed because they couldn't keep up with the call volume that it was generating (White, 2010).

Passive Rainwater harvesting

Permeable surfaces and Rain Gardens. Another form of rainwater harvesting is what some call passive rainwater harvesting. The most basic form of passive rainwater harvesting is diversion by altering the landscape to slow the energy of the incoming water. As rainfall is diverted the risks of storm runoff are reduced and the flow is directed to zones where it serves to irrigate plants in a rain garden, as shown in Figure 8. Homeowners can couple these systems with their active rainwater systems by directing any overflow into the rain garden. Permeable pavements provide a route for rain to infiltrate the subsurface. The rain garden allows the soils and subsurface to absorb rainwater, rather than have it runoff. This then helps irrigate the deep roots of plantings in the garden (Rainwater Observer, 2009). Official U.S. drought maps show that many American cities may be in dire straits for long-term water sustainability (Gleeson, 2012). For example, the presence of "long-term" severe-to-extreme drought conditions is impacting much of the Southwest (Gleeson, 2012). Suburban sprawl specifically threatens water quality (Benfield, 2012). Rain that runs off roads and parking lots carries pollutants that contaminate rivers, lakes, streams, and the ocean, in addition to reducing water supplies (Benfield, 2012). Impervious surfaces replace meadows and forests and rain can no longer infiltrate to replenish aquifers. Rather, rainwater runoff is diverted into gutters and sewer systems. Similar to xeriscaping techniques, this approach re-establishes conditions that are closer to the original natural habitat condition. The benefits include reduced stormwater runoff and increased recharge through permeable surfaces.

Permeable paving typically costs about 20 percent more than traditional paving (Ferguson, 2010), but with proper installation and maintenance, and with the financial incentives that many municipalities offer, it can mean great savings. One reason for this is that successful permeable paving renders storm water retention ponds unnecessary, freeing up the land they require. Permeable surfaces are also good for home owners. The driveway, patio, or basketball court can be replaced with permeable pavement that can hydrate the lawn and protect local waterways.

American Rivers, National Resources Defense Council, and Smart Growth America (Otto, et al, 2002) recommend that state and local authorities embrace smart-growth policies to address water shortage issues; which specifically:

- Allocate more resources to identify and protect open space and critical aquatic areas.
- Practice sound growth management by passing stronger, more comprehensive legislation that includes incentives for smart growth and designated growth areas.
- Integrate water supply into planning efforts by coordinating road-building and other construction projects with water resource management activities.
- Invest in existing communities by rehabilitating infrastructure before building anew – a “fix it first” strategy of development.
- Encourage compact development that mixes retail, commercial and residential development.
- Manage storm water using natural systems by replacing concrete sewer and tunnel infrastructure, which conveys storm water too swiftly into our waterways, with

low- impact development techniques that foster local infiltration of storm water to replenish groundwater.

- Devote funding and time to research and analysis of the impact of development on water resources, and make this information accessible (Otto, Et al, 2002).

The American Rivers, NRDC, and Smart Growth America maintain that these are efficient, cost-effective and proven approaches that would provide multiple benefits for communities who want to conserve water and find relief from endless commutes, air and water pollution, and disappearing open spaces (Otto, et al, 2002). What is lacking is the political will to adopt them. Stormwater could be a key to generating the Citizen interest in order to make these changes a reality.

To comply with the Clean Water Act many cities now have to meet codes for their own stormwater management systems. The EPA does not offer funding to help, so communities have to figure out how to make stormwater abatement pay and comply with an unfunded mandate. Local governments need to collect, treat, and store and convey stormwater in an environmentally friendly manner. In addition the management and upgrading of legacy resources requires an intensive capital investment. A popular option is to create a Stormwater Utility, similar to the local power or water company.

The main factors that influence how much runoff is generated by a piece of land are the size, soil type, topography, and the amount of impervious area. The impervious surfaces are the major contributor to runoff, and the easiest and fairest to bill. Utilities frequently use the Geographic Information System (GIS) and air photos to assess the level of impervious surfaces on individual properties.

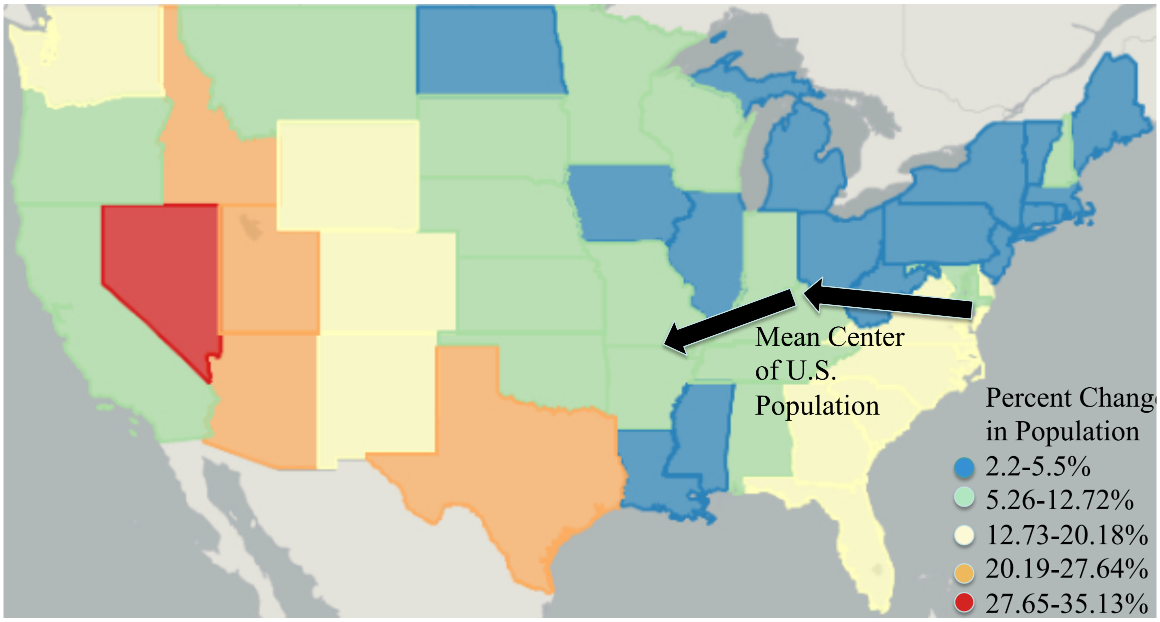


Figure 1: Population shift in the contiguous United States (Yen, 2011; Geocommons, 2013) Heading

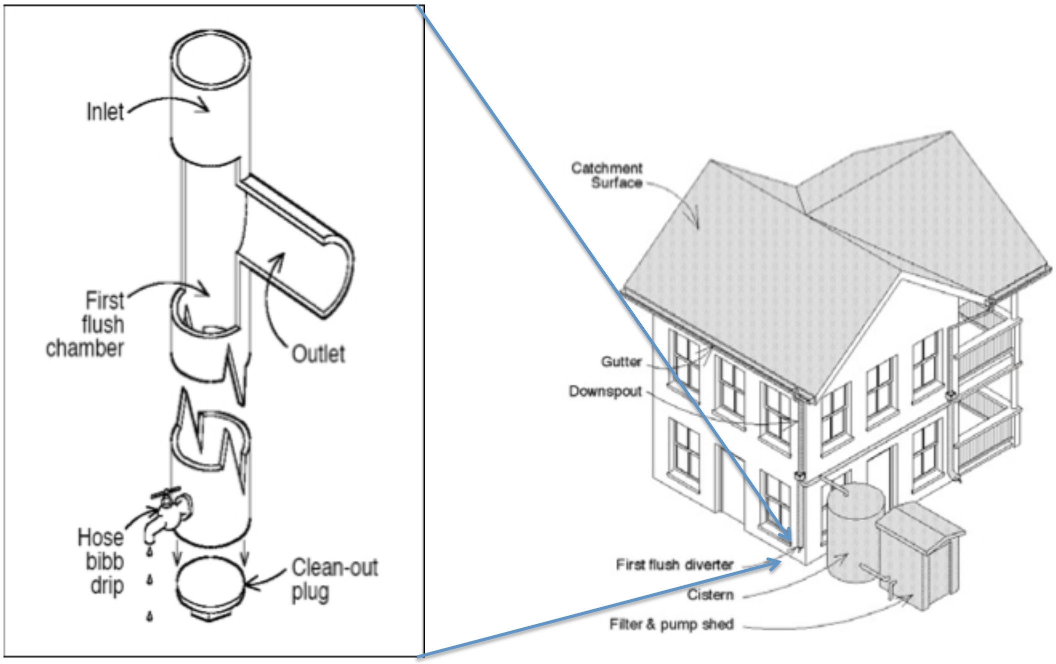


Figure 2. A typical rainwater harvesting system diagram and (inset) detail of a standpipe first-flush diverter (modified from TWDB, 2005)

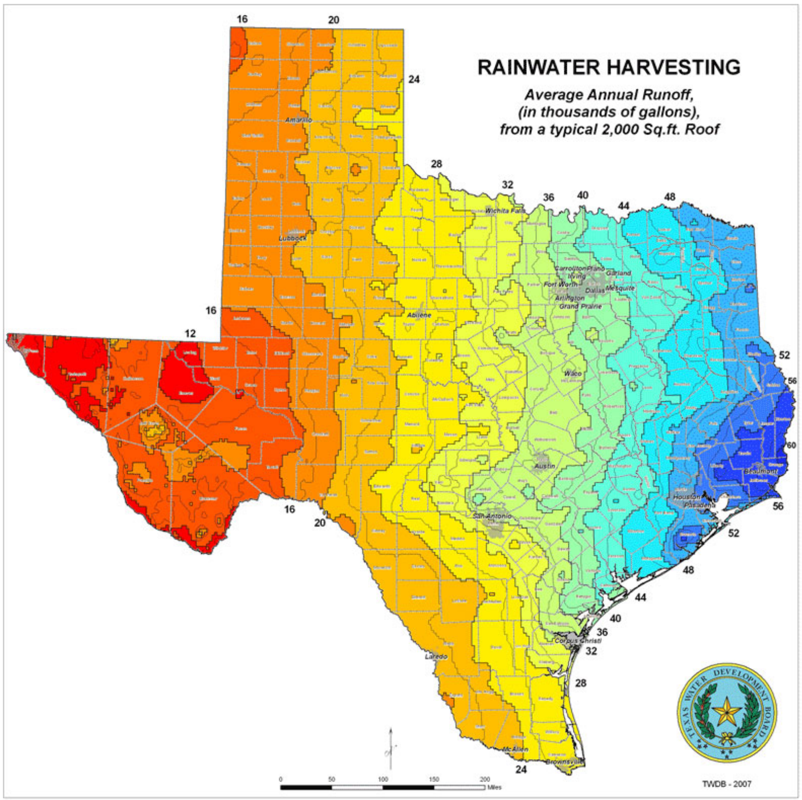
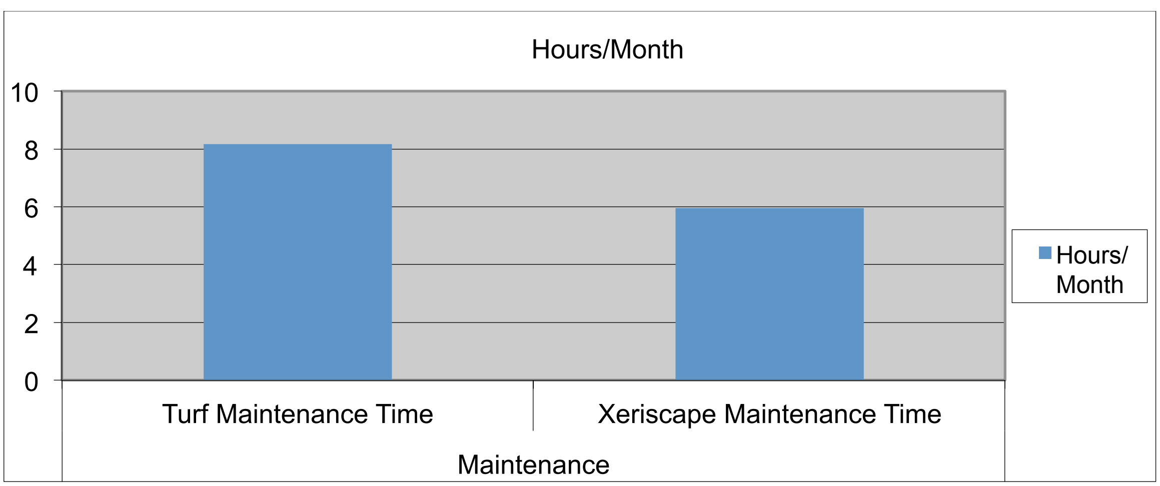


Figure 3. Average Annual Runoff (1000's gallons) (TWDB, 2009)



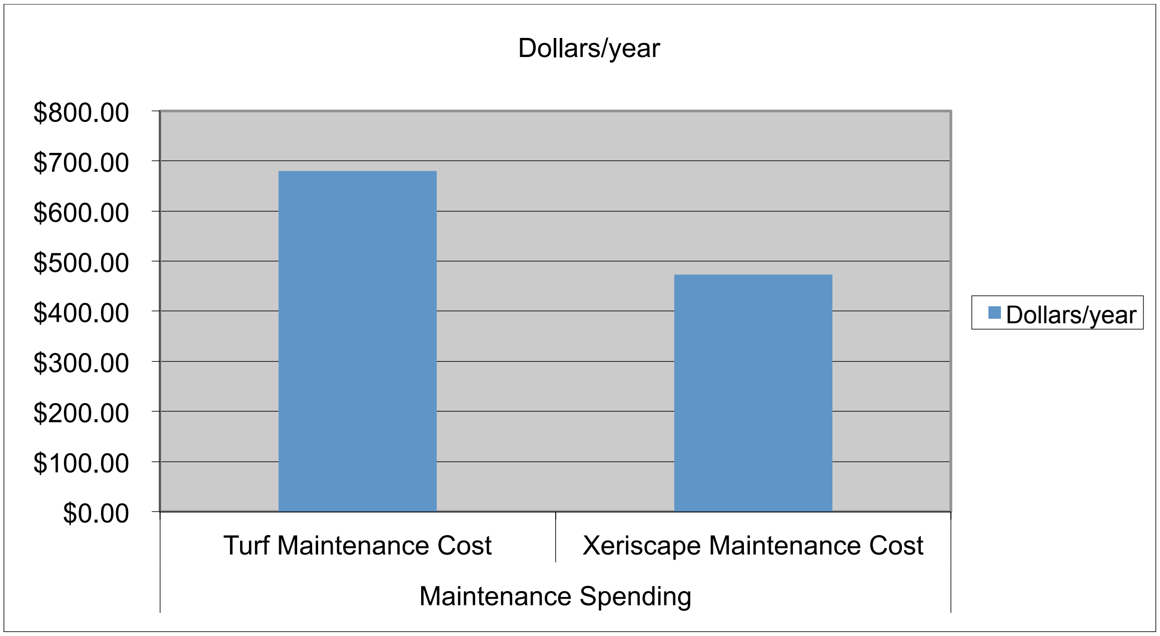


Figure 4. Xeriscape time and cost (SNWA, 2005)

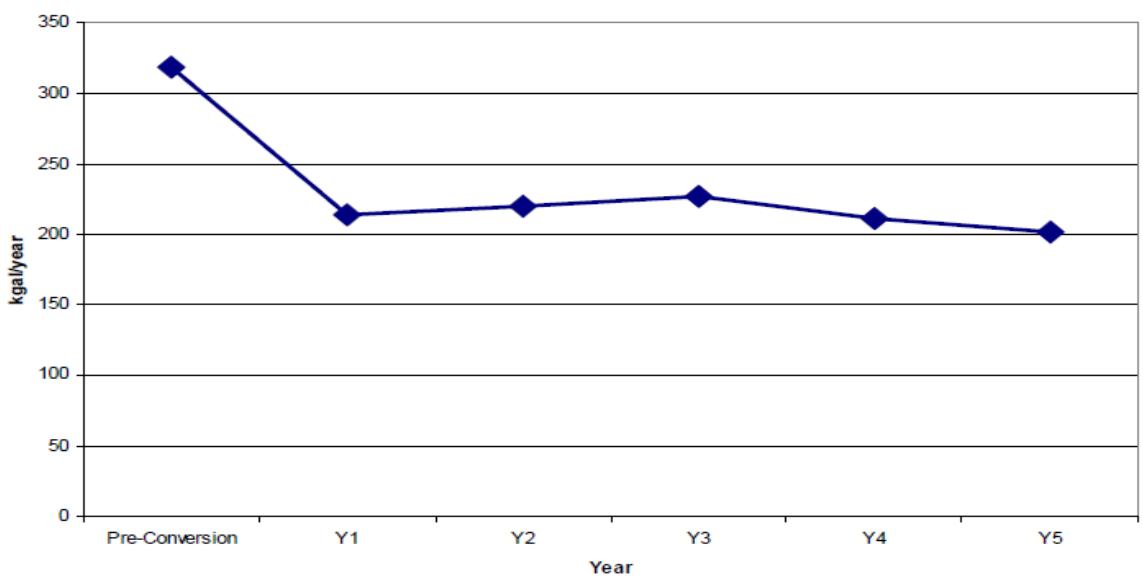


Figure 5. Water Use of xeriscaped land vs. non-xeriscaped land (SNWA, 2005)

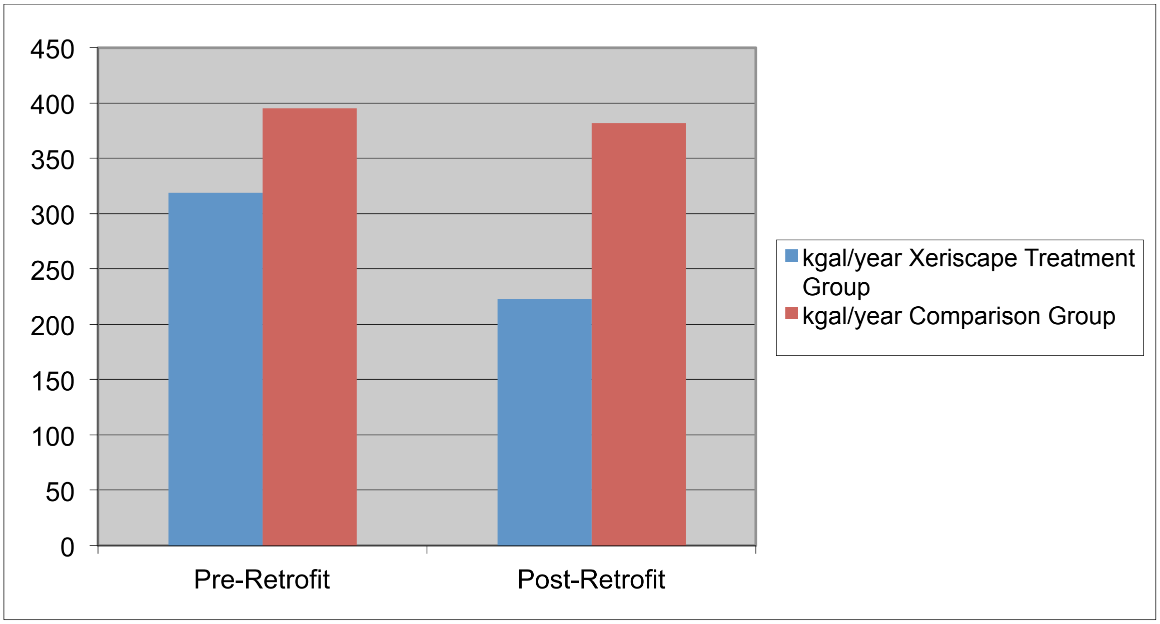


Figure 6. Expense and time expenditures of Xeriscapers Versus non-Xeriscapers (SWNA, 2005)

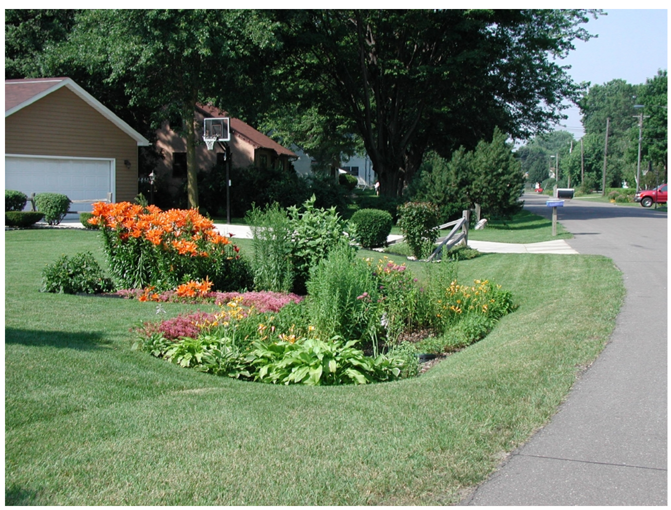


Figure 7. Example rainwater garden (from Rainwater Observer, 2009)

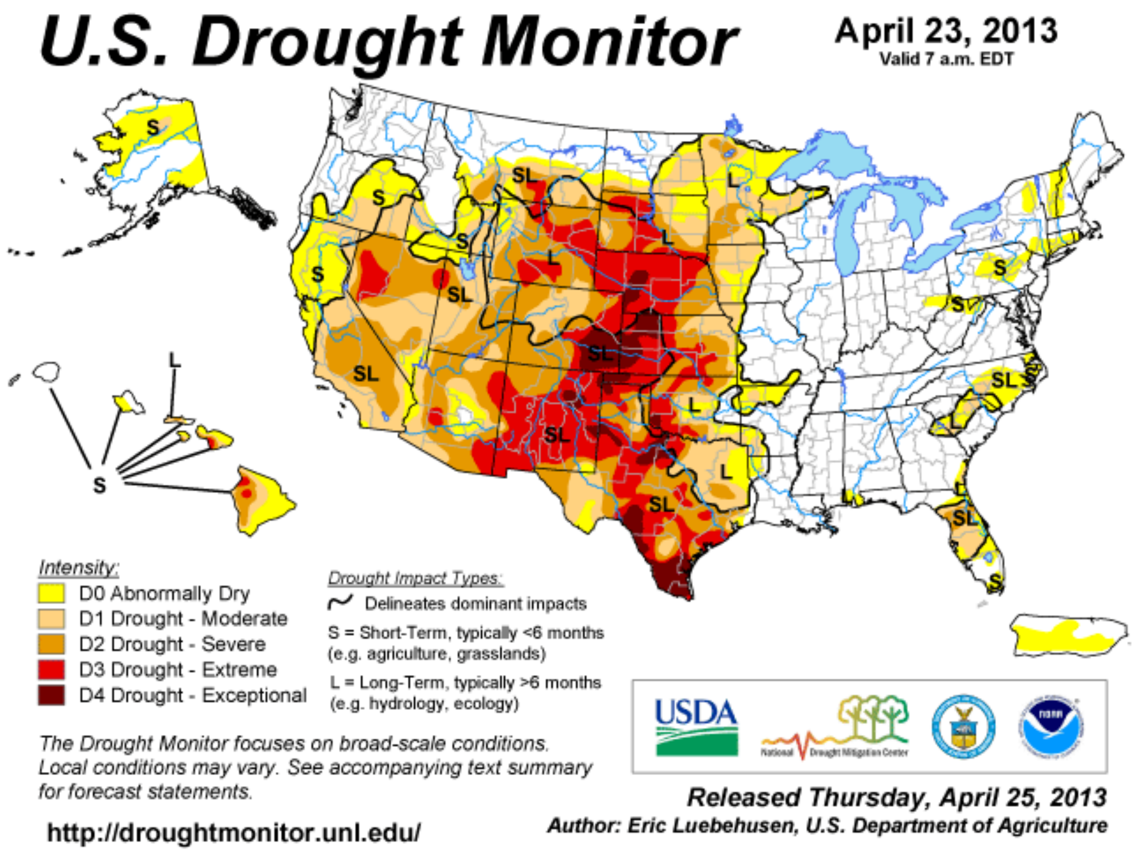
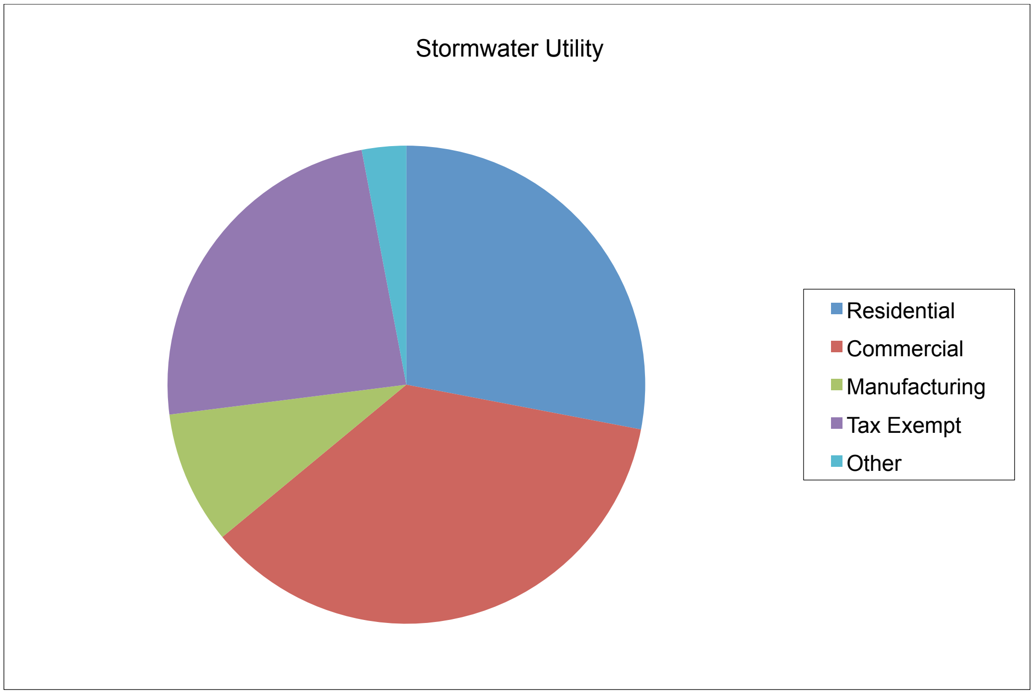


Figure 8: Example of Drought prognosis for United States (Luebehusen, 2013)



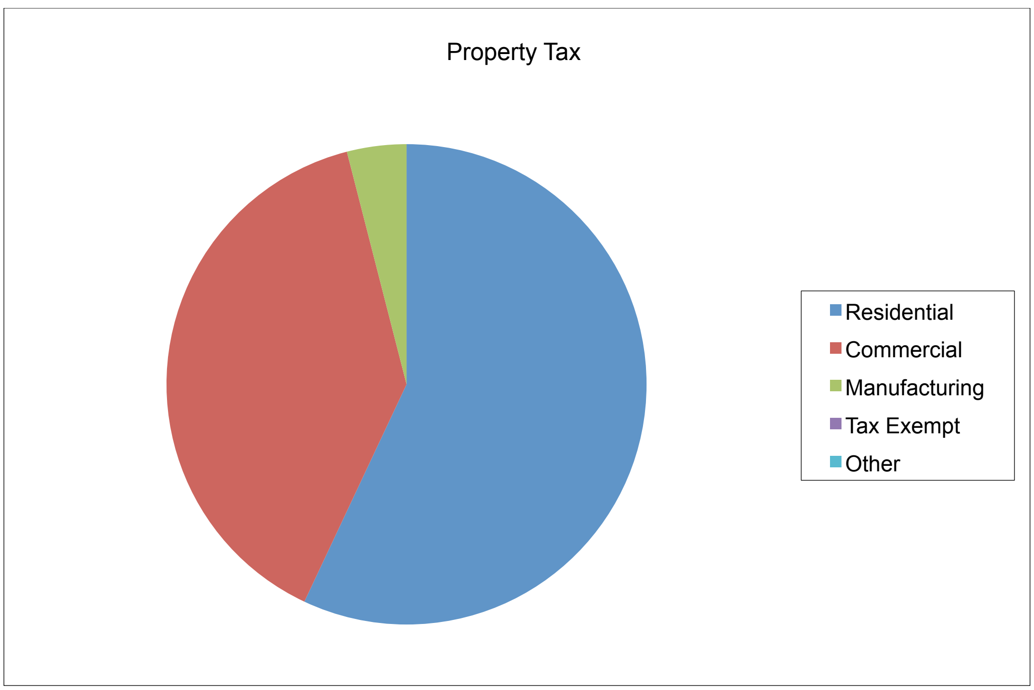


Figure 9. Stormwater Utility versus Property Taxes (AECOM, 2009)

Chapter 2 – Current Water Conservation Policy & Practice

The first chapter gave background information on water conservation technologies and the environment in which they function. Recognizing the context of water conservation in the United States, and assessing water conserving techniques; rainwater harvesting, xeriscaping, and permeable surfaces that are proven and available, the question of adoption and implementation emerges. While technologies and approaches for water conservation are known and proven, large scale adoption has not been achieved. If the technical ability to implement solutions is recognized, as described in Chapter 1, then an evaluation of current policy can provide insights into the lag in adoption of conservation measures.

Chapter 2 describes the policy incentives states and cities in the United States are using to encourage the use and implementation of water conservation strategies. The analysis highlights specific policies that have proven to be effective, and/or unique barriers that must be overcome. Among these barriers is the artificially low price of water, which is discussed. Chapter 2 also includes a discussion of an emerging policy mechanism, Stormwater Utilities and Credits, and how they can be used to encourage xeriscaping, pervious surfaces and rainwater harvesting. This analysis aides the design and creation of a generalized "Model Policy" in Chapter 3, that encompasses the best practices from around the country and defines a hypothetical legal framework for enacting these measures more effectively.

State Summaries

The following section presents brief descriptions and key policy highlights from example states. Table 1 presents a summary for each state so that policy comparisons can be made easily. Appendix A presents a complete set of data and information regarding the policy setting for each state, along with more detailed descriptions of the policies, opportunities, and barriers to implementation on a state-by-state basis. The set of best practices and recommended policy inclusions are derived from this set of information. The discussion section summarizes the key considerations for developing a model policy recommendation. Brief descriptions of existing policies for a set of example states are presented in this chapter, more detailed descriptions are included in Appendix A. The State Summary section seeks to display to key considerations, which in turn inform the model policy that is presented in a subsequent chapter of this document.

Texas

Texas has adopted a Advanced approach to water conservation strategies. It has some of the clearest and most direct statewide regulations on rainwater harvesting in the nation, and has gone further than most in creating formal direction through the TWDB.

<u>Policy Highlights:</u>

-Mandating that Home Owners Associations allow rainwater harvesting (RWH) systems.

-Mandating the State environmental Bureau to study and set guidelines for use of RWH.

-Enacting: Rebates, and tax incentives.

-Issuing $6 Billion of bonds for water source development, and including RWH as a potential source.

Florida

Florida is a leader in xeriscaping law. It was one of the first states to mandate that cities consider xeriscaping. It has set clear deadlines for landscaping design and outlined the process for landscape designers and inspection.

Policy Highlights:

- Requires every local government to consider enacting water-efficient landscaping regulations.
- The state hosts a water savings demonstration project for citizens to learn more about the benefits and possibilities of different practices.
- Developed a water saving videogame

Arizona

Arizona is the one of the Four Corners States that has come the furthest in legalizing the concept of rainwater harvesting. The City of Tucson is a leader in urban level policymaking.

Policy Highlights:

-50% of all municipal buildings landscaping water must be from RWH.

-Excellent public education materials

-Multi-family units can only have 10% high water use plants, the must rest be xeriscaped.

-Tax Credits

Colorado

Colorado is one of the most restrictive states in the union regarding rainwater harvesting. Colorado water policy Section 36-20-103, C.R.S., proclaims the state's right to all atmospheric precipitation that falls within its border; and said moisture is declared to be the property of the people of the state. However, Colorado is beginning to loosen these restrictions and has started some pilot programs for rainwater harvesting.

Policy Highlights:

-Recently began to change understanding of water rights to legalize RWH in a limited way.

-Lafayette,Colorado passed a xeriscaping ordinance

Georgia

Lack of water is a relatively recent problem for Georgia. However the historic drought of 2009 changed the regulatory environment drastically. Georgia set standards for harvested rainwater use, and has developed good public education materials.

Policy Highlights:

-Recently legalized use of RWH for non potable uses

-Good public education materials

New Mexico

New Mexico has very restrictive "Prior-Appropriation" laws. Meaning that a person cannot technically reduce the runoff water from their property. However, the state also does encourage rainwater harvesting and no cases have been prosecuted against harvesters.

Policy Highlights:

-Began to change legal concept of water to legalize RWH for homeowners

-Offering tax incentives, rebates, and direct subsidies. Albuquerque offers a $1.50 rebate per every 0.093 square meters (square foot) of passive rainwater harvesting landscaping

DISCUSSION

The key takeaways from the above highlights are that States are implementing a range of policies for distributed water conservation strategies. Evaluating these existing efforts provides a preliminary list of key policy considerations. For example, Texas serves as a model for the rest of the nation by passing a law forbidding rainwater harvesting restrictions by Home Owners Associations (HOAs). Other states should follow suit, and expand the law to encourage HOAs to embrace xeriscaping. This could easily apply to Historic Landmark buildings and Historic districts in cities, because in the past rain barrels were common features and most lawns were predominately native plants, with few impervious surfaces.

Southern Nevada Water Authority and the city of Albuquerque in New Mexico offer an exemplary turf buyback program. Through this program, residents who install turf receive “fast lane” permitting and projects that incorporate water wise features receive priority treatment. All new developments should have to get the permits, even if they don’t use them. Regular homeowners don’t want to deal with the hassle of permits, so having the builder do it saves significant headache for the homeowner and makes it much more likely that they will enact the savings measures, if all the work is done for them.

Tax credits or rebates for water systems are another effective manner of encouraging these conservation practices. And, policies that instill requirements for confirmed water supplies prior to development, as the state of Texas has done by requiring all new developments to show where they will get their water from, help incentive holistic designs with conservation from the start.   In addition the presentation of the use of Storm water credits is a relatively new practice that is providing an excellent incentive to homeowners to adopt water conservation practices.

Stormwater

Stormwater regulations and the increasing implementation of Stormwater Utilities by cities enables another avenue of adoption for practices such as rainwater harvesting, xeriscaping, and pervious surfaces. When a typical homeowner can save a significant amount of money from storm waters credits it increases the likelihood that they will implement Best Management Practices (BMPs). In addition, when designing regulations states and cities should focus on new development, because the costs at the time of initial construction are much lower than retrofitting an existing property. As a measure to encourage developers to include these water saving practices in their designs, governing agencies may offer expedited processing and inspection for building permits.

It can be difficult to get taxpayers to approve any measures that would increase their tax burden, however if framed as stormwater reduction practices it is possible that a more compelling argument could be presented to highlight the added value to public safety. In the wake of Hurricanes Sandy and Katrina homeowners across the nation have seen the destructive potential that floodwaters have, and understand that it is in their best interest to take any measures available to reduce the possible impacts of these destructive weather events.

Another option for gaining public support and encouraging conservation is to put a user-based fee system into effect. In the past, some communities have raised capital for their stormwater management with Ad Valorem property tax revenues, and simultaneously increased the tax burden on the property owners. Basing stormwater fees on estimated runoff, offers a more equitable solution to the average citizen and encourages those properties with high amounts of impervious surface to enact mitigating solutions. In addition, the more stormwater homeowners eliminate from their property the less there is for the city to handle.

Comparatively speaking homeowners have little impervious area, but are paying the majority of the property taxes in relation to other types of properties in the city, such as: commercial, government, and tax exempt entities. A stormwater utility system shifts much of the burden to commercial and tax exempt entities that have high areas of impervious surfaces. The graphic in Figure 9 presents before and after depictions of the re-allocation of storm waters costs in La Crosse, Wisconsin. Currently, single-family residential homeowners in La Crosse fund approximately 57 percent of the stormwater management costs, while commercial property owners pay 33 percent, and manufacturing property owners pay approximately 4 percent (AECOM, 2009). If a tax incentive program were implemented, then the burden on single-family homeowners could be reduced to 28 %, or approximately half of the current burden in the existing property tax system. The owners of tax-exempt properties, who previously paid nothing for stormwater services, now pay approximately 24 percent of the total cost of stormwater management. Under a modified tax incentive policy, the burden on commercial and manufacturing property holders increases slightly to fund 36 percent and 9 percent, respectively (AECOM, 2009).

Stormwater Utility Fees and Credits

The preferred fee methodology is the Equivalent Runoff Unit or ERU method is the most easily judged/enforced. It is based solely on the amount of impervious surfaces on the parcel of land. This is based on the high correlation between impervious surface and runoff, with the assumption that the more runoff the parcel will produce the more the owners should pay.   One ERU should be set at the amount of impervious surfaces on an average home. This methods advantages are ease of administration and general acceptance as a fair and standard method of billing.

Fees pay for the operation of the Stormwater utility to perform its function. However the Stormwater policy can also be designed so that homeowner's are encouraged to construct their own abatement technologies reducing the burden on the city system. An important part of any new stormwater policy is credits for homeowners who enact beneficial practices, such as rainwater harvesting, rain gardens, pervious pavements and xeriscaping. These credits are a "Win-Win" proposition: they improve the quality of water that reaches the storm system, they lower bills for homeowners, and they can help conserve water after the storm is passed.

Since stormwater credits are a societal benefit, the next question is to determine their worth. What percentage of a customer's bill should be able to be abated in this manner? Stormwater management costs fall into three categories: citywide administrative, quality, and quantity. While the Best Management Practices (BMPs) do improve the quality and reduce the quantity of stormwater entering the system, they actually increase the citywide administrative costs since they need to be verified and the applications need to be processed. Therefore a customer should not be able to get a credit for 100% of their bill by instituting these practices. The engineering firm AECOM in their report to the city of La Crosse Wisconsin, suggests a maximum possible credit of 80% of the bill (assuming the administrative costs are under 20% of the total cost). (AECOM, 2009)

Water Pricing

A key barrier to adoption of these water saving techniques is the low price of water. If the price of water were higher, consumers and policy makers would have a higher incentive to use it more wisely. To maximize efficiency of water use, utilities need to change their rate structures. Most current utility structures are based on a Cost Plus model. Where the utility determines it's price of providing service to their customers and a set rate of return, this is set as part of a “Rate Case” presented to the governing authority, be it state or local. The typical bill has two parts the service charge and the consumption charge. The Service Charge is the fixed service fee per billing period, regardless of consumption level. The Consumption Charge is the price for each unit of water consumed. Thus the utility earns a higher profit the more water it sells, which discourages efficiency measures, this is called “the throughput incentive” (NREL, 2009). This means that between rate cases the price charged per unit of water stay the same, however actual revenue varies as a function of sales. Decoupling seeks to eliminate the throughput incentive, encouraging efficiency, and allow utilities to adjust prices between rate cases, often automatically. It also reduces the volatility of customer bills as the price adjustments are always opposite of the direction of changes in consumption.

The unit price of water is traditionally determined based on the revenue requirements and the forecasted consumption. The utility’s actual revenue is a function of actual units sold. It is unlikely that the forecasted sales will match the actual sales used to set the prices during the rate case. There is often a span of several years between rate cases, so that for this long period of time, the utility could be earning more or less than it’s allowed revenue.

There are two main types of decoupling, deferral and current.

Deferral Decoupling: The utility holds the over or under collection of revenue in a balancing account. This becomes the allowed revenue in a subsequent period for distribution to customers, in the form of lowered or raised per unit prices.

Allowed Revenue =Last Rate Case / Revenue Requirement

Prior Period Over or Under Collection =Allowed Revenue –Actual Revenue

Unit Price =(Allowed Revenue +or- Prior Period over or under collection) / Expected units of consumption

Current period decoupling: rates are adjusted each billing cycle to ensure the utility collects the allowed revenue. This alleviates the need for a balancing account. Which enables the utility to have a fair revenue stream (as defined by regulators) that is related to providing water and customer service versus amount of water sold.

Allowed Revenue= Last Rate Case Revenue Requirement

Unit Price=Allowed Revenue/ Actual Units of consumption.

Beyond decoupling water rate structures are broken into four separate types:

Decreasing block rates- where the unit price of water decreases as the volume purchased increases. This structure involves a set of "price blocks" which are set amounts of water sold at a given price.

Uniform rates- where the price per unit of water remains constant, no matter how much or little water is used.

Increasing block rates- where the unit price of water increases as the volume purchased decreases. This structure involves a set of "price blocks" which are set amounts of water sold at a given price.

Seasonal rates- the unit price for water varies from season to season. Generally summer water rates are higher because water is scarcer in those months.

The optimal structure for conservation would be an increasing block, seasonal rate hybrid. Some key features of this rate would need to be a survival allowance of a base amount of water to protect the economically disadvantaged. Then steeply increasing block rates, while instituting a low service charge. This is an important aspect because if there is a high fixed service charge and low increases in the block rates the customer does not have the same incentive to conserve water. (Water Rate Structures in New Mexico, Western Resources Advocates)

Block rates represent the marginal cost or providing the next unit, so summer block prices for high users should be very expensive as those additional resources are hard to obtain. Similar to peak electric power. Plus the high users are often large estates or golf courses so it makes it an easier sell to the public that in essence they are subsidizing the activities of the rich.

Water Conservation Strategies by State							
		Allows The practice	Offers tax incentives	Offers rebates	Mandates Gov't buildings use the tech.	Mandates Commercial or Multi-Family use the Technology	Demo. Site
States	Cities						
Florida		Xeri,RWH	Xeri		Xeri		Xeri
Georgia		RWH					
Texas		Xeri,RWH	RWH	RWH			
New Mexico		RWH	RWH	RWH			
Arizona	Oro Valley	RWH					
	Phoenix	RWH	RWH				
	Tuscon	RWH	RWH			Xeri,RWH	
Utah							
Colorado	Lafayette					Xeri	
Nevada	Las Vegas	RWH	Xeri	Xeri			
s: Xeriscaping=Xeri ; Rainwater Harvester= RWH							

Table 1: Comparison chart summarizing policy strategies implemented in various states that can serve to inform the design of a model policy table

Chapter 3- Model Policy Design

Introduction

Using a comparative approach and aggregating the best management and policy practices from various states, a model policy document is presented. This model policy may serve as a guide to actual implementation and addresses some of the key weaknesses and needs for useful incentives to accelerate implementation the broader scale of conservation practices.

The model policy presented below draws from many different state policies to design and create the ideal environment for rainwater harvesting and xeriscaping practices. It encompasses many of the elements that have proven to be effective, and sets a beneficial legal understanding of rainwater as a water resource. This policy is for the fictional state of Absaroka, which was a union of several counties proposed in Montana, South Dakota and Wyoming in 1939 (Works Progress Administration, 1941). In the original proposal for Absaroka, the counties identified similar geography, environment- high plains grasslands, and economic base as the compelling reason for merging (Johnson, 2008) and identifying similar geographies may be a consideration for implementation of shared policies in states. Abrasoka was chosen as an example and reminder that all regions are shaped by their environment and policy makers should aspire to preserve and/or protect that local identity and resources.

ABSAROKA MODEL POLICY

Legal Framework of Rainwater

It being judged that water conservation is a worthwhile goal and a public necessity in this state, the legislature here fore proposes the following as a means of implementing these practices for the public good.

Though "The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belong to the public and are subject to appropriation and beneficial use as provided in this chapter" (A.R.S. § 45-141, 2010) rain water that falls on private property is the for the owner of that property to put to beneficial use. It will not be deemed to be pre-allocated.

Landscape Design- Xeriscape Policies

All landscapes shall be designed to use water efficiently and follow Absaroka-friendly landscape principles. The most current versions of *Absaroka Yards & Neighborhoods Handbook*, the Water Management Districts' *Water wise Absaroka Landscapes*, *Xeric Landscaping with Absaroka Native Plants* by the Association of Absaroka Native Nurseries, the *Absaroka Green Industries Best Management Practices for Protection of Water Resources in Absaroka*, and *Water Right: Conserving our Water, Preserving our Environment* published by the International Turf Producers Foundation shall guide landscape designs.

A landscape design certified by a landscape design professional shall be submitted to the

City/Town/County prior to landscape installation. Landscape design documents shall include a landscape layout and planting plan, and if irrigation is provided, an irrigation plan completed in accordance with the irrigation system design requirements of this ordinance. Landscape design professionals shall meet the licensing and certification requirements of this ordinance.

A deed restriction or covenant (such as a Home Owners Association of Historic District) entered after October 1, 2001, or local government ordinance may not prohibit any property owner from implementing Xeriscape or Absaroka-friendly landscape on his or her land.

New landscapes or substantially replaced landscapes shall meet the standards established in this section. Maintenance of all landscapes shall comply with maintenance standards of this section.

No permit shall be issued for building, paving, or tree removal unless the landscape construction documents comply with the provisions hereof; and no Certificate of Occupancy shall be issued until the requirements herein are met.

Landscape installers

Any person providing landscape installation services for hire is a landscape installation professional and shall meet the licensing and certification requirements of this ordinance.

Appropriate plant selection and location

Plant selection for landscaped areas shall be based on the plant's adaptability to the existing conditions present at the site, and shall consider the appropriate hardiness zone, soil type and moisture conditions, exposure to sun, and mature plant size. Plants selected must be suited to withstand the soil and physical growing conditions found in the microclimate of each location on a site with supplemental irrigation only during periods in which rainfall has been less than one inch in the last seven days.

Plants shall be grouped in accordance with their respective water and maintenance needs to provide for efficient irrigation. Plants with similar water soil, climate, sun, and light requirements shall be grouped together.

Plants prohibited by Absaroka Department of Agriculture and Consumer Services rule, Chapter 5B- 57 *F.A.C.*, shall not be used not be used for landscaping purposes.

Controlled plants named in Chapter 5B-57, *F.A.C.,* may not be used except as allowed by Chapter 5B-57, *F.A.C.*

Use of mulches

Mulches with a minimum depth of two inches shall be used in all planting beds.

Landscape certification

The completed landscape installation shall be certified by a landscape design professional that meets the licensing and certification requirements of this ordinance. When the landscape installation is part of a construction project, the certification is required before issuance of the Certification of Occupancy or its equivalent. The certification shall indicate that plants were installed as specified in the landscape design documents, that an irrigation audit has been performed, and that the audit confirmed that the system functions properly.

Landscape maintenance standards

Landscape maintenance shall be performed in accordance with the *Absaroka Green Industries Best Management Practices for Protection of Water Resources in Absaroka,* the University of Absaroka Cooperative Extension Service and with the *Absaroka Yards & Neighborhoods Handbook*.

Landscape maintenance professionals

Any person providing services for hire regarding any aspect of landscape maintenance including the application of fertilizer and pesticide is a landscape maintenance professional and must meet the licensing and certification requirements of this ordinance.

Demonstration landscapes

The City/Town/County shall provide demonstration landscapes at government facilities. Developers of single family residential subdivisions, PUDs, or any non-residential development, which include model buildings, shall provide demonstration landscapes at the site of at least one model building. Information about Absaroka-friendly landscape principles shall be provided at demonstration landscape.

Licensing and Certifications

1. In general

The license or certification specified in this section is required to provide the corresponding services regulated in this ordinance.

2. Landscape design professionals

Landscape design professionals shall include landscape architects licensed in the State of Absaroka, and landscape designers certified by the Absaroka Nurserymen Growers and Landscapers Association, the Absaroka Yards & Neighborhoods program or comparable program.

3. Landscape installation professionals

Landscape installation professionals shall include landscape architects licensed in the State of Absaroka, and landscape contractors certified by the Absaroka Nurserymen Growers and Landscapers Association, the Absaroka Yards & Neighborhoods program, or comparable program.

4. Landscape maintenance professionals

Landscape maintenance professionals shall include landscape architects licensed in the State of Absaroka, landscape contractors certified by the Absaroka Nurserymen Growers and Landscapers Association, the Absaroka Yards & Neighborhoods program, or comparable program, and holders of a valid pesticide license issued under Ch. 482 or Ch. 487, *FS,* (for pesticide applications only).

5. Irrigation design professionals

Irrigation design professionals shall include state-licensed plumbers operating within the limits of the Absaroka Building Code, professional engineers or landscape architects registered in the State of Absaroka, and irrigation designers certified by the Irrigation Association or Absaroka Irrigation Society.

6. Irrigation Installation and Maintenance Professionals

Irrigation installation and maintenance professionals shall include state-licensed plumbers operating within the limits of the Absaroka Building Code, and specialty contractors licensed by the City/Town/County and certified by the Irrigation Association or the Absaroka Irrigation Society.

7. Training

The professionals listed above must annually complete a minimum of 4 professional development hours (PDH) in principles of Absaroka-friendly landscaping from an approved training organization unless their license or certification requires a minimum of 4 PDH per year or 8 PDH over a two year period to maintain licensing or certification. 50 minutes of instruction equals a PDH.

8. **Public Education Materials**

State guidance to these practices can be found in the State-Friendly Landscape Guide, published by the State Department of Water and Environmental Management .Such as Absaroka or TWDB reports as good examples. Absaroka created a Xeriscaping Video Game and Public Access Television program.

Assessments

In order to fund the monitoring and administration of these programs the Declarant shall establish a State-Friendly Landscaping capital fund for the initial operation of the Committee by collecting a ______% of _______or $ _______ assessment from each Unit/Lot purchaser at the time of conveyance. Amounts paid into such fund shall not be refundable or considered as advance payment of regular, special or individual assessments.

4.2 Resale State-Friendly Landscaping Capital Contribution. Subsequent to the initial sale of a Unit/Lot, upon the conveyance of a Unit/Lot from one person to another, the purchaser of the Unit/Lot shall pay to the Association a "Resale Absaroka-Friendly Landscaping Capital Contribution." This sum shall be used and applied as a working capital fund, and shall not be refundable or applied as a credit against the Unit Owner's payment of Assessments. The Board shall set the amount of the Resale Absaroka-Friendly Landscaping Capital Contribution from time to time, but the amount of the Resale Absaroka-Friendly Landscaping Capital Contribution shall be consistent for the Units/Lots in the Development.

Absaroka Water Authority Turf Buyback

Pre-Conversion Eligibility

A. Authorization to Proceed: Before removing any lawn or water features, the application must be submitted to Absaroka Water Authority and the applicant must participate in an Absaroka Water Authority pre-conversion site review. Starting without Absaroka Water Authority approval will make the conservation ineligible.

B. Customer Eligibility: Areas to be converted must use water from an Absaroka Water Authority water agency or groundwater well within the Las Vegas Valley Groundwater Basin. The applicant's water and/or groundwater account(s) must be in good standing.

C. Qualifying Areas: Areas to be converted must be maintained lawn or permanently-installed outdoor surface of water. Conversions necessary to comply with any governmental code, law or policy relating to landscape design standards are ineligible.

Project areas previously declared ineligible by Absaroka Water Authority will not be reconsidered.

D. Minimum Project Size: At least 400 square feet of lawn and/or water surface must be converted. Smaller projects are accepted if they completely eliminate a lawn or water feature on a commercial, institutional or multifamily property or eliminate the front or back lawn of a single-family home.

Landscaping Requirements for the Converted Area

A. 50 Percent Living Plant Cover: At completion, converted areas must contain enough plants to create at least 50 percent living plant cover at maturity. The Absaroka Water Authority provides a list of plant cover values to be used regardless of the size of the plants at the time of inspection. In a single family residential project, you may instead request Absaroka Water Authority to determine whether the requirement is met by considering the entire plantable area of the front or back yard where the conversion occurred (in which case all plantable areas must meet the requirements of sections II(B) and II(C) of this program agreement and no lawn areas may remain).

B. Efficient Irrigation: If a watering system is used, it must be a drip irrigation system equipped with a pressure regulator, filter and emitters. The system must be free of leaks and malfunctions. Each drip emitter must be rated at less than 20 gallons per hour (gph). If part of a lawn is converted, the sprinkler system must be properly modified to provide adequate coverage to the remaining lawn without spraying the converted area (narrow lawn areas often waste water and should be avoided).

C. Surface Treatments: The converted area must be completely covered by a layer of mulch permeable to air and water. Common mulching materials include rock, bark, ungrouted flagstone or pavers and artificial turf manufactured to be permeable. Concrete or other impermeable treatments do not qualify. Living groundcovers qualify as mulch provided the individual plants are installed at sufficient density to assure 100 percent plant cover. If a weed barrier is used beneath the mulch, it must be manufactured to be permeable to air and water.

Terms of the Rebate

A. Important Timelines and Deadlines: Within 6 months of executing this agreement, you must complete your conversion and notify Absaroka Water Authority. Absaroka Water Authority will inspect completed projects for compliance. If the conversion fails inspection, you will be granted 60 days or the remainder of the 6-month period, whichever is greater, to attain compliance and notify Absaroka Water Authority. This agreement terminates one year after execution or upon incentive payment, whichever comes first. All applicant obligations, including submittal of properly executed covenant documents, must be fulfilled within the one year period or the rebate may be forfeited.

B. Incentive Amounts and Limits: $1.50 per square foot for the first 5,000 square feet and $1 per square foot thereafter, not to exceed $300,000 of approved payments per fiscal year. Limitations are per property, per owner, per Absaroka Water Authority fiscal year (July 1 through June 30). Checks are issued to property owners or their legally-appointed agent. Well users' rebates are limited to 2,500 square feet per fiscal year and are subject to availability of special funds. The Absaroka Water Authority may limit new agreements to manage program costs.

C. Requirement to Sustain the Conversion: Owner must accept a restrictive covenant and grant of conservation easement that requires the conversion to be sustained in perpetuity.

D. Other Responsibilities of the Applicant: Absaroka Water Authority enforces only the conditions of this agreement. The applicant is responsible for complying with all laws, policies, codes and covenants that may apply. Quality and appearance of the conversion is the responsibility of the applicant. Rebates may be considered taxable income.

http://www.Absaroka Water Authority.com/rebates/wsl_conditions.html

Rainwater harvesting

Water Related Exemptions: The following are exempted from taxes, sales and otherwise imposed by this state rainwater harvesting equipment or supplies, water recycling and reuse equipment or supplies, or other equipment, services, or supplies used to reduce or eliminate water use; including those of xeriscaping and pervious paved surfaces.

AN ACT relating to rainwater harvesting and other water conservation initiatives. 1. Subchapter A, Chapter 59, Finance Code, is amended by adding Section 59.012 to read as follows: Sec. 59.012.Loans for Developments that Use Harvested Rainwater. Financial institutions may consider making loans for developments that will use harvested rainwater as the sole source of water supply. SECTION 2. Section 447.004, Government Code, is amended by amending Subsection (c-l) and adding Subsection (c-3) to read as follows: (c-l) The procedural standards adopted under this section must require that on-site reclaimed system technologies, including rainwater harvesting, condensate collection, or cooling tower blow down, or a combination of those system technologies, for potable and non-potable indoor use and landscape watering be incorporated into the design and construction of: (A) each new state building with a roof measuring at least 10,000 square feet; and (B) any other new state building for which the incorporation of such systems is feasible; and (2) rainwater harvesting system technology for potable and non-potable indoor use and landscape watering be incorporated into the design and construction of each new state building with a roof measuring at least 50,000 square feet that is located in an area of this state in which the average annual rainfall is at least 20 inches. (C-3) The procedural standards required by Subsection (c-l)(2) apply to a building described by that subdivision unless Subsection (c-2) applies or the state agency or institution of higher education constructing the building provides the state energy conservation office evidence that the amount of rainwater that will be harvested from one or more existing buildings at the same location is equivalent to the amount of rainwater that could have been harvested from the new building had rainwater harvesting system technology been incorporated into its design and construction. SECTION 3. Section 341. 042, Health and Safety Code, is amended by amending Subsection (b) and adding Subsections (b-1),

19 (b-2), and (b-3) to read as follows:

(b) The commission by rule shall provide that if a structure

Is connected to a public water supply system and has a rainwater harvesting systems.

(B-1) The commission shall develop rules regarding the installation and maintenance of rainwater harvesting systems that are used for indoor potable purposes and connected to a public water supply system. The rules must contain criteria that are sufficient to ensure that: (1) safe sanitary drinking water standards are met;

(2) Harvested rainwater does not come into communication with a public water supply system's drinking water at a location off of the property on which the rainwater harvesting system is located.

(B-2) A person who intends to connect a rainwater harvesting system to a public water supply system for use for potable purposes must receive the consent of the municipality in which the rainwater harvesting system is located or the owner or operator of the public water supply system before connecting the rainwater harvesting system to the public water supply system. (B-3) A municipality or the owner or operator of a public water supply system may not be held liable for any adverse health effects allegedly caused by the consumption of water collected by a rainwater harvesting system that is connected to a public water supply system and is used for potable purposes if the municipality or the public water supply system is in compliance with the sanitary standards for drinking water adopted by the commission and applicable to the municipality or public water supply system.

RAINWATER HARVESTING. (a) Each municipality and county is encouraged residential, commercial, to promote rainwater harvesting at and industrial facilities through incentives such as the provision at a discount of rain barrels or rebates for water storage facilities. (Bbl. The Absaroka Water Development Board shall ensure that training on rainwater harvesting is available for the members of the permitting staffs of municipalities and counties at least quarterly. Each member of the permitting staff of each county and municipality located wholly or partly in an area designated by the Absaroka commission on Environmental Quality as a priority groundwater management area under Section 35.008, Water Code, whose work relates directly to permits involving rainwater harvesting and each member of the permitting staff of each county and municipality with a population of more than 100,000 whose work relates directly to permits involving rainwater harvesting must receive appropriate training regarding rainwater harvesting standards and their relation to permitting at least once every five years. Members of the permitting staffs of counties and municipalities not located wholly or partly in an area designated by the Absaroka Commission on Environmental Quality as a priority groundwater management area under Section 35.008, Water Code, whose work relates directly to permits involving rainwater harvesting and members of the permitting staffs of counties and municipalities with a population of 100,000 or less whose work relates directly to permits involving rainwater harvesting are encouraged to receive the training. The Absaroka Water Development Board may provide appropriate training by seminars or by videotape or functionally similar and widely available media without cost. (c) A municipality or county may not deny a building permit solely because the facility will implement rainwater harvesting. However, a municipality or county may require that a rainwater harvesting system comply with the minimum state standards established for such a system. (d) Each school district is encouraged to implement rainwater harvesting at facilities of the district.

Home Owners associations

This section does not:

(I) Restrict a property owners' association from regulating the requirements, including size, type, shielding, and materials, for or the location of a composting device, if the restriction does not prohibit the economic installation of the device on the property owner's property where there is reasonably sufficient area to install the device (2) require a property owners' association to permit a device described by Subdivision (I) to be installed in or on property

(A) Owned by the property owners' association;

(B) Owned in common by the members of the property owners' association; or (C) in an area other than the fenced yard or patio of a property owner; (3) prohibit a property owners' association from regulating the installation of efficient irrigation systems, including establishing visibility limitations for aesthetic purposes; (4) prohibit a property owners' association from regulating the installation or use of gravel, rocks, or cacti; (5) restrict a property owners' association from regulating yard and landscape maintenance if the restrictions or requirements do not restrict or prohibit turf or landscaping design that promotes water conservation. (6) Require a property owners' association to permit a rain barrel or rainwater harvesting system to be installed in or on property if:

(A) The property is: (I) owned by the property owners’ association (ii) owned in common by the members of the property owners' association; or (iii) located between the front of the property owner's home and an adjoining or adjacent street or (B) the barrel or system:

(I) is of a color other than a color consistent with the color scheme of the property owner's home; or (ii) displays any language or other content that is not typically displayed by such a barrel or system as it is manufactured; or (7) restrict a property owners' association from regulating the size, type, and shielding of, and the materials used in the construction of, a rain barrel, rainwater harvesting device, or other appurtenance that is located on the side of a house or at any other location that is visible from a street, another lot, or a common area if: (A) the restriction does not prohibit the economic installation of the device or appurtenance on the property owner's property; and (B) there is a reasonably sufficient area on the property owner's property in which to install the device or appurtenance.

5 SECTIONS 8. If the 82nd Legislature makes an appropriation to the Absaroka Water Development Board to provide matching grants to political subdivisions of this state for rainwater harvesting demonstration projects, the board shall, not later than December 1, 2012, provide a report to the lieutenant governor and the speaker of the house of representatives regarding the projects for which the board has provided grants, including:

(1) A description of each project; and

(2) The amount of the grant provided for each project. SECTION 10. This Act takes effect September 1, 2013.

Stormwater Policy

The Association shall not prohibit the following structures and activities including, but not limited to, cisterns, rain barrels, rain gardens, washing cars on lawns and other pervious surfaces, and the use of LID designs including, but not limited to, curb cuts and swales. Where possible, the Association and the Homeowner shall use low-impact development (LID) designs and practices that reduce stormwater runoff.

The Association and the Homeowners shall not sweep organic debris, such as leaves or grass, into storm drains or curbs. LID designs and practices that reduce stormwater runoff includes, but is not limited to, designs and practices creating curb cuts that direct the flow of runoff to depressional areas and designs and practices adding depressional areas such as rain gardens and swales, including pervious surfaces.

I. PURPOSE

The purpose of this Stormwater utility Credit Policy is to encourage actions by property owners within the City of La Crosse that 1) reduce stormwater flow and therefore stormwater quantity, or 2) improve stormwater quality by reducing total suspended solids (TSS) pollutant loadings. Credits to stormwater user fees are available when it can be demonstrated by the customer that a condition or activity on the property results in meeting 1), or 2), or a combination thereof.

II. CREDIT STRUCTURE

The City's stormwater management program essentially consists of three major components. Administrative NPDES permit compliance Stormwater quality improvements (up to 50% credit available)Stormwater quantity reductions (up to 50% credit available)the maximum credit that shall be available is 80% of the user fee. A maximum of 50% of the credit can come from stormwater quality improvements and a maximum of 50% of the credit can come from stormwater quantity reductions.

Stormwater credits are available to residential and non-residential properties. The City provides stormwater credits for the use and implementation of stormwater best management practices (BMPs) such as stormwater ponds, bio-retention cells, rain gardens, porous pavements, or rain barrels, etc. as provided in Section 23.08 Adjustments and Credits of the City Code.

III. RESIDENTIAL PROPERTIES

By definition, a residential property means any property developed exclusively for residential purposes with three or fewer residential housing units. Residential properties may receive a credit against their stormwater utility fee under one of the following conditions:

A. Rain Gardens

Rain gardens are depressions that collect rain water and/or snow water melt-off and infiltrate that water into the ground thereby reducing actual run-off to the City's stormwater system. Rain gardens are often vegetated with ornamental flowers or landscaping grasses but can also be simply grass or even rock lined depressions over soils that have high water infiltration rates. The key to a rain garden is that they trap and hold run-off that then infiltrates into the ground rather than running off into the City's storm sewer system. Multiple rain gardens are allowed from multiple roof downspouts on a single residential parcel. Credit is based on the total combined volume of all rain gardens serving that parcel. The following requirements apply to rain gardens

1. Rain gardens shall be designed and constructed following the criteria in the publication 'RAIN GARDENS A how-to manual for homeowners' (University of Absaroka - Extension publication number GWQ037 or Absaroka Department of Natural Resources

Publication number The publication is also available for review during normal office hours in the Public Works Department at City Hall.

The following credits apply to rain gardens:

Rain Garden Volume ..... Credit

185 cubic feet or greater... 80%

139 to 184 cubic feet 60%

92 to 138 cubic feet .... 40%Less than 92 cubic feet.....no credits

B. Rain Barrels

This credit is intended to facilitate the purchase and installation of rain barrels. Generally, a rain barrel is installed at the base of a roof downspout and collects run-off from roof tops for later use on the property. Water collected in such a way does not end up in the City's storm sewer system. More information on rain barrel use and installation can be found at www.rainbarrelguide.com.

The following criteria shall apply for rain barrels to be eligible for credit.

1. A barrel must have a minimum volume of fifty (50) gallons

2. The barrel must collect run-off from a rooftop that exceeds 200 square feet per barrel.

3. The barrel must be mosquito proof, complete with lid and screening of all access points to the barrel to let water in but mosquitoes and other vermin out.

4. The barrel must be capable of being drained from the bottom with complete drain down occurring at an interval of every 2 weeks or less.

The following credits apply to rain barrels:

Number of Rain Barrels Credit

8 or more 80%

7 70%

6 60%

5 50%

4 40%

Less than 4 barrels no credits

C. Engineered Best Management Practices (BMPs)

A credit may be granted to a residential parcel for any other Engineered device or practice that can demonstrate a reduction of the 10-year peak flow and/or the amount of Total Suspended Solids (TSS) leaving the parcel via the use of Storm Water Best Management Practices (BMPs). Credit is based on percentage reduction in flow or TSS from the existing impervious surface with no controls in place. No more than 50% credit can come from either reduction. Credits can be combined to account for a total reduction of up to 80% of the Stormwater Utility Fee. It is the applicant's responsibility to prove the claim. Documentation must be provided to the City for evaluation of the claim and must include drawings and calculations to support the claim that are stamped and signed by a licensed professional engineer, a licensed landscape architect, or a licensed professional hydrologist. Additionally, the applicant is required to submit a Maintenance Plan for the device that includes both the annual and long-term inspection and maintenance required to keep the Best Management Practice functional. This maintenance plan can come from the device manufacture or be developed by the licensed professional designing the BMP; however, the plan must include a required inspection schedule, criteria of what constituents a failure of the device based on the required inspection, and the remedy for each failure to restore the BMP back to function as originally designed and constructed.

IV. NON-RESIDENTIAL PROPERTIES

(including multi-family apartments larger than four (4) units)

By definition, the term 'non-residential property' means any developed property not defined as 'residential property', including but not limited to transient rentals (such as hotels and motels), multi-family apartment buildings of four or more dwelling units, commercial, industrial, institutional, governmental property, and parking lots. On-residential properties may receive a credit against their stormwater utility fee under one of the following conditions:

A. Stormwater Bio retention Cells

Bio retention cells is an infiltration device consisting of an excavated area that is backfilled with an engineered soil, covered with a layer of mulch, and planted with a diversity of woody or herbaceous vegetation. Stormwater directed to the device percolates thru the mulch and engineered soil, where it is treated by a variety of physical, chemical, and biological processes before infiltrating into the native soil. Typically, the contributing area to a bio cell is a parking lot or drive surface. The following criteria shall apply for bio retention cells to be eligible for credit.

1. The bio retention cell must be designed to Absaroka Department of Natural Resources Conservation Practice Standard 1004: "Bio retention for Infiltration".

2. The ponding depth shall be 12 inches or greater.

3. A designated overflow shall be provided to can safely pass runoff from events up to the 100 year, without causing damage to structures or property.

4. The bio retention cell to impervious surface ratio must account for all areas contributing water (including rooftops); however, only the drive surfaces of that contributing area are eligible for credit under this provision.

5. Credit for treating run-off from other surfaces with a bio-retention cell can also be applied for separately under Section IV(E) of this policy.

The following credits apply to Stormwater Bio retention Cells:

Ratio of Bio-cell Surface Area to Contributing Area Credit

<1:20 80%

1:20 to 1:28 70%

1:28 to 1:37 60%

1:37 to 1:50 50%

Less than 1:50 Submit under Section IV(E)

B. Permeable Pavement Credit

The permeable pavement credit is offered to properties that reduce the volume (quantity) of stormwater runoff to the City's system after constructing and installing porous pavements on their property. Porous pavement allows water to infiltrate versus running off. Various porous materials can be used so long as the following criteria are met.

1. Interconnected void space of pavement shall exceeds 15%

2. Initial porosity rate shall exceed 30 inches per hour

3. Base material consists of washed rock 1" to 3" in diameter

4. Native soil must be of NRCS soil classification "sandy loam, loam, silt loam, or clay". (Native soil of NRCS soil classification "coarse sand or gravel" requires 3 feet of engineered soil below the base coarse to protect ground water before permeable pavement is used.)

5. Documentation that permeable pavement is vacuumed or washed once every 6 months must be maintained for the life of the pavement.

The following credits apply to Permeable Pavement:

Thickness of Base Coarse Credit

11.5 inches or greater 80%

8.6 to 11.4 inches 60%

5.8 to 8.5 inches 40%

3 to 5.7 inches 20%

Less than 3 inches no credit

C. Disconnected Impervious Surface

Directing run-off from impervious surfaces such as rooftops, driveways, and parking lot into lawns and landscaping rather than collecting and transporting that water directly to the City Storm Sewers allows a portion of this run-off to be filtered and infiltrate; thus reducing both pollution and peak lows. Adequate green space in relation to the contributing impervious area is necessary to earn this credit. Credit is available for disconnecting impervious surfaces from the storm sewers given the following criteria.

1. The receiving green space must be the same size or larger than the contributing impervious area.

2. The slope of the receiving area cannot exceed 3 percent.

3. No more than 1000 square feet of contributing rooftop is allowed per downspout.

4. Runoff cannot travel more than 75 feet on impervious surface before reaching green space.

5. Downspout discharge must be at least 10 feet away from any impervious surface.

6. Site and contributing area must be graded to use the entire receiving area for infiltration (i.e.- avoid "reconnection" of run-off to an impervious surface)

7. Additional credit would be available for areas with storage such as a rain gardens, and would need to be applied for under Section IV(D) of this policy. The following credits apply to disconnected impervious surfaces: Disconnected drive surfaces (i.e.- parking lots and driveways) 70% Credit Disconnected rooftops or non-drive hard surfaces 45% Credit

D. ERU Adjustment

The Ordinance allows for a non-residential parcel to request that their ERU rate be reduced if "…some or all of the owners property does not discharge directly or indirectly to or through any form of conveyance system owned or operated by the Stormwater Utility at any and all run-off events." This adjustment applies to riverside properties that sheet flow to Waters of the State or properties adjacent to a river that have private storm sewer pipes discharging directly to the Waters of the State. Typically, these properties will be operating under their own NPDES permit from the State.

E. Engineered Best Management Practices (BMPs)

A credit may be granted to a non-residential parcel for any other Engineered device or practice that can demonstrate a reduction of the 10-year peak flow and/or the amount of Total Suspended Solids (TSS) leaving the parcel via the use of Storm Water Best Management Practices (BMPs). Credit is based on percentage reduction in flow or TSS from the existing impervious surface with no controls in place. No more than 50% credit can come from either reduction. Credits can be combined to account for a total reduction of up to 80% of the Stormwater Utility Fee. It is the applicant's responsibility to prove the claim. Documentation must be provided to the City for evaluation of the claim and must include drawings and calculations to support the claim that are stamped and signed by a licensed professional engineer, a licensed landscape architect, or a licensed professional hydrologist. Additionally, the applicant is required to submit a Maintenance Plan for the device that includes both the annual and long-term inspection and maintenance required to keep the Best Management Practice functional. This maintenance plan can come from the device manufacture or be developed by the licensed professional designing the BMP; however, the plan must include a required inspection schedule, criteria of what constituents a failure of the device based on the required inspection, and the remedy for each failure to restore the BMP back to function as originally designed and constructed.

V. STORMWATER CREDIT APPLICATION PROCESS

Property owners applying for a stormwater credit shall follow the credit application process applicable to there property type using the forms created by the City. Application forms are available on-line at www.cityofabsaroka.org and from the City Clerk.

Definitions

For the purpose of this ordinance, the following words and phrases shall have the meanings respectively ascribed to them by this section.

Automatic Controller. A mechanical or electronic device, capable of automated operation of valve stations to set the time, duration, and frequency of a water application

Best Management Practices (BMPs). A practice or combination of practices based on research, field-testing, and/or expert review, determined to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality, conserving water supplies, and protecting natural resources.

Ground cover. Low growing plants, other than turf grass, used to cover the soil and form a continuous, low mass of foliage.

Absaroka-friendly landscape. Quality landscapes that conserve water and protect the environment, and are adaptable to local condition. Absaroka-friendly landscape principles include planning and design, appropriate choice of plants, soil amendments, efficient irrigation, practical use of turf, appropriate use of mulches, and proper maintenance. *State guidance to these practices can be found in the State-Friendly Landscape Guide, published by the State Department of Water and Environmental Management.*

Landscapable area. The area of a site less the building area, natural water features, driveways, paved walkways, and hardscapes such as decks, patios, and fountains, but including areas set aside for the preservation of native vegetation, swales, retention and detention basins.

Low volume irrigation (Micro irrigation). The application of small quantities of water directly on or below the soil surface, usually as discrete drops, tiny streams, or miniature sprays through emitters placed along the water delivery pipes (laterals). Micro irrigation encompasses a number of methods or concepts including drip, subsurface, bubbler, and trickle irrigation.

Turf or turf grass. A mat layer of monocotyledonous plants such as Bahia, Bermuda, Centipede, Paspalum, St. Augustine, and Zoysia.

Chapter 4 - Conclusions

Distributed water conservation can provide significant benefits to overall water availability. There are many studies and estimates from examples in the United States that indicate conservation contributions can be significant if adopted at a large scale. This thesis completed an evaluation of distributed conservation strategies currently in use to analyze policy alternatives and assess the respective effectiveness. Using a comparative approach and aggregating the best management and policy practices from states with existing policies, a model policy document that could serve as a guide to actual implementation was developed. The model policy addresses aspects of the key weaknesses and/or needs for useful incentives to accelerate implementation on a broader scale of conservation practices.

Conservation strategies that employ distributed approaches, such as rainwater harvesting and xeriscaping, can effectively and economically augment water resource availability. Governance strategies that prioritize conservation mechanisms offer potential to significantly reduce demand, especially in the event of wide spread adoption. Analyses of xeriscaping and rainwater harvesting demonstrate that the benefits and risks of the two systems are largely dependent on the scale of adoption. Rainwater harvesting, xeriscaping, and permeable pavements are desirable practices because they: conserve water, bring typical American homes and their yards closer to their native hydrological basis, and reduce risks of stormwater runoff in urban settings. While the potential for conservation strategies to improve the overall water availability scenario in the United

States is understood, the benefit can only be realized if conservation practices are adopted at large scale

In general, distributed water conservation strategies are understood, proven, and in use in the United States. Yet, conservation strategies not implemented at large scale. Though conserving water is an admirable goal, the low price of water through much of the United States makes the added cost to implement systems difficult to justify for existing construction. Simultaneously, the need for implementation is increasing at rapid rates and governing agencies must seek effective measures to incentivize the use and incorporation of water conservation mechanisms in both new and existing structures. An evaluation of existing policies, and programs from various states in Chapter 2 serves to delineate current best practices.

The comparative evaluation of water conservation policies and best management practices evaluated in this study informed a set of recommended elements to inform the model policy design. The model considers key policy measures to serve as a guide to actual implementation.

By addressing key weaknesses in current policy implementation and identifying useful incentives, governing bodies and communities throughout the U.S. will be better able to accelerate implementation of water of conservation practices on a broader scale.

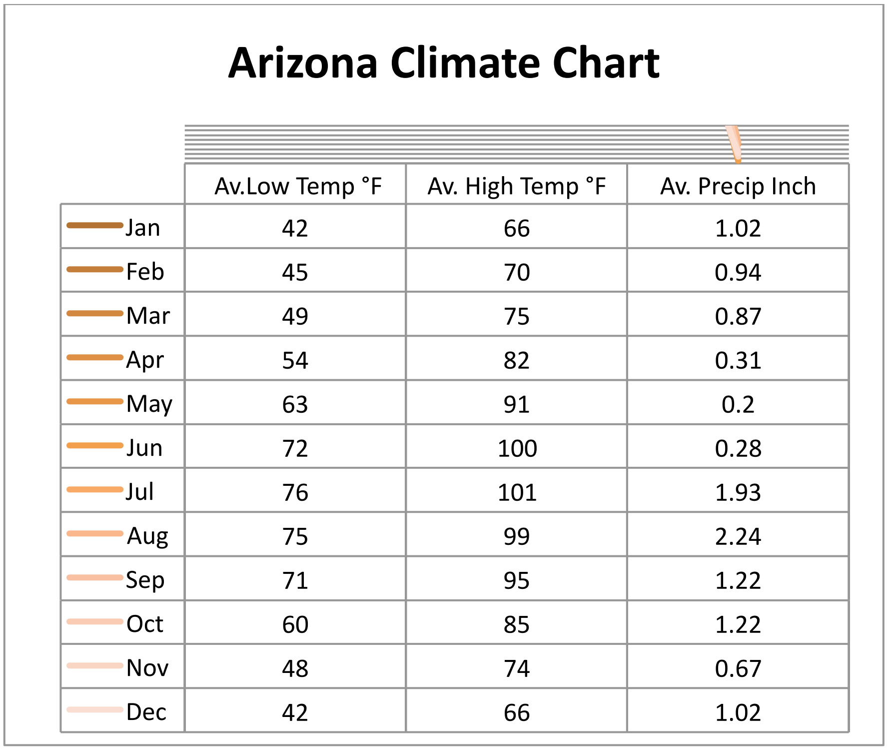
Successful policy implementation is important to water conservation practices because without it, approaches, such as xeriscaping and rainwater harvesting, would be limited to a small water conservation conscious segment of a community. Deploying distributed water conservation strategies, such as xeriscaping or rainwater harvesting, is difficult for individual property owners. However, it remains significantly more economic when compared with large-scale infrastructure options. The public benefits and reduced water use of these distributed conservation strategies, are worth pursuing. Therefore, policy initiatives must be successfully converted into practice across large segments of a population.

Appendix A: Laws and Policy Levers by Select States

Arizona

Arizona statutes on water usage have been interpreted to allow rainwater harvesting for the benefit of the state and no successful legal challenges have been made against the practice to date. In fact Tucson Arizona, with the passage of the nations first "municipal rainwater harvesting ordinance for commercial projects", is at the forefront of the continental U.S. rainwater harvesting legislation (Gaston T. L., 2010, p. 2). The ordinance calls for 50% of all landscaping water used on such properties to be provided via rainwater harvesting strategies.

Arizona's climate varies throughout the state, however overall Arizona faces arid conditions and rainwater harvesting is a vital step to help meet in water usage obligations.



	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	42	66	1.02
Feb	45	70	0.94
Mar	49	75	0.87
Apr	54	82	0.31
May	63	91	0.2
Jun	72	100	0.28
Jul	76	101	1.93
Aug	75	99	2.24
Sep	71	95	1.22
Oct	60	85	1.22
Nov	48	74	0.67
Dec	42	66	1.02

(Belsoft, p. 2012)

The Tucson program will also require that within 3 years of occupying the property the landscaping water will be increased from 50% to a 75% requirement

Laws. Arizona ideas of appropriable waters does not explicitly include tributaries but still allows all natural water channels as public domain and under the control of the government.

> The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds and springs on the surface, belong to the public and are subject to appropriation and beneficial use as provided in this chapter (A.R.S. § 45-141, 2010) (Gaston T. L., 2010).

Following Tucson, Oro Valley Arizona also issued a new water landscaping code. Under the new ordinance both commercial property and housing developments are required to use rainwater harvesting. The goal is to reduce water consumption by 6,784,150.20 cubic meters (5,500 acre-feet) per year (Gaston T. L., 2010). Further Tucson and Oro Valley are frequently cited in guides to rainwater harvesting in other communities (Gaston, 2010).

Tucson, Arizona enacted Xeriscape rules in 1990 mandating the practice for commercial and multi-family properties. Properties are allowed to have 10% of their property be an "oasis" using high amounts of water, but the rest must be strictly xeriscaped (Kunzler, 2004). Because of these landscaping requirements the authorities have set up classes for landscapers to teach them proper xeriscaping technique. It has had a noticeable impact; in 1974 average use per person was 776 liters (205 gallons) per person per day in 2004 (Kunzler, 2004).

Incentives. Tucson lends a good example to the effects of regulation and education on implementation of rainwater harvesting strategies. Tucson has developed formal regulatory and ad hoc requirements for rainwater harvesting for commercial sites and educational programs for residential, commercial landowners, and developers, which serve to emphasize the potential conflict between surface water rights and rainwater harvesting (Gaston, 2010). Tucson is making the most progress on rainwater harvesting policy through its landscaping. According to Tucson Land Use Code 1995, "the landscaping regulations require, "maximum use of storm water runoff for supplemental on-site irrigation purposes", further, "this regulation requires the capture of runoff from a development, in part through the use of rainwater harvesting techniques", which is a departure from "traditional storm water regulations, which typically call only for retention of runoff in basins to achieve balance between the water entering the sight and the water leaving the sight" (Gaston, 2010, p. 10).

Tucson also developed The *City of Tucson Water Harvesting Guidance Manual* specifically designed to educate developers, homeowners, and home builders to incorporate rainwater harvesting techniques on their property, which provides a "comprehensive review of design principles, the site design process, and common rainwater harvesting techniques at a variety of scales" (Gaston, 2010).

Taxes. Arizona's commitment to rainwater harvesting is affirmed by tax credits offered by the state for the development and installation of water conservation systems that include rainwater harvesting. The state offers a 25% off the installation cost of a water conservation systems, up $1000 as a tax credit as of January 1, 2007. Although $250,000 is set aside annually to fund the tax credit, since the start of the program most of the funds go unused. (Harvesting Rainwater)

Colorado

Colorado water policy Section 36-20-103, C.R.S., proclaims that the state's right to all atmospheric precipitation that falls within its border; and said moisture is declared to be the property of the people of the state (Colorado State; Rein, 2012). In addition, however, water must be appropriated according to priority, and many of Colorado's river basins are over-appropriated, and as such it is illegal to divert rainwater falling on your property expressly for a certain use unless you have a very old water right. “This system of water allocation plays an important role in protecting the owners of senior water rights that are entitled to appropriate the full amount of their decreed water right, particularly when there is not enough to satisfy them and parties whose water right is junior to them” (Colorado State, 2012). Colorado’s water appropriation rights not withstand, the overall climate offers a relatively good amount of rainfall, which arguably should be available for all.

Colorado Climate Chart

	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	15	43	0.51
Feb	19	47	0.47
Mar	25	54	1.3
Apr	34	61	1.93
May	44	71	2.32
Jun	53	82	1.57
Jul	59	88	2.17
Aug	57	86	1.81
Sep	47	77	1.14
Oct	36	66	0.98
Nov	24	51	0.98
Dec	16	44	0.63

(Belsoft, p. 2012)

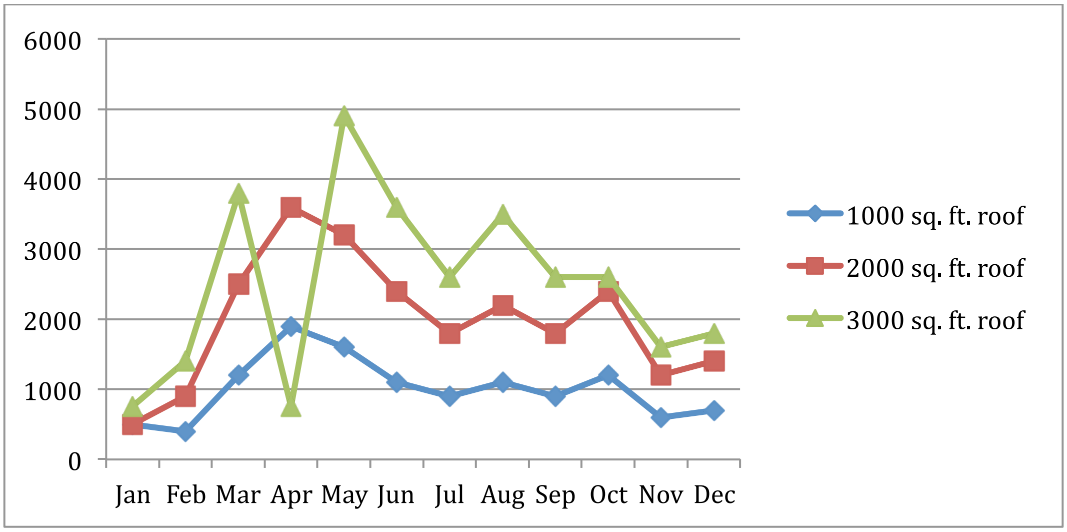
Laws. Water has always been an issue in Colorado, from complex water rights history to restrictions on harvesting rainwater that falls on a landowner’s property. It’s a vital resource that is invaluable to everyone, and it has to be protected for the benefit of future generations (FLXX, 2011).

Colorado has one of the most restrictive rainwater harvesting appropriation polices in the U.S.; and technically rainwater harvesting is illegal, water from a landowners property must not reach a natural stream or it is then considered a tributary. The policy, which has been in effect since 1928 is far reaching; it is understood to mean that water flow from private properties, including rainwater from rooftops, is classified as tributaries and is usurped by the senior water right holders (Gaston T. L., 2010).

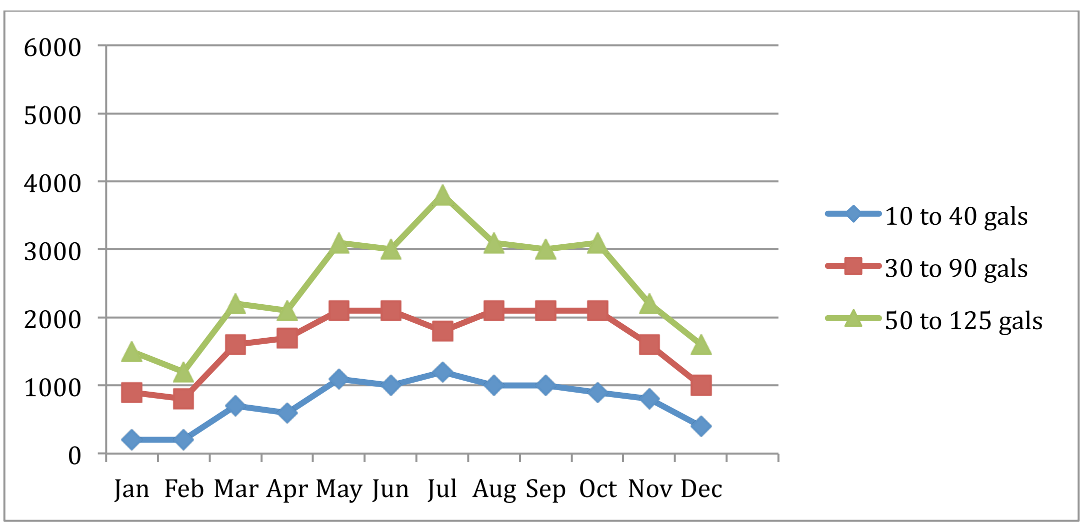
Gaston (2010) cites a Colorado case in June 2008 where a household living at 2.74 Kilometers (9,000 ft.) above sea level applied to the state for the “right to collect precipitation and was denied on the grounds that other water users had already locked up the right[s]” (Gaston, 2010). Such laws have forced those who do want to augment their water supply to hide rainwater harvesting systems in their backyards, even though the fines for exposures can be up to $500 a day.

As of July 2009, the Colorado Legislature has provided a way for rural Colorado residents to capture rainwater from their rooftops (FLXX, 2011). With the passage of the State of Colorado Senate Bill 09-080, Colorado residents that can obtain a well permit, or residents that have a current well permit, can capture rainwater for ordinary household purposes, such as fire, watering of poultry, domestic animals, livestock, and irrigation of lawns and gardens.

Whenever it rains, residents can now catch, store, and use the rainwater that falls every year, saving money, time, and the hassle of trucking in hundreds of liters of water annually (FLXX, 2011). This important, especially for rural property owners because a significant amount of water can be generated from only a thousand square meter or less of rooftop, which compared to usage, adds up to large saving for the property owner.



Monthly water harvest in gallons of water per Sq. foot of roof top (Colorado State, 2012)



Monthly water usage in gallons (Colorado State, 2012)

Although this is a very important bill for Colorado, the restrictions are still heavy and must be followed to the letter in order to avoid stiff fines:

1. The property on which the collection takes place is residential property, and

2. The landowner uses a well, or is legally entitled to a well, for the water supply, and

3. The well is permitted for domestic uses according to Section 37-92-602, C.R.S., (generally, this means the permit number will be five or six digits with no "-F" suffix at the end), and

4. There is no water supply available in the area from a municipality or water district, and

5. The rainwater is collected only from the roof, and

6. The water is used only for those uses that are allowed by, and identified on, the well permit (Colorado State).

Colorado established the Colorado Water Conservation Board (CWBC) as the sole entity for holding all water rights and maintaining in stream flows in 1973. These water rights were purchased or leased from senior appropriators. Following this a landowner may also purchase or lease from a senior appropriator, however, it is a high cost transaction in terms of money and time spent in lengthy courts process (Gaston T. L., 2010).

A CWCB study conducted in 2007 found that roughly 3% precipitation made its way to streams and groundwater, with a variation of 1% during dry years and 15% during wet years, disputing the point that all flowing water reaches the natural stream system and therefore any rainwater harvesting would deprive senior appropriators of their rights (Gaston T. L., 2010). In the aftermath of the CWCB study Colorado saw the passage of a few new House and Senate Bills permitting limited capture of precipitation for beneficial use. In addition House Bill 09-1129 launched a pilot project allowing for mixed-use developments and new residents to collect rooftop and impermeable surfaces precipitation for non-potable ordinary household use. The pilot will be evaluated in ten years and allow those in the pilot who wish to remain in the program to augment water supply based on the reports data.

After a severe drought, Lafayette, Colorado enacted a new landscaping law that said that developers must divide and specify their landscapes into high medium and low water zones. The very specific landscape ordinances are key; it sets a clear framework for what is and is not acceptable. This is very important when introducing a new concept to an area, so that people know exactly what they are dealing with (Kunzler, 2004).

Incentives. Despite the constant struggle with Colorado water rights laws, new initiatives are being presented in rainwater harvesting laws. In 2009, Pilot Project Bill HB09-1129 and Rooftop Precipitation Collection Bill SB09-80) started a state wide initiative for rainwater harvesting efforts for impervious surface and non-potable uses (Rein, 2012).

Taxes. Currently, since the idea and practice of rainwater harvesting is in its pilot stages, there is no tax incentive available on the state books.

Florida

Water issues in Florida are rather different than other places in the U.S., mainly due to its unusual climate. Florida experiences subtropical effects in the North and Central regions and more tropical effects in the South. Added to this is Florida's geographical position at the southeast tip of the North America continent, bordered by the Atlantic Ocean to the east and the Gulf of Mexico to the south, and directly in the path of tropical cyclones, which provides Florida with a very defined rainy season positing large amounts of rainfall from June through September each year.

Florida Climate Chart

	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	52	70	2.28
Feb	54	72	2.68
Mar	58	76	2.83
Apr	62	81	1.81
May	69	86	2.83
Jun	74	89	5.51
Jul	75	90	6.5
Aug	75	90	7.6
Sep	74	89	6.54
Oct	68	84	2.28
Nov	61	78	1.61
Dec	55	72	2.28

(Belsoft, 2012)

This abundant rainfall provides exceptional prospects for rain water harvesting and xeriscaping, however at this time most legislation is directed towards non-potable irrigation water supply. Florida Department of Environmental Protection (DEP) implemented a revised Stormwater Quality rule (Chapter 62-347, *Florida Administrative Code*), making storm water for irrigation a viable option for both residential and commercial development (State of Florida, 2012).

As part of Florida's water management efforts, the district, increasing contact between local governments, administers Department's storm water management programs and expediting development of local government comprehensive plans (State of Florida, 2012). Florida maintains five Water Management Districts (WMD): South Florida Water Management District, West Palm Beach, http://www.sfwmd.gov; Southwest Florida Water Management District, Brooksville, http://www.swfwmd.state.fl.us; Saint Johns River Water Management District, Palatka, http://sjr.state.fl.us; Suwannee River Water Management District, Live Oak, http://www.srwmd.state.fl.us; and Northwest Florida Water Management District, Havana, http://www.nwfwmd.state.fl.us.

(State of Florida, 2012).

Laws. The following are a list of the active legislation the State of Florida has created since 1977, in efforts to manage its water supply primarily for restoration and protection: The Florida Safe Drinking Water Act of 1977, which allowed the State to have primacy to adopt and enforce the Federal Safe Drinking Water ACT of 1976; The Water Quality Assurance Act of 1983 that addresses ground water or hazardous waste problems; specifically the need for proper treatment, storage, and/or disposal of all hazardous waste; The State Underground Petroleum Environmental Response Act of 1986 that further addressed the need to prevent pollution from leaking from underground storage tanks; The Surface Water Improvement and Management Act of 1987, that promised state funding to water management districts for remedy of previously contaminated water; The Marjory Stoneman Douglas Everglades Protection Act of 1991 that combines provisions for taxes, land acquisition, and regulations designed to address lawsuits concerning the impact of irrigation drainage in the region (Carriker & Borisova, 2009) Sections 125.568 and 166.048, F.S., require every local government to consider enacting water-efficient landscaping regulations by October 1, 1992. (Caputo, Kavouras, & Wang, No Date). In 1991 the Florida Legislature passed a law promoting and clarifying its favored water reduction strategies. Statute Xeriscaping. Section 373.185 require Water Management Districts to: Design and implement incentive programs to encourage governments to adopt Xeriscape ordinances; Adopt rules governing implementation of its incentive programs and governing the review and approval of local government.

Xeriscape ordinances assist local governments by providing a model xeriscape code and other technical assistance; and work with local governments to promote the use of xeriscape including the use of solid waste compost. (St. Johns River Authority, 1993) For example, all Florida government-building grounds must now be xeriscaped. Sections 125.568 and 166.048, require Boards of County Commissioners of each county and the governing body of each municipality to: Consider enacting ordinances requiring the use of Xeriscape landscaping by October 1, 1992; Consider promoting Xeriscape in areas under its jurisdiction. Provide public education; Offer incentives to local residents and businesses to implement Xeriscape. (St. Johns River Authority, 1993)

Currently, Florida relies on comprehensive regulations, to manage its water districts; as such monetary incentive and tax relief are not generally employed for rainwater harvesting. An increasing number of Floridians are taking it upon themselves to apply water saving techniques by employing the use of cisterns for potable and non-potable water catchments; finding useful models from other governments programs outside the State (City of Tampa Bay, 2007).

There is also the Southwest Florida Water Management District (SWFWMD), the City of St. Petersburg, and Pinellas County, Florida who have pooled resources together to produce the "Xeriscape It" Video game (EPA, Water Efficient Landscaping). The videogame enlightens people on the seven principles of xeriscape landscaping. Furthermore, through the collaboration, SWFWMD has sponsored numerous xeriscape demonstration sites, besides having a xeriscape garden it its headquarters in Brooksville. The garden showcases the variety of native and non-native plants that that are appropriate for xeriscaping. The garden is accessible for viewing by the public who are issued with a guide about it (EPA, Water Efficient Landscaping).

Besides, the South Florida Water Management District together with the Florida Nurserymen and Growers Association, the Florida Irrigation Society and the local business community have collaborated to produce the "Plant It Smart with xeriscape" television program that seeks to promote the use of xeriscape in the state. The program showcases an ideal Florida residential yard and how it can be retrofitted using xeriscape landscaping techniques to safe on costs, energy and time. The fact that the SFWMD is involved shows the level (Manning, 2007) .

Georgia

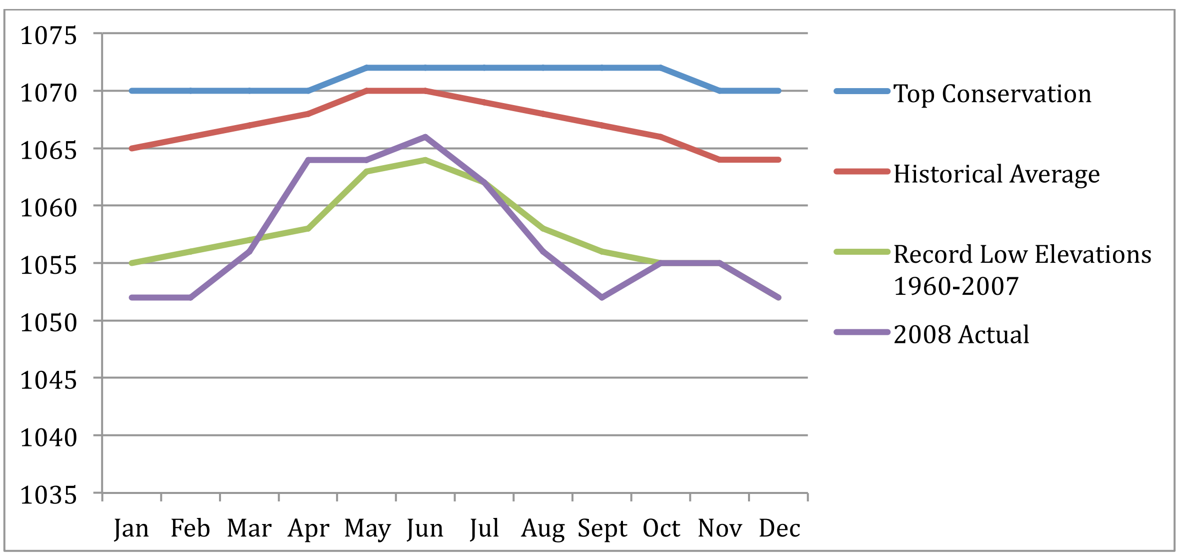
In Georgia, a Level 4 drought, “extreme drought,” with lake levels, stream flows and rainfall at or approaching the lowest levels in 100 years, was declared in 2007 for the northern third of the state. “The declaration was made because rainfall in this portion of the state was more than 50 centimenters (20 inches) below normal in 2007 and 2008 and stream flows were far below normal across the state” (State of Georgia, 2009).

The State of Georgia is facing an unparalleled water supply crisis. And the ongoing growth and prosperity of the region depend on finding new water resources as well as making the most effective use of current supplies. Fortunately, rainwater harvesting legislation designed to “address many water issues associated with population growth and urban expansion, such as reduced public water consumption, improved storm water quality and increased soil infiltration”, has been made available to Georgia residents for the benefits and potential of addressing the crisis (State of Georgia, 2009).

Georgia Climate Chart

	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	35	51	4.45
Feb	37	54	4.53
Mar	43	62	5.35
Apr	53	71	4.49
May	60	79	3.15
Jun	67	86	3.82
Jul	70	87	4.72
Aug	69	86	3.58
Sep	64	82	3.27
Oct	54	72	2.44
Nov	43	62	2.95
Dec	37	52	4.37

(Belsoft, 2012)



(State of Georgia, 2009)

Rainwater harvesting can offer significant relief to water challenges in the state. As such, the regional government and other organizations are reaching out to educate the citizens on the benefits public policy incentives to encourages rainwater harvesting, and promote high professional standards for the equipment and installation companies that provide it to businesses and homeowners.

As part of this effort, the State of Georgia has developed the *Georgia Rainwater harvesting Guidelines* to assist owners, building officials, design professionals, and contractors in the design construction, inspection, and maintenance of rainwater harvesting systems. Further, the guidelines help all parties effectively comply with the Georgia 2009Amendments to the 2006 International Plumbing Code (IPC) of Appendix I-'Rainwater Recycling Systems' (State of Georgia, 2009). The amendments maintain that "The use of rainwater harvesting systems in Georgia can serve to supplement non-potable water demands while maintaining and enhancing the quality of the environment" (State of Georgia, 2009). These codes where ratified on January 1, 2009 and allowed for the first time rainwater harvesting in certain capacities throughout the state. Other amendment, designed to further the rainwater harvesting applications, are also in under development.

Laws. The following legislation list is part of the amendments made to the International Plumbing code of 2006 in 2009, which allow residents to purse rainwater harvesting agendas.

301.3 Connections to the sanitary drainage system.

Exception: Bathtubs, showers, lavatories, clothes washers and laundry trays shall not be required to discharge to the sanitary drainage system where such fixtures discharge to an approved gray water system for flushing of water closets and urinals or for subsurface irrigation. Gray water may also be used for other purposes when designed by an engineer licensed in the State of Georgia and the authority having jurisdiction approves the system.

C101.1 Scope. The provisions of this appendix shall govern the materials, design, construction and installation of gray water systems for flushing of water closets and urinals. Gray water may also be used for other purposes when designed by an engineer licensed in the state of Georgia and the authority having jurisdiction approves the system.

C103.1 Scope. Gray water may be used for subsurface irrigation of landscape and shall be permitted by the local county health department in accordance with Georgia Department of Human Resources regulations as a separate onsite sewage management system. The local county health department requires permits and inspections.

C101.2 Health and Safety. Humans shall not contact gray water, except as required to maintain the gray water treatment and distribution system. Nothing contained in this appendix shall be construed to prevent the local government from mandating compliance with stricter requirements than those contained herein, where such requirements are essential in maintaining safe and sanitary conditions or from prohibiting gray water systems.

C103.1 Scope. Gray water may be used for subsurface irrigation of landscape and shall be permitted by the local county health department in accordance with Georgia Department of Human Resources regulations as a separate onsite sewage management system. The local county health department requires permits and inspections.

I101.4 Permits. Local authority having jurisdiction for permit requirements (Georgia Department of Community Affairs, 2009).

At this time Georgia is still working out the details to its incentive and taxation code regarding the retrieval and use of rainwater harvesting.

New Mexico

New Mexico supports rainwater harvesting technologies and to date has passed some of the U.S. most progressive rainwater harvesting policies; however, policy legislation is not very specific concerning prior appropriation rights, as such interpretation of rainwater harvesting rights and implications is difficult. "Historically, the need for regulation of surface water came first, as farmers, miners, and other users appropriated almost all the available surface water"…and many rights date from the late 18^{th} and 19^{th} centuries (Barroll, 2003,). Originally the territorial engineer was responsible for all regulations and changes in water rights and appropriations; this is now The Office of the State Engineer (OSE), which is responsible for delineation, interpretation, supervision appropriation measures, and distribution of all water rights legislation ((Barroll, 2003; Gaston, 2010).

The OSE evaluates water applications either of new use or the protections of old uses by senior appropriators. In this regard, New Mexico's primary water challenge is the amount of rainfall it receives per year in relation to its hot climate, which translates into larger amounts of water evaporation compared to other states.

New Mexico Climate Chart

	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	24	48	0.47
Feb	28	55	0.43
Mar	34	62	0.59
Apr	40	71	0.51
May	50	80	0.59
Jun	59	90	0.67
Jul	65	92	1.26
Aug	63	89	1.73
Sep	56	82	1.06
Oct	44	71	0.98
Nov	32	57	0.63
Dec	24	48	0.47

(Belsoft, 2012)

As such efficient water management is vital. "On average, New Mexico receives about 35 centimeters (14 inches) of precipitation a year, earning it the dubious honor of being the third most arid state in the nation"…with precipitation varying per year from 17.78 centimeters (7 inches) in the northwest to 50.8 centimeters (20 inches) in the mountains respectively (Harris, 2002, p. 7). Even with this small amount of annual rainfall New Mexico stills manages to cover all of its water obligation under current laws.

Laws. New Mexico has been regulating its water sources for many years with great success and failures. "Beginning in 1953, by statue, the State Engineer was required to grant applications that were filed seeking groundwater diversion for livestock wells and for household and domestic purposes, including the irrigation of up to one acre of non-commercial trees, lawns, and gardens" (NMSA 1978, § 72-12-1, 2003; in Brockmann, 2009, p. 9). The current statutes state that: New Mexico's statutory law concerning prior appropriation is:

> All natural waters flowing in streams and watercourses, whether such is perennial, or torrential, within the limits of the state of New Mexico, belong to the public and are subject to appropriation for beneficial use. A watercourse is hereby defined to be any river, creek, arroyo, canyon, draw or wash, or any other channel having definite banks and bed with visible evidence of the occasional flow of water (N.M. Stat. § 72-1-1, 2009) (Gaston T. L., 2010, p. 18).

Like other states in the Southwest, streams and waterways are public domain and can be appropriated by the state for beneficial use, still some restrictions on rainwater harvesting are exercised by the OSE:

> The New Mexico Office of the State Engineer supports the wise and efficient use of the state's water resources; and, therefore, encourages the harvesting, collection and use of rainwater from residential and commercial roof surfaces for on-site landscape irrigation and other on-site domestic uses.

> The collection of water harvested in this manner should not reduce the amount of runoff that would have occurred from the site in its natural, pre-development state. Harvested rainwater may not be appropriated for any other uses (NM OSE, 2004) (Gaston T. L., 2010).

Although some calculation appear to be required as to not "reduce the amount of runoff that would have occurred from the site in its natural use" no cases have been prosecuted in this regard. Rather, the statute perhaps is set in place as a precautionary measure. The OSE put forth a state in 2005 to clarify the current legislations:

> Most homeowners can install and use a rainwater harvesting system for landscape irrigation without public health and water rights concerns. For larger-scale commercial projects, it is a good idea to check with the local OSE Water Rights Division to make sure the project does not inappropriately affect rainwater runoff into a stream system, therefore impacting a public water supply (NM OSE, 2005) (Gaston T. L., 2010).

Incentives. State and local government financial support in the form of tax credits and incentivizes are also available for residents wishing to install water conservation technologies. In addition some local government branches are counseled to buy water conservation products at wholesale and provided them to residents at little or no cost (NMDTF, 2003) (Gaston T. L., 2010). How many, what was the effect? Some local municipalities have taken further rainwater harvesting steps. Santa Fe County Ordinance 2003-6 has required rainwater-tank and water-harvesting-earthwork fittings on new residential and commercial construction and Albuquerque offers a $1.50 rebate per every sq. of passive rainwater harvesting landscaping (Gaston T. L., 2010).

Taxes. Senate Bill 463 provides tax credit for industrial and commercial use, specifically given credits to new green buildings, for which rainwater harvesting counts towards LEED points.

Texas

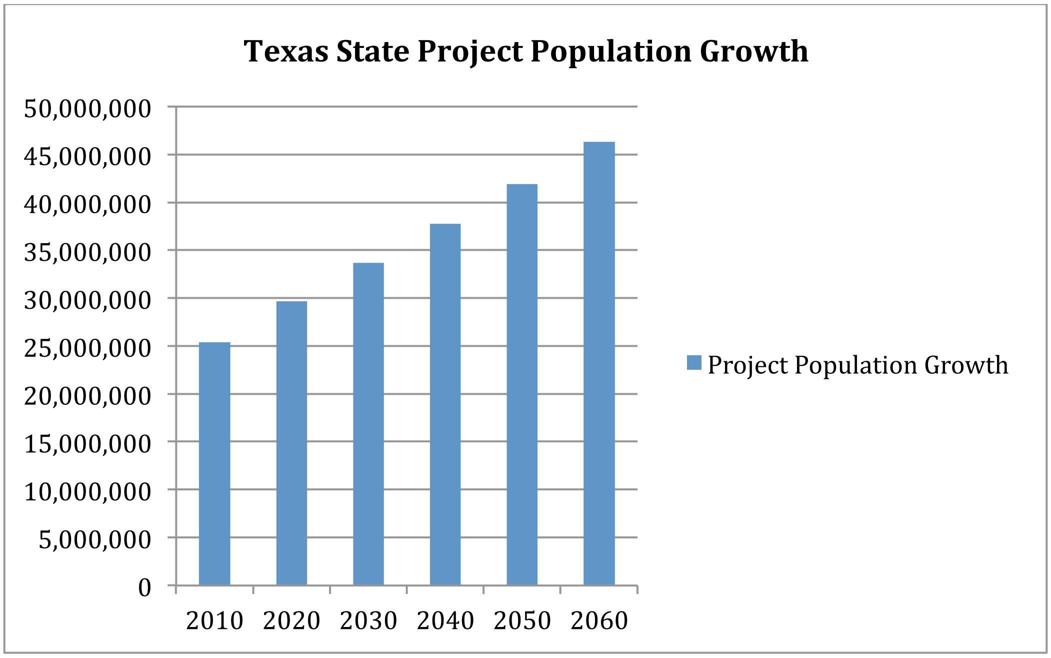
A quote from *A Plan for Meeting the 1980 Water Requirement of Texas* of 1961 reads, "If Texans cannot change the weather, they can at least, through sound, farsighted planning, conserve and develop water resources to supply their needs" (Texas Water Development Board, 2012). Fifty years later this same quote is acutely relevant and adorns the beginning of the Executive Summary of Water *for Texas 2012 State Water Plan*. At the time of the original quote Texas had just began recovering from its worst drought on record and for the first time started realizing that water scarcity would be its most important challenge for the future. On average Texas receive an adequate amount of annual precipitation to cover its water obligations.

Texas Climate Chart

	Av.Low Temp °F	Av. High Temp °F	Av. Precip Inch
Jan	36	55	1.89
Feb	41	61	2.32
Mar	49	69	3.15
Apr	56	76	3.46
May	65	84	5.31
Jun	73	92	3.94
Jul	96	96	2.44
Aug	96	96	2.17
Sep	89	89	2.64
Oct	79	79	4.65
Nov	66	66	2.6
Dec	57	57	0.47

(Belsoft, 2012)

Fast forwarding to the present, however, and the struggle to meet water demand still remains, and with a population boom set to double in size over the next 50 years, the challenge is perhaps even more pressing today.



Projected Population Growth for the State of Texas over the next 50 years (Texas Water Development Board, 2012)

According to current projection developed by 16 regional water planning groups, composed of members from agriculture, industry, business, river authorities, water utilities, power generation and others, this population increase will mean that Texas' water demand will increase by at least 22% or 27,136,600,817.04 cubic meters (22 million acre-feet) per year by 2060 (Texas Water Development Board, 2012). To meet the upcoming water demand the TWDB proposed a number of long-term sustainable project implementation and legislation.

Laws. Texas took serious legislative action to promote rainwater harvesting with House Bill 2430 in 2005. This bill directed the Texas Rainwater harvesting Evaluation committee, which was under the management of the TWDB to evaluate the potential for rainwater harvesting in Texas and come up with recommendations regarding: Setting minimum water quality guidelines for potable and non-potable indoor uses of rainwater; treatment methods for the potable and non-potable indoor uses of rainwater; and, ways rainwater harvesting systems can be used in conjunction with the existing infrastructure of municipal water systems, such as dual use plumbing systems; and additional ways that Texas can promote rainwater harvesting. This bill also mandated the Texas Commission on environmental Quality (TCEQ) to create health and safety standards for the use of harvested rainwater, as well as developing standards for collecting rainwater.(TWDB, 2006) The Texas Rainwater harvesting committee submitted their report a year later, while the TCEQ is still developing their standards.

Senate Bill 2, which was the follow up to the landmark Texas Water Senate Bill 1, stipulated rainwater harvesting equipment, such as storage tanks and catchment systems to be exempt from the state sales tax, under Section 4.25. Subchapter H, Chapter 151, of the Tax Code. (LCRA, 2009) Additionally the city of Austin offers a rebate of up to $500 for the cost of purchase and installation of a rainwater harvesting system. This is based on an assumption of $0.15/gallon of storage. In the past Austin provided discounted small-scale rain barrels for $45, and cash rebates for other rain barrels of $30. Austin also shared up to 50% of the cost for small pumps up to $100.(Krishna, 2004) This number may seem low when compared to the costs for a system can range from a few thousand dollars to upwards of $30,000, but the systems for use within the city would be smaller, and therefore less expensive. These rebates can go up to $40,000 for a commercial scale rainwater harvesting system.(Brunett, 2010)

Sunset Valley, TX has also enacted financial incentives particularly for large rainwater harvesting systems (1135 liters or 300 gallons +). They offer rebates towards the cost of rainwater harvesting systems, that fund 100% of the cost up to $500, and 50% of the cost thereafter, up to a total rebate of $3,500 per household. (Sunset Valley)

After the 2011 Drought Texas state and counties became very serious about water conservation. In November of 2011 Proposition 2 was passed which directed Texas Water Development Board (TWDB) to issue up to $6 billion of bonds to support local governments in developing water conservation technologies (Susan , 2012). Texas water codes are now designed to promote water harvesting projects:

> Texas Water Code 16.053(e)(5)(C) requires regional water planning groups to consider all potentially feasible water management strategies including those that develop new supplies. Water collected through rainwater harvesting could be considered to be a new supply and hence a potential water management strategy (Texas Rainfall Catchment, 2011).

Incentives. Local government, counties and municipals encourage even greater rainwater harvesting liberties through incentives such as water storage facilities rebates and discarded rain water barrels. Hays County offers: a $100 rebate in application fees for rainwater harvesting systems, allows developers to build on smaller size lots if they include a rainwater harvesting system, it does not include rainwater harvesting in property tax assessment, and provides financing assistance.(Krishna, 2004) School districts also encourage implementation of rainwater harvesting technologies (Texas Rainfall Catchment, 2011). In addition, property owners are restricted from stopping persons from installing a rain barrel or rainwater harvesting device with few exceptions (Texas Rainfall Catchment, 2011). Financially, Texas allows banks and financial institutions to make loans available to business and home owners that will use RHW methods as the sole source of their water supply.

Taxes. The Texas tax code is also in favor of rainwater harvesting, there is no sales tax on rainwater harvesting equipment and some governmental agencies exempt equipment from property tax (Tax code, SB2, 2001) (Texas Rainfall Catchment, 2011). State facilities are encouraged to provide incentives to finance retrofits with monies from reduced utility expenditures (Texas Rainfall Catchment, 2011). In places where average rainfall is less than 50 centimeters (20 inches), some government codes such as HB3391, require new government buildings to incorporate rainwater harvesting in structures over 50,000 sq. ft. and government code HB 3391, 2011, allows rainwater systems to be connected to public water supplies (Texas Rainfall Catchment, 2011)

House Bill 9 also allows for an innovative financing mechanism for Rainwater harvesting systems. It allows state facilities to enter into performance contracts with to fund the deployment of a rainwater harvesting system or xeriscaping with the money saved from the future reduced utility expenses. (HB9, 2003)

Despite Texas' best efforts implementation of rainwater harvesting systems is a slow process, as water conservation technologies are usually more often talked about than acted upon. Texas 2012 State Water Plan (Texas Water Development Board, 2012).

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