WATER

Yours, Mine & Ours

A user's manual produced by the Cow Creek Groundwater Conservation District

Dear Friends:

Water: Yours, Mine, and Ours was produced through an EPA Nonpoint Source Pollution project of the Cow Creek Groundwater Conservation District (CCGCD) known as the Water Stewardship Initiative. The purpose of this initiative is to heighten peoples' awareness about the importance of **Conserving**, **Capturing**, and keeping water **Clean**. The project produced several useful tools for educating people, including this manual. Ideally these new concepts will steer people away from their water waste habits and toward water stewardship practices. We refer to this as the New Water Culture. These tools are available from the CCGCD and include the following:

- *Water: Yours, Mine, and Ours* manual
- Water Stewardship Video Series that includes videos on Rainwater Harvesting, Drought Preparedness, and an Introduction to Water Resource Stewardship
- Power Point Presentations on Water Conservation and Rainwater Harvesting
- Brochures on Water Capture, Water Conservation, and Nonpoint Source Pollution

We hope you find *Water: Yours, Mine, and Ours* helpful and informative. If you would like to order any of the materials produced by this project, please contact:

Cow Creek Groundwater Conservation District
201 E. San Antonio Ave., Ste. 100
Boerne, Texas 78006
(830) 816-2504

In addition to distributing these materials, the CCGCD and its partners conducted an outreach and education program involving schools, businesses, municipal staff, homeowners and developers in the CCGCD. The outreach and education activities emphasize education priorities of the CCGCD and the Upper Cibolo Creek Watershed Partnership, funded also by an EPA Nonpoint source Grant.

The project partners included:

- United States Environmental Protection Agency
- Texas Commission on Environmental Quality
- Cow Creek Groundwater Conservation District
- Greater Edwards Aquifer Alliance
- Guadalupe-Blanco River Authority
- Cibolo Nature Center
- City of Boerne
- Upper Cibolo Creek Watershed Partnership
- Hill Country Alliance

If you have not already embraced the New Water Culture, get started today. Together we can secure a safe, clean, and abundant water future.

Sincerely,

Micah Voulgaris

Micah Voulgaris,
General Manager

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Introduction

Water: A Brief Hill Country Perspective

Milan J. Michalec, Director, Pct. 2, CCGCD

Beginning with the first humans who wandered through the land between the Edwards Plateau and the Coastal Plains of Texas, better known as the Hill Country, once abundant groundwater sustained the growth of this region. Here, countless artesian springs were the foundation of life for the native people over the course of thousands of years and fostered the expansive growth of permanent settlement beginning with the Spanish Missions of the 15th Century. It was this plentiful resource that attracted the early European settlers in the mid 1800's and fostered the settlements of Comfort, Boerne, Fredericksburg and New Braunfels. As the rains came and went, they left behind recharged aquifers from which springs flowed to keep the rivers and streams running clear and cool. It is this water moving through the Trinity Aquifer System that has nourished and sustained an ecosystem flowing from the headwaters of the Guadalupe River, west of Kerrville, over a course of more than 400 miles bringing freshwater to the Gulf Coast estuaries at San Antonio Bay.

"The top three conservation issues in Texas are water, water and water."

-Robert Cook, Exec. Director TPWD 2002-2008

The entire cycle begins with the first drop of rain that falls to the ground. It is good stewardship of our land that is the key to maintaining our water supply; a water supply inextricably interlinked as it moves both above and below the ground. All previous settlers of this region learned how the land and its resources, particularly water, could only support so many people, a certain quantity of livestock or a particular industry before its quality and a quantity would be impacted.

For all who choose the Hill Country today as their home (the new settlers), a call is being made for development that is designed to accommodate existing needs without compromising the ability of future populations to meet their needs. Future

Water: A Brief Hill Country Perspective - Continued

growth must be respectful of the unique local conditions and not sacrifice those institutions and natural resources that contribute so greatly to an enviably high quality of life. This includes preserving the natural scenic beauty, native wildlife, as well as the local historical and cultural heritage of this unique region. Then, as now, it is the clear running water from the seeps and springs of an aquifer system in balance that makes life in the Hill Country not just attractive, but perpetual. The recognition of these simple principles will serve us well as we strive to achieve growth that is sustainable for those who live in the Hill Country today and for those who will follow tomorrow.

Produced by the Cow Creek Groundwater Conservation District, this Manual challenges us to strive for one simple goal: live within our water budget. In the pages that follow we tell the story of our water resources in nature, and our over-reliance on the aquifer. In turn, we present a three-part strategy for taking better care of it: **Conserve it, Capture it, Keep it Clean.**

First we need to **Conserve** water, which means changing our Water Culture from one that takes and uses water for granted and freely wastes it to a New Water Culture that considers it priceless.

Second, we will need to **Capture** water by harvesting rain. By doing this, both homeowners and businesses can achieve water independence even during times of drought.

Finally, we need to keep our water **Clean**, which means protecting the water underground and the water in our reservoirs by minimizing pollutants in our yards, on our rangeland and on our streets. It also means that our wells and septic systems must be properly constructed and maintained. Keeping water Clean, whether it is stored in the ground, in a reservoir, a creek, or storage tank, protects our health, reduces unnecessary purification costs, helps the environment, and promotes a desirable, attractive place to live and work.

Obviously, just recognizing these steps doesn't solve our water crisis. We will need to take action- and that's where this Manual can help.

Who Can Benefit From This Manual

Just about anyone who cares about our water future, from kids to adults, can benefit from this Manual by gaining an understanding of bad water habits and adopting new conservation practices that can make a difference. Motivated landowners and developers will find sections on landscaping, low impact development design and rainwater harvesting particularly helpful. This information can help property owners capture more water on their site and reduce the quantity of runoff that leaves the property during storm events. It can also help them improve the quality of water that makes its way to nearby creeks and streams. What is important here is that everyone begins to Conserve, Capture, and Clean water while saving money, enhancing our springs, protecting our creeks, reducing the severity of floods, and leading the way to a water culture that respects and values water now and for future generations.

Contents

Water In Nature. Learn how our water is generated, transported, and stored in nature and where our water comes from in Kendall County. This knowledge can help us intelligently participate in water resource decision-making.

Our Impact on Water. Understanding how our homes, yards, neighborhoods, streets, and cities alter nature gives us insight into how we relate to the natural environment every day. This knowledge can help us work through water problems and develop sustainable solutions to our water crisis.

A New Water Use Culture. A vision for where we are going and what a new water use culture looks like can establish common ground for change and clarify long-term benefits as we prepare to Conserve, Capture, and Clean our water.

Protecting Our Quality of Life Through Conservation. This section provides an overview of how water connects with our quality of life, how minor changes in water use can make a big difference, and how creative and intelligent landscaping can be a powerful step to lower your water use while returning native beauty to your yard.

Rainwater Harvesting. This section provides an overview of rainwater harvesting, how to plan your own system, and recommendations on how to begin construction.

Where Does Our Water Come From?

If we want to know how the water actually gets to each of us, the answer is a bit more complicated because we need to understand how it is captured, stored and accessed.

Rain falling to the earth is captured and stored when it seeps through soils and openings in the bedrock into our aquifers or flows into our reservoirs. If it is stored underground in sufficient quantity, excess water emerges as spring flow, filling our creeks for wildlife, fish, and people or flowing into reservoirs. Water that remains underground or in reservoirs can be pumped, treated, and used as drinking water, for landscaping, agriculture, and industry.

Considering the pressure on these water sources, additional water supply options should be considered.

Many residents of Kendall County pump their water from the Trinity aquifer system. Boerne Lake reservoir captures rainfall and springflow, supplying a portion of Boerne's water demands. The remainder of Boerne's water demands are supplied by water from Canyon Lake in Comal County, distributed from the Western Canyon Water Treatment Plant.

Currently there is a revival of a traditional water capture and storage method called Rainwater Harvesting. Rainwater that is captured and stored can be accessed by homeowners and businesses. This will reduce dependence on surface and groundwater sources; as well as provide a clean reliable source of water, even during a drought. In fact, rainwater harvesting and storage is the most dependable source of water making it a centerpiece of a new water use culture and a key to water independence.

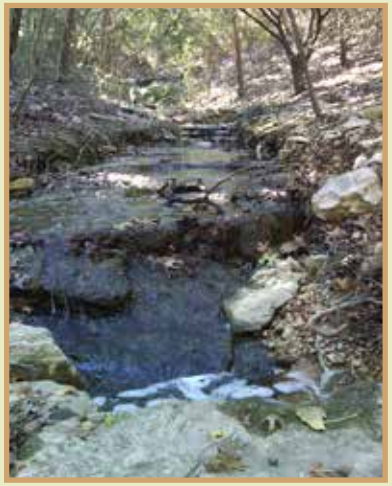


Photo by Milan J. Michalec

Photo by Cinde Thomas-Jimenez

2012 State Water Plan Message is a Simple One

In 1990, the Texas Water Commission (TWC), (the leading state water agency at the time) predicted that within 25 years water supply and water quality in the Texas Hill Country would be at risk. Less than a decade later in 1999, these predications came true - 16 years ahead of schedule. In 1999, authorities declared that the water in one of the largest and most important creeks in the region, Upper Cibolo Creek (UCC), was impaired for contact recreation. By 2012, UCC had appeared on the State's impaired waters list for the seventh time. In 2010-11 a record-breaking drought burned its way through Texas, launching a water supply crisis that continues to impact most of the state.

In serious drought conditions, Texas does not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises."

-Edward G. Vaughan, Chairman
Texas Water Development Board

There are two trends in Kendall County, largely beyond our control, that suggest this water crisis will only deepen into the future. First, Kendall is one of Texas' high growth counties, the reality is that more water users will continue to move here. The second trend involves the climate of Texas. Our climate has been described by State Climatologist Dr. John W. Nielsen, in respect to Texas' size, total land area of 261,914 square miles and its geographical location. "Its size and geographical location combine to give it a diverse climate, with a wide variety of local and regional climatic influences" (*The Impact of Global Warming on Texas*, Chapter 2, Gammon, 2011). With regard to a position on climate change, Dr. Gammon notes that the State of Texas lacks an official position on climate change, (*Climate Change*, TAMU, 2013). Furthermore, the Texas Water Development Board (TWDB) recognizes that scientists on the Intergovernmental Panel on Climate Change believe a warming trend is "unequivocal" (IPCC, 2007). In response, the TWDB states "While the TWDB is not endorsing this panel's conclusions, additional challenges, primarily to agriculture could arise if the climate of Texas becomes permanently warmer" (*Water For Texas 2012 State Water Plan*, page 231). Though we may not be able to predict a future warmer climate, we do know the present and past climate has been variable and punctuated by droughts, some with devastating consequences due to their intensity and duration.

Climate uncertainty and the population growth make the water challenges of today more daunting than those we faced in 1990. If we do nothing to change our water use culture, wells could run dry or produce only water of poor quality. Potable water would become more expensive due to treatment costs or the cost of transporting it if it must be imported.

Are we doomed to a future of water shortages and paying astronomical prices for water? If we resist the idea of moderating our water use or simply face our future with a "deer in the headlights" response, many would answer "Yes". We are accustomed to ready access of clean, cheap drinking water. Many of us don't want to think about how much water we use.

But a new water use culture does not mean a water shortage culture. It simply refers to a culture that values water enough to capture it and use it more efficiently. Despite the severity of our water crisis, the way out of crisis toward sustainability is simple and effective as we will see in the next section.

Conserve, Capture, Clean - A Powerfully Simple Solution

While prospects for our water future are cause for concern, there is one idea, if embraced by everyone, that gives rise to hope:

We all share the same water.

From this idea flow powerful solutions that can turn this water crisis into a clear call for community action. The intensity of this could rival the collective purpose we garnered when we set out to the moon, faced tyranny in WWII, or dug our way out of the Great Depression. These solutions start with changing one's mind about water. Just knowing that all water is in use by something, somewhere at some time can transform ones thinking from "our supply is unlimited" or "if I can afford it, I can use it" to "water is a precious, valuable and finite resource" and "maintaining our quality of life depends on conserving water."

While prospects for our water future are cause for concern, there is one idea, if embraced by everyone that gives rise to hope -

We all share the same water

Unlike the 1990's when TWC warned us of our water risks; we now know more about our water, how it is stored and how much we use. We also have better tools to practice for securing a safe, low cost, and sustainable water supply for everyone, long into the future. This Manual is one such tool.

Developed by the Cow Creek Groundwater Conservation District (CCGCD), this Manual is designed to help people adopt practical techniques for reducing water usage and harvesting more water for their own use. What is striking about these techniques is that there is really nothing new about them. Our forefathers used many of these practices such as water conservation and rainwater collection before the introduction of powerful groundwater pumps that made us all think water is unlimited. Our need to return to these conservation practices means the days of surplus water are a thing of the past.

Will it take long to adjust our course? Since it took us decades to get into this situation, you might think it would take as long to get out. But some of the most effective solutions don't cost anything and can be implemented immediately. We can water our lawn less or shut off the water while we brush our teeth or shave. Simply put, stopping water waste is the first step in addressing this emergency situation. It means practicing conservation by changing our behavior and using less water starting right now. It also means capturing more water when it rains, and ensuring that our water is clean.

Photo by Ryan Bass

Conserve, Capture, Clean - A Powerfully Simple Solution - Continued

Several immediate no cost and low cost solutions that decrease our water use are presented in detail in this manual. You will also find solutions that can move us from conserving a dwindling water supply, to generating more water through rainwater harvesting. Today we are fortunate to have modern technology which enables us to quickly install water saving devices and efficient rainwater harvesting systems. The combination of conservation and harvesting, along with ensuring the water we do have is clean, can be a centerpiece for community action; a clear call that reflects pride in our heritage, respect for ourselves and our neighbors, and a deep respect for the earth and its resources. No one person can solve our water crisis. Together we ensure a prosperous future.

Photos by Paul Barwick

Patrick Heath Public Library Stormwater Detention Basin & Bioswales

Paul Barwick, ASLA, Hon. TSA

It is best to capture rainfall where is falls, keeping it on site and getting it into the ground as quickly as possible so flooding and erosion can be minimized and groundwater recharge maximized. To implement this strategy a series of depressed vegetated median islands and open space areas were designed to capture the first flush of stormwater pollutants from roadways and parking lots. This water is then conveyed to a stormwater detention basin, to hold and slowly release stormwater runoff. In addition, once the rainwater tanks are full the excess rainwater from the roof is directed to the basin and gradually released. Finally, a variety of permeable surfaces such as mulched plant beds, decomposed granite paving, concrete pavers with sand joints, and turf grass areas were installed to allow for greater water infiltration.

Photo by Janet Thome

Bust the Water Myths

If you have gotten this far in the Manual, you are probably someone who wants to take action and be part of the New Water Use Culture.

As indicated earlier, an effective solution to our water crisis requires that we all change our attitudes and beliefs about water. There are numerous myths (or mis-truths) about water and its availability that influence how we use water. Many myths are untrue and are the source of water use habits that unnecessarily waste water and damage the quality of our water supply. At the heart of a New Water Use Culture is a commitment to become a water steward by changing our own beliefs, attitudes and behaviors, and by educating people who just plain have it wrong. This means examining myths, sharing factual information about water, and "busting" myths if they are untrue. This section presents several common water myths and offers fact-based responses that you can use when people express these myths to you.

Take a look at these myths. Think about how you might respond and then check the response provided.

Myth **We might be in drought now but the rain will come back, not to worry.**

Fact The last several years have included some of the driest years recorded since we have started collecting rainfall data. Drought is one aspect of changing climate while another could be higher rainfall rates. In the Texas Hill Country, climate fluctuations are becoming more extreme.

Myth **We've always had plenty of water here. Running out is a myth created by the government to tax and regulate us.**

Fact The Cow Creek Groundwater Conservation District (CCGCD) scientifically measures well levels using manual and automated sampling technology. It uses these measurements to determine how quickly water is being used and alerts water users when levels are getting dangerously low. At lower levels, wells can begin to dry up or produce poor quality water. To notify users that levels are dropping, the District implements a drought stage notification system that ties pumping restrictions and water use to aquifer levels. These pumping restrictions are enforceable by law and violations come with fines.

Bust the Water Myths - Continued

Photo by Milan J. Michalec

Photo by Milan J. Michalec

Myth **If I pump my well dry, it will fill back up in the next rain.**

Fact When a good quality well is full, it produces good water. The lower the water level in the well, whether it is due to over pumping or just lack of rain, the more likely it is that poorer saline water from deeper aquifer layers will seep into the well. In some cases, once the poor quality water becomes established in the well, it can permanently degrade the quality of the well water. The cure for this is expensive and can range from treating the water with a softening system to drilling a new well.

Myth **Conserving water requires too much sacrifice, causing my family and I to suffer.**

Fact People generally use more water than they need. So in many cases, small changes in behavior such as making sure you have a full load before running the dishwasher and washing machine can save lots of water. As a matter of fact, installing low flow plumbing fixtures requires no sacrifice at all because it allows you to conserve water without changing any water use habits.

Myth **I can use as much water as I can afford to pay for.**

Fact Think of our water supply as one giant “common cup”. This cup includes all of our rivers, reservoirs and aquifers. Even if you are on a private well,you have only one of thousands of “straws” pumping up the water. Many homeowners just like you have a straw in the “common cup”. Some people can afford to pay more for using additional water, but this does not mean they are using their own supply. The fact is, they are using everyone’s water. Think of the common water cup like Sunday communion. You wouldn’t drink all the wine from the common cup leaving none for the other parishioners would you?

Bust the Water Myths - Continued

Myth **If my well runs dry, I can just drill deeper.**

Fact Wells drilled for residential use pinpoint the location of the best drinking water available at a particular geologic depth. In some cases drilling deeper is an option, but an expensive one. It does not guarantee the water in the deeper layers will be of the same quality as the water you are currently pumping. If you have a reliable well that is producing good quality water, don't take it for granted.

Myth **If I conserve water, I will have a dead, lifeless yard.**

Fact Most nurseries in the Texas Hill Country will include a wide range of drought tolerant plants that thrive during water shortages, with minimal supplemental watering. Choosing these plants and implementing landscape designs such as xeriscaping will enable you to enjoy a beautiful yard all year. You will not run the risk of high water bills, or lose plants that are not suited for this part of Texas.

For more myth busting information visit: www.hillcountryalliance.org/HCA/Home

Photo by Milan J. Michalec

Photo by Chase Fountain, TPWD

Cow Creek Groundwater Conservation District

In the 1990's, state water authorities declared the Texas Hill Country a Critical Groundwater Area and formed the Hill Country Priority Groundwater Management Area (PGMA). This designation meant that within 25 years (by 2015), the area would experience critical groundwater problems related to quantity and quality. Twelve years after the State designated the area a PGMA, the CCGCD was confirmed as a permanent groundwater district.

The CCGCD was created for the purpose of conserving, preserving, recharging, protecting and preventing waste of groundwater from the aquifers within Kendall County.

To accomplish these goals, the District:

- Registers all wells located in the District (more than 7000 wells as of 2013).
- Permits all non-exempt wells (any well not used for domestic or livestock use).
- Adopts and enforces rules related to permitting, registrations, well construction and completion standards, well spacing, waste, groundwater production limits, drought management, and water quality.
- Monitors at a minimum 40 wells at least bi-monthly.
- Inspects all new wells drilled in the district.
- Participates in local and regional planning.

Declaring a change in Drought Stage is serious business and the District does not take drought stage declarations lightly. The District does not want to restrict water use if the water supply can handle it. The problem is that the District has to consider both current use and projected use. To fully understand and predict projected use and the consequences of this use on the aquifer, the District sits at the center of a regional water planning process that sets Desired Future Conditions (DFC) for our water supplies. These DFC's allow the District to establish a goal for water use that can ensure our aquifers' ability to supply us with water. By understanding what we want our water future to look like and what our potential for growth is in the area, we can better anticipate the water use habits that people will need to adopt in order to live here sustainably.

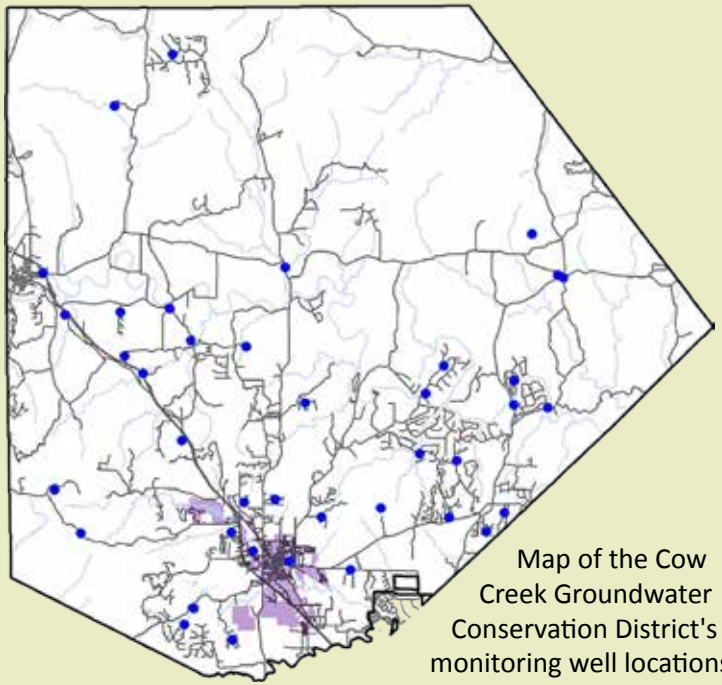
One thing we know for certain is that any changes that take place in our aquifer will most certainly involve less water for more people. Reducing the severity of changes to the aquifer by encouraging the elimination of excessive water use and wasteful habits is one of the most important and visible roles of the Cow Creek Groundwater Conservation District.

Our Water Management Network

The Edwards-Trinity Aquifer System extends over a wide area of central Texas and southeastern Oklahoma. The three major aquifers that constitute the system include: the Edwards-Trinity Aquifer; the Edwards Aquifer, and the Trinity Aquifer. In general, the water in the upper layers of these aquifers is shared, while deeper water is confined to the formation.

The CCGCD monitoring well network includes at least 40 monitoring wells that record water levels across Kendall county. The CCGCD website includes an interactive map that provides access to well water levels that are reported bi-monthly. Information can be found at:

www.ccgcd.org/?page=levels



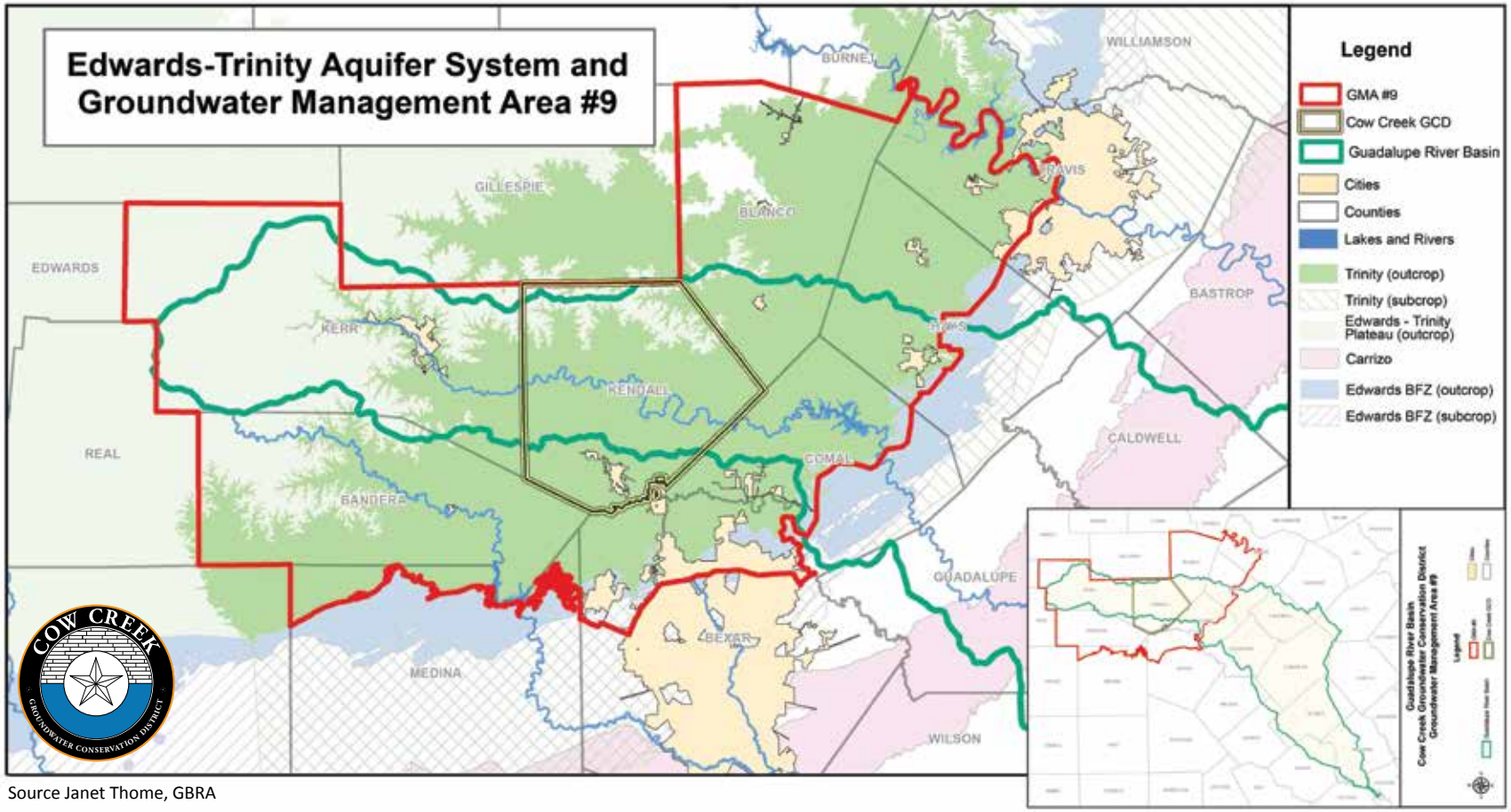
Map of the Cow Creek Groundwater Conservation District's monitoring well locations

"Surplus water implies that the water is serving no use and is available. I repeat, all water is serving a useful purpose, and transferring from one area to another has social and environmental consequences that must be well understood before taking such action."

- Conn Mims, Director
Nueces River Authority

©Photo by D K Langford

Our Water Management Network - Continued



Source Janet Thome, GBRA

Our Water Management Network - Continued

The map shows that groundwater does not respect political boundaries, including those of groundwater conservation districts. Groundwater management plans may include groundwater that is located beneath the boundaries of adjacent or regionally aligned groundwater districts that are within the same groundwater management area. Further complicating this issue is the fact that not all counties in the Groundwater Management Area #9 are represented by groundwater districts. In these non-management areas the biggest pump, or "rule of capture" prevails.

Groundwater conservation districts are the state's preferred method of managing groundwater. One of the main functions of the CCGCD is to monitor aquifer levels in order to manage the rate at which water is withdrawn from the aquifer.

The Texas Commission on Environmental Quality (TCEQ), manages surface water use through water rights permitting and manages water quality through a permitting process known as the Texas Pollution Discharge Elimination System.

The City of Boerne manages drinking water for residents of Boerne. The sources of this drinking water include groundwater and Boerne Lake.

Photo by Janet Thome

The Mission of the Guadalupe-Blanco River Authority is to protect, conserve, reclaim and steward the resources of the ten-county District in order to ensure and promote quality of life for those it serves. This includes Kendall County.

©Photo by D K Langford

Join the New Water Culture

If you share a concern for our water future and want to make a difference, know that joining and strengthening the New Water Culture is one of the most practical and effective ways to become involved. And you don't have to wonder what your next steps might be. This manual will help you move forward with actions that range from very simple behavioral changes to actions that involve reconfiguring the way you access, use, and dispose of water. Consider any of the following steps a launching point:

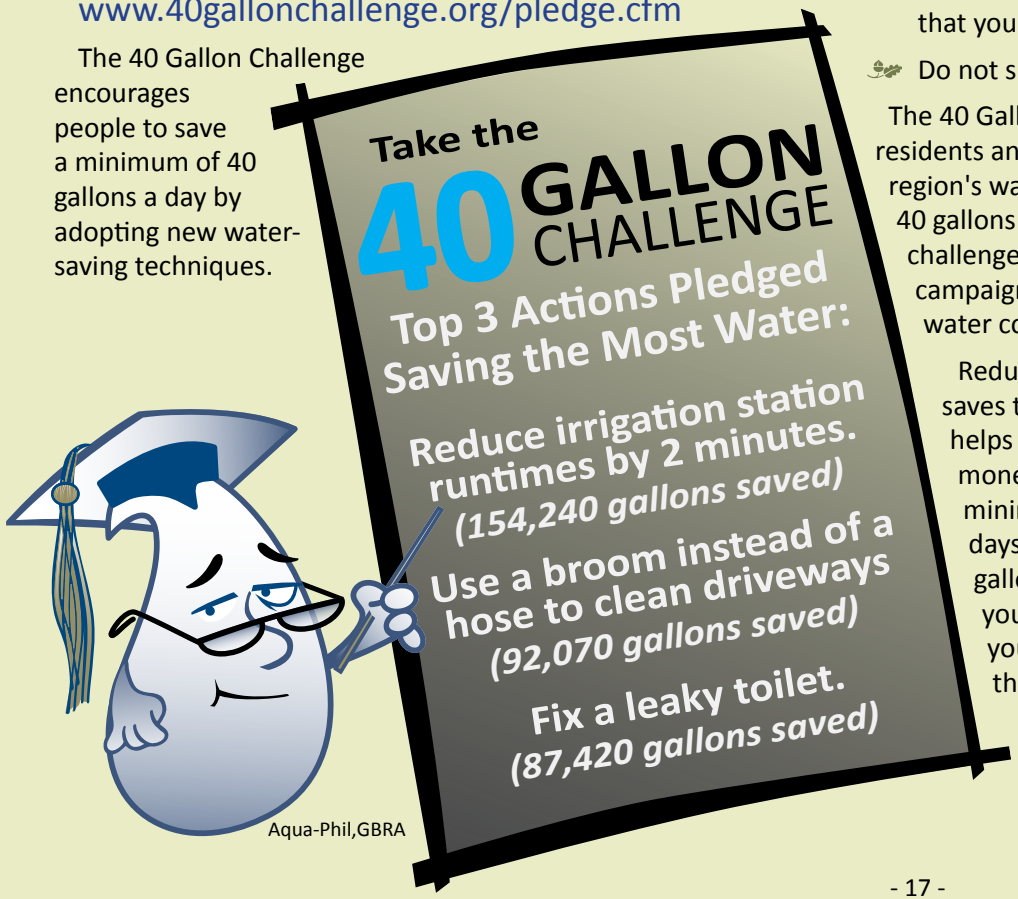
- Set a good example. No one needs to change the world by themselves. Small consistent and organized change over time can serve as the foundation for larger changes.
- Make small changes. Pick one or two actions to take in each of the three priority strategies: Conserve, Capture, Clean.
- Increase awareness. Read this Manual and share the information with family and friends. Listen carefully for the water myths that people hold onto, speak up, and share the facts about water and the benefits of a New Water Culture.
- Help decision makers. Our policy makers, politicians, public officials, and water utilities need to know what is important to you. Coming to public meetings prepared with facts, strategies and goals is vital to expanding the awareness that the New Water Culture is alive and growing and has an economical and effective strategy to implement.
- Make big changes when you are ready. Begin collecting rainwater for your landscaping needs. You might get hooked on capturing and storing your own, high quality water. Before long you might be collecting it for all your water needs. At this point you will have crossed over completely into a culture of water independence.

The 40 Gallon Challenge

Water conservation is an ever-growing concern for everyone on our planet. How can you make a difference to save water on a daily basis? Take the pledge at:

www.40gallonchallenge.org/pledge.cfm

The 40 Gallon Challenge encourages people to save a minimum of 40 gallons a day by adopting new water-saving techniques.



Aqua-Phil,GBRA

Here are a few guidelines before you start:

- Submit only one pledge per household.
- Check off only new practices or actions that you will do to save water.
- Do not submit duplicate pledges.

The 40 Gallon Challenge is a call for residents and businesses to reduce our region's water use on average by 40 gallons per person, per day. The challenge began in 2011 as a voluntary campaign to increase water conservation.

Reducing water usage at home saves this precious resource. It also helps homeowners keep more money in their wallets. Saving a minimum of 40 gallons a day for 30 days adds up to more than 1,000 gallons per month. In other words, you should see real savings on your water bill if you follow through with your pledge and put to use the recommended water-saving practices.

Water in Nature

Overview

Water is the essence of Life. Life as we know it is not possible without water. Because we depend on it for our very existence, it is extremely important that we understand the nature of water, how it moves, where it comes from and where it goes.

The natural movement of water, known as the water cycle, allowed our forefathers to settle here and create the cities and communities we have come to know in Central Texas.

Allowing water to move naturally maintains a healthy ecosystem, and it is the cheapest and simplest approach to ensuring we have adequate clean water into the future. Over the last 50 years, however, we have begun to alter the natural system that replenishes and cleans our water. In *Our Impact on Water*, we will explore the ways we are impacting and altering the natural water cycle and as a result, putting at risk our ability to access clean, affordable water.

For now, let's look closely at how healthy water systems naturally work - how the sun, the earth, and the atmosphere work together to power the water cycle and supply us with all the water we need to thrive.

Water covers more than 75% of the earth's surface. Of that, 97% is salt water found in the oceans, bays and estuaries. The remaining 3% is fresh water and 2/3 of this is frozen in polar ice caps and glaciers. This leaves 1% of our planet's water as fresh water, accessible to humans, plants and animals.

Water is in continuous motion, moving through a reliable cycle that keeps our springs and rivers flowing, our aquifers filled, and our coastal waters teeming with life. There are stages of the water cycle that are visible and there are stages that are not visible. The parts of the cycle that are visible include cloud formation, rainfall, runoff, and flowing springs and rivers. Stages that are unseen include evaporation, transpiration, subsurface flow, and ocean currents. Because we are dependent on groundwater in the Hill Country, we need to understand how the unseen stages (subsurface flow), relate to the visible stages, (surface flow) and how we impact this relationship.

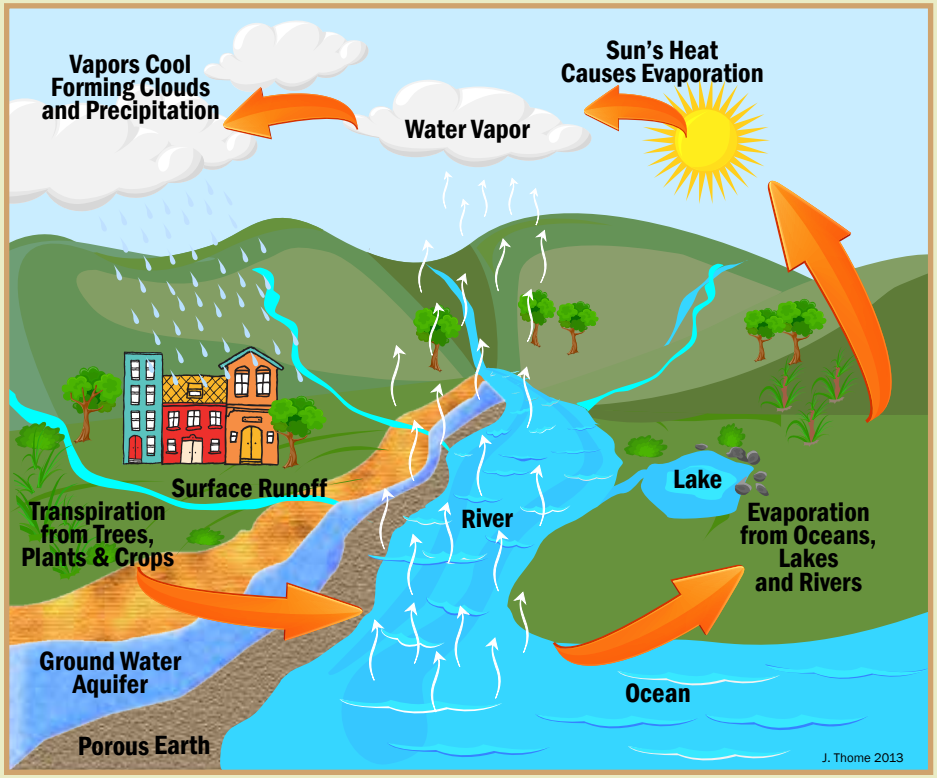
> *"It is the clear running water from the seeps and springs of an aquifer system in balance that makes life in the Hill Country not just attractive, but perpetual."*
>
> *-Milan J. Michalec, Director, Pct. 2, CCGCD*

Photo by Connie Rothe

Photos by Janet Thome

The Water Cycle

A simple definition of a *watershed* or drainage basin is: an area of land in which water drains to a single point. This definition of a watershed, however, is not complete in areas where people depend on groundwater for survival, such as the Texas Hill Country. We live in watersheds that not only facilitate drainage to a single point but also slows water down, captures it, and stores it both above and below the ground. This is what we mean by the term *water catchment*. The distinction between a watershed and a water catchment is vitally important because we can't always count on rain to continuously replenish our water supplies.



So what constitutes a healthy watershed? In the Texas Hill Country, you could say that a watershed is healthy to the extent that it performs as a water catchment by both capturing and shedding water. For our watersheds to act as catchments they must have lush, diverse vegetative cover and thick riparian buffers that support abundant wildlife, generate productive springs and steadily flowing streams even in times of drought. So if you want to know if your watershed is healthy, look

Photo by Cinde Thomas-Jimenez

The Water Cycle - Continued

around. Do you see plants? Wildlife? Trees? Flowing water? All of these suggest that the watershed is healthy and, more than likely, there is abundant water underground as well.

As we mentioned previously, later in this manual, we will examine human impacts on watersheds and how these impacts can alter the watershed's ability to function as a water catchment. To fully understand human impacts on water catchments, let's examine more closely how water behaves in such a system, i.e. how water on the surface of a watershed/water catchment interacts with water underground. We will find that these interactions are subtle but are very dynamic and vital to sustaining a steady supply of clean, affordable water.

Surface Water and Groundwater Interaction

Water is very dynamic. It rarely stays in one place for very long. During storms it falls from the skies, flows to creeks, or into the ground. If it pools in one spot, it can evaporate relatively quickly under the power of the sun. Most of us are familiar with water dynamics that happen above ground. In the Hill Country, flooding is probably the most dramatic, visible example of water in action.

Interactions between the water in rivers and streams on the earth's surface and the water underground are much more widespread and more persistent than the occasional flood. In fact, surface water and groundwater interaction is quite common in Central Texas where karst geology facilitates rapid movement of water between the surface and underground.

Streams that receive water from springs are known as *Gaining Streams*. Stream segments that recharge to aquifers are known as *Losing Streams*. Depending on aquifer levels, this same stream may be a Gaining Stream at one time and a Losing Stream at others. Once we understand that our aquifers and streams are constantly "trading water" we begin to understand that streams and aquifers comprise one dynamic system.

Photo by Chase Fountain, TPWD

Photo by Cinde Thomas-Jimenez

Photo by Janet Thome

Healthy Ecosystems for a Healthy Future

What makes up a healthy ecosystem? Did you answer a healthy water cycle? That is correct. But the importance of a healthy ecosystem gets personal when it comes to water. Consider these situations we take for granted and imagine if things were different:

- **You turn on the tap and water comes out.**
  What if water did not come out? Would that shock you?
- **You spend less than one percent of your income on water.**
  What if your water bill was two, three, or ten times as much as it is now? Could you pay it? What would you have to give up if you had to pay ten times your current rate?
- **You can access water whenever you need it.**
  What if you could get water only on designated days or at designated times such as between 8am and 6pm? What if your use was rationed? How would that change your life?
- **Your water is clean enough to drink when it comes out of the tap.**
  What if you got sick when you drank your tap water? Would that be acceptable? What additional costs would you incur if you had to treat your own water or had to see a doctor or visit the emergency room after drinking it?

A healthy ecosystem makes possible all of these situations we take for granted and protects us from these worst case scenarios. This is because a healthy system cleans and stores water so it can be accessed readily and safely by plants, animals and humans.

As ecosystems break down, so also does our access to clean and affordable drinking water.

Photo by Ryan Bass

Photo by Janet Thome

Characteristics of a Healthy Ecosystem

The characteristics of a healthy ecosystem can be stated generally but in some cases they can be specific to a particular location. Recognizing and protecting these characteristics can help us maintain access to pure clean water. For the Texas Hill Country, these include:

- **Vegetation:** Plant abundance and natural diversity on the surface slow down runoff and allow water to percolate into the ground while removing pollutants. Because our thin Hill Country soils and porous aquifers make poor pollution filters, plants play a key role in removing pollutants before they enter our drinking water. Deep root systems also hold soil in place and facilitate water cycling from within the ground into the atmosphere.
- **Permeability:** Permeability is the ability of a substance to transmit water. In the Hill County, this enables water to be evenly distributed throughout our ecosystem. Permeable features such as sinkholes, karst substrate, and caves recharge rainwater into the limestone aquifer, generating seeps and springflow. This recharge helps keep our creeks and rivers flowing and reservoirs like Boerne Lake full.

Microbes in Healthy Ecosystems

It may be hard to believe, but some of the environment's best friends are things that cannot be seen without a microscope, things we call microbes. Words like bacteria and fungus often bring to mind infections and diseases, but in truth there are far more beneficial microbes than harmful ones.

Microbes purify our water as it moves through the soil, break down pollutants, and destroy harmful pathogens. Microbes also protect plants from many harmful insects and diseases. Some even allow plants to thrive with less watering.

As we work to protect the environment and our water supplies, we should also be sure to protect the microbial life it contains. To do so, we need to avoid the use of synthetic fertilizers and pesticides. Also, compacting the soil unnecessarily drives out oxygen, destroying beneficial microbes and creating a zone where harmful types can thrive. Small as the microbes may be, they play a big role in protecting our world.

Mycorrhizal fungi keep plants healthy and help them fight disease and survive droughts.

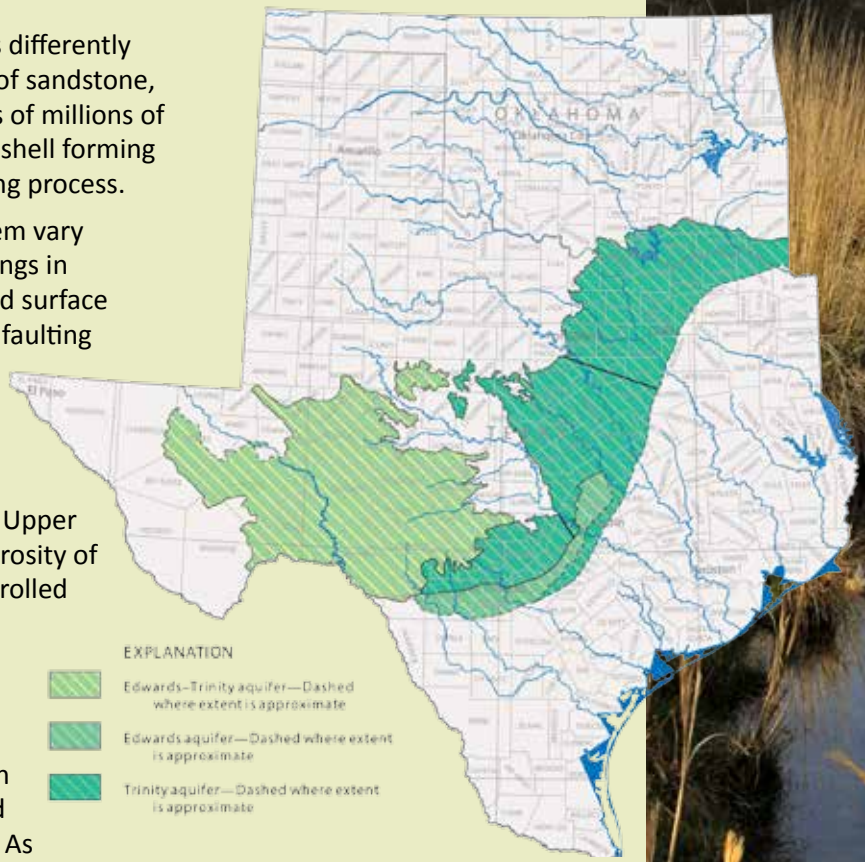
Trinity Aquifer Anatomy

The Trinity Aquifer formation is very diverse and behaves differently across the area. This diversity is attributed to the layering of sandstone, limestone/dolostone aquifers which formed over hundreds of millions of years when river sediment and/or calcium carbonate from shell forming creatures were compressed and heated through the layering process.

The holding and transmitting qualities of the Trinity System vary with the orientation and prevalence of fractures and openings in the rock. These openings form when fresh groundwater and surface water dissolve carbonate rocks. Fractures were formed by faulting associated with the Balcones Fault Zone that took place millions of years ago. The number and direction of fractures control the underground water flow.

In this area, the recharge to and the flow within our carbonate rock aquifers (Cow Creek, Lower Glen Rose, and Upper Glen Rose) depends on the distribution of fractures and porosity of the rock, both at the surface and underground. This is controlled largely by the faulting and may vary from place to place.

The story of the Cow Creek formation is a long one, going back more than 115 million years when the area was covered by a marine environment. Cow Creek's core structure formed from ancient sea creatures. Later, through uplifts and changing conditions on land, layers of river sand known as the Hensel Sand covered the Cow Creek system. As ancient seas rhythmically rose and receded, the Trinity and ultimately the Edwards Aquifer systems formed, resulting in the complex matrix that stores groundwater and replenishes creeks in Kendall County.



USGS Water Resources Investigation Report 94-4039.

©Photo by D K Langford

Caves and Sinkholes

Parts of Kendall County are dotted with areas known as "significant recharge features". These are areas where water enters the aquifers very rapidly, sometimes taking only a few seconds to move from the surface to the aquifer. The most common features are caves and sinkholes.

Water entering the aquifers through these areas undergoes little filtration or purification, so the health of these areas can significantly impact the quality of our groundwater.

If you are a landowner fortunate enough to have these features on your property, take special care to protect them.

The rules of the Cow Creek Groundwater Conservation District prohibit alteration of the flow of water to these recharge features, and do not permit the storage of toxic products such as paint, fertilizer, fuel, and pesticides within a certain distance of them. In addition, septic drain fields can not be located where they may impact caves and sinkholes. See the "Rules" section of the district's website at CCGCD.org for more information on this subject.

Valdina Farms sinkhole in Medina County, January 2013. The diversion channel that directs flow to the sinkhole is seen at upper left.

Since 1982, annual recharge at the sinkhole has varied from zero to 12,915 acre-feet. The sinkhole can recharge up to 1,770 gallons per second. (Hammond, 1993).

Photo courtesy of Gregg Eckhardt, EdwardsAquifer.Net.

Water, A Precious Inheritance

Unlike some other parts of the world, the Texas Hill Country does not have large, powerful rivers that continuously replenish themselves with snow melt or large amounts of rainfall. Instead, we rely on modest rainfall and a sensitive dynamic water system. Rivers, streams, aquifers, and springs are inextricably linked to the rich riparian habitat, abundant wildlife, and rolling rangelands.

Indeed, the land, its vegetation, and dynamic geology where water lies hidden are as integral to our drinking water supply as the places where it can be seen: our reservoirs, flowing rivers and rising springs. Water in Nature is our precious inheritance. By altering the land and the natural flow of water, we must realize the potential for putting this precious inheritance at risk.

In the next section, we will examine how we impact the precious water system that sustains us. Knowing how humans negatively impact water is the first step to understanding how we can work alongside nature to ensure that we continue to have access to clean and affordable water.

Photo by Janet Thome

Our Impact on Water

As the Land Goes, So Goes the Water

Land and water are interlinked. In the Texas Hill Country, water is stored below us in the Trinity Group of limestone aquifers. In Kendall County, we rely heavily on the Cow Creek formation for our well water and springflows that keep our local lakes full for use as a municipal water supply. Water enters the Trinity Group through recharge features that extend well beyond Kendall County. In fact, very little recharge of the Cow Creek formation takes place in Kendall County. As a result, we rely on people who live far away to manage the land in a way that preserves and encourages recharge.

Because recharge takes place outside the area, the primary focus for managing water for Kendall County residents is not to enhance water supply by encouraging recharge. Instead, we need to be concerned about conserving and protecting the water we do have by:

- Preventing water waste
- Preventing pollution from entering the groundwater

Taking appropriate action to follow through on these concerns requires that we understand how human behavior changes the land and affects water supplies. But let's be clear about one thing: As long as humans have lived on the earth, they have impacted the land. Trampling plants, producing garbage, and emitting pollutants has been part of our way of life.

As humans, though, we have the power to be stewards of the earth and work with nature to ensure that our impact is minimized. We can choose to work with the natural systems that surround us and adjust our habits to the changing natural conditions.

In order to do this, we need to understand how current land uses and the cumulative effect of bad habits and practices can result in very damaging effects on our water supplies.

Photo by Milan J. Michalec

Ecosystem Alteration

How do humans change, or alter, the environment? When individuals gather into groups, the intensity of each individual impact is multiplied. If the ecosystem is not given sufficient time to absorb this impact, it will be altered. If the impact is repeated enough, the ecosystem will be altered permanently. For example, when people form villages, they tend to stay in one place. Over time, the village alters the land and produces more waste in one location in the same way that large animal herds can have a significant impact on range conditions due to trampling and concentration of waste.

We Texans take pride in the long history of our communities and towns, many of which have formed along rivers or near springs. As settlers, we have permanently altered the natural environment in numerous ways that are discussed throughout this section.

For the purpose of forming an action plan, it is helpful to understand how each of the impacts listed below alter aspects of the water cycle. Recognizing these are instrumental in supplying us with clean and plentiful water.

- Human Impacts on the Ecosystem
- Population density
- Moving around– transportation & recreation
- Impervious cover– Parking lots
- Toxic pollution discharge
- Food production and resource harvesting
- Building shelter
- Over pumping
- Habitat alteration & destruction

Photo by Milan J. Michalec

Photo by Milan J. Michalec

Impervious Cover– Water Given Away

The earth is naturally dynamic, receiving and giving water and nutrients to all living things. When we place impervious surfaces on the earth; we impede or alter the land's natural function. Impervious surfaces are widespread where humans live and work. They can be created intentionally to facilitate transportation or to provide shelter. Examples include roads, parking lots, sidewalks, and buildings. Impervious surfaces can also be created unintentionally, when land is overused and compacted making it less porous. Trampled common areas and overgrazed pastureland are examples.

Impervious surfaces alter the land's ability to sustain the natural cycling of water through the environment by:

- Blocking or plugging recharge features such as caves and sinkholes.
- Filling in wetlands.
- Removing vegetation that facilitates recharge and pollutant uptake.
- Accelerating storm water drainage, resulting in flooding.
- Increasing the intensity and destructive force of floods resulting in stream bank scouring, and property and habitat loss.
- Accumulating and concentrating pollutants from cars, pets and other point and nonpoint sources that are washed into drinking and recreational waters during storm events.

Photo by Milan J. Michalec

Impervious surfaces move water away from areas that would naturally store the water. The more impervious surfaces we create, the more water we give away.

Pollution Can Foul Our Drinking Water

There are two types of pollution that we need to be aware of: Point source pollution and nonpoint source pollution.

Point source pollution comes from a single source such as a pipe and is typically regulated by a discharge permit. Violations of discharge permits can cause severe environmental damage and are usually associated with a heavy fine.

Nonpoint source pollution is common and can come from anywhere. Most of the pollution we are responsible for as individuals is nonpoint source pollution. Using too many chemicals on our lawn, washing our car in the street, or failing to fix oil leaks can release nutrients and other contaminants into our streams and groundwater.

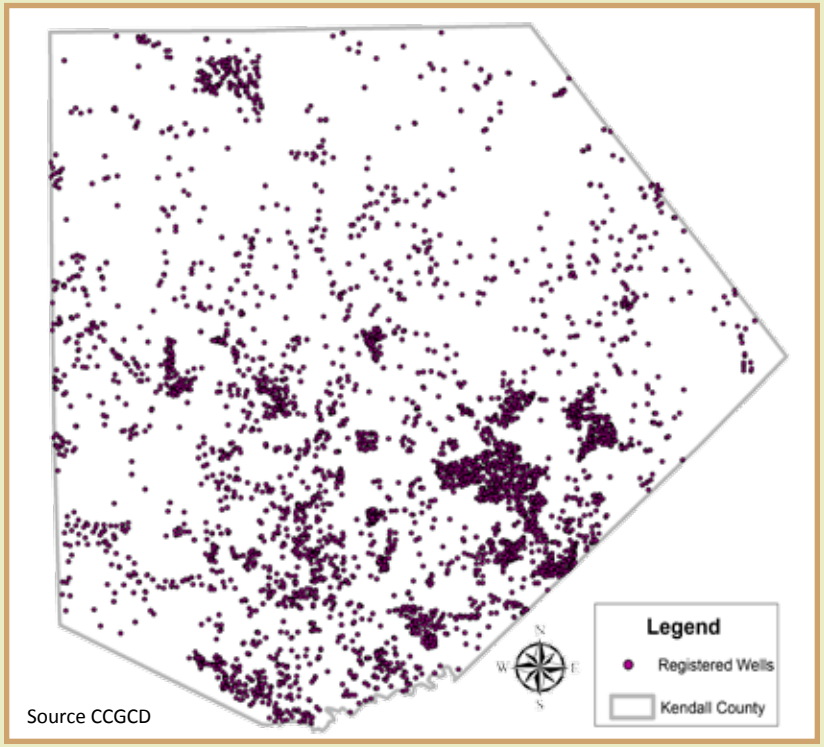
Other examples include: Sewage spills that take place when sewer systems become blocked or if the lift stations fail to operate and cause accidental or unintentional chemical releases. Chemical waste is expensive to dispose of legally and is occasionally dumped in remote areas. Illegal dumping of both toxic and household waste is a widespread problem in Texas. Historically, aquifer recharge features and caves have been illegal dump sites.

Illustration provided courtesy of University of Wisconsin-Extension and the Wisconsin Department of Natural Resources

Photo by Cinde Thomas-Jimenez

Registered Wells in Kendall County

The map shows registered wells located in Kendall County. Not shown are wells that were drilled prior to February 1975. With the growing population, the demand for water in the Cow Creek Groundwater Conservation District will continue to increase, making the need even greater to understand how to preserve and conserve this natural resource we are all dependent on.



Source CCGCD

Impacts on Microbes in Water

The number of beneficial microbes in our environment is staggering. A cup of healthy soil may contain 10,000 different kinds of bacteria and 5,000 kinds of beneficial fungi. As discussed in the previous section, they do many things to support life while eliminating pathogens and pollutants. However, many of the beneficial microbes can be destroyed by man-made products like weed killers and other pesticides, along with synthetic chemical fertilizers. They can also be harmed by pharmaceutical products that we may dispose of improperly or flush away.

The effects of these products can be far reaching when they wash off of our lawns and agricultural fields. Even modern sewage treatment facilities may do little to remove the anthropogenic contaminants (personal care products, hormones, antibiotics, and other unmetabolized drugs) that enter our waste stream. These contaminants are now being detected in our streams and groundwater.

The best plan is to avoid the use of synthetic pesticides and fertilizers and dispose of household chemicals and pharmaceuticals properly.

Photo by Ryan Bass

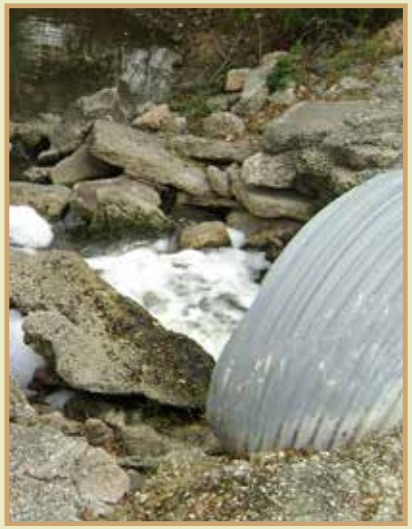
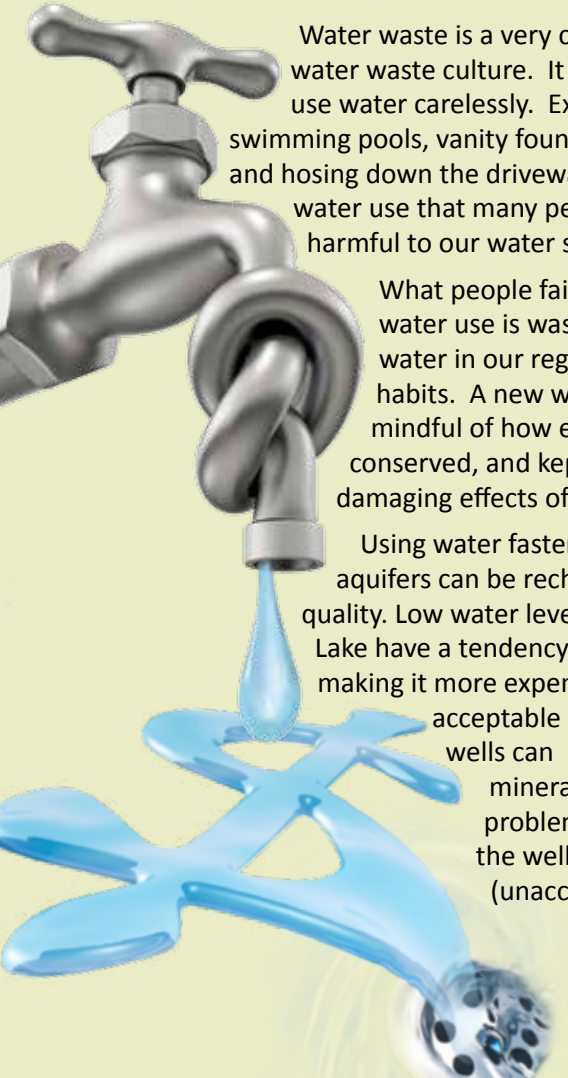


Photo by Cinde Thomas-Jimenez

The Impact of Excessive Water Use



Water waste is a very common occurrence in a water waste culture. It can occur whenever people use water carelessly. Excessive landscape watering, swimming pools, vanity fountains, showering too long, and hosing down the driveway are just a few examples of water use that many people consider benign and not harmful to our water supply.

What people fail to understand is that careless water use is wasteful, and there is not enough water in our region to support water wasting habits. A new water use culture is both mindful of how every drop of water is captured, conserved, and kept clean and aware of the damaging effects of water waste.

Using water faster than our reservoirs and aquifers can be recharged can degrade water quality. Low water levels in reservoirs like Boerne Lake have a tendency to concentrate pollutants, making it more expensive to treat the water to acceptable standards. Low water levels in wells can increase the concentration of minerals, which can cause odor problems and in some case render the well water non-potable (unacceptable for drinking).

Over-pumping can also draw down water levels in surrounding wells. This 'cone of depression' can impact both water quality and water levels in nearby wells. When an aquifer system is heavily pumped over a long period of time, springs can dry up permanently as aquifers fail to reach levels sufficient to produce spring flow.

"In times past, when most people lived in rural areas, they had to find ways to supply their own water—often by drilling a well and pumping water to their homes. Not many city dwellers have a well in their backyards today. A public-water supply system, such as your local water department, nowadays delivers water to most homes."

-USGS, (2013). *Public-supply water use*. Retrieved from website: http://ga.water.usgs.gov/edu/wups.html

Photo by Alvin Schuerg

The Impact of Excessive Water Use - Continued

Clean and Sufficient Water

Water Stewardship

Human Disruption of the Water Cycle and Degradation of Water Quality and Quantity		
Action	**Water Cycle Impact**	**Water Quality Impact**
Impervious cover	Reduces local recharge Reduces evapotranspiration	Reduces pollutant uptake Concentrates pollutants
Removal or degradation of vegetative cover	Reduces recharge Worsens flooding, creates streambank scouring and property loss Shortens reservoir life through silt deposition	Reduces pollutant uptake
Excessive use of lawn chemicals		Pollutes ground and surface water
Leaking sewer lines and leaching landfills		Pollutes ground and surface water
Over pumping and water waste	Reduces or eliminates springflow Lowers aquifer levels	Concentrates minerals Allows intrusion of saline water into fresh water zones

Water Ignorance

Dirty and Sparse Water

What Future Will We Choose?

Future 1: A Culture of Water Waste

We live with one, limited water source. Given the amount of rainfall we typically receive in Kendall County, wasting water is a luxury we can not afford. How we use our water involves choices. If everyone chooses to use water without regard to the needs of others and the environment, the quality of our well and reservoir water could degrade or these sources could simply dry up along with our creeks and streams. Providing water to our homes could become problematic and expensive when:

- People with wells are forced to drill deeper.
- Water treatment systems need to be added to existing wells.
- Well owners are forced to have water delivered to their home.
- Public water systems must purchase water from other sources outside our area.
- How much are you willing to spend on water?
- What are you willing to give up for a green lawn?
- Is wasting water worth losing our water independence?

Photos by Milan J. Michalec

Future 2: A Culture of Water Stewardship

Water stewardship culture recognizes that our water is precious, life giving, and belongs to everyone. Embracing a future in which water remains affordable, clean, and readily available is the first step in securing that future. In order to move forward though, we need to recognize that a secure water future will not be achieved without effort. Making the effort will require that we become more aware of what is happening with the water in our environment. In doing so, we will adjust our water use habits and beliefs to accommodate the needs of the natural systems that supply us with water.

In short, we will need to adopt a mindset in which we first serve the needs of our water environment versus expecting the water environment to first serve us. Out of consideration for our water, out of consideration for our future, and out of consideration for our environment, we can put water first. Isn't something as precious and life-giving as water worth the effort?

Photo by Ben Eldredge

Toward A More Secure Future . . . Change Begins With You

We have explored why we need to conserve, how nature works to provide us with water and what we do to interfere with these processes. In the next section we will explore how Texas is moving forward with new ways of managing our water. Some of the emerging changes involve the laws, rules, and regulations governing water use. Other changes involve how we use water and how we are designing our yards, neighborhoods and cities in harmony with the natural systems described in *Water in Nature*. Whatever our movement to a new water stewardship culture may be, we will always find people at the heart of that change.

> *"Water conservation is planned. It does not just happen."*
>
> *- John Kight, Cow Creek Groundwater District Board of Directors*

In other words, our water future depends on people who are willing to make the effort to change the way we have done things, think of new and exciting ways of conserving water, and spread the word that we must tread lightly on the planet and treasure every drop of water.

Photo by Milan J. Michalec

Photo by Milan J. Michalec

Photo by Ben Eldredge

A New Water Culture

Overview

A new water culture is emerging throughout the Texas Hill Country. People are quickly realizing that the conservation and management of our water resources will determine the long-term economic and ecological outcomes of the region. This new approach to managing landscape features which are vital to water quality protection and production means that we will need to develop new water use habits, new ways of building our homes, designing our yards, neighborhoods and cities. One of the most effective ways to move forward with these new habits and design strategies is through a process called watershed management.

Watershed management requires a holistic approach when working to solve water quality problems. All watersheds, regardless of size, have unique characteristics and require specific planning and implementation efforts to improve water quality. Watershed planning is effective because it engages local stakeholders in the planning process where they provide first hand knowledge of urban and rural watershed conditions and potential sources of pollution. Watershed planning organizations and stakeholders work to evaluate current and future land uses and how changes will complement or negatively impact site-specific drainage patterns, geologic features, soil depth, existing habitat, vegetative cover and riparian areas.

An example of a watershed planning effort in Kendall County is the Upper Cibolo Creek (UCC) Watershed Protection Plan (WPP) developed by the City of Boerne in partnership with the Texas Commission on Environmental Quality and funded by the US Environmental Protection Agency (US EPA). The city worked with local stakeholders to identify both urban and rural pollution sources throughout the watershed and developed strategies to improve water quality conditions within UCC and its tributaries. The UCC WPP not only addresses existing water quality concerns but also works to prevent future land management decisions from negatively impacting the water quality. The UCC WPP's approach to watershed stewardship is a direct example of the new water culture emerging in Kendall County.

Upper Cibolo Creek Watershed Protection Plan

Prepared for the
UPPER CIBOLO CREEK WATERSHED PARTNERSHIP

By

Ryan Bass and Don Burger
City of Boerne

Mel Vargas, Kirk Dean Ph.D. and Marcel Deiler
Parsons Water and Infrastructure

Lauren Bibbo and Arthur Talley
Texas Commission on Environmental Quality

PARSONS

June 2013

This Watershed Protection Plan was prepared in cooperation with the Texas Commission on Environmental Quality. The preparation of this report was financed through a federal Clean Water Act §319(h) grant from the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency.

Photo by Ryan Bass

In this section we will explore both innovative and traditional management and design practices for urban and rural watersheds. The section on urban watersheds discusses Low Impact Development Design for urban infrastructure, homes and businesses. This is followed by a presentation of rural watershed management practices that include streamside and rangeland stewardship. Finally, we will discuss conservation easements and how they can be used to protect areas that are vital to watershed health.

Urban Watershed Stewardship

Green infrastructure

The shelter and transportation systems we depend on for living and working inherently disturb the environment. A basic challenge of the new water stewardship culture is to design such systems in innovative ways that harmonize with the cyclical nature of water, the regional climatic conditions such as rainfall, and the local geology.

Green Building and Low Impact Development (LID) aim to reduce environment impacts and may be engineered to either mimic the function of a healthy natural system or harmonize with the local hydrology and drainage patterns. Instead of using large centralized stormwater collection systems, LID uses decentralized stormwater controls to capture and process nonpoint source pollution. The benefits of LID include a decrease in erosion and flooding, improved water quality, and the aesthetic appeals of the decentralized stormwater controls, including rain gardens and other vegetated retention systems.

Green Infrastructure includes natural areas that are secured and maintained because they naturally capture, conserve and clean stormwater runoff. In the New Water Culture, urban environments use a combination of these approaches to create a green tapestry that harmonizes with the water cycle. This also integrates natural areas with residential and work environments, and offers numerous benefits in terms of improved air quality, reduced noise and light pollution, and creates a more natural and peaceful place to live.

Home and Business

Because home and business owners can develop and maintain their property (within the bounds of various restrictions), they can implement stormwater management practices that promote infiltration, reduce flooding and nonpoint source pollution.

One of the most effective urban features for managing stormwater is the Rain Garden. A Rain Garden is designed to capture and hold large amounts of water before it enters the municipal stormwater system. Rain Garden plants effectively absorb pollutants and the garden's deep, porous substrate allows water to settle and infiltrate into the ground.

Green roofs are another of the LID practices. Green roofs are designed using a moisture barrier and thick layer of soil. It is then planted with native plants and grasses that absorb water and serves as an insulation to the

"The City of Boerne is working to retrofit portions of its downtown with Low Impact Development systems. This is helping to protect water quality in Cibolo Creek."

- Paul Barwick, City of Boerne

Urban Watershed Stewardship

Home and Business - Continued

structure improving energy efficiency. In areas where recharge needs to be maximized, the runoff reduction features of green roofs such as absorption and evapotranspiration, may be seen as a disadvantage and their adoption discouraged.

Another tool for conserving water is mulch. Mulching gardens and landscape vegetation holds water in place, reduces evaporation and the need to water as frequently.

Photo by Janet Thome

Native plants along with drought resistant grasses with deep root systems also aerate the soil. This vegetation provides a unique system that transmits water into the soil when it rains and moves water to the surface during dry weather.

Driveways and sidewalks can be built with pervious materials. This enables pollutants to seep into the ground to be absorbed by plants or processed by microbes instead of washing into nearby creeks and ponds.

The Green Building movement encourages the use of cisterns in the Austin-San Antonio region. These are fairly common on LEED-rated buildings, see page 42. Cisterns come in many sizes, depending on their purpose. Cisterns are excellent for use as part of the overall Low Impact Development (LID) treatment plan (see next section).

Green Terminology

- **Green Building or Green Architecture**: Building design that reduces environmental and health impacts through energy and water efficiency, waste reduction, and protection of occupant.
- **Low Impact Development (LID)**. Undisturbed, vegetated sites naturally retain water, facilitating infiltration, filtration, storage and evaporation. LID models stormwater management systems after the natural, predevelopment hydrology in order to retain the natural dynamics that keep our water clean and locally available.
- **Green Infrastructure**. The multifunctional natural areas that provide parkland, wildlife habitat, and stormwater controls that absorb pollution and reduce flood severity.

Low Impact Development

We Have Options

Low Impact Development (LID) offers options for how we develop the Texas Hill Country. LID is not a new concept and its development and use is not limited to Texas. In fact, LID practices have guided urban planners and builders across the country for years in complying with stormwater management regulations. These regulations consider stormwater runoff to be a pollutant. While traditional storm-water management channels runoff to a central location such as a retention pond, LID aims to slow down runoff throughout the management area and encourages pollutant uptake and stormwater evaporation.

In Central Texas, where we frequently experience water shortages, stormwater is increasingly viewed not as a pollutant but as a valuable resource to be captured, naturally filtered, and stored in our aquifers. As we look to LID as a way of capturing additional water to enhance water supply, we also need to keep in mind that in the Hill Country our aquifers are highly vulnerable to pollution. This is because water moves into the aquifers quickly, without filtration. Therefore, implementing LID practices in our area requires additional planning, rather than adopting off-the-shelf designs that may have worked somewhere else.

Over the last two years, several LID manuals have been published in Central Texas to guide urban planners, developers and decision makers in the design and implementation of LID systems that serve the unique needs of the Hill County. One of the most comprehensive manuals, *"Watershed Stewardship for the Edwards Aquifer Region: A Low Impact Development Handbook"* is published by the Greater Edwards Aquifer Alliance. While this Manual offers alternative LID approaches that facilitate recharge while achieving the water treatment benefits of traditional LID, GEAA recognizes that development brings with it other risks - such as failing sewage management systems. With this, we are reminded that a new water stewardship culture must rely on multiple strategies to reduce the risks of growth.

"LID is an effective tool, but not a panacea. Development in sensitive karst recharge areas that increases impervious cover and incorporates the installation of sewage infrastructure poses risks to our water supply that require regulatory solutions and the use of common sense, in addition to the implementation of LID techniques."

-Annalisa Peace, GEAA Executive Director

Photo by Janet Thome

Low Impact Development

We Have Options - Continued

Watershed Stewardship For The Edwards Aquifer: A Low Impact Development Handbook

Produced by the Greater Edwards Aquifer Alliance, the LID Handbook's basic philosophy is: Work with the site, not against it. In keeping with this, LID methods should be thought of as a natural extension of site topography and hydrology. In the Edwards Aquifer region, for example, the rolling topography produces natural swales and basins that can be adapted as part of the site stormwater system. As part of a responsive site development plan, application of this principle preserves local character and features closely associated with the Texas Hill Country landscape. To access the LID Handbook, contact:

Greater Edwards Aquifer Alliance
www.aquiferalliance.org
P.O. Box 15618
San Antonio. TX 78212
(210) 320-6294

Low Impact Development - Toolbox

LID tools mimic the natural environment and facilitate the cycling of water while correcting man-made interferences that disrupt this cycle. Below are some examples of LID tools that encourage infiltration while filtering out pollutants. The following pages will explain how these tools function.

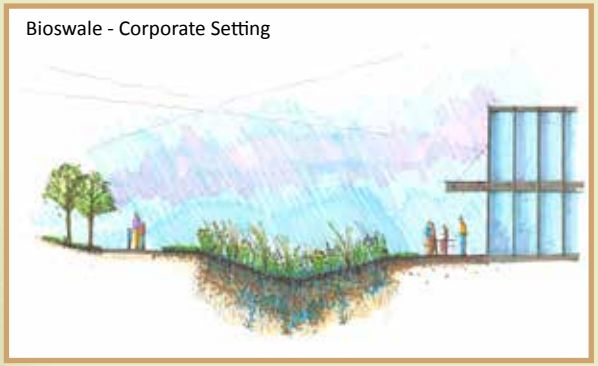


Illustration by Doug Adamson, USDA-NRCS

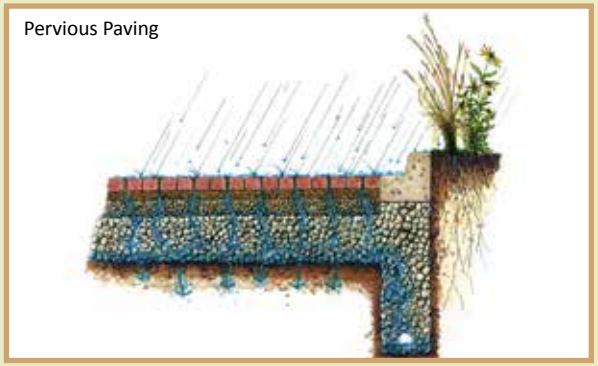


Illustration by Doug Adamson, USDA-NRCS

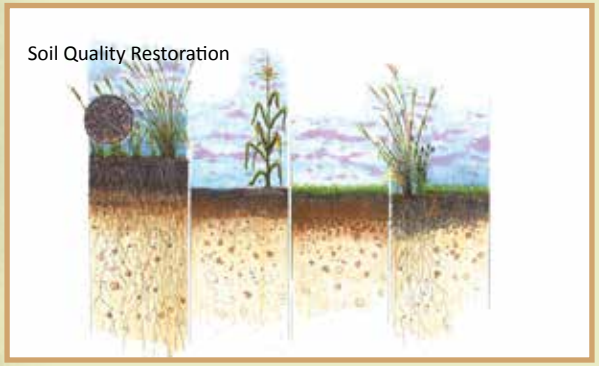


Illustration by Doug Adamson, USDA-NRCS

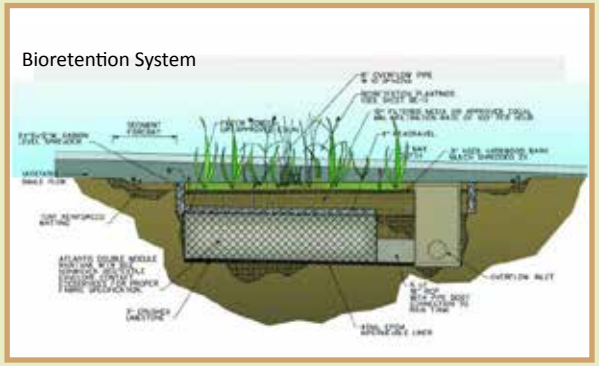


Illustration provided courtesy of the nctcog.org

Low Impact Development

Low Impact Development - Plant Selection

The best plants to incorporate into your LID toolbox are those that are native, have a high tolerance for drought, and do a good job of absorbing nonpoint source pollution. Shown here are examples of some of these plants. The end of this section provides a comprehensive list of plants that are compatible with LID projects.

Obedient plant, courtesy of Jennifer Anderson USDA-NRCS PLANTS Database

Muhly grass, courtesy of Larry Allain USDA-NRCS PLANTS Database

Cardinal flower, courtesy of Nelson DeBarros USDA-NRCS PLANTS Database

Indian grass, courtesy of Jennifer Anderson USDA-NRCS PLANTS Database

Clasping coneflower, courtesy of Thomas G. Barnes USDA-NRCS PLANTS Database

False Indigo bush, courtesy of Jennifer Anderson USDA-NRCS PLANTS Database

Patrick Heath Public Library

A Model for Sustainability

In 2008, the Boerne City Council, with support from citizens, had the desire, inspiration and foresight to look to the future for emerging sustainability practices and technologies.

The result was the Patrick Heath Public Library (PHPL) that opened June 4, 2011 and was awarded LEED (Leadership in Energy and Environmental Design) Gold certification by the United States Green Building Council. This is the first building on the Boerne City Campus located on North Main and Johns Road and first LEED Gold certified public building in Kendall County.

Photo by Paul Barwick

The 30,250 square foot, $7.1 million library utilized a comprehensive program of design and sustainability strategies to produce energy-efficient results measureable in a 37% reduction in water use and 17.5% reduction in energy use. The building is sited in the trees to effectively shade and capture natural sunlight and prevailing winds. A variety of stormwater management strategies were utilized to maximize water capture, flood abatement and minimize runoff.

Energy and Water Conservation Strategies included interior and exterior LED lighting technology, rainwater catchment and air conditioning condensate collection (23,400 gal. storage capacity), exclusive installation of native and adaptive, drought resistant plants, low flow drip and tree bubbler irrigation and a high tech evapotranspiration-based irrigation controller.

Site Resource Conservation and Protection Strategies included cultural resource surveys, substantial removal of exotic and invasive plant and animal species, protection of native tree root zones, restoration of overgrazed areas with native grasses, silt prevention fencing, and other retention methods using hay bales.

"The inspired goal for the PHPL was set by the City, its elected officials and citizens to produce a real world example of sustainability, of which, implementation of a variety of low Impact development strategies for this important community asset was of primary importance."

- Paul Barwick, City of Boerne

Patrick Heath Public Library

The Library As Classroom

The Patrick Heath Public Library was built not only to save water and energy, but also to heighten awareness of site and building design that facilitates life in the New Water Stewardship Culture.

The conservation practices implemented at the Library educate home and business owners about innovative energy and water conservation practices that they can adopt. The Library's integration of the natural and built environment along with the integration of historic and modern designs presents visitors young and old with an inspiring vision of a future that is more about reclaiming the simplicity of the past than implementing complex solutions in the future.

Photo by Paul Barwick

Natural and Cultural Resource Outreach Strategies include:

- Installation of donated vintage 40' windmill and water tank display.
- Relocated and repurposed 1870's limestone smokehouse.
- A grape arbor.
- An outdoor classroom for nearby schools.
- Interior and exterior interpretive elements that promote watershed and water resource awareness.
- Sustainable building practices.
- Wildlife habitat protection.
- Awareness of geologic features.
- Hosting of culturally significant events and resources.

What is LEED?

Leadership in Energy and Environmental Design (LEED) comprises a suite of rating systems for the design, construction and operation of high performance green buildings, homes and neighborhoods.

Developed by the U.S. Green Building Council, LEED is intended to provide building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

Photo by Cinde Thomas-Jimenez

Implementation of Best Management Practices

Low Impact Development Strategies (LID) include the implementation of a treatment plan of best management practices including a variety of pervious pavements, grass filter strips, parking lot bioswales, and terraced sedimentation and detention basins.

Cisterns or *rain barrels* are simply a means to capture roof runoff or air conditioning condensate and store the water for reuse on site or in building graywater systems. Cisterns are well represented as part of the agricultural landscape of central Texas, along with windmill-driven pumps. As a LID technique, cisterns provide storage and slow release of water to bioretention facilities or landscape irrigation systems. If used as part of an on-site water quality treatment plan, cisterns should be sized to drain within 120 hours (Austin ECM, Section 1.6.7.D). It should be noted that cisterns alone do not provide water quality treatment.

Photo by Janet Thome

Native and drought resistant plants provide aesthetically pleasing landscaping year-round while requiring minimal watering.

Photo by Milan Michalec

Implementation of Best Management Practices

Bioswales are landscape elements designed to remove silt and pollution from surface runoff water. They consist of a swaled drainage course with gently sloped sides (less than six percent) and filled with vegetation, compost and/or riprap.

Stormwater outfalls are the discharge point of a waste stream into a body of water.

Curb cuts are approximately a foot (0.3 meters) in width, and can be utilized in parking areas or sidewalks to allow for a drainage path of water runoff to flow into an area where it may infiltrate such as grass or a garden.

Photos by Paul Barwick

Photo by Janet Thome

Implementation of Best Management Practices

A *filter strip* is an area of vegetation, generally narrow and long, that slows the rate of stormwater runoff. It allows sediments, organic matter, and other pollutants that are being carried by water to be removed by settling out. Filter strips reduces erosion and stream pollution and can be a best management practice.

A *stormwater detention basin* or retarding basin is an excavated area installed on, or adjacent to, tributaries of rivers, streams, lakes or bays to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of a time.

Photos by Paul Barwick

Lessons Learned

In the course of building the Library, the city learned several important lessons:

- Allocate enough time to fully understand the existing site's conditions and constraints so that all of the opportunities for optimizing the use of the site can be accurately identified.
- Ensure that construction methods avoid soil compaction in all future water storage and percolation areas.
- Diligently protect tree root zones, install and properly maintain all dripline fencing.
- Utilize as much on-site material as feasible.

Streamside Stewardship

The Texas Hill Country

Whether you are a new land owner or ranching has been in your family for generations, you most likely have a deep appreciation for the inherent beauty of the Hill Country. Not everyone who appreciates the beauty of the Hill Country's natural scenery recognizes that the rolling, grassy hills, sinkholes, and rocky creeks also capture and protect our water sources. As a matter of fact, some landowners allow a strong sense of property rights to drive the belief that actions on their property do not impact others. They fail to understand how their property functions within a larger ecosystem whose healthy functioning is responsible for maintaining a consistent water supply for everyone living in the region.

Because every piece of the Hill Country is interconnected, it is vitally important that all landowners acknowledge their role in maintaining ecosystem health. Understanding how the various natural features on the land contribute to the integrity of the water cycle is the first step in becoming an effective land and water steward.

In this section on Streamside Stewardship, we will look at some of the most common natural features in the Hill Country and the role these features play in the New Water Stewardship Culture.

The Importance of Riparian Habitat

Clean, abundant water in the [Texas Hill Country] depends on an amazing natural system of tributary streams, creeks and riparian land that subtly works its magic-filtering, storing and releasing this precious resource. The transitional band of vegetation that occurs between waterways, large and small, and the upland regions marks the critical riparian landscape. This zone is where water, soil and vegetation interact. The plants within this system help determine its proper function– holding soil, and holding and cleaning water. Healthy riparian lands will determine the amount and quality of water in our rivers, bays and groundwater aquifers in the future.

Your Remarkable Riparian: A Field Guide to Riparian Plants Within the Nueces River Basin of Texas

Riparian areas are very resilient and can even be strengthened in times of drought when riparian plants are forced to expand their root systems as water levels recede. If damaged, a riparian area can often be restored by letting it recover naturally. In cases where severe damage has already occurred, a combination of stream bank stabilization and replanting of native vegetation may be required.

Reference: Wikipedia

Streamside Stewardship

The Riparian Zone

The word riparian is derived from the Latin word "ripa", which means river bank. Like many natural features mentioned here, riparian areas serve multiple functions including:

- Dissipating stream energy, resulting in less soil erosion and flood damage.
- Storing and gradually releasing water, helping to maintain streamflows. In this regard, some describe the riparianzone as being like a sponge.
- Sheltering streams from urban pollutants and other impacts of urbanization.
- Providing wildlife habitat.
- Providing popular recreation areas for fishermen, boaters and other outdoor enthusiasts.
- Regulating water temperature and reducing evaporation through shading.
- Contributing wood debris and plant litter to provide aquatic habitat and nutrients.
- Acting as a buffer to absorb impacts from urbanization.

Photo by Janet Thome

Because riparian zones have been degraded around the world, many riparian zones' valuable services have been lost. Some of the primary causes of riparian zone degradation include:

- Removal of woody plants, mowing riparian areas and dumping grass clippings into riparian areas. Mowing is a big culprit as is the belief that humans must clean up the creek.
- Removal of woody debris that may shelter wildlife and help to slow streamflow.
- Removal of trash is beneficial. Removal of woody debris is not.
- Dams that flood riparian zones.
- Livestock grazing that destroys riparian habitat.
- ining that leaves toxic minerals in riparian soil.
- Invasive animals such as wild hogs that damage stream banks.

Reference: https://en.wikipedia.org/wiki/Riparian_zone

A final note: No system of riparian protection is complete without considering the advantages of limited impervious cover in the contributing watershed. Conservation practices that limit development such as Conservation Easements can be an integral part of preserving the integrity of a riparian system. See page 57 for an overview of Conservation Easements.

Texas Springs

The Importance of Springs

As a nourishment for body and spirit, springs have no equal. There are fewer places now to experience this sense of rightness than at any other time in our past. Springs are drying up and the loss is more than that of historical interest.

[But] institutional and legislative interests are turning their attention to conserving Texas springs. Developing groundwater models and establishing groundwater management conservation districts are chief among these efforts. There is just a "rightness" about it that naturally appeals to us all, said Larry McKinney, TPWD *The State of Springs, 2005*.

The sense of "rightness" which Larry McKinney refers to in his 2005 *Texas Parks and Wildlife Magazine* article speaks to a quality in springs that is extraordinary. It seems that springs have their own voice that speak directly to our heart, giving us the sense that they must be protected. There is an intimacy and power to springs that captures the soul, perhaps because springs connect us with something in ourselves that is alive and life giving.

Springs hold a historical significance and over time reflect conditions in our ecosystem, making them accurate indicators of ecosystem health. They contribute to the baseflow for rivers, allowing some to flow year-round, even during times of drought. Their unique habitat sustains a variety of species, including rare, threatened, and endangered species.

Some springs, like San Marcos Springs, have never stopped flowing in recorded history. These perpetual springs provide stable recreation sites and hold historical and cultural significance.

Despite our passion for springs, some in Texas have gone dry due to over-pumping of their source aquifer. Comanche Springs, for example, has been dry since 1961 and may never flow again.

Quietly and energetically water seeps to the earth's surface forming a secluded Hill Country spring. Water from thousands of these springs converges to form our rivers that feed our reservoirs, provide habitat for wildlife, and a cool, peaceful place to recreate.

The New Water Culture embraces the survival of springs as profoundly important to our water future.

Photo by Ryan Bass

Rural Watersheds

The lush vegetation and abundant springs that the first settlers discovered in the Texas Hill Country fueled a ranching economy that flourished until the last half of the 20th century. Over time, heavy grazing, over pumping and periodic drought reduced spring flow and the amount of vegetative cover that supported ranching on a large scale. This section will discuss how poor range management in the past harmed our ecosystem and how holistic rangeland stewardship can help restore ecosystem health and play a role in the New Water Stewardship Culture.

Today we know that overgrazing without periods of rest does not allow vegetation sufficient time to recover. As pastures lose water-absorbing vegetation along with the root systems that hold soil in place, rainfall produces a silty runoff, filling downstream creeks and stock tanks with sediment. Springs that depend on local recharge cease to flow while creeks and stock tanks tend to dry up. Because insufficient forage and poor water quality reduces stocking weight, ranchers can be forced to supplement feed and pump water, or accept lower prices for their stock. Poor range conditions and extended periods of drought have driven numerous ranchers out of business.

We depend on the discharge of countless minor springs to generate flow in our creeks, contribute to downstream aquifer recharge, and fill our reservoirs. As indicated above, the vitality of these rural springs is determined by range condition. By extension then, regional water supplies depend on healthy range conditions to assist with recharge, minimize soil loss that can settle in reservoirs and shorten their life, and maintain high water quality in creeks and rivers. So how does a holistic rangeland stewardship approach help achieve this?

Photo by Milan J. Michalec

Photo by Ryan Bass

Rangeland Stewardship

Principles of Rangeland Stewardship

Effective Rangeland Stewardship is holistic. It recognizes that the amount of wealth ranching, farming, hunting or any other enterprise it generates depends on the land's health. Healthy land is resilient and dynamic, yet stable. It can cycle water, energy, nutrients and other elements that are vital to plant and animal growth while maintaining its integrity in times of heavy rain, prolonged drought, or extreme hot or cold weather. Producing wealth from land requires that the primary unit of production is a healthy, dynamic ecosystem characterized by:

- Abundant and/or consistent spring flow.
- Animal/plant abundance and diversity.
- A predominance of native species.

Management tools and techniques are selected for their ability to stimulate the cyclical energy flow that sustains these primary "products". The income generated from a healthy ecosystem then is a secondary product.

Examples of Tools, Techniques, and Value:

- Tool: Livestock. Techique: Short term, high impact rotational grazing with extended periods of rest. Value: Increased forage production, enhances soil health, encourages native biodiversity, improves ecosystem services.
- Tool: Fire. Technique: Prescribed burning during winter months, in accordance with a plan. Value: Maintains grasslands by reducing woody plants and encourages biodiversity.
- Tool: Machinery. Technique: Brush clearing. Value: Expands grazing areas and bird habit.

Cibolo Nature Center & Farm

Photo by Janet Thome

The Cibolo Nature Center & Farm is located on what was once Herff Ranch, established in 1852 by pioneer and surgeon Dr. Ferdinand Herff. In 1988 Carolyn Chipman Evans (a Herff family descendant) approached the City of Boerne to urge them to restore disappearing marshland and create nature trails in 100 acres of Boerne City Park. The city's cooperation and Carolyn's enthusiasm brought a rebirth to the land and a renaissance of public concern for conservation of Boerne's natural resources.

Open to the public since Earth Day 1990, the Cibolo Nature Center (CNC) provides education, research, entertainment and outdoor activities for more than 100,000 visitors a year, while promoting sound stewardship of land, water and wildlife.

Conservation

Land conservation and stewardship is particularly vital to the long term health of the watershed since rapid development, population growth and the increased use of groundwater threaten overall watershed health, including the people and wildlife that rely on it. Through collaborative conservation efforts, the CNC and its partners have protected nearly 1,300 acres within the Cibolo Watershed, including nearly five miles of a sensitive groundwater recharge zone along the Cibolo Conservation Corridor.

Children's Education

The Cibolo Nature Center is a leader in land stewardship and nature education in the Hill Country. Through its Outdoor Classroom, the nature center serves over 4,400 students annually throughout the San Antonio and Boerne region. The Outdoor Classroom brings biology and ecology to life with a TEKS aligned curriculum. Many of the lessons emphasize the importance of water quality and protecting watershed health.

Through its Nature Box program, the nature center conducts outreach to over 6,000 students in Boerne schools. This team of volunteer educators brings boxes of nature education materials to schools, including birds, butterflies, fossils, geology, space, soils, turtles, and many more topics that teachers can choose from.

Cibolo Nature Center & Farm

Land Stewardship and Sustainable Living

The nature center offers numerous programs to adults. Workshops cover a range of topics, including land management for wildlife, prescribed burning, riparian stewardship, species identification, native landscaping, vegetable gardening, rainwater harvesting, solar energy for the home, and many more topics.

Photo by Ben Eldredge

Citizen Science

The citizen science program coordinates teams of volunteer scientists to conduct surveys of the ecology at the nature center and neighboring preserve. Additionally, the nature center's Texas Watch stream monitors conduct routine assessments of water quality throughout Upper Cibolo Creek and along local reaches of the Guadalupe River.

The Herff Farm

Recently acquired by the Cibolo Nature Center, the Herff Farm is located on 62 acres adjacent to the nature center, along Cibolo Creek. The farm currently hosts gardening workshops, a farmers market, historical re-enactments, and numerous festivals.

The Cibolo Conservancy

The Cibolo Conservancy partners with the Cibolo Nature Center to conserve land throughout the Hill Country. By providing conservation easements to landowners, the Cibolo Conservancy has conserved over 13,000 acres of pristine Hill Country Land. The Cibolo Conservancy also offers estate planning workshops at the Cibolo Nature Center every fall and spring.

Photo by Janet Thome

Cibolo Nature Center & Farm

Habitat Management

The Cibolo Nature Center has four habitats under management spanning 100 acres: Tall Grass Prairie, Marsh, Riparian Streamside, and Oak/Juniper Woodland.

Tall Grass Prairie

The nature center's tall grass prairie is primarily composed of Switch Grass, Lindheimer's Muhly, Little Bluestem, and a diverse mix of forbes, including Engelmann's daisy and Maximillian Sunflower.

Maintaining a tall grass prairie requires periodic disturbance to reduce woody plants and to encourage biodiversity. Although the herd impact of grazing animals feeding and moving in dense bunches is one of the best ways to stimulate the land, the nature center is a public park, which is not very conducive to grazing animals. Therefore the Nature Center uses other methods to stimulate the land.

- Prescribed Fire: Fire is one of the primary tools in our toolkit.
  - Applied no more than every 5 years to a section of prairie.
  - Removes dead and oxidized vegetation to allow new growth.
  - Reduces woody plants, preventing transition to a woodland.
  - Recycles minerals from oxidized plant material, returning them to the soil.
  - Reduces leaf litter, which can choke out new growth plants.
- Prescribed Mowing: A substitute for burning and grazing.
  - Applied no more than once every 5 years.
  - Removes dead and oxidized vegetation that inhibit new growth.
  - Reduces woody plants, preventing transition to woodland.
- Selective removal of woody species: Willow Baccharus, Ashe Juniper Cedar, and non-native invasive plants.
  - Maintains prairie ecology by preventing a transition to a woodland.
  - May include chemical treatment with an herbicide, depending on the species being treated.

Photos by Ben Eldredge

Often woody plants are cut and brushed with herbicide to minimize the amount of herbicide used and reduce the potential for overspray. Herbicide is only used if absolutely necessary and if there are no sensible, natural treatment methods available.

Cibolo Nature Center & Farm

Habitat Management - Continued

Photo by Ben Eldredge

Riparian Streamside

The riparian zone along Cibolo and Menger creeks is mostly composed of trees and woody plants, including Bald Cypress, Sycamores, Walnuts, and many other species. The under-story is composed of a wide variety of woody plants and forbs.

Maintaining a riparian area is mostly a hands-off effort. Left alone, most riparian areas maintain a stable and healthy ecosystem. However, there are still some management practices that are important to maintaining healthy riparian areas.

Photo by Ryan Bass

These include:

- Remove garbage.
- Remove invasive species that can overpopulate a riparian area and choke out native wildlife. Plants that are routinely removed include Lingustrum, Chinese Tallow, Chinaberry, Japanese Honeysuckle, Vinca and other non-natives. Often these plants require treatment with an herbicide and every effort is made to reduce the amount of herbicide required because herbicides can be very harmful to aquatic life.
- Leave brush piles from flood events to slow stream flow during future flood events and to provide habitat for wildlife.
- Leave brush and branches in the riparian zone when it is necessary to cut or mow brush when they pose a hazard to humans. Never mow or clear brush in the riparian zone. This reduces its ecological health and function, leading to erosion and habitat loss.

Cibolo Nature Center & Farm

Habitat Management - Continued

Marsh

The marsh is a wetland frequently flooded during periods of high precipitation. Marshes clean water and are often protected due to their valuable ecological service. The CNC Marsh is composed of switch grass, cypress trees, sedges, and a variety of forbs and aquatic plants. Maintaining the marsh is mostly a hands-off approach to management. However, prescribed burning on rare occasions can be beneficial and may be employed in the future. To stimulate biodiversity in the marsh, two weirs have been installed to increase the flow of water to the marsh and raise the water level. The outflow from the marsh was recently changed so it flows over the nature center's prairie with the intention of increasing wetland habitat.

Woodland

The woodland is composed of Texas Live Oak, Ashe Juniper, Cedar Elms, Hackberry, and an assortment of other tree species. The understory is a blend of grasses and forbs, including grapevines, spicebush and varieties of milkweed. The woodland is left in its natural state with the exception of removing dead branches and trees that could be hazardous to visitors.

Canyonlands

The Cibolo Canyonlands rise dramatically from Cibolo Creek on the eastern edge of the CNC. The steady pulse of water over millions of years has carved deep, flowing paths through porous limestone cliff walls.

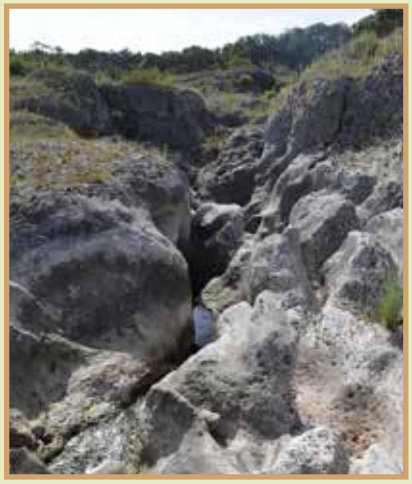


Photo by Janet Thome

Photo by Ben Eldredge

Texas mock-orange, big red sage and hairy sycamore-leaf snowbell line the banks. One of the only great blue heron rookeries in the county regenerates these majestic birds. Kingfishers, caracaras, red-shouldered hawks and great horned owls are a common sight. The federally endangered golden-cheeked warbler and black-capped vireo sporadically appear. The creek is home to the Guadalupe bass - our state fish, as well as the threatened Cascade Caverns salamander.

Monitoring

The Cibolo Nature Center is supported by a team of citizen scientists who help monitor the nature center's four habitats. This data helps the center assess the influence of land management practices on the nature center ecology. The data is also submitted to global data sets to help researchers understand the impacts of climate change, urbanization, and other influences on the park's ecology and wildlife. Water quality is monitored throughout the Upper Cibolo Watershed to keep the city informed about water quality conditions that may be harmful to human health.

Conservation Easements

Hill Country Residents

Many Hill Country residents are choosing to preserve their land in perpetuity with the use of a conservation easement. A conservation easement places permanent restrictions as to how the property can be used.

Each easement is tailored to the property and the landowner's specifications. A conservation easement becomes a permanent part of the deed and requires current and future landowners to abide by the provisions of the easement.

Placing a conservation easement on your property does not make the land public and it is not a government program. It is a voluntary agreement between a landowner and a land trust.

To learn more about conservation easements and their benefits, contact area land trusts, speak with other landowners that have gone through the process, and speak with your legal or financial advisor. Local land trusts in the Kendall County include the Cibolo Conservancy and the Guadalupe-Blanco River Trust.

A Landowners Story

Photo by Roberta Churchin

It has been a little over 10 years since I placed the first portion of my ranch under a conservation easement. In retrospect it was one of the smartest moves I have ever made, and I would recommend it to anyone who truly loves their land.

My ranch is a beautiful piece of Hill Country property. The kind of place a developer would love to grab and cut up into little pieces to be sold at a high price. I heard that a conservation easement might be a good way to keep that from happening without giving up ownership of the land. I started looking and I was amazed at the many things I discovered.

A conservation easement in its basic form is an agreement between a landowner and a land trust. Each conservation easement is tailored to the individual and the property. As the landowner, you decide how you would like your property to be used and maintained forever. The Land Trust agrees to ensure the provisions of the easement are being kept regardless of who owns the property in the future. Typically this is done during an annual inspection. The Land Trust has the obligation to protect your property even if it takes court action to make this happen.

Conservation Easements

A Landowners Story - Continued

Generally you retain ownership of the land and you maintain the right to sell it, leave it to the heirs of your choice, etc., and you donate the conservation easement to a Land Trust. In some cases a land trust may offer to purchase your easement, but in that case you may be obligated to do certain things, and complications can arise.

I looked into a conservation easement initially to protect my land, but soon discovered that there were huge savings on my personal income tax (property tax is usually not affected). In simple terms, the government knows that you are giving up land value because your land can no longer be highly subdivided, and they let you take the difference as a charitable contribution. This can reduce your personal tax by 30-50% or more. It can also reduce or eliminate inheritance tax. A conservation easement can be formed up to six months after a landowners death to help protect the land for the family. The time frame you can use your deduction may be limited to a few years, which is why I choose to protect my ranch in pieces rather than all at once. I should mention, I did not have to give up any of the things I love about my ranch. I can fish, hunt, run cattle, all the things I do now, and my heirs can do the same.

If you are considering a conservation easement, there are a number of things you should be aware of. Your land must have "conservable values." This could be protecting a riparian area, vegetation, wildlife habitat, or scenic views. You have several choices of Land Trusts to work with (over 40 in Texas), each with their own mission and criteria. Typically the Land Trust will request a donation or an endowment as they are agreeing to protect your land forever.

It takes time to create the conservation easement, as it may involve a survey, an appraisal, and some legal work, and there will be some expense involved. If you want the tax deductions, an appraisal will be required. Legal costs vary, but mine were only about $250 since I basically wrote my own easement documents after my land trust gave me other conservation easement documents to study while deciding what I wanted in mine. There will usually be an endowment cost paid to the land trust. For families that are "land rich" and "cash poor", special arrangements can sometimes be made.

Most of my ranch is now protected by conservation easements and one day it will all be. I love my land, and I literally sleep better at night knowing it will never be turned into a golf course or subdivision, nor can it be pawned off by greedy heirs. As you can tell, I also love helping others protect their land!

Bob Webster is one of the Hill Country's leading conservationists. He serves on the Cow Creek Groundwater Conservation District's Education Committee and has hosted the KTSA Garden Show since 1993. He is one of the state's leading proponents of organic and natural gardening, and is a recipient of the CNC Conservation Stewardship award. He is the co-owner of Shades of Green Nursery in San Antonio, founded in 1980.

A New Water Use Culture - Action Plan

Whether you live in the city, suburbs or on a ranch, your participation in a New Water Stewardship Culture is vital to the health of our environmental, economic, political, and cultural future. As indicated previously, participation boils down to three basic actions: **Conserve, Capture** and **Clean** our water.

The remainder of this manual presents tangible and practical ways to accomplish each of these tasks. The next section focuses on water conservation with an emphasis on conserving water in the home and yard. You will notice some of the same principles that apply to water friendly range management also apply to home and business landscaping.

The water conservation section is followed by rainwater harvesting. If you are not familiar with rainwater harvesting, you will find background information and tips for planning and building your own system.

Once you have the basics and are fully engaged in Conserving, Capturing, and Cleaning water, you will be on your way to spreading the word for others who still need to learn. Make it a point not just to change your own behavior, but to help others change as well.

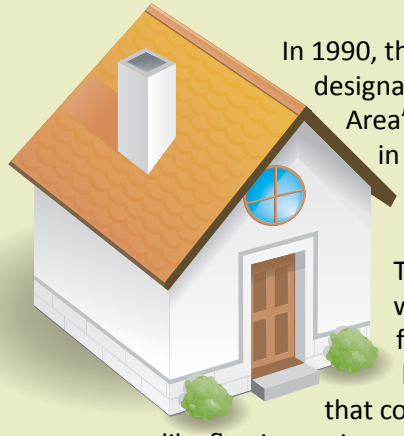
A new water stewardship culture will grow and thrive to the extent that you contribute to it. Take time to learn, to plan, to act and spread the word. A sustainable water future is possible, but it is up to you!

"As Texans we all have a role to play in managing our aquatic resources. Whether we know it or not, we all live in a watershed. The raindrops that fall in our lawns, fields, woods and pastures ultimately either replenish an aquifer or flow into a creek or stream. As a result, the actions we take and the decisions we make with how we use, manage, conserve and value water impact the needs of those downstream, including our fish and wildlife. Our aquifers, springs, creeks, rivers, bays, estuaries and gulf waters need you more than ever."

-Carter Smith, Executive Director
Texas Parks and Wildlife Department

Conserve

Conservation Priorities



In 1990, the Hill Country, including Kendall County, was designated a "Priority Groundwater Management Area" that will likely experience water shortages in the future, especially if we don't manage our water supplies wisely.

Water shortages can take many forms. They can trigger stringent drought rules and watering restrictions. Rural homeowners may find that their wells produce significantly less water, or go dry completely. Things that contribute to the natural beauty of our area, like flowing springs, creeks, and even rivers may cease to exist, especially in times of drought.

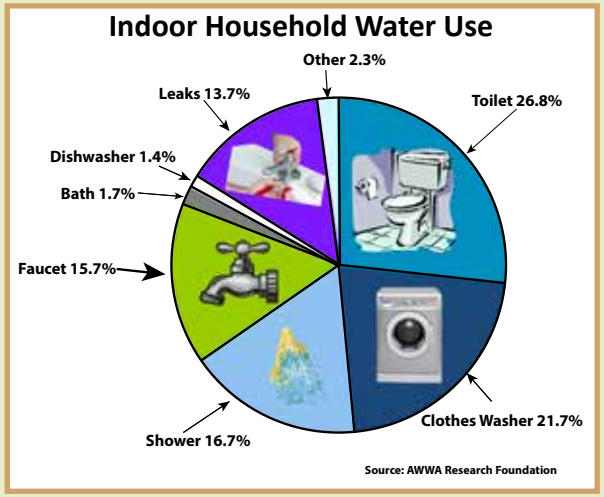
In the New Water Stewardship Culture people are committed to minimizing the impacts of water shortages on both nature and our communities. Moving toward this new culture requires that we understand where we use the most water and work to reduce our use in these areas. For most of us, water use is highest in and around our home, so reducing residential water use is a cornerstone of the New Water Stewardship Culture.

Conserve Water At Home

In a water waste culture, people believe changing water use at home requires too much expense and personal sacrifice. Reducing water use does not require tremendous sacrifice because we use more water than we need. Furthermore, we can install plumbing fixtures that conserve water for us. In this section, we will explore a variety of approaches to reducing home water use, beginning with plumbing retrofit and repair, recommended behavioral changes and how to reduce water use in the yard.

Plumbing Retrofit and Repair

Retrofit and repair begins with installing water-efficient fixtures and repairing old and leaking fixtures. Using high-efficiency toilets, water-efficient washing machines, rainwater harvesting systems, and water-efficient landscaping, all help reduce water use. Water-efficient showerheads and aerators for faucets can significantly reduce the amount of water used. Installing a water-efficient showerhead is one of the most effective water-saving steps that can be taken inside of a home. Insulate your hot water pipes so you don't have to run the water as long for it to get hot.



Install water-softening systems only when necessary. If you have one, save water and salt by running the minimum amount of regenerations necessary to maintain water softness. Know where the master water shut-off valve is located so in case of an emergency it can be shut off.

Conservation Priorities

Changing Water Waste Behavior

Bathtubs, showers, toilets, and bathroom sinks use the most water in the home. Because of this, they can hold the key to dramatically reducing household water consumption with minimal changes in your habits.

Saving Water in the House

- Take showers instead of baths. Showers with water-efficient shower-heads use less water than bathtubs. Keep your showers short and get in as soon as the water is warm enough. If you use the bathtub, reduce the level of water used by one or two inches. Turn off the water while shaving or brushing or brushing teeth.
- Test toilets for leaks by placing a dye tablet or food coloring in the tank. If the coloring appears in the bowl within a few minutes, the toilet has a leak that needs to be repaired. Never use the toilet to dispose of trash or medicine.
- Conventional washing machines use 32 to 59 gallons of water per load. Wash only full loads and use the lowest water level setting needed for light or partial loads. For added savings, use cold water when possible to save energy.
- Wait for a full load to run the dishwasher. Use a shorter wash cycle for dishes not heavily soiled. Scrape dishes rather than rinsing and let your dishwasher take care of the rest. When washing dishes by hand, do not allow the faucet to run while rinsing. Fill one sink with wash water and the other with rinse water. Soak pans rather than scrubbing them with running water and use your garbage disposal sparingly.
- Installing faucet aerators can cut sink water consumption in half.
- Don't use running water to thaw food. Use the refrigerator or defrost function on the microwave oven.

Energy Star appliances use less water than conventional appliances and are qualified by the EPA Energy Star Program. Energy Star washing machines use 30% less water and half as much energy as conventional appliances. Energy Star dishwashers use 18% less water and 10% less energy than conventional machines.

www.energysavers.gov/publications

Conservation Priorities

Changing Water Waste Behavior - Continued

Implementing conservation practices in the home is a first step in moving toward a new water use culture. Outdoor water use is generally greater than indoor use, especially during the spring and summer months. Implementing water conscious landscaping and watering practices in combination with indoor conservation is one of the most important steps we can take toward a New Water Stewardship Culture.

Landscaped yards, swimming pools, and vanity fountains can require large quantities of water if improperly designed and maintained. Outdoor watering frequently represents 40-70% of our total water use. This is because many homeowners as well as landscaping companies attempt to cultivate non-native plants that cannot survive without large amounts of watering. With proper management, you can have a beautiful, healthy landscape while using far less water than a conventional yard, totaling hundreds of dollars in savings each year.

Reducing Outdoor Water Use

An area where we use the largest quantity of water is in our landscapes. A well designed yard can be lush, colorful, carefree, durable, and beautiful while requiring little to no watering. Water conscious landscaping begins with proper planning and plant selection. You should also consider how you will use your yard, maximizing your hardscape or non-planted areas. When you think of hardscape think of patios, outdoor kitchens, sitting areas, hot tubs or gazebos, walkways, driveways, and RV parking areas.

Grassy areas should be minimized. You may only need a small grassy area if you have children, grandchildren, or pets. Remember, grass is the automobile equivalent of a gas guzzler. In the Texas Hill Country, we should become accustomed to turfgrass covering only 5% of the yard, rather than the 95% seen in water abundant areas. If you want a large grassy area, plant native grasses that don't require supplemental watering or a wildflower meadow. This alternative is an attractive choice and reminds you of the reason why you came to the Hill Country, to appreciate and perpetuate its' natural beauty.

Water Conscious Landscaping Practices

Simple Water Conscious Landscaping Practices

Water conscious landscaping practices do not require a lot of extra time or money. Begin with a few simple changes in how you care for your yard.

- If you mow your lawn, set the blade to a higher level, the grass uses less water. The more you water, the more often you need to mow. Give yourself a break and don't worry about mowing so often.
- When you do mow, leave the grass clippings to decompose naturally.
- To prevent evaporation, water lawns early in the morning or late evening during the hotter summer months. Don't water on windy days.
- Keep pools and spas covered when not in use.
- Use plenty of mulch around shrubs and trees to retain moisture and reduce run-off.
- An inch of water per week in the summer will keep most Texas grasses healthy. To determine how long to run the sprinklers, place straight-edged cans at different distances from the sprinkler and time how long it takes to fill an average of one inch of water in each can.
- Make sure sprinklers are watering the lawn and not the sidewalk or driveway.
- Use rain shut-off devices on automatic waterers.
- Sweep patios and sidewalks with a broom and not the watering hose.
- Use greywater. You can reuse up to 60% of your household water to irrigate your lawn with a properly installed greywater system. Not all areas allow such systems, so check your local regulations. Clarify what kind of system you can install. Homes with on-site sewage treatment facilities (septic and aerobic systems) may find it easier to install greywater systems.

After you have changed your mowing habits you will probably have a little extra time to implement some more water saving components in your landscape. Groundcover, planting strategies, cultivation techniques, and non-traditional sources of water can optimize your water use. Some additional practical tips can help you establish water conservation as a deeply rooted practice (pun intended). At the same time you will enhance the lasting beauty of your yard.

Photo by Milan J. Michalec

Water Conscious Landscaping Practices

Simple Water Conscious Landscaping Practices - Continued

The Role of Mulch

With such a strong focus placed on plants, we often overlook an important water conservation component, mulch. Use a thick layer to keep moisture in the soil and maintain plant health by providing habitat for beneficial mycorrhizal fungi. This fungus forms a special relationship with plant roots and reduces long-term water needs. Mulch also inhibits weed growth and reduces soil temperature. Add mulch annually, as it decomposes.

Planting Tips

Young plants typically need supplemental watering until they become established. When possible, plant during cooler months. Plant in stages rather than all at one time. Generally grass needs four to six weeks to become established. Perennials and small shrubs take two to four months and large trees and shrubs may take one to two years.

Watering Tips for Establishing Plants and Grasses

Turfgrass should be watered once a week and less if it rains. While perennials, small shrubs, and groundcovers should be watered every two to three weeks. Large trees and shrubs typically do not need to be watered except in drought, a few times per year.

Fertilizers and Spraying

When possible, use organic and natural products Organic fertilizers feed slowly, don't leach away, and do not increase water use the way synthetic products do. They also pose less of a pollution threat to our rivers, streams, and groundwater. In addition, they won't kill off the beneficial microbial life that you wanted to establish in your soils. If you need to control nuisance pests and plants, use natural products such as beneficial nematodes that won't pollute our groundwater and creeks or poison our families and pets.

Non-traditional sources of water for landscaping

Non-traditional sources of water include air conditioner condensate, captured rainwater and greywater from sinks, showers, and washing machines. Once you identify non-traditional sources of water for landscaping, you may wonder why you were using your drinking water to water outdoors. Non-traditional sources of water are free and can produce high quality water. There may be restrictions on their use however, so be sure to check with your area agencies or neighborhood associations before investing in these systems.

Water Conscious Landscaping Practices

Grasses

Planting turfgrass in Kendall County deserves careful consideration, as lawns are typically the largest users of water. The type of grass you choose is important, but the amount of grass is even more important. Many landscapes have too much turfgrass. In addition to their water consumption, they require the largest amount of labor to maintain (and exhaust from lawn equipment is a significant contributor to air pollution) and the largest amount of fertilizer. If insects and diseases become a problem they need the most intensive treatment.

To minimize the labor and expense, plant only the amount of turfgrass that you and your family need. Groundcover, shrubs and flowers require less maintenance and water and are more attractive. Cover large open spaces with wildflowers and native grasses.

Turfgrass Choices

Bermuda grass is the most common and widely used grass. Bermuda requires full sun to thrive. Bermuda and its hybrids can be planted from seed during warm weather or from sod anytime. The Tiff variety is often used on golf greens and is planted as sod only.

Buffalo grass varieties remain green with the least amount of water. They require full sun but are the least resistant to weed encroachment. There are two types of Buffalo grass. Our native type tends to form clumps and can be planted from seed. The turf variety has longer runners and is planted from sod only.

St. Augustine (incorrectly referred to as carpet grass) has always been popular as it is the only grass that does well in the shade and it does not harbor chigger mites. It is sometimes thought of as a high water user, but really takes no more water than other grasses. Unlike other grasses it does die when not watered. If you choose St. Augustine, plant small areas only, and realize that you may lose it in times of drought. Floratam is the most sun and drought tolerant variety. Avoid Raleigh as it is more susceptible to fungus diseases.

Zoysia grasses are popular, having a dense, attractive turf and relatively slow growth rate; it needs mowing less frequently. However, this slower growth rate makes it not as wear resistant as other grasses, an important consideration if you have children or pets. Because of its density, it is best mowed with a reel mower rather than the standard rotary mower. Zyosia grass needs full sun for best growth. Its narrow blades are more disease resistant than broad bladed types. It is usually planted from sod, but there are new varieties that can be started from seed during the warm season.

Plant Selection, Choose Wisely

Trees

Trees are usually the most prominent feature in any landscape and should be chosen carefully. When young, they are more susceptible to disease, less drought tolerant and easily damaged by deer or other livestock. It is important to protect them by placing a wire cage around them. Check with your local nursery for other options best suited for your area and tree species. Prior to planting trees, consider the location carefully, avoiding powerlines, underground plumbing or other factors that could create problems as the tree grows.

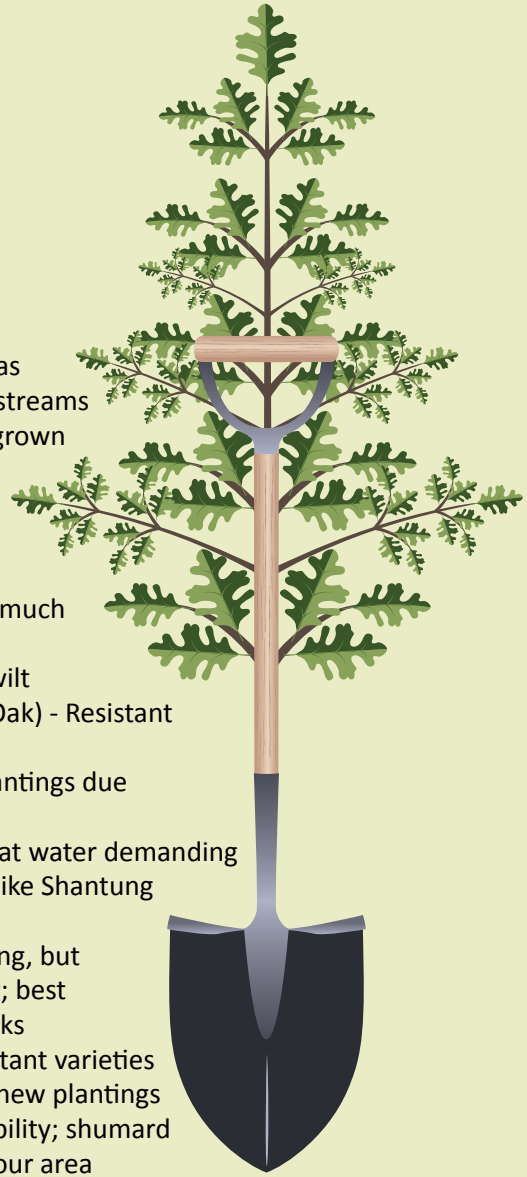
Listed are trees that typically do well in our area and can usually be found at local nurseries. This is not meant to be a complete list but gives an idea of varieties available.

Small Trees

Carolina Buckthorn
Chitalpa
Desert Willow
Eve's Necklace
Mexican Buckeye
Mexican Plum
Mountain Laurel
Redbud
Red Buckeye
Sabal Palm
Texas Persimmon - Can become invasive
Windmill Palm

Large Trees

Bald Cypress - Use in moist areas along and around perennial streams and ponds. Plant only trees grown from local seed
Bois d'Arc (Osage Orange)
Bur Oak - Resistant to oak wilt
Escarpment Cherry
Green (Texas) Ash - Native and much better than Arizona Ash
Lacey's Oak - Resistant to oak wilt
Mexican Live Oak (Monterrey Oak) - Resistant to oak wilt
Native Live Oak - Avoid new plantings due to oak wilt susceptibility
Montezuma Cypress - Somewhat water demanding
Maples - Bigtooth and hybrids like Shantung are best - avoid Silver Maple
Mexican Sycamore - Fast growing, but somewhat water demanding; best planted along perennial creeks
Pear - Plant only fireblight resistant varieties
Red Oak (Spanish Oak) - Avoid new plantings because of oak wilt susceptibility; shumard variety is poorly adapted to our area



Plant Selection, Choose Wisely

Shrubs

When choosing plants consider size and light requirements and plant them appropriately. Drought tolerant plants will need regular watering when first planted to develop a healthy root system.

These species typically do well in our area and can usually be found at local nurseries. This is not a complete list but gives an idea of varieties available.

Small Shrubs

Aspidistra
Compact Abelia*
Dwarf Barberry*
Dwarf Yaupon Holly**
Harbor Dwarf Nandina*
(avoid curly leaved nandinas)
Ornamental Grasses*
Red Yucca*
Upright Rosemary**

Medium Shrubs

Agarita**
Agave (Century Plant)
Boxwood**
Ceniza** (Purple Sage)
Compact Nandina*
Evergreen Sumac**
Flowering Sumac**
Quince*
Glossy Abelia*
Indian Hawthorne
Oleander**
(Susceptible to a new fatal disease)
Pittosporum
Primrose Jasmine*
Pyracantha*
Sandankwa Viburnum*
Sotol**
Southern Wax Myrtle*
Spirea

Large Shrubs

Anacho Orchid Tree*
Crepe Myrtle
Eleagnus
Flameleaf Sumac*
Lady Banksia Rose*
Mexican Redbud*
Mutabilis Rose
Pomegranite*
Possumhaw Holly**
Rusty Blackhaw Viburnum*
Texas Pistache
Vitex**

*Somewhat deer resistant
**highly deer resistant

Plants listed as being deer resistant may not hold true during drought conditions.

Plant Selection, Choose Wisely

Annual and Perennial Flowers

The plants listed here followed by a (p) are perennial in Kendall County. If we have an unusually cold winter, they may die completely, especially if they are not mulched. Those followed by an (a) are annual and typically only last a single season.

Even though these plants are drought resistant, they will need regular watering when first planted to help establish a healthy root system.

These plants typically do well in our area and can usually be found at our local nurseries. This is not a complete list but gives an idea of varieties available.

(p) are perennial
(a) are annual
*Somewhat deer resistant
**highly deer resistant
Plants listed as being deer resistant may not hold true during drought conditions.

Anisicanthus (p) - Reseeds profusely, making it somewhat invasive
American Beautyberry*(p) May have lavender, purple, or white berries
Asclepias (p)
Betony*(p)
Blackfoot Daisy*(p)
Bluebonnet*(a)
Buddlaea*(p)
Bulbine (p) - May have orange or yellow flowers
Calylophus*(p)
Chile Pequin (p)
Canna (p) - Dwarf and standard types.
Columbine*(p) - Red and yellow varieties
Copper Canyon Daisy*(p)
Coralberry*(p)
Coreopsis*(p)
Dahlberg Daisy*(a)
Damianita*(p)
Erigeron (p)
Esperanza*(p)
Fall Aster*(p)
Firebush (p)
Garden Phlox (p)
Gaura*(p)
Gayfeather*(p)
Gomphrena (a) - (southern bachelor buttons)
Iris (p) - Many varieties available
Lantana* (p) - Many varieties available
Madagascar Periwinkle*(a) Sometimes called annual vinca
Mexican Bird of Paradise*(p) Also called "Pride of Barbados”
Mexican Honeysuckle (p)
Mexican Mint Marigold*(p)
Mexican Oregano*(p)
Mexican Petunia (p)
Pansy (a)
Plumbago (p)
Portulaca (a)
Purple coneflower*(p)
Purslane (a)
Rudbeckia*(p)
Shrimp Plant (p)
Skullcap*(p) - Pink and white forms are best
Society Garlic*(p)
Salvia*(p) A large number of varieties are available
Texas Star Hibiscus (p)
Thryallis (p)
Turk's Cap*(p)
Winecup*(p)
Yarrow*(p)
Zexmania*(p)

Plant Selection, Choose Wisely

Vines, and Groundcovers

Asiatic Jasmine - Standard, dwarf, and variegated
Clockvine *
Coral honeysuckle * - Better than the invasive Japanese
Crossvine *
English ivy
Liriope
Monkey Grass
Passion Vine *
Prostrate Rosemary **
Queen's Crown *
Santolina ** - Green and gray leaf varieties

*Somewhat deer resistant
**highly deer resistant

Plants listed as being deer resistant may not hold true during drought conditions.

Conservation Resources

Websites

Cow Creek Groundwater Conservation District
www.ccgcd.org

Texas Water Conservation Association
www.twca.org

Barton Springs Edwards Aquifer Conservation District
www.bseacd.org

Edwards Aquifer Authority
www.edwardsaquifer.org

Texas Water Development Board
www.twdb.state.tx.us

Guadalupe-Blanco River Authority
www.gbra.org

Capture

Rainwater Harvesting Overview

Clean, pure water. It is such a beautiful thing, in so many ways. There are few things in life that are more important to us. We could go for a while without electricity if we had to. The same thing is true of gasoline, inconvenient as it might be. Most people have enough food in the pantry to last at least a few days. But take away water and we would be in trouble in a hurry.

Most of us take water for granted. You turn on the faucet and there it is. Imagine for a minute what would happen if it suddenly wasn't there. No water for cooking and drinking. No water for bathing and sanitation. No water for public safety. It would be a nightmare.

Our water resources in the Texas Hill Country are limited in quantity. Most of us have enough water to meet our needs now, but as our population grows, more people will be relying on these same water resources. Recent droughts have shown how uncertain and unpredictable our water supply can be, resulting in some rural landowners experiencing low production or totally dry wells.

Photo by Milan J. Michalec

What is the answer?

Conservation is the first of three vital elements for water sustainability. Many people are going a step further, capturing the best water source we have: rainwater. The Cow Creek Groundwater Conservation District and Texas Water Development Board offers written material on rainwater harvesting that can help you conserve and capture this vital resource.

Properly collected, stored, and managed, rainwater can supply all the water most of us will ever need, making you self-reliant. This enables you to have total independence, never having to rely on others for your water. It gives you complete control over your water future.

Rainwater can also provide benefits even if you are on a reliable public water supply system. You can have water that is not regulated by drought stage rules and save you money. Clean water can be costly in some areas, and the cost is only going up. Since most municipal utilities base sewer rates on a customer's water use, it can save you money on this part of your bill as well.

Rainwater capture is not a new idea. It has been around for thousands of years. Ancient civilizations relied on it. One elaborate system dates from 1,700 B.C. Some, like the Romans, devised elaborate systems to harvest and store it using reservoirs and cisterns.

Rainwater Harvesting Resources

Rainwater Harvesting in Kendall County

Closer to home, many historic houses in the Hill Country have large cisterns that were once the family's primary source of water. Today's technology makes it easier for virtually everyone to benefit from mother nature's most abundant water supply. Many Hill Country families have been successfully using rainwater as their sole water source for years, even during severe droughts.

The 2005 edition of the *Texas Manual on Rainwater Harvesting* states "more than 400 full-scale rainwater harvesting systems have been installed by professional companies in Central Texas. An estimated 100,000 residential rainwater harvesting systems were in use in the United States and its territories."

It states, "Harvested rainwater may also help some Texas communities close the gap between supply and demand projected by the Texas Water Development Board (TWDB), as the state's population nearly doubles between 2000 and 2050."

"In fact, rainwater harvesting is encouraged by Austin and San Antonio water utilities as a means of conserving water. The State of Texas offers financial incentives for rainwater harvesting systems. Senate Bill 2 of the 77th Legislature exempts rainwater harvesting equipment from sales tax and allows local governments to exempt rainwater harvesting systems from property taxes. Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus."

"Rainwater harvesting is practical only when the volume and frequency of rainfall and size of catchment surface can generate sufficient water for the intended purpose."

Rainwater Harvesting Resources

Rainwater Harvesting In Texas, Dr. Hari J. Krishna
www.ccgcd.org/Education/RWH_in_Texas.pdf

The Texas Manual on Rainwater Harvesting, Dr. Hari J. Krishna, P.E., TWDB, Third Edition, 2005, Austin, TX
http://www.twdb.state.tx.us/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

Rainwater Harvesting
http://rainwaterharvesting.tamu.edu/

Rainwater Harvesting Potential and Guidelines for Texas, Report to the 80th Legislature, Texas Rainwater Harvesting Evaluation Committee

Rainwater Harvesting Reasoning

Why Harvest Rainwater?

Financially speaking, rainwater harvesting for potable water can not compete with water supplied by a public utility. However, it is often cost competitive with the installation with a well in a rural setting.

When you consider the depletion of groundwater sources, the poor quality of some groundwater, high tap fees for isolated properties, the flexibility of rainwater harvesting systems coupled with modern methods of treatment provide excellent reasons to harvest rainwater for domestic use.

The third edition of the *Texas Manual on Rainwater Harvesting (2005)* is available online for download (link can be found on page 71). This manual serves as a primer in the basics of residential and small-scale commercial rainwater harvesting system design, and is intended to serve as a first step in thinking about options for implementing rainwater systems.

The benefits of harvesting rain are extensive. Review this list to see if you would like to reap the rewards:

- Rainwater is a viable option as a water source.
- Drought stage rules don't apply to its use.
- Stored rainwater provides water for gardening, landscape watering, and ornamental fountains and ponds.
- Using rainwater reduces the demand on groundwater sources and helps our aquifers.
- Using and maintaining a rainwater harvesting system makes you more conscious of the water you are using.
- Installing and maintaining a rainwater system is easier and often less expensive than drilling and maintaining a well.
- Rainwater is naturally clean.
- Rainwater is soft, making a water softener unnecessary.
- Harvesting rainwater gives you peace of mind about your water supply. You know how much water you have available and helps to conserve our precious aquifers and springs.
- If your pumps and UV light have a battery back-up, you never have to worry about power outages interrupting water service.
- Stored rainwater is a ready source of water for firefighting.
- If you do run out of water, you can fill the tanks using an alternative source.
- There are tax incentives for harvesting rainwater. Parts to build a rainwater catchment system are exempt from sales tax. The value of your system is not included in your ad valorem property tax base. In a number of counties cash and tax rebates and credits are also available. Check with your local tax district.

Photo by Milan J. Michalec

Rainwater Harvesting Implementation

Planning and Construction

Anyone relatively "handy" can build a simple rainwater harvesting system. Place one or more rain barrels of your choice under your gutter downspouts and you are ready to go! Even with a large system it can still be easy, especially if you get a few neighbors and friends to help. If you prefer using a contractor, there are a number of qualified companies that can install your rainwater harvesting system. If you choose to use a contractor, stay involved in the planning process to better understand what is involved.

Before you begin construction, decide what you want to use the water for. This helps define what type and size of system you will need. A basic rain barrel system can provide water for ornamental fountains and landscaping. This can be very helpful when drought stage restrictions are in place. They do not restrict the use of rainwater. If you plan to use the collected water for a large outside area, use a larger system with more capacity to allow for watering of larger gardens, yards, fountains, pools and ornamental ponds.

If you are looking for a system that can provide water for indoor use, including drinking water, you should consider additional factors including expense and space.

Photos by Milan J. Michalec

Rainwater Harvesting Implementation

Planning and Construction - Continued

Larger systems are more expensive to install and require more room for storage tanks. If space is a factor, you can have tanks installed underground. Often, people begin with a smaller system and expand as they see how beneficial the harvesting of rainwater can be. As a general rule, install as much storage as your budget and space will allow. If you are considering a potable water system as your primary source of water, you should allow for 10,000 gallons of storage for each person in the household. This should carry you through the driest year on record.

Another factor to consider is area rules and regulations. If you live in a neighborhood that has a homeowners association, check to see if there are any guidelines to be considered including the size and location of the storage tanks.

After you have an idea of what type and size system to install, you need to consider the catchment area. It could be the roof of your home, an outbuilding, barn, workshop roof or even the rain barrel used for storage. The potential for catchment average is 1,000 square feet of roof area, which can collect up to 600 gallons of water for each inch of rain. This means if you have 3,500 sq. feet of roof, you would collect over 2,000 gallons of rainwater for each inch of rain. In the driest year on record, you would have collected over 20,000 gallons, which is a lot of water. With the average rainfall for the last hundred years, your roof would catch over 60,000 gallons of rainwater each year!

Efficient gutters and a series of pipes are needed to transport water to your storage tanks. With most larger systems, you will design a series of pipes to carry the water by gravity flow to a central point for storage. Plan on using large diameter pipes of three to four inches, to ensure you capture every drop of water during a hard rain.

Filters and screens are also used. The primary filters keep leaves and debris from washing into the tanks. Secondary filters are used for larger systems, especially those providing drinking water, to trap smaller particles. With potable water systems you will also want a “first flush” device that captures and diverts the first few gallons of water that come off of a dirty roof.

Maintenance of the system requires filters to be cleaned. Install the filters in an area that is easy to access to facilitate the maintenance of your system.

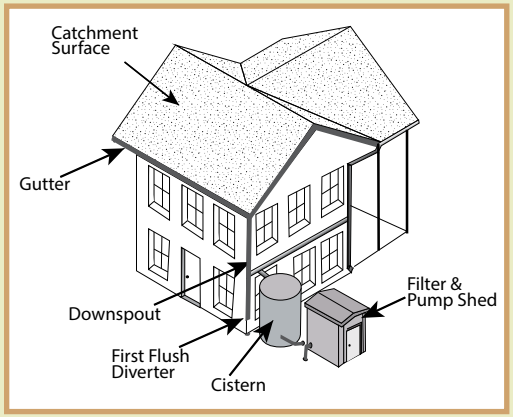
Photo by Milan J. Michalec

Rainwater Harvesting Implementation

Planning and Construction - Continued

Once you have made the decision to design and install a rainwater harvesting system, the following checklist can help you avoid wasting time and money.

- Leaves, pebbles and other debris can clog gutters and pipes decreasing the systems efficiency. Install a fine mesh gutter guard to minimized the need for repairs.
- Between storms, soot, dust, and other debris may be deposited on your roof and can degrade the water quality in the storage tank. Installing a first flush device is recommended to bypass the first few gallons of water, allowing only clean water to enter the storage tank.
- Before installing your system, perform a thorough site inspection to make sure you have a level and secure platform for the storage tank. As a tank fills, bare soil may shift under the weight of the water, creating unsafe conditions.
- Use plumbers tape or other strapping material to secure smaller tanks to a secure structure for added support.
- Plan an overflow system so during large storms your rain storage tankdoesn't overflow. A modest 1,000 square foot roof will produce ~600 gallons of run off during a one inch storm. Discharging overflow to an adjacent landscape or a rain garden is an excellent way to maximize stormwater retention on your property.



- Use smooth pipes instead of flexible piping (a food grade material is preferred). This will maintain water quality and prevent mosquitoes from taking advantage of pooled water in flexible pipes.
- When installed properly, rainwater catchment systems will not allow mosquitoes to breed. All tanks should have a screen to ensure mosquitoes cannot enter the barrel and all overflow systems are designed to prevent water from standing for more than 48 hours.

Rainwater Harvesting Arguments

System Pro's and Con's

Type of System	Description	Pros	Cons
Rain Barrels	A 55 gallon USDA-approved food grade barrel is commonly used. An inexpensive adapter kit that can be purchased for a few dollars will allow you to place a hose bib toward the bottom for easy watering.	Simplest and least expensive way to harvest rain water. Inexpensive, $25.00 to $35.00	Smaller sizes do not store large quantities of water.
Ceramic Urns	Available in a variety of sizes.	Attractive	Heavier than plastic barrels.
Storage Tanks	Available in various sizes up to 5,000 gallons. Usually fitted with one or more connection points at the top for filling and an outlet point at the base. They are available in more than one color and different gauges or wall thickness.	Made of durable UV resistant plastic. Thinner ones are less expensive and lighter in weight.	Lighter tanks are not nearly as durable.

Photo by Chase Fountain, TPWD

Rainwater Harvester Profiles

Rain Catcher Award

John Kight, CCGCD Board of Directors

When the Kights purchased land to build their home in Boerne, they investigated the availability of water in the area and the cost to install a groundwater well. They discovered that groundwater in the area was hard. Containing both iron and sulfur that would need to be treated before the water could be used. The cost to install a well would have been in excess of $26,000. Under these circumstances, they concluded that harvesting rainwater was a better option and rainwater would be their sole source of water supply.

- Kight Residence, Boerne, Texas
- Designed by John Kight
- System capacity is 34,650 gallons, using six 5,000-gallon and three 1,550-gallon cisterns
- Catchment area is 6,400 square foot
- Water use for potable and non-potable

Photo provided courtesy of John Kight

"You wouldn't believe the number of calls I have been getting," said John. With a chuckle, he tells them they should have had a system in place when we were getting rain. But, he is quick to point out that now is a good time to install one to be ready for when the next rain comes.

Rainwater Catchment... Where Every Drop Counts.

By Dixie Pape -- 7/15/2009

Photo by Alvin Schuerg

Rainwater Harvester Profiles

Rain Catcher Award - Continued

Constructed in 2002, the Kight's rainwater collection system includes a 6,400 square foot roof area, six 5,000 gallon, and three 1,550 gallon above-ground polypropylene tanks for collecting rainwater. Collectively, the tanks have a maximum holding capacity of 34,650 gallons. The system is almost entirely gravity driven, except for a pump that is used to move water into the house.

Water collected from the roof initially passes through a double-weave sock filter to remove solid particles such as dust, leaves, bloom, and bird droppings. From there, water targeted for potable supplies is pumped through a 5-micron cloth filter, then through a 3-micron charcoal filter, and finally through an ultraviolet filter to kill bacteria resulting in water that is almost completely free of total dissolved solids. The EPA standard for total dissolved solids for drinking water is set at 500 milligrams per liter. The Kights typically have the water tested by a laboratory twice a year. They also use the harvested rainwater to irrigate their lawn.

The system was designed and installed at a cost of $14,500. The annual maintenance cost is approximately $100, mainly for filters and ultraviolet lamp replacements.

The Kights are dedicated to spreading the word about the benefits of rainwater harvesting in the Hill Country and have conducted over 50 workshops. They have also given numerous presentations to interested community groups. To date, over 1,000 individuals have visited their home to get a first-hand look at the system and taste the water.

Overview and Best Management Practices

If you are ready to start building a rainwater harvesting system, congratulations! This will be one of the most rewarding and enriching experiences of your life. Harvesting and caring for your own water will make you and everyone who sets foot in your home more sensitive to water and how valuable it is. It will also make you much more aware of how water is used in your community, county, state and around the world.

Touring a rainwater harvesting system is an excellent way to get a feel for what kind of system is right for you and what it might take to build one. If you don't have access to a system to tour in person, take a moment to review the two *Rainwater Harvester Profiles* in this section. In addition, be sure to view the companion videos to this Manual. These videos feature examples of rainwater harvesting systems and provide helpful information on how to plan and build a system that meets your needs.

Rainwater Harvesting Profiles

A Rainwater Harvester's Story

Milan J. Michalec, CCGCD Board of Directors

Photo by Janet Thome

Milan J. Michalec and his wife Tracey, has been harvesting rain and other reclaimed water at their home as a water management strategy. They understood that water is precious, and living in the Texas Hill Country brought that point home. The Michalec's began harvesting and storing and rainwater in 2006. They realized that using harvested rainwater for their landscaping would eliminate their use of groundwater for these needs, thereby saving it for the springs and creeks.

The Michalec's started capturing rainwater in larger quantities using common 55 gallon plastic barrels. Eventually increasing their supply by adding condensate collected from the home AC system and greywater from the washing machine. Placing a dozen of these barrels throughout areas in the yard and garden provided water where and when it was needed. Since 2008, the core of this network has been a single 1,550 gallon storage tank that reliably refills throughout each year, even during drought, capturing rainfall that falls to the roof of a 200 square foot gazebo.

Milan's system is featured in the *Water Yours, Mine & Ours* companion video.

Their first consideration was determining the systems purpose. Would it be used for indoor use and drinking water (potable) or outdoor use? This decision was a necessary first step. They then needed to calculate how much water they wanted to have available on demand. This helped determine how much storage capacity would be needed and if the capture area was adequate. They chose to harvest rainwater for outdoor watering (non-potable usage), knowing they could modify the system for drinking water at a later date.

Photo by Andrew Michalec

The size of the storage tank was based on the need to store enough water for a garden, fruit trees and landscape designed for the Hill Country—Buffalo Grass, native plants and mulch.

Photo by Milan J. Michalec

Rainwater Harvesting Profiles

A Rainwater Harvester's Story - Continued

The Michalec Rainwater Harvesting System (RWHS) began with the gazebo. Its roof is approximately 200 square feet and captures more than 100 gallons of water for each inch of rain. The annual potential for captured rainwater can be more than 3,000 gallons. The tank is 1,550 gallons which meets the annual observed demand. Another 600 gallons can be stored in ten 60 sixty gallon containers. The size and quantity of storage tanks should be determined by your intended use of the rainwater.

Photos by Milan J. Michalec

The Michalecs realized early on that it was important to research the project. In order to determine how much storage and capture area is needed, an excellent source is available on the Texas A&M AgriLife Extension website that can be viewed at: www.rainwaterharvesting.tamu.edu/calculators/. Another source is the Texas Water Development Board (TWDB) viewed at: www.twdb.state.tx.us/innovativewater/rainwater/resources.asp.

Tips From the Michalecs

The most basic first flush device can be built in the downspout that leads to the storage tank. Considering that an 18" section of a 4" PVC pipe holds about one gallon of water and these two sections total six feet, this device is adequate to catch the dust, dirt and bird droppings that would be washed from a roof. After the rain, simply open it and drain out the dirty water.

Gutters and downspouts were purchased at local big box stores in standard dimensions and installed with simple tools.

Filters to screen out leaves were purchased at the same places.

Additional screening of unwanted material was installed immediately below the leaf screen. Milan bought these from commercial sources, but they could have also been custom made. A final filter made of nylon mesh was installed just before the water enters the tank.

Rainwater Harvesting Profiles

A Rainwater Harvester's Story - Continued

Photo by Milan J. Michalec

Still needing a way to access and distribute the stored water, it was decided a gravity system was acceptable for small amounts. They also considered an electric sump pump for larger storage. A sump pump can be dropped into the tank through the access cover. Pumps of this type can be purchased at the same kinds of commercial stores as the other equipment.

Milan plugged in the pump to a power source and used a common hose with a positive shutoff valve. This performed very well. The pressure provided by a 1/3 horsepower pump is powerful enough to push water through a 100 foot length of hose.

Stored water from the main tank is pumped to smaller barrels for landscape watering. The Michalecs use the same pump when watering by hand or use drip tube irrigation for minimal water loss.

The total cost for the RWHS described here was less than $1,200, excluding the gazebo. More than half of the cost was for the main storage tank. The system has been in use since 2008 and has not dropped below 25 percent of capacity even during times of drought.

For the Michalecs, maintenance of the system has been minimal, including cleaning and replacing filters periodically and keeping rain gutters clear of debris. The lesson here is simple: the cleaner the water going into storage, the cleaner it will be when it is taken out of storage.

When you look to the sky for your water supply, what you capture is limited only by your imagination.

For detailed information on RHS in Texas see the *Texas Rainwater Harvesting Manual* available online: http://www.twdb.state.tx.us/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

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Scan the QR code with your phone using a barcode reader app to download or forward a link of this manual online.

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