February 2015

DROWNING IN THE CENTRAL TEXAS DROUGHT

Austin Area Research Organization
White Paper Executive Summary

Given the current drought, does it make sense for Austin's water supply to be solely dependent on the amount of rainfall that enters the Highland Lakes?

FACT: Central Texas is currently in the midst of a major drought.

FACT: Central Texas' population continues to grow.

FACT: The City of Austin has only one source of water.

THE BOTTOM LINE: If future rainfall runoff to the Highland Lakes mirrors the last four years, the lakes may contain only three to seven years of an adequate water supply, even with aggressive conservation.

ACTION ITEM: The City of Austin and Lower Colorado River Authority should work together with a renewed sense of urgency to analyze conditions and evaluate new water supply options.

Key Points

- Central Texas appears to be facing a long-term downward trend in the amount of water available from the Highland Lakes.
- Inflow – or lack thereof – is the most urgent of all the issues contributing to a pending water shortage. Inflow is now drastically lower than it was when the drought began in 2008 and to make matters worse, the annual inflows to the Highland Lakes in 2014 were the second lowest on record and according to LCRA, "seven of the 10 lowest annual inflows have occurred since 2006."
- Depending on assumptions made about future inflows to the Highland Lakes and considering the last four years of experience, we may have from three to seven years before the lakes are not able to provide an adequate water supply, even with severe use curtailment.
- Austin needs to develop new water sources. The good news is that options for new supplies do exist.
- We can solve Austin's water availability issue if we're willing to take immediate action.

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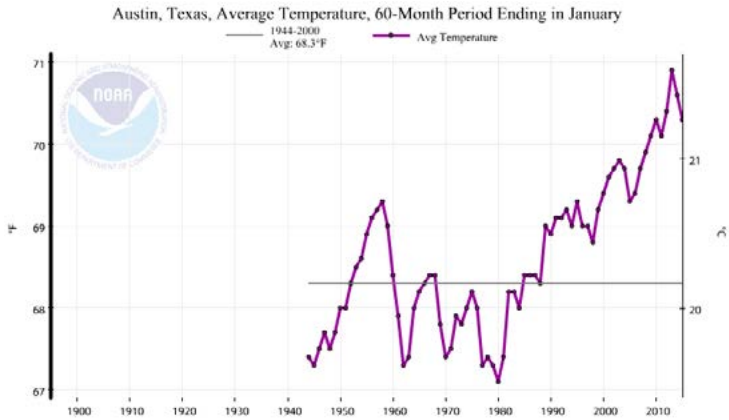
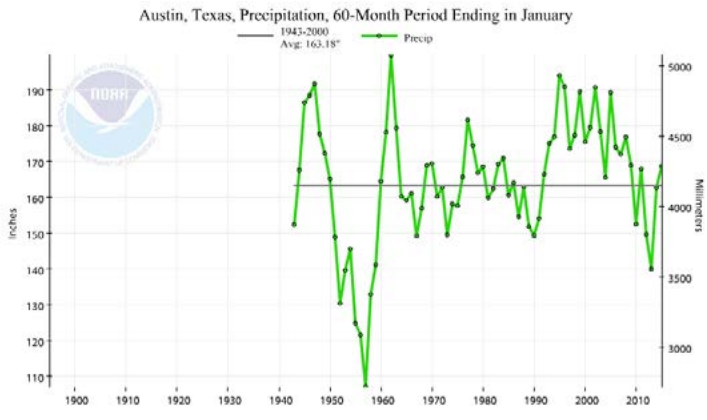
Is Central Texas In A Mega-Drought?

The current drought in Central Texas began in March 2008, the last point in time both Lakes Travis and Buchanan were full. Temperature and rainfall patterns provide a sobering look at the situation gripping the region.

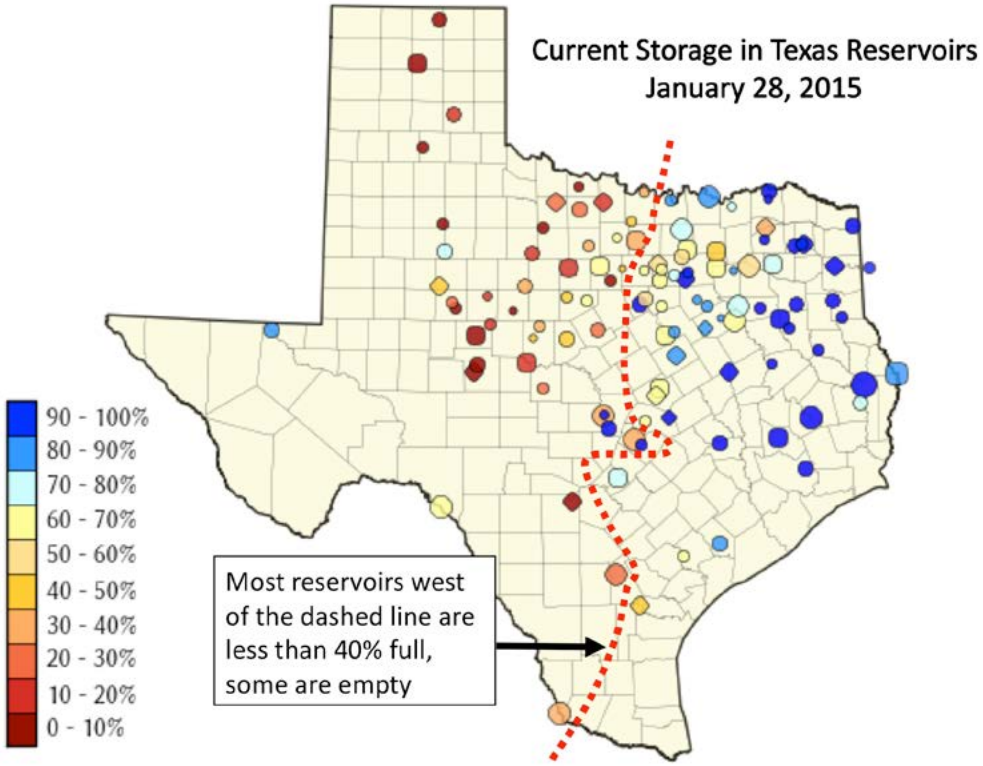




Source: http://www.ncdc.noaa.gov/cag/time-series/us

While 2014 wasn't as dry as the immediate preceding years, the ground in Central Texas is parched due to prolonged dry periods and warmer temperatures. Tree ring and ice core data show that over the past 1,000 years, periodic "mega-droughts" lasting 20 or more years have occurred. Meteorologists are beginning to speculate that Central Texas may be in such a drought.

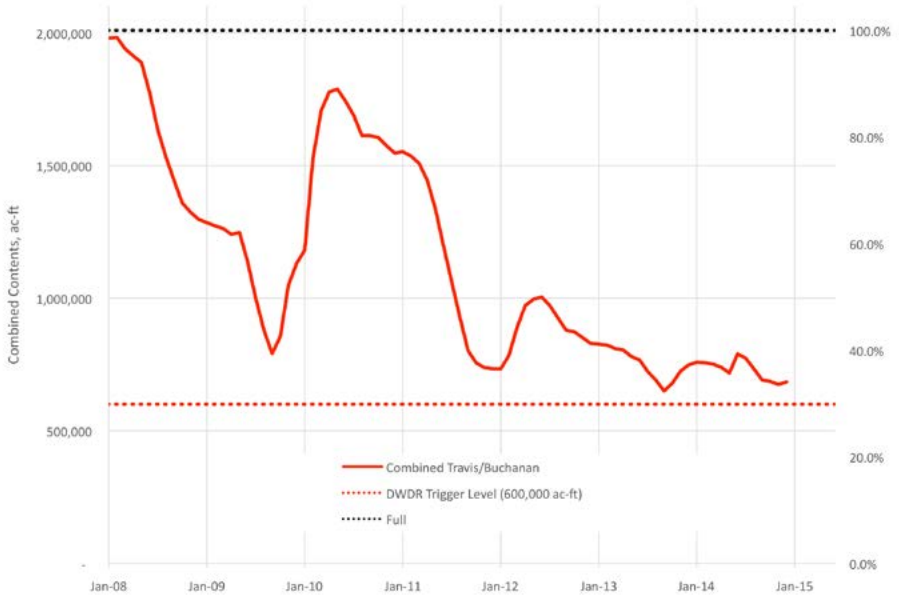
In a February 1, 2015 article in Science Advances, Benjamin Cook, a NASA Goddard Institute scientist and his colleagues reported that, "the mean state of drought in the late 21st century over the Central Plains and Southwest will likely exceed even the most severe mega-drought periods of the Medieval era in both high and moderate future emissions scenarios…"



Source: Texas Water Development Board

Consistent with this observation is that in Texas, western reservoirs are at or near empty (0-20%) while eastern reservoirs are beginning to show signs of stress, indicating an eastward moving drought line.

On February 18, 2015, Lower Colorado River Authority (LCRA) general manager Phil Wilson added to the evidence by saying, "We're in a historic drought like we've never seen in our lifetimes. Based on our preliminary analysis of 2014 data, we are now in a new critical period." A new critical period means Central Texas is marking the driest conditions on record, eclipsing the 1947-57 drought that until now was the worst on record for this region. The graph below shows the cumulative effects of these conditions on Highland Lake levels.

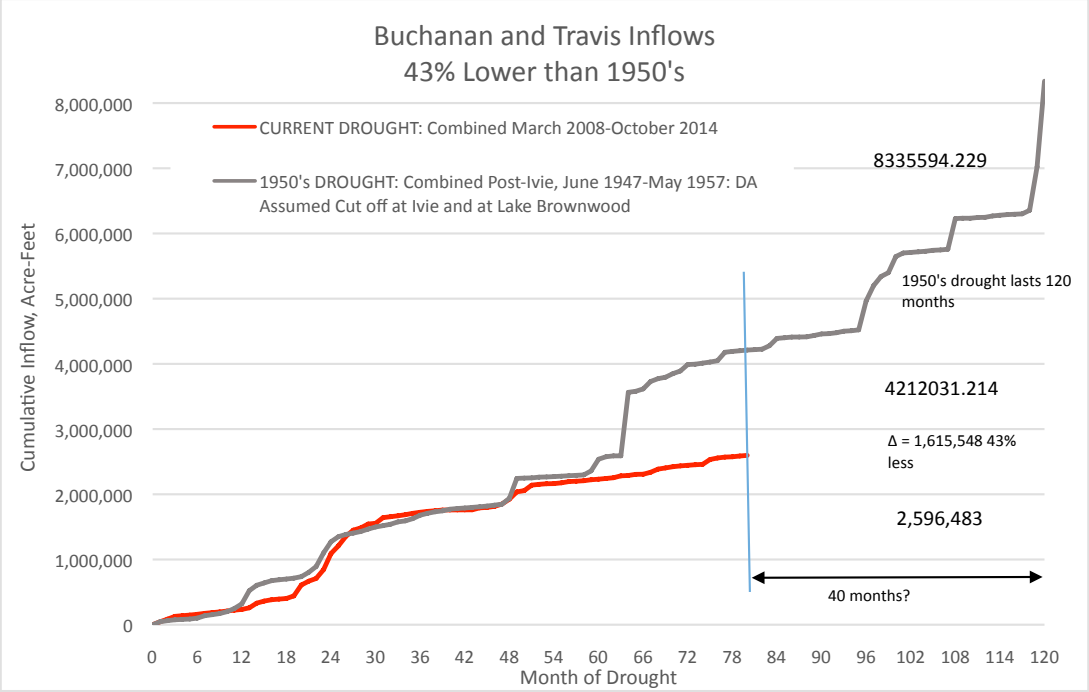


Source: Data from LCRA

Note: DWDR is "Drought Worse than the Drought of Record"

The strongest indicator of the presence or absence of a drought for a water storage system like the Highland Lakes is the inflow these lakes receive. Inflow – or lack thereof – is the most urgent of all the issues contributing to a pending water shortage. Inflow is now drastically lower than it was when the drought began in 2008 and to make matters worse, the annual inflows to the Highland Lakes in 2014 were the second lowest on record and according to LCRA, "seven of the 10 lowest annual inflows have occurred since 2006."

Total inflows for the period March 2008 to the end of October 2014 were 43 percent less than for the corresponding period in the 1950's drought. Warmer temperatures have vaporized soil moisture so that rather than flowing into the Highland Lakes reservoirs, a higher ratio of new rainfall is now being absorbed by the soil.



Source: USGS data and LCRA inflow computation methodology

In addition, multiple upstream reservoirs built since the 1950's drought, including the O. H. Ivie Reservoir, built in 1990 and located between San Angelo and Brownwood, are capturing water that would have previously flowed into Lake Buchanan at the northwestern end of the Highland Lakes chain. The steep decline in flow measured on the Colorado River near San Saba reflects this.

In the near future, the City of Corpus Christi will begin drawing its portion of the Garwood rights – the second most senior water right – from the Lower Colorado River. Corpus Christi's draw will take an additional 35,000 acre-feet per year from the Colorado River system. This is equivalent to more than 25 percent of Austin's current demand.

The bottom line: Without significant additional and sustained rainfall in the Highland Lakes watershed, the combined storage of Lakes Buchanan and Travis could fall below 600,000 acre-feet — the trigger point for declaration of a drought worse than the drought of record under the LCRA Water Management Plan.

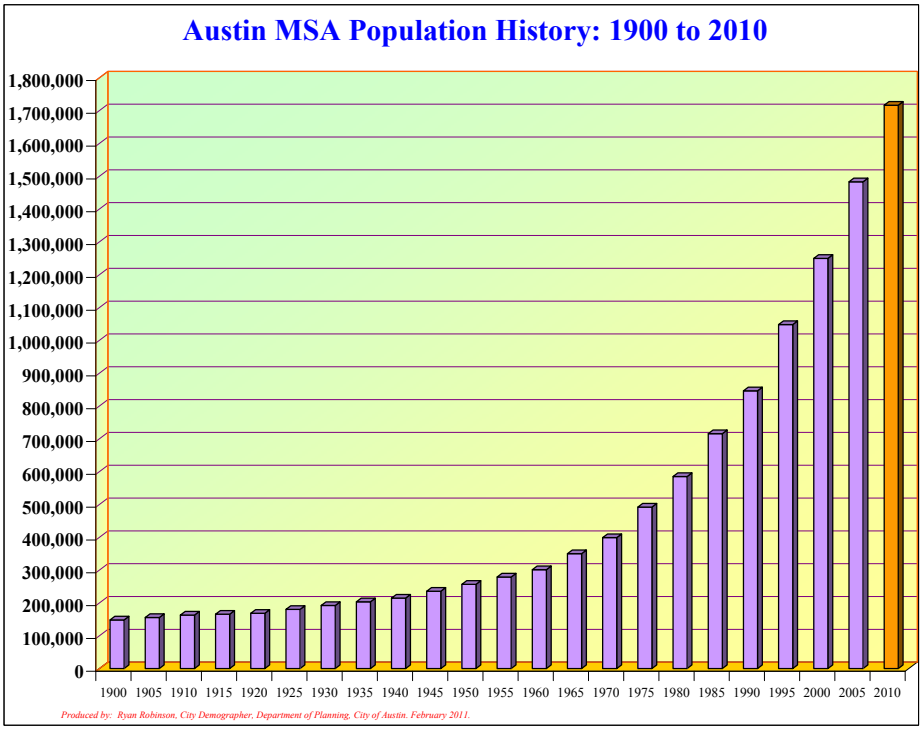
Can Current Supply Meet Austin's Growing Demand?

Austin's water supply is not as secure as policy makers and the public may believe.

In its contract with LCRA, Austin pre-paid $100 million for all water used up to and including two years at or above 201,000 acre-feet per year. Until that threshold is crossed, currently estimated to occur in 2030-2035, Austin pays LCRA nothing more for its water. Thus, even if LCRA had to go find other sources of water to make up the deficit in firm yield, Austin would pay nothing more until such time as their use exceeded 201,000 ac-ft/yr.

According to Austin Water Utility, Austin used approximately 137,500 ac-ft of water in 2014.

However, Austin's water contract with the LCRA does not actually guarantee plentiful water for the city for the duration of the contract. The issue: in order to get water from the Highland Lakes, it has to be available.



Source: City of Austin

History has shown Austin's population doubling about every 20 years and, on average, 110 people move to our city every single day. With the area's growth showing no signs of slowing, it is more important than ever to make sure we tackle water planning responsibly.

According to Water Data for Texas, Lake Buchanan and Lake Travis now hover near 35 percent and 36 percent of their respective capacities. That may seem like a respectable supply, but **if those levels slip below the 600,000 ac-ft (30 percent of capacity) trigger level currently in place, curtailments of 20 percent or more will be imposed by LCRA**. Most agricultural users were 100 percent curtailed starting in 2012. Given the possibility of many more years of drought, curtailment of all remaining use once storage falls below 600,000 ac-ft is quite possible.

If at the end of this drought, it is determined that the firm yield of the Highland Lakes system is less than previously calculated (utilizing inflow data from the 1950s drought,) it is likely that many of LCRA's firm water supply contracts, like Austin's, will be reduced in volume.

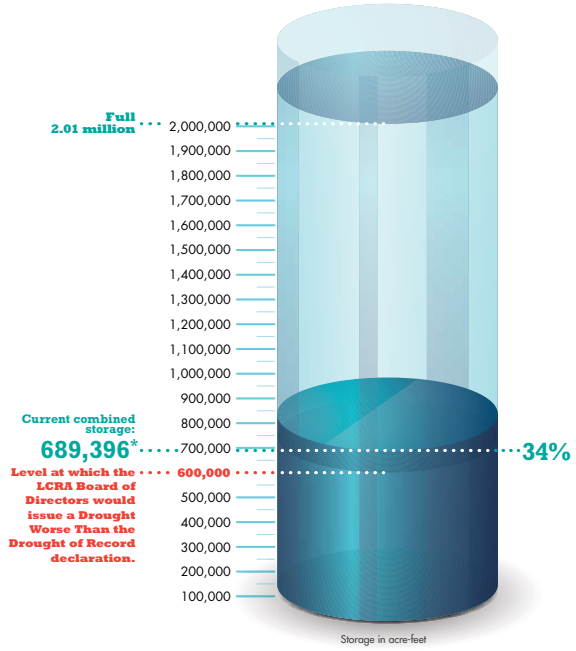
It is also important to understand that even though the City of Austin has a firm water supply contract with the LCRA, the LCRA has no legal responsibility to find new sources of water to supply customers in the future.

Though LCRA is developing new supply options, such as the new off-channel Lane City reservoir near the Gulf Coast and drilling wells to tap groundwater supplies in Bastrop, that water isn't committed to Austin. While the Lane City reservoir may have a small beneficial effect on Highland Lake releases, it is 135 miles southeast of Austin, is expected to cost $215 million, and would require a 135+ mile pipeline to bring water back to Austin.

LCRA is not, however, obligated to build that pipeline. LCRA's policy is to sell water "at the source" – usually from the river or the lakes. The agency, therefore, does not participate in delivery projects except when the customer agrees to pay all costs. Thus while replacement firm yield water may be available, cities must bear the total cost of delivery.

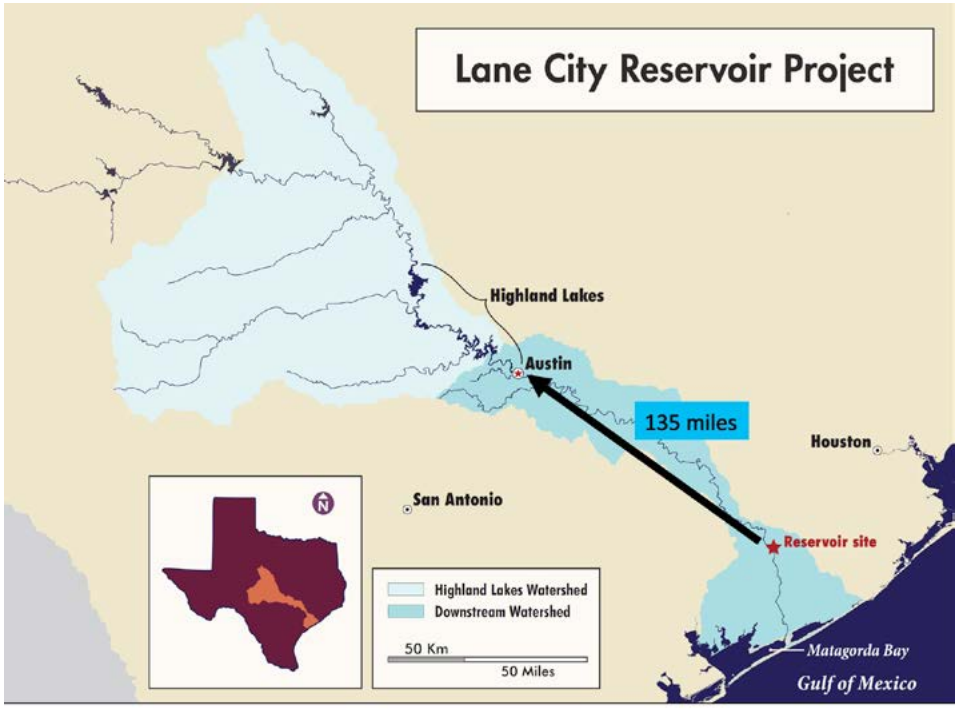
LCRA's ongoing project to permit and drill 10 wells in Bastrop County to replace releases of Highland Lake water to the Sim Gideon Power Plant will have a direct one-for-one benefit of diminishing releases from the lakes. Use of groundwater to directly replace Highland Lakes firm yield makes that firm yield available again from the lakes, thus increasing total supplies and benefitting lake levels.

HOW FULL ARE LAKES TRAVIS AND BUCHANAN?



Without additional rain in the Highland Lakes watershed, there is a small chance the combined storage of lakes Buchanan and Travis could fall to 600,000 acre-feet as soon as March 2015.

As of Jan. 1, 2015
Source: LCRA.org



Source: LCRA website and Google Earth

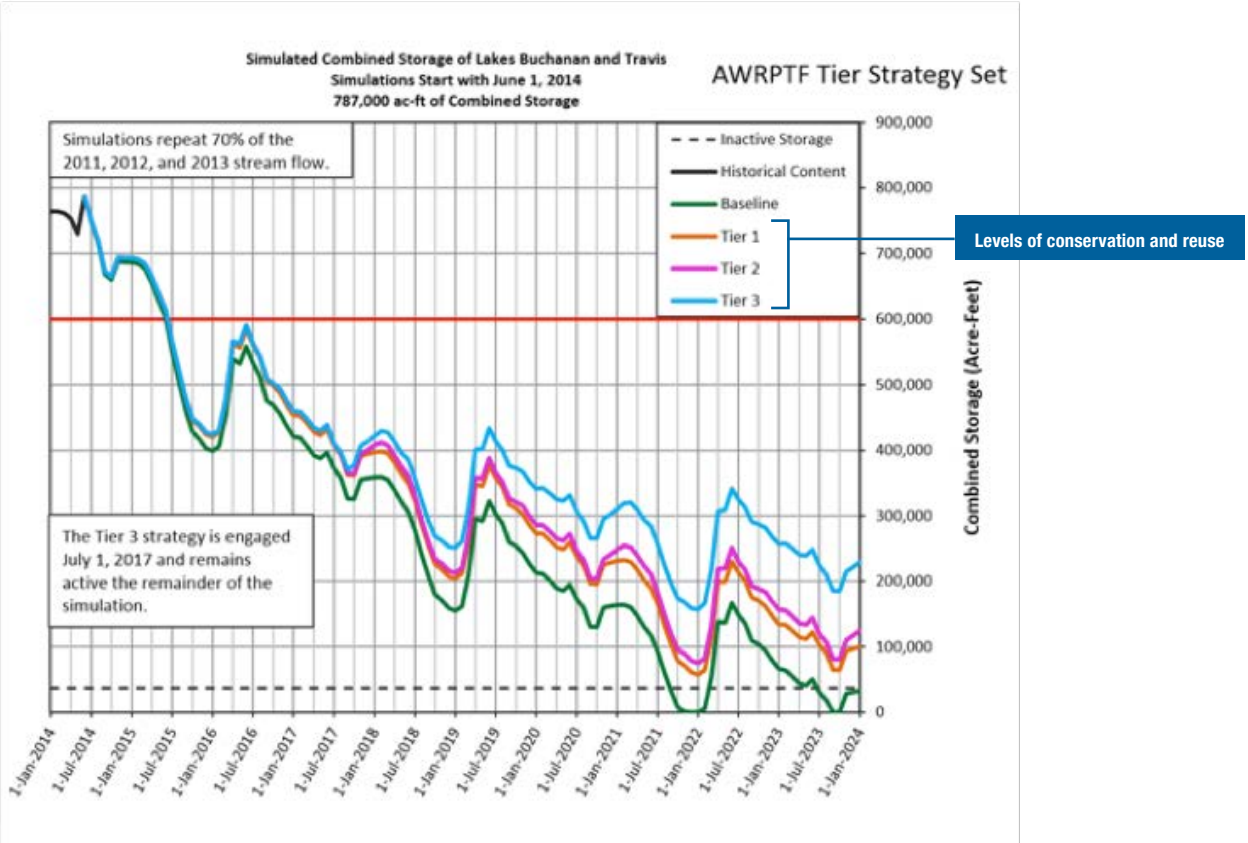
Is Conservation Enough?

In 2014, an Austin City Council Water Task Force developed a series of recommendations to boost conservation, setting forth an ambitious vision for Austin to become "the most water-efficient city in Texas." Conservation has been successful in reducing Austin's water demand. In fact, Austin has successfully lowered per capita demands to the point where even with significant population growth, the city uses approximately the same volume of water today as it did 10 years ago. However, given prevailing and forecasted conditions, it is likely conservation measures will not be sufficient to offset the need for new supply, especially in light of the region's continued growth and continuously expanding population.

A suite of conservation and reuse alternatives studied by Austin in June 2014 found that even with 787,000 acre-feet of water in storage at that time, the lakes could go dry within seven years (Source: Modeling Drought Response Strategies. Austin Water Resources Planning Task Force, June 10, 2014, Richard Hoffpauir, Ph.D., P.E.). If that same methodology were to be applied today with the lakes at 716,000 acre-feet (9% lower than last June), the result would likely be worse.

As the chart below shows, even implementation of the Water Task Force options across the board would still result in lake levels falling below 600,000 ac-ft in Summer 2015, with the possibility of empty or almost empty lakes within a few years if inflows continue to decline.

The bottom line: Depending on assumptions made about future inflows to the Highland Lakes and considering the last four years of experience, we may have from three to seven years before the lakes are not able to provide an adequate water supply, even with severe use curtailment.



Source: City of Austin Water Utility, Source: Modeling Drought Response Strategies. Page 17. Austin Water Resources Planning Task Force, June 10, 2014, Richard Hoffpauir, Ph.D., P.E.

Should Austin Continue to Rely on a Single Source of Water Supply or Should Austin Develop An Additional Water Supply?

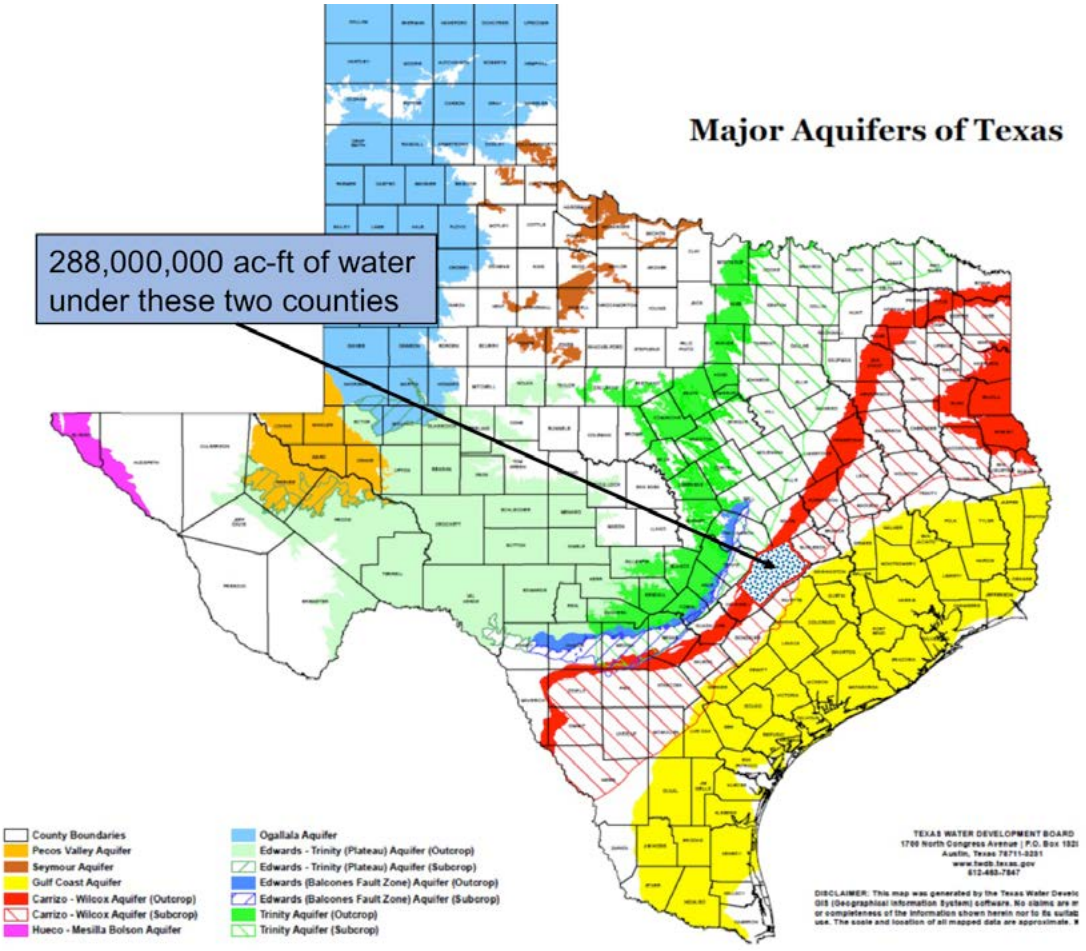
Along with its vision for efficiency, the 2014 Austin Water Task Force also recommended that new sources of water be secured as close to Austin as possible to reduce the cost of importing water.

New sources of surface water take 20-30 years to permit and develop. The good news is that new sources of groundwater take only between three and five years to develop and Central Texas has an abundant supply in the Carrizo-Wilcox aquifers under Bastrop and Lee Counties. The eight aquifers in the Carrizo-Wilcox are close in proximity to Austin. Access to these aquifers can be developed with a 35-mile pipeline, and while not 100 percent usable, the total volume of water in storage within these eight aquifers is many times the storage capacity of Lakes Travis and Buchanan combined.

In addition to the cost advantages associated with the development of groundwater, it:

- Is evaporation-proof – protected under ground from the evaporative effects of sun and wind. .
- Is generally better quality meaning it requires less purification treatment than surface water because it has been filtered through natural sand formations.

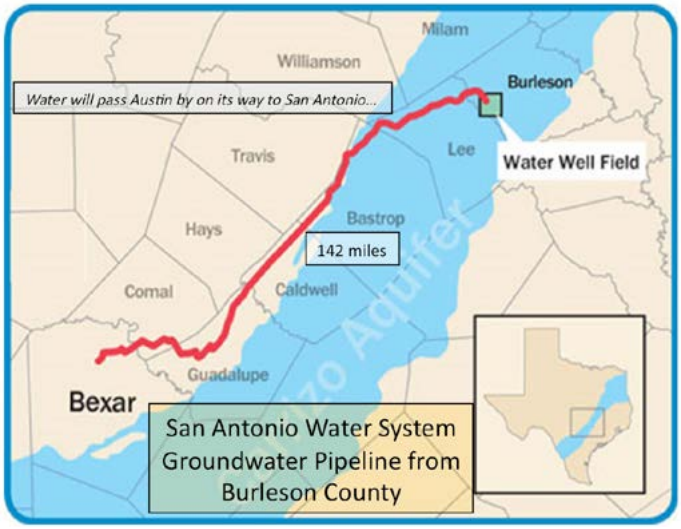
Two private entities are seeking permits to deliver 91,000 acre-feet of water to Travis, Williamson and Hays Counties, but are facing challenges by the Lost Pines Groundwater Conservation District, which regulates Bastrop and Lee Counties.



Source: Texas Water Development Board

While 288 million acre-feet is the estimated amount of water, not all of the Carrizo-Wilcox water is available for use.

In response to the resistance by the Lost Pines Groundwater Conservation District, the City of San Antonio, through the San Antonio Water System (SAWS), sought water farther north. SAWS recently agreed to an historic deal to secure future water from the Carrizo-Wilcox aquifer in Burleson County. SAWS signed a $3.4 billion, 30-year contract with the Vista Ridge Consortium (Abengoa and BlueWater corporations) in December 2014 for 50,000 acre-feet of water per year. The water will be delivered via a 142-mile pipeline from five counties away. The pipeline will skirt the entire length of the eastern boundary of Travis County. Burleson and Milam Counties are the boundaries of the Post-Oak Savannah Groundwater Conservation District, which has granted export permits – allowing SAWS to effectively leap-frog Bastrop, Lee and other counties as well as the Lost Pines Groundwater Conservation District in order to obtain their water.



Source: San Antonio Water System

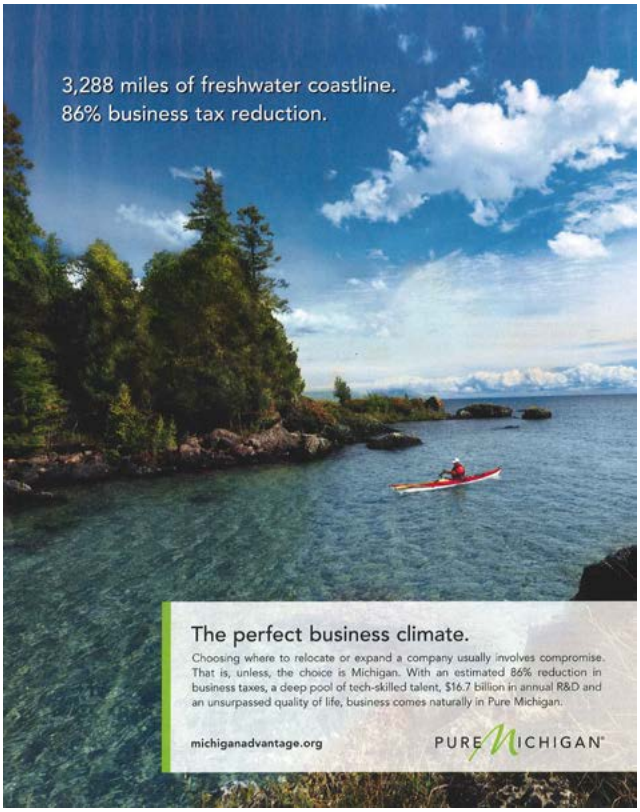
While groundwater is not a panacea and over-withdrawals can have serious ecological impacts as well as unintended consequences to other water users, groundwater is an option when surface water supplies are uncertain. The City should evaluate the opportunity presented by the Carrizo-Wilcox.

The bottom line: Austin needs to develop new water sources. The good news is that options for new supplies exist.

Recommended Actions for the City of Austin

1. The City of Austin and Lower Colorado River Authority should work together with a renewed sense of urgency to analyze conditions and evaluate new water supply options.
   a. Develop a uniform definition of "critical drought" and "drought of record" based on rainfall runoff inflows so that policy making language can be clearly understood by the public.
   b. Agree upon the most current possible standard set of models, assumptions and metrics from which policy makers can craft proactive policies to best manage the available water supply.
   c. Take steps to jointly evaluate development options to reduce Austin's sole-source dependency on the Highland Lakes. Establish a process to evaluate all options (Highland Lakes and other surface water sources, Carrizo-Wilcox groundwater and other groundwater sources, reuse, aquifer storage and recovery and other water supply strategies) on their affordability, ecological impact, and reliability.
2. Create a committee of the whole Council for the Austin Water Utility, to study and fully understand the myriad issues facing Austin and its water supply situation, similar to the Council Committee on Austin Energy.
3. Create a citizens education program to:
   a. Help citizens fully understand the value and true cost of water.
   b. Help citizens understand the current status of Austin's water shortage.
   c. Better inform citizens about methods to improve water conservation in their homes and businesses.
4. Actively participate in Texas Water Development Board conversations regarding groundwater development, and support state legislation aimed at improving and standardizing water permitting processes.
5. Educate community leaders, policy makers and elected officials on the importance of proactively addressing the City's water situation including how competing cities are using abundant water as an economic development message, as the adjacent advertisement shows.

The bottom line: We can solve Austin's water availability issue if we're willing to take immediate action.



Economic development experts from across the country agree that consistent and adequate availability of water resources is key to a strong business climate.

Water Glossary

Acre-foot: The amount of water required to cover an area of 1 acre to a depth of 1 foot. One acre-foot of water is equal to 325,851 gallons.

Conservation pool: The area of lakes Travis and Buchanan dedicated to water storage for municipal, domestic, industrial, agricultural and recreational purposes. The conservation pool of Lake Travis is the area below 681 feet above mean sea level (feet msl). It holds about 1,135,000 acre-feet of water. The conservation pool of Lake Buchanan is the area below 1,020 feet msl. It holds about 876,000 acre-feet of water.

Drought of Record: The drought that affected Central Texas from 1947 through 1957. No other drought in recorded history has been as severe or sustained (although the current drought, which began in March 2008, is likely to exceed the 1950's drought from a water supply from the Highland Lakes perspective). LCRA and other organizations use it as a benchmark to compare recent droughts and to prepare for future droughts. Droughts begin when lake levels are full and droughts end when lakes finally refill to full.

Firm Yield: The amount of water lakes Buchanan and Travis could supply each year during a repeat of the most severe drought on record. Cities, industries, power plants and protection of aquatic life all rely on firm water. Firm Yield is the amount of water in acre-feet per year during a drought of record that the LCRA can contract to firm water customers as a dependable supply.

Groundwater: Water below the surface of the ground, usually in an aquifer or underground stream or lake. Wells are used to draw up groundwater for drinking and other purposes.

Highland Lakes: The chain of six lakes along the Colorado River, upstream of Austin. Each lake — Buchanan, Inks, LBJ, Marble Falls, Travis and Austin — is created by one of the six dams owned or operated by LCRA.

Inflow: Rainfall runoff that flows into a reservoir.

Interruptible water: Water that is available for use on a year-to-year basis, depending on how much water is stored in lakes Travis and Buchanan. Interruptible water is subject to curtailment during water shortages.

Pass-through lakes: Lakes designed to allow water to pass through as opposed to being stored. Lakes Inks, LBJ, Marble Falls and Austin are pass-through lakes.

Region K: The state's designation for the water planning region that includes all or part of 14 counties in Central and South Central Texas. The Texas Water Development Board (TWDB) divided the state into regions and appointed regional planning groups to implement the statewide water planning process required by Senate Bill 1 (SB 1), passed by the Legislature in 1997.

River Operations Control Center (ROCC): The control center in Austin at which LCRA staff analyzes data from LCRA's Hydromet system, plans daily operations to supply water for customers and environmental needs and controls hydroelectric generation. During floods, the staff prepares lake level forecasts, communicates with the National Weather Service and U.S. Army Corps of Engineers, and dispatches crews to operate floodgates, if necessary.

Surface water: Water above the surface of the ground, such as a lake or river. The term is used to distinguish it from groundwater.

Volume: The amount of water in the lake, usually measured in acre-feet.

AARO

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