tx H_2O

A Publication of the Texas Water Resources Institute

Fall 2011

Texas drought: Now and then

Also in this issue . . .

A timeline of drought in Texas, Re-water,
Drought detective, and much more!

Texas AgriLife Research
Texas AgriLife Extension Service
Texas A&M University College of Agriculture and Life Sciences

Working to make every drop count

In his recent book, *The Big Thirst*, Charles Fishman writes that we don't pay much attention to water until it becomes scarce: "When water is in short supply, we not only pay more attention to how we use it, and how much we use, we're suddenly alert to how other people use water, and how much they use."

With the drought, Texans are suddenly alert to water and water use in Texas.

This issue of *txH_2O* takes us through a timeline of drought and drought recovery in Texas. The timeline chronicles many of the state's responses to drought over the decades, making it obvious that drought is a defining occurrence for Texas and its residents, natural resources, policies and institutions.

A major part of the state's drought response will be the *Water for Texas 2012* state water plan. This compelling document provides, among other things, a benchmark for potential consequences if we do not successfully plan for the next drought. Visit the Texas Water Development Board's website (*www.twdb.state.tx.us*) to view the draft released in September.

By all accounts, the current drought has been nothing short of a natural catastrophe, but we will recover.

With the opportunity to serve as director of Texas Water Resources Institute comes the pleasure of working with a top-notch communications team. This special drought issue of *txH_2O* is evidence of its good work.

Neal Wilkins

tx | H_2O

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Rice field near Bay City, Texas
LCRA Corporate Archives W00988

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Texas Water Resources Institute
make every drop count

Volume 7, number 1 Fall 2011

Photo: Lake Austin, 1950s
LCRA Corporate Archives W00275

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TIMELINE OF DROUGHTS IN TEXAS

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Story by Danielle Kalisek

THE GRASS ISN'T GREENER ON THE OTHER SIDE

Drought's effects on waterbodies, crops, livestock, energy, consumers and pocketbooks

Stephen F. Austin's first colonists' initial food crop of corn dies from lack of moisture.

The Republic of Texas adopts the English common law riparian principle that gives landowners the right to reasonable use of water for irrigation or for other purposes.

1800 1810 1820 1830 1840

Drought—a word that's receiving a lot of attention throughout Texas—seems to be on everyone's mind. From agriculture to urban life, from farmers and ranchers to energy producers, water suppliers and consumers—everyone and everything are being affected by drought.

"No one has escaped the far-reaching impact of this historical disaster," said Texas Agriculture Commissioner Todd Staples. "By the numbers, beef cattle have the greatest cash loss, followed by cotton, a loss of hay, corn and sorghum. Dairy producers are suffering because of high feed costs they've been associated with. The pain has been broadspread, and no one has escaped, unfortunately."

The drought's effects on the agricultural industry are also passed on to consumers, who depend on these products for their daily necessities, he said.

"Consumers are being impacted because they rely on fuel and food and fiber," Staples said.

Dr. John Nielsen-Gammon, state climatologist and professor of atmospheric sciences at Texas A&M University, said, "It's the worst one-year drought in the sense that we had so little rain during the winter time (of late 2010 to early 2011) and then the spring and summer. It's had maximum impact on agriculture—crops are having serious problems throughout the state. Ranchers are cutting back on herds, or some of them are selling off completely. So the timing of this (drought) has made it particularly bad."

In addition to the lack of rainfall, heat-related records were broken in Texas. The hottest statewide average temperatures for June, July and August were all in 2011. The combined June through August temperature was one of the hottest ever for any state, breaking a record set by Oklahoma during the Dust Bowl.

"That's caused primarily by the drought, because if you have less rain, then when the sun hits the ground there's no water to evaporate; it all goes into heating it, and that then leads to warm temperatures and more evaporation, and the drought becomes that much more severe," Nielsen-Gammon said.

The excess heat means air conditioners are being set to cooler temperatures, which in turn causes electricity demands to rise. This further stresses water supplies for the power plant cooling towers or even causes power output to shut down.

The current drought is being compared to the drought of record in the 1950s, and thus far each industry, along with the weather, is breaking its own records. The effects are widespread.

Drought 2011: Setting the tone

"We first started getting concerned about the possibility of a drought back in the summer of 2010 when all signs pointed to a La Niña developing in the Pacific Ocean," Nielsen-Gammon said. "That's when water temperatures in the tropical East Pacific are unusually cold, which affects the jet stream pattern and tends to give us a warm and dry winter. So we were alert to that possibility. Starting about October the rain really shut off, and we did have a dry winter and a dry spring—but drier than anyone was expecting."

While some parts of the state, such as East Texas, were dry during summer 2010, he said, most of the state didn't have problems until the beginning of 2011. ⇨

Grass that once provided a lush, green pasture for cattle is now brown and crisp. Photo by Danielle Supercinski Kalisek, TWRI/IRNR.

"For the twelve months ending September 30, Texas received a little more than 10 inches of rain on average for the state. This is the driest 12 consecutive months on record; normal would be about 26 inches, so we're well below 50 percent," Nielsen-Gammon said.

Other records set so far include the driest year to date, with January through September precipitation being 2.5 inches below the previous record for the state as a whole. Records were also set for the driest seven, eight, nine, 10 and 11 consecutive months.

"The previous record for driest 12 months was set in 1956," he said. "We haven't had the really major impacts on water supplies like we saw during the 1950s, but with La Niña conditions back in place, this is looking more and more like a multiyear drought."

He said this fall brought some hope of rain from tropical storms, depressions or hurricanes, but La Niña conditions have returned and are forecasted to remain for at least several months, which will tilt the odds toward another dry winter.

"Even if we do have another La Niña, I wouldn't expect precipitation running as far below normal as it has been, because this was a record-setting drought," Nielsen-Gammon said. "But the difference from this year and last year is last year we were starting off with mostly full reservoirs and plenty of stream flow and plenty of water in aquifers, and this year we're not. So even a mild precipitation deficit will make next year, especially for water supplies, worse than this year.

"No two years are alike and no two droughts are alike, but I suspect that if the drought continues like it has, sometime next year some places in the state will exceed their drought of record, and with the increase of population and the increased water use, we'll start seeing some serious water supply problems."

Agricultural crops

When asked what his overall impression of the drought is, Agriculture Commissioner Staples summed it up in one word: "Devastating."

"Texans are suffering through the worst one-year drought on record, and the calamity is just getting worse by the day," he said. "The unprecedented lack of rainfall, combined with extremely intense heat and high winds during the year, just crippled agricultural operations across the state."

Dr. Travis Miller, professor and Texas AgriLife Extension Service program leader for soil and crop sciences at Texas A&M, said as of August, losses were estimated at $5.2 billion. "That's a direct loss to ag producers from this drought, and that's continuing. In other words, as we go weeks and months further into this thing, the loss numbers get higher and higher."

The biggest crop losses have been in cotton. "We estimated a little over a $1.8 billion loss in cotton; about 52 percent of the total crop was zeroed out with no yield at all," he said. "So we planted 7.1 million acres, and we'll harvest about 3.4 (million acres), maybe. The jury's still out on some of that."

Cotton harvest time depends on the location in the state—the Rio Grande Valley begins harvesting in late July to early August, and cotton harvesting wraps up in the High Plains around the first of November through December. However, due to the drought and extreme temperatures, even harvesting times are being affected, which in turn affects yield.

Heavy rains falling on the Colorado River watershed cause the river to crest 11 feet above the Austin Dam, ultimately destroying it.

Houston RR v. East confirms the English law of the rule of capture, which allows landowners to pump as much groundwater as can be used beneficially, regardless of the impact on neighboring wells.

1900 1901 1902 1903 1904

Wheat crops, which are usually harvested in May and June in Texas, were also greatly impacted. Miller said only about 35 percent of the wheat crop was harvested, and harvest totals this year were estimated at 54 million bushels compared to 124 million bushels last year. While not all wheat is normally harvested—a lot of it is grazed by livestock—on average about 55 percent to 60 percent is harvested. Less than half of the normal acres were harvested, and the yields were very low, at about a 26-bushel average compared to about 34 bushels last year, he said.

As the next wheat crop is already being planted, farmers are finding soils that are absolutely dry. He said much of the Texas wheat crop is typically grazed, providing wheat growers with two sources of income and cattlemen with nutritious winter grazing for their herds.

"So it's potentially a double-whammy loss with loss of the wheat crop and nothing for cattle to graze," Miller said. "We use that wheat pasture a lot for grazing livestock, and the wheat crop is seriously threatened at this point. The soils are dry. Our chances on our wheat crop are pretty limited."

He said corn and sorghum and all the other crops, except rice, are affected in the same way with these drought conditions. The corn crop was very short, but the sorghum crop did pretty well, with the Gulf Coast having good numbers with sorghum and cotton, although it was short through the Blacklands.

Rice, on the other hand, had a pretty good crop; however, water suppliers may curtail the ratoon crop water, so chances are the ratoon rice won't produce, Miller added.

Overall for crops, Miller said, "It's a pretty gloomy situation."

Rangeland and ranching

Rangeland is also being seriously affected by the drought. Dr. Ron Sosebee, professor emeritus with Texas Tech University's Department of Natural Resources Management and a 40-year expert on battling the brutal effects of Texas' droughts, said the entire state has been severely affected.

"The pastures and the rangeland look … I want to say like the dead of winter, but it really looks worse than that," he said. Sosebee's area of Lubbock in particular has received about 10 percent of the annual average rainfall to date, or about 1.3 inches since November 2010. And the heat only exacerbated the problem.

Then add livestock and the hay situation into the mix and it gets worse.

"About half of our total agricultural income comes from crops, and about half comes from livestock," Miller said. "One of the crops we harvest is hay. It's usually $750 million, maybe as much as $1 billion worth of hay; we harvested essentially none, probably less than 5 percent of a normal hay crop. (Hay) feeds our livestock, which means ranchers don't have any hay to buy, and if they do it's double or triple the price because it's being brought in from Louisiana, Missouri, Nebraska and Kansas and other places to the north that got rainfall."

Miller said hay that normally would have been cut has already all been fed to livestock, and that hay is what ranchers usually use to feed cattle from October through spring when the grass greens up. "So the beef situation is in a very serious mess right now." ⇨

TIMELINE OF DROUGHTS IN TEXAS

1905 — 1906 — 1907 — 1908 — 1909

A treaty between the United States and Mexico apportions waters of the Rio Grande above Fort Quitman, Texas, to be used for agricultural irrigation.

Drought

Stock tank levels are decreasing throughout the Lone Star State due to the lack of rainfall during the current drought. The far left photo was taken in 2004 when the tank was full and the land was in pristine condition.

Sosebee added, "The options aren't very many. If we don't move our livestock, they're going to continue eating and damaging the rangeland until there won't be anything left. This year is actually the worst drought year that we have ever had.

"I know the drought of the 1950s is still considered to be the worst drought on record; at least during the 1950s we did get some rain annually, and we could actually get something to grow for grazing, like haygrazer and sometimes wheat. This year we didn't get anything."

The lack of water only adds to the problems.

"The water situation for livestock is very perilous as well," Miller said. "Many traditional sources of water are stock tanks where water collects in our pastures, and (now) there's no water. So we're selling our herds off as fast as we can sell them—more than 600,000 cows, not calves; in other words, our brood stock that would make next year's calf crop is going."

Due to these conditions, many ranchers started moving cattle this year as early as June and July, and the movement continues to leased pastures in Oklahoma, Montana, the Great Lakes states such as Wisconsin—anywhere they can find grass to lease, or to the auction barn, Sosebee said.

"In fact, one rancher that I know of moved a bunch of cattle to northern Montana, and those cattle will never come back to Texas because he secured a long-term lease, and those cattle will just stay there," Sosebee said. "So whenever this drought

In Post City, near Lubbock, cereal magnate C. W. Post spends four years and $50,000 on 23 attempts to use explosives to cause rain. He died in 1914 believing that he could "shoot up a rain" whenever he wanted to.

Using the rule of capture, the newly established Texas Board of Water Engineers declares the state's nonappropriated waters to be property of the state and abolishes riparian rights that applied to state land acquired after 1895.

The Paddock Viaduct in Fort Worth is completed.

The Texas Board of Water Engineers produces its first set of rules and regulations.

Drought

1910 1911 1912 1913 1914

The center photo was taken in April 2011 when water levels were noticeably decreasing due to drought. By August 2011, as seen in the right photo, the pier is no longer in the water. This side of the tank is now completely dry. Photo by Danielle Supercinski Kalisek, TWRI/IRNR.

breaks, they will just start all over again here with the herd in Texas."

In other cases, the only option ranchers have is taking their cattle to auction.

"Auction barns in Abilene, Coleman and that central part of West Texas have been running 48 hours straight selling cattle—people are bringing them in to just get rid of them," Sosebee said. The same can be said for most auction barns throughout the Lone Star State.

"If we don't protect our rangeland by moving our livestock, I'm going to suggest that keeping them and feeding them hay is not a very good option," he said. "They'll still be trampling the rangelands, and they're still going to be eating whatever grass that's out there because when we come out of the drought, if we maintained our herds by feeding them hay, our pastures and rangelands are going to absolutely suffer immensely.

"Plus the economic side of that is it's not a very viable option. It doesn't take that much hay to buy that cow over again."

Commissioner Staples added, "How much longer these drought conditions continue will be a big factor on how soon we'll be able to recover. But it will take a while to overcome the reduced beef cattle numbers that are at their lowest point since 1958, nationwide." ⇨

TIMELINE OF DROUGHTS IN TEXAS

Drought

1915

A flood destroys the rebuilt Austin Dam.

1916

February 1917–January 1918 ranks as the 3rd driest 12-month period.

Drought stimulates renewed interest in constructing storage reservoirs for irrigation.

1917

1918

Legislature passes the "Drouth Relief Law," authorizing counties to loan money for citizens to purchase seed and feed.

1919

Wildfire and wildlife

While mid-July 2010 brought significant rainfall, since then, it has been extremely dry.

"It wound up that we had a lot of moisture (in 2010) on the Gulf Coast, Central Texas, out to West Texas and the High Plains," Miller said. "The fact is about the end of August (2010) we'd had double the normal amount of rainfall in the High Plains, but with this came a lot of summer growth on grasses, much more than normal. Particularly when La Niña moved in during the fall, it just quit raining."

Nielsen-Gammon recalled, "Last year when the drought started, the biggest initial problem was wildfire, especially out in West Texas. The fire danger has moved into central and eastern Texas, where forests have become very dry and tree mortality is increasing.

"Major forest fires such as the early September fires near Bastrop, Linden and Magnolia will continue to be a danger as long as undergrowth remains dry," he said. "Wind speeds normally increase this time of year, and each strong cold front will bring the threat of major fires unless the fronts also bring rain." He added that the longer the drought goes on, the drier the junipers, oaks and pines become, making conditions ripe for crown fires—fire jumping from tree to tree.

"There is more housing encroaching into the Hill Country and the East Texas forests than ever before," Nielsen-Gammon said. "If we don't get rain this fall, the biggest concern will be a major fire in a major populated area in Central Texas. The Bastrop fire destroyed more homes than any fire in Texas records, but the potential is there for something even worse."

"We have had more than 3.8 million acres burn in Texas, which is phenomenal," said Tom Boggus, Texas Forest Service director. "It is more burned than of any season since we have been keeping records—significant, large amounts of acreage.

"When we get to 2 million acres a year, that is a significant fire season," he continued. "At one time in April we had a million acres on fire in the same week. That shows you how radical and how unusual this fire season is. We are having 35 to 50 fires a day, 150 to 200 fires a week. It just keeps going on. It's all drought-driven."

Urban consumers

The drought's effects on agriculture, rangeland and livestock and the wildfires seriously impact consumers. Limited crop yields mean less availability and higher prices at the grocery store. The livestock situation means higher prices for beef products.

Dry stock tanks also mean water losses in rivers, lakes, reservoirs and other bodies of water that are sources of drinking water for urban areas. This decrease in water supplies leads to less availability for a growing population and demand.

"What is this going to do to reservoirs where people get drinking water?" Sosebee asked. "Lubbock has just been informed that they will not get any more water from Lake Meredith; we knew that was coming. I understand that Robert Lee is out of water, and Spence is just about dried up, and Midland gets their water from Lake Spence. So what are these people going to do? Now that is a serious situation."

Water supplies also affect power generation. Declining reservoir levels can mean not enough water for power plant cooling. In these situations power plants might have to shut down completely.

Dr. Michael Webber, associate director of the Center for International Energy and Environmental Policy in the Jackson School of Geosciences and assistant professor of mechanical engineering at The University of Texas at Austin, said the drought and heat wave conditions could cause power plants to cut back power output. If that happens, consumers will experience rolling blackouts, power price spikes or curtailment.

The drought comes around full circle.

"I think consumers need to understand that this type of dire circumstances that our farmers and ranchers are facing affects all Texans and all Americans who rely on what is produced," Staples said.

He stressed that Texans must understand how important thoughtful water planning is, not only for agriculture but also for Texas' economy and future jobs.

What lies ahead

"There's a lot of speculation about what lies ahead of us," Miller said. "We know that most of the major drought events we experience are a part of La Niña. With the second La Niña moving in in September 2011, there will likely be another dry winter; we don't know how dry. It doesn't look favorable with the dry conditions we're going into the fall with and the La Niña; it doesn't look favorable for fall crops or for next spring."

Staples said, "Droughts of this nature are unplanned, unexpected and unwelcome natural disasters. When a hurricane is bearing down on the Texas coastline, you can take some precautions and mitigate the damage and chaos and start the rebuilding process. With this ongoing drought, it's something we're just having to manage our way through.

"These circumstances certainly paint a gloomy picture, but I must point out that Texans are survivors; our farmers and ranchers have the ability to overcome and adapt," he said. "And don't forget to pray for rain daily, and thank the good Lord when we get some."

TIMELINE OF DROUGHTS IN TEXAS

Drought

1925 — The Texas Legislature authorizes the formation of water control and improvement districts.

1926 — The Texas Supreme Court, in Motl v. Boyd, determines that riparian rights are attached only to the ordinary flow and underflow of rivers.

1927

1928

1929 — Legislature creates the Brazos River Conservation and Reclamation District, the first river authority and the first "state agency" in the U.S. created specifically for the purpose of developing and managing the water resources of an entire river basin.

Lake Austin, 1950s
LCRA Corporate Archives W00275

1930

1931

The Texas Legislature passes a law designed to prevent artesian water wastage.

1932

1933

Lowest temperature is recorded in Seminole on February 8 at -23°F.

Drought

1934

The Dust Bowl stretches from the Panhandle to the Great Plains.

The Lower Colorado River Authority (LCRA) is established and charged with controlling floods, providing water supplies, and generating electricity.

LCRA built 6 dams in the next decade.

Story by Kathy Wythe

The Time It Never Rained

How Texas water management has changed because of recurring droughts

It crept up out of Mexico, touching first along the brackish Pecos and spreading then in all directions, a cancerous blight burning a scar upon the land.

Just another dry spell, men said at first. Ranchers watched waterholes recede to brown puddles of mud that their livestock would not touch. They watched the rank weeds shrivel as the west wind relentlessly sought them out and smothered them with its hot breath. They watched the grass slowly lose its green, then curl and fire up like dying cornstalks.

Farmers watched their cotton make an early bloom in its stunted top, produce a few half-hearted bolls and then wither.

Men grumbled, but you learned to live with the dry spells if you stayed in West Texas; there were more dry spells than wet ones. No one expected another drouth like that of '33. And the really big dries like 1918 came once in a lifetime.

Why worry? They said. It would rain this fall. It always had.

But it didn't. And many a boy would become a man before the land was green again.

Prologue, *The Time It Never Rained*, by Elmer Kelton ⇨

Timeline of Droughts in Texas

1935 — Dust storms inundate Amarillo from January through March. Seven times, the visibility declines to zero. One complete blackout lasts 11 hours, and one storm rages for 3 1/2 days.

1936 — The highest temperature of 120°F is recorded in Seymour on August 12.

1937

1938 — LCRA board of directors approves the installation of 50 rain gauges, which initiates the first comprehensive watershed reporting system in Texas.

1939 — The Texas State Soil and Water Conservation Board is established to enforce the state's soil and water conservation laws.

Drought

The Time It Never Rained, a historical novel by Elmer Kelton, embodies Texas' drought of record that lasted from 1950 to 1957. The book reflects many of the experiences Texans, especially rural Texans, had during the worst drought in recorded history.

Ranchers sold entire herds of livestock. Farmers watched as their crops shriveled and blew away.

Comal Springs stopped flowing out of the Edwards Aquifer for the first and only time in recorded history.

Rural towns turned into ghost towns when the agricultural population fell by 35 percent. Dallas built pumping stations to pump water out of the salty Red River, making it flow by gravity to Lake Dallas. Once the water arrived in Dallas, people were afraid to drink or use it because of the damage it might do to their families, their water pipes and their laundries. In 1952 the Cotton Bowl, the stadium at Fair Park in Dallas, drilled its own water well within the stadium to water its turf because Dallas could not furnish the water.

By the end of the drought, 244 of 254 counties in Texas were classified as disaster areas. The cost of the drought is estimated at about $3.5 billion (in 2008 dollars) for each year from 1950 to 1957.

Those experiences are etched into the minds of Texans. And those memories were translated into major changes in the way the state of Texas managed and regulated its water.

TWDB formed

One of the first actions the Texas Legislature took after the 1950s drought was the establishment of the Texas Water Development Board (TWDB) in 1957. The new state agency was charged with forecasting water supply needs and providing funding for water conservation and water supply projects. Today, the TWDB is responsible for state water plans that, in part, forecast the water needed by the state in times of drought.

Reservoirs built

To help the new water board with its mission, the Texas Legislature also presented Texans with a constitutional amendment in 1957, authorizing the issuance of $200 million in general revenue bonds for TWDB to make loans to municipalities for use in the conservation and development of water resources.

"Because of that and subsequent bonding authority, as well as water providers stepping up themselves to respond to that drought, there was quite an increase in reservoir construction across the state," said Dr. Robert Mace, deputy executive administrator of TWDB's Water Science and Conservation program area.

More than 126 major reservoirs were constructed from 1957 to 1980.

Water planning

Along with the creation of the TWDB, the Legislature passed the Water Planning Act of 1957, which mandated that the Texas Board of Water Engineers (later renamed the Texas Water Commission) develop a plan to meet the state's future water needs.

"That plan was published in 1961. So that really formally kicked off what we would call state water planning in Texas," Mace said.

"This blueprint of how the state would deal with another drought of record showed how seriously everyone took that drought," said Dr. Todd Votteler, executive manager of intergovernmental relations and policy for the Guadalupe-Blanco River Authority.

Having been twice destroyed by floods, the Austin Dam (later renamed the Tom Miller Dam) is reconstructed by LCRA and is owned by the city of Austin.

The United States signs a water treaty with Mexico for allocation of the waters of the Rio Grande below Fort Quitman, Texas.

Drought

1940 1941 1942 1943 1944

Surface water rights overhaul

Droughts in Texas have also brought major changes in the state's surface water rights management. A water right is a legal right to divert surface waters for a beneficial use. Although today the state owns the surface water in Texas and grants the right to use this water to different people and entities, it was not always that way.

Dr. Ronald Kaiser, chair of the Texas A&M University Interdisciplinary Graduate Water Degree Program, said the state's challenges with water rights go back further than the 1950s drought, to the droughts of the late 1880s and early 1890s.

The riparian doctrine that Texas used at the time, in which landowners adjacent to a stream or river had a right to use the water, "proved unworkable in resolving water scarcity conflicts, forcing the Texas Legislature to change its water allocation law," he said. "Relying on the water law experiences of western states, the Texas Legislature incrementally adopted the prior appropriation doctrine. In adopting appropriation principles, the Legislature preserved water rights granted under civil law and riparian."

Prior appropriation is based on "first-in-time, first-in-right," which gives the water first to the most senior water rights holder, or the entity or person that had a water right in the river or stream earlier in time, before junior water right holders during times of scarcity and drought.

"This system presented few problems when water was available to satisfy all users," he said. "However, during drought conflicts arose."

Those conflicts were brought to a head in a massive lawsuit filed in 1953. The state of Texas filed a lawsuit, referred to as the Valley Water Case, against a Rio Grande Valley irrigation district. The state asked the court to adjudicate the water rights in the Rio Grande Valley because the water rights claims based on civil law, riparian law and the prior appropriation system exceeded the amount of water available in the Rio Grande, said Kaiser, who is also a professor in Texas A&M's Department of Recreation, Park and Tourism Sciences.

The suit took years to resolve and involved about 3,000 parties seeking rights to a limited supply of water in the Rio Grande.

"This case illustrated that 78 years of legislative and judicial attempts to reconcile the two systems were expensive and lengthy, and that another approach was needed," Kaiser said.

A district court judge took possession of the United States' share of Rio Grande waters, reassigning the rights and establishing the Rio Grande Watermaster.

Carlos Rubinstein, head of the Texas Commission on Environmental Quality (TCEQ), said that by reassigning the rights, the judge "created the new way of managing water in the lower Rio Grande where priority was based on the type of water use, with municipal uses having the highest priority.

"Because of the lawsuit, water rights in the Rio Grande downstream of Amistad Reservoir, unlike the rest of Texas surface water rights, are not based on seniority," he said. "Instead, the Rio Grande Watermaster controls water allocations under a complex system that is designed to apportion water first for municipal, domestic and industrial uses, then to irrigation districts and agriculture uses.

"It was a significant departure on how water rights in the West are managed," Rubinstein said. "For the lower Rio Grande below Amistad now, we don't ⇨

TIMELINE OF DROUGHTS IN TEXAS

1945 — The Legislature authorizes the Texas Department of Health to enforce drinking water standards for public water supply systems.

1946 — Of the 194 electric power plants in Texas, 26 are hydroelectric, generating about 15 percent of the state's electric power.

1947

1948 — Of the nearly 30 million acres in Texas agriculture, about 3 million acres are irrigated. Almost 30,000 farms use irrigation systems.

1949 — The Texas Legislature declares groundwater to be private property. The Legislature also provides for the voluntary establishment of underground water conservation districts.

have a priority date. Everywhere else in Texas we have a priority date when it comes to water rights."

Today the state has two additional watermaster programs—South Texas Watermaster Program and Concho River Watermaster Program—that manage, monitor and enforce surface water rights based on priority date and ensure compliance with water rights by monitoring stream flows, reservoir levels and water use.

In 1967, the Texas Legislature passed the Water Rights Adjudications Act, merging the riparian rights system into the prior appropriations system, thus consolidating the allocation of surface water into a unified water permit system, Kaiser said. The Texas Water Rights Commission, a predecessor to TCEQ, was given charge of surface water rights.

Comal Springs and groundwater

When Comal Springs dried up in 1956, another conflict eventually ensued.

In 1991, the Sierra Club filed a lawsuit under the Federal Endangered Species Act. The federal judge in the case, Sierra Club v. Babbitt, ruled that limits on the use of the Edwards Aquifer were needed to protect endangered species found in Comal and San Marcos springs. The best solution, he said, was for the state to manage the aquifer, and in 1993, the Texas Legislature created the Edwards Aquifer Authority (EAA) to regulate groundwater in the aquifer.

The Legislature directed the EAA to regulate pumping from the aquifer, implement critical period management restrictions and pursue measures to ensure minimum continuous springflows of the Comal and San Marcos springs are maintained to protect endangered and threatened species, according to the Edwards Aquifer Recovery Implementation Program website.

"Giving the Edwards Aquifer Authority the authority to regulate groundwater changed the landscape and represented a fundamental change in groundwater law in Texas," Votteler said. "You saw an explosion in creation of groundwater districts once the Texas Supreme Court decided the regulatory powers of the Edwards Aquifer Authority were constitutional. The Court gave the Legislature the green light to create districts that could regulate groundwater."

More droughts, more changes

After the drought in 1995–1996, the Texas Legislature passed Senate Bill 1, probably the most comprehensive water bill in the state's history. One of the major changes was the state water planning process.

"Initially the planning process was a top-down approach," Mace said. "It wasn't until 1997, after another drought in 1996 and the passage of Senate Bill 1, that a regional water planning concept—a 'bottom-up' approach—was developed."

Senate Bill 1 established 16 regional water planning groups that include members representing agriculture, industry, the environment, cities, water utilities, power companies and other interests. The bill also required the TWDB to publish a comprehensive state water plan every five years and base its projections on a 50-year planning horizon.

Mace said the drought in 1996 served as a wake-up call that perhaps the state wasn't as ready for a drought as it should be, and the state water planning approach needed revising.

Drought of record begins; 7.7 million people live in Texas.

First groundwater conservation district, the High Plains Underground Conservation District No. 1, is created.

Dallas City Council passes a resolution limiting lawn watering.

Lake Dallas holds 11 percent of its capacity.

Falcon Dam completed.

Drought

1950 1951 1952 1953 1954

"The concern was that the stakeholders, the local folks, weren't familiar with the plan and hadn't participated in the development of the plan," Mace said. With the regional water planning adopted in Senate Bill 1, the local groups "were in the driver's seat of the planning process with state oversight. The regional water planning groups now make decisions on what projects or strategies need to get used to make sure the state was ready for a drought."

Votteler agreed that working on water issues through the state water plan is a priority for the state, but the plan is just half of the equation. "The other half of the equation is how we would finance the projects in the plan," he said. "That has never been resolved. The Legislature has struggled with that issue and continues to struggle with it."

He believes that lack of adequate funds is mainly because the state has not had another serious multiyear drought for a number of decades. "People were lulled into complacency," he said. "Since the 1980s we have had many one- to two-year droughts, and they have terrible impacts, particularly on agriculture, but large municipal and industrial users of water have not been affected as seriously. And so it is not spurring people to action."

Senate Bill 1 also required water suppliers to develop drought contingency plans that list how they are going to respond when drought comes.

Drought Preparedness Council

In the midst of another drought, the Drought Preparedness Council was created by the 76th Texas Legislature in 1999. The council is a collection of state agencies that coordinate activities on drought. The council develops and implements a comprehensive state drought preparedness plan, separate from the state water plan, for mitigating the effects of drought in the state.

Current drought

Have all the changes in policies, laws and agencies through the years made a difference in the current drought?

"They absolutely have," Rubinstein said. "We learn from every drought. And each one leads to identification of things that you might need to look at in statutes or in rules to manage droughts in the future as well.

"That is indicative of what occurred in our sunset bill, where we actually got some additional clarifying authority on how we manage water rights," he said, adding that the bill was a result of what the state learned from the 2009 drought.

TCEQ has curtailed junior water rights this year to meet at least 12 senior priority rights calls.

"What we would do in a watermaster area, relative to the monitoring of river conditions and ordering curtailments where needed, we're doing that statewide," Rubinstein said.

If the commission is not going to curtail the water rights, it can adjust the diversion rate, he said.

"We (the commission) can adjust the diversion rate of a water rights holder, and that's a way of making it work for everyone," Rubinstein said. "If you're a junior rights holder and you can satisfy your demands and save over 30 percent of what you're entitled to by not diverting other water so that we can make water available to senior water rights holders downstream, then it's good for us to have the ability to do that rather than to cut you off entirely.

"When you're dealing with an emergency, such as a drought, and trying to mitigate it, you don't want to go create another emergency, such as curtailing water rights inappropriately and creating a public health concern," he said. "We do take into account ⇨

TIMELINE OF DROUGHTS IN TEXAS

Drought

1955

The Trinity River Authority is created by the Texas Legislature.

1956

President Eisenhower declares 244 of the state's 254 counties as drought disaster counties.

1957

Heavy, general rains begin.

Legislature creates Texas Water Development Board (TWDB), in part to protect against the devastating effects of this drought.

The Water Planning Act of 1957 mandates a process for developing a plan to meet the state's future water needs.

1958

1959

what it means to shut down a city that happens to be a junior water rights holder.

"When you are in a drought, the watermaster has access to more current data and a constant interaction with the users that allows him to more quickly respond to water shortages," Rubinstein said. "When you're looking at how to best utilize state water, you're able to determine where and what actions you could take to stretch that water as far as you can to meet the demands. We've taken the things that we've learned from watermaster areas, applied them not only in the 2009 drought but in the drought of this year, in the areas where we don't have a watermaster."

Mace said he believes the water planning process adopted by the state has made a difference in its ability to cope with the current drought. "Are we where we need to be with implementation?" he said. "No."

"One thing to remember is that it's a plan. So there's still the responsibility of individual water suppliers and cities to implement that plan to make sure they're ready for the next serious drought," he said.

"The plan, at the very least, gets people thinking about the fact that we've had really bad drought in the past—therefore, we could have really bad drought in the future—and ask the question, 'What do we need to do to make sure we have enough water?' But then it's contingent upon the local leadership to ensure that those strategies get employed, or put into place, before the next drought hits."

Votteler agreed that the state is in better shape after the massive effort to develop the water planning process to get the state through the next drought of record. "However, once we achieved having those water supplies online in the 1980s, the effort didn't continue," he said. "As new residents have flooded into the state, the surplus has evaporated."

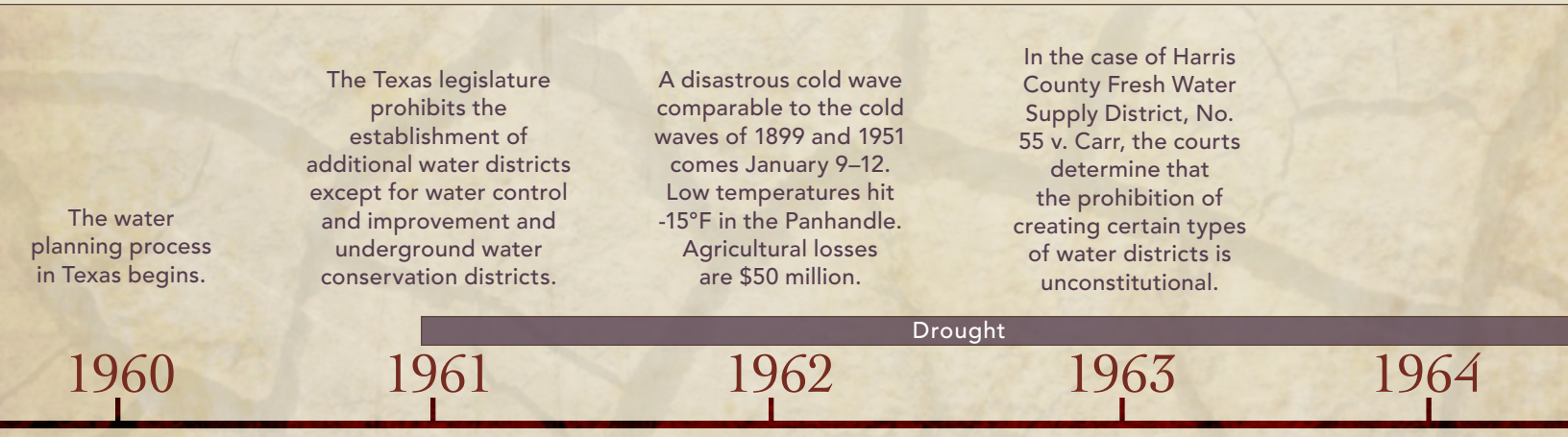
A look to the future

Mace said he is concerned about how this drought is being conveyed to Texans as the worst drought on record. Because drought can be measured in different ways, this drought may be one of the most intense, but at least for now, it is not the longest, and the impact on water supplies and agriculture is not as great as the 1950s drought.

"Now if it rains this winter, people might walk away from it, going, 'Well shoot, I just lived through the drought of record, and it wasn't all that bad,'" he said. "But if conditions like this go on for another five years, you can imagine what that would do to stressing everybody's water resources. This drought doesn't have anything on the drought of the '50s yet.

"The last year of that drought was still fiercer, as far as the Palmer Drought Severity Index is concerned, than this current drought, but its persistence is what was really damaging.

"People need to ask themselves the question, 'What if this drought lasted another five years? How would we be doing with our water supplies?' These are the questions the water planners are asking."



Remembering the past

Memories and recollections of the 1950s drought

The Time It Never Rained is a historical novel about the 1950s drought of record, written by Elmer Kelton, who was a novelist and longtime editor of *Livestock Weekly*. After the book was published, many people thought Kelton crafted the story after their parents or grandparents. He didn't, but the experiences in the book were realistic. The following are accounts from Kelton's book as well as from Texans who remember what it was like during those drought years.

"That was my growing up years. I graduated from college in '60. So I went (to that school) throughout the 1950s. I remember my dad saying subsequent to that time that we could always get feed up—high gear, what we call hay-grazer now, Sudan back then.

"We had more cattle on our place then than we've ever run since then; I'm not exactly sure how we did that because as many cattle as we had then and, of course, before that time, I don't know what it looked like in the 1940s. I do know that 1941 was the wettest year on record for all of the Southwest, so probably that had some impact on our abilities to run more livestock.

"Following the drought of the 1950s, in many areas in the Southwest, mesquite became much more of a problem, much more prevalent. We could drive anywhere we wanted to on our place; we had mesquite but we could still get around in a pickup anywhere we wanted to go. After the 1950s, we had some wet years in the 1960s, and in the 1970s my dad looked out over the place and he said, 'Oh, where did all these mesquite come from?'"

Ron Sosebee
Professor Emeritus with Texas Tech University's Department of Natural Resources Management and 40-year expert on battling the brutal effects of Texas' droughts

"Six years," Charlie said, counting on his fingers. "It's a blessin' the Lord never gave us the gift of prophecy. If we'd known when we started that we'd still be in it six years later, I think we'd of all gone and jumped into the Concho River. I get to thinkin' sometimes that maybe drouth is the normal condition here and the rainy years are the freaks."

Charlie Flagg
Chapter 15
The Time It Never Rained, by Elmer Kelton

"The drought of the 1950s was a lot like the drought we are in right now. I don't remember as many trees dying in the 1950s as you see now, but then again, this 'ole prairie didn't hardly have any trees on it. There weren't even that many trees down in the creek bottoms then, either.

"The prairie land we farmed was so dry and cracked so bad that you literally had to watch your ⇨

TIMELINE OF DROUGHTS IN TEXAS

Drought

1965 — The Sam Rayburn Dam and Reservoir is completed near Jasper, along with Lake Waco on the Bosque River in McLennan County.

1966

1967 — Legislature passes the Water Rights Adjudication Act; it consolidates all surface water rights into a unified system by transforming previously held Spanish and Mexican grants, riparian water rights and claims into "certificates of adjudication."

1968 — TWDB adopts second state water plan, recommending 62 new reservoirs and addressing issues surrounding drainage, water quality, recreation, and fish and wildlife.

1969 — Amistad Dam on the Rio Grande is completed; Toledo Bend Reservoir in far East Texas is completed by damming the Sabine River.

step to make sure you didn't step in one of the cracks. There weren't too many water wells in the country back then, so folks would have to drive their livestock down to holes in the creeks for water. Eventually the creeks stopped running, and folks would dig big holes in the creek bottoms, board up the sides and let them fill in with water. That was really the only source of water for the livestock. Luckily, back then nobody really had many cattle. Mostly folks would have a few mules and a milk cow or two, so livestock water wasn't as important then as it is now.

"It got so dry that nobody really even planted; there wasn't any use in doing so."

Frank Oliver Gilbert, Jr.
Flynn, Texas, who lived in Leona in the 1950s
Grandfather of Lucas Gregory of TWRI and IRNR

For a long time Charlie Flagg had watched other men burn the thorns from prickly pear so their livestock could chew the pulpy green leaves. He had sworn that Rio Seco would have six inches of snow on the Fourth of July before he would subject his animals to eating cactus. Now he found himself face-to-face with necessity. The low-growing cactus he had fought for years was, finally, to be what saved him—if anything could.

Chapter 14
The Time It Never Rained, by Elmer Kelton

"I remember the drought of the 1950s as a 6- to 11-year-old boy living on a farm in the southern Rolling Plains of West Texas. 1952 was a particularly bad year with almost no measurable rainfall. Sandstorms were very bad, and so bad on one occasion that near midday a dust storm rolled in and the sky was just black, so black that the chickens went to roost and we had to use lights in the house. My mother announced that it was a total eclipse of the sun.

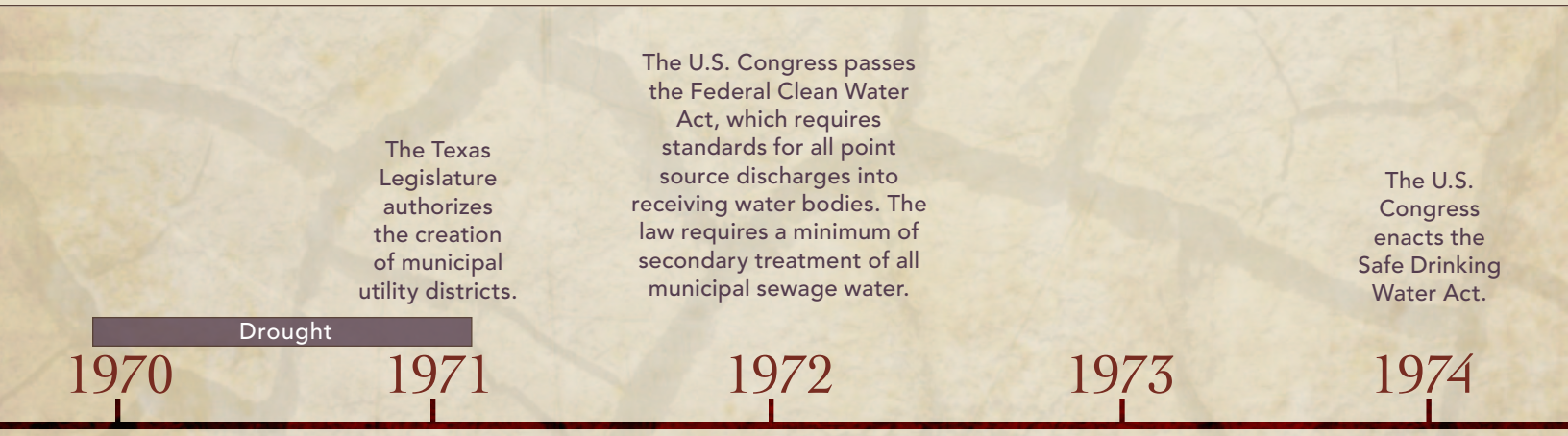
"During that time, with no rain to grow grass to feed our cows, we had to resort to raking up mesquite beans to feed the milk cows. Also, with so little cotton and grain harvest from our fields, my father had to obtain work off the farm to keep his family of a wife and four boys fed.

"Those years from 1951 to 1957 were mighty lean years for farmers. Fortunately, we had understanding and patient bankers. Farm income almost came to an end, but in 1957 the rains returned and so did the bumper crops."

B.L. Harris
Former Acting Director and Associate Director of
Texas Water Resources Institute

Time was when an inch of rain would have brought fresh life, a greening to the land. But there had been grass then, a spongy turf to soak up and hold the moisture, and live roots to draw sustenance from it. Now the bare ground had nothing to soften the impact of rain, to catch and drink up the water. The first burst of precipitation would pack and seal the topsoil. The falling raindrops would strike hard and splash upward, brown with mud. Instead of soaking in, the water would swirl and run away, following the contours of the land, seeking out the draws and swales.

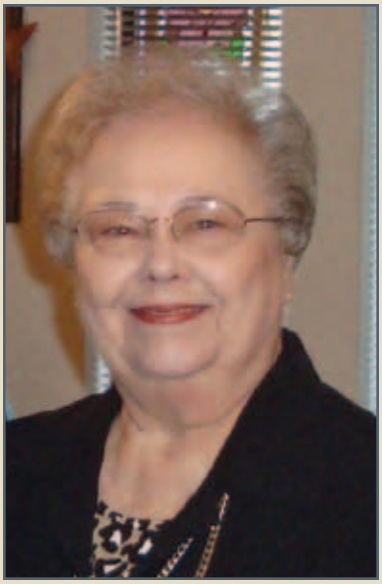
Chapter 14
The Time It Never Rained, by Elmer Kelton



"In 1956 the economy was very, very bad. Grandpa was Sheetrocking for our living from 1953, and jobs kept getting more scarce all the time, until we just were barely making it already. Since we lived here in Houston, we really can't remember that much about a drought.... I guess we were watering so much anyhow since April of 1954 because we had to hand-plant our whole yard with squares of grass.

"Grandpa asked our longtime friend, Erwin Gross, what he remembered about drought around 1956; he said he remembered they were living on sandy land at the time, and it was so very dry that sand just flew on everything and stuck onto the roofs of everything. Then when it finally started raining, it was like it was raining mud ... so much sand had accumulated on the roofs and stuck so that it was actually like raining mud as it ran off the buildings."

LaVerne Pivonka
Houston resident
Grandmother of Danielle Supercinski Kalisek
of TWRI and IRNR



LaVerne Pivonka recounts memories of the 1950s drought with her granddaughter, Danielle Supercinski Kalisek of TWRI and IRNR.

He (Charlie Flagg) turned his back on all he had lost, and they walked together through the cold rain.
Last paragraph in *The Time It Never Rained*
by Elmer Kelton

If you have memories of the 1950s drought, TWRI would like to hear from you. Please email twri@tamu.edu and send us your story. We'll feature them on our website with this story.

TIMELINE OF DROUGHTS IN TEXAS

1975
Construction begins on the Lake Fork Dam and Reservoir to provide industrial and municipal water for the cities of Longview and Dallas.

1976

1977

A pair of sandstorms ruin $6 million worth of Panhandle winter wheat and injure 20 people in El Paso.

1978
Several reservoirs are completed, including Lake Limestone, Lake Granger, Lake Georgetown, and the Lake Fork Dam and Reservoir.

1979

Story by Danielle Kalisek and Leslie Lee

The energy-water tug of war

Drought exacerbates the paradox of efficiently producing energy while conserving water

1980 — The state has 179 major reservoirs.

1981 — The Sabine River Authority and the city of Dallas sign a contract to move water to the Dallas Water Utilities Eastside Water Treatment Plant from Lake Fork Reservoir.

1982

1983

1984 — A revised Texas Water Plan addresses future demand for water by identifying conservation strategies for increasing water resources.

The energy-water nexus may be one of the biggest challenges of this generation. Making energy requires water, and getting water requires energy. Both are essential.

So what happens when the latest drought pushes Texas' resources near the brink? The electricity, oil and gas industries are all under strain as water supplies wane.

Power generation feels the squeeze

Continued drought, decreasing water availability and increasing water temperatures are affecting power plants, which in turn affects energy consumers throughout the state, according to experts at The University of Texas at Austin.

"If we see this drought continue, combined with this heat wave, we might see power plants throttling back or curtailing their power output to avoid overheating the water," said Dr. Michael Webber, associate director of the Center for International Energy and Environmental Policy in the Jackson School of Geosciences and assistant professor of mechanical engineering at UT Austin.

Webber's graduate student, Ashlynn Stillwell, with the university's Department of Civil, Architectural and Environmental Engineering, said, "Lack of streamflow or declining lake or reservoir levels can mean there is not enough water physically available for power plant cooling. The high temperatures have also increased water temperatures, meaning power plant cooling is not as efficient."

Webber added that with lower water levels, power plants might have to turn off completely because the water isn't available for cooling.

"Consumers are affected when power plants start turning off because of the drought," Webber said. "If it's drought from a heat wave, we might see rolling blackouts, and we might see power price spikes."

Webber's and Stillwell's research focuses on analyzing power plant cooling technologies for mitigating water management challenges such as drought and high temperatures.

Generally, Stillwell said, thermoelectric power plants burn fuel in a furnace-connected boiler to convert high-purity water to steam. "Steam is then condensed back into high-purity water using a noncontact cooling system so the process can continue. That cooling system requires large volumes of water."

In a paper published recently in the journal *Environmental Research Letters*, Webber and his team wrote that changing the cooling technologies used by power plants in 11 Texas river basins could reduce the water they divert each year by an amount equivalent to the annual water use of at least 1.3 million people.

Policy changes and conservation are key

In the midst of these new technologies, numerous factors are leading to strained water and energy supplies. Webber noted this during his testimony, "Trends and Policy Issues for the Nexus of Energy and Water," before the U.S. Senate in March.

"While the energy-water relationship is already under strain today, trends imply that the strain will be exacerbated unless we take appropriate action," he said. "There are four key pieces to this overall trend: (1) population growth, which drives up total demand for energy and water; (2) economic growth, which can drive up per capita demand for both energy and water; (3) climate change, which intensifies the hydrological cycle; and (4) policy choices, whereby we are choosing to move toward more energy-intensive water and more water-intensive energy."

During this time, power plants are doing what they can to cope with the drought, Stillwell said. ⇨

As the drought continues, Texas' energy production will be affected by water availability.

TIMELINE OF DROUGHTS IN TEXAS

Drought

1985 — Conservation of water, which is recognized as being more economical than developing new sources of water, becomes a key factor for granting water permits.

1986

1987 — The U.S. Congress passes the Federal Water Quality Act, intending to reduce nonpoint source water pollution.

The Wellhead Protection Program, approved by the U.S. Environmental Protection Agency, is initiated in Texas.

1988

1989

"Unfortunately, the drought and extreme heat have caused high demands for electricity. Meeting that electricity demand (without rolling outages) requires cooling water."

The high temperatures have increased the electricity demand for air conditioning, so some days have set records of peak electricity use, she said, and meeting the electricity demand requires additional power generation.

"Conserving both water and electricity helps manage the situation on the demand side," Stillwell said.

Webber added that both consumers and energy producers must keep conservation in mind.

"Conservation is a pretty cheap solution to mitigate some of these effects and buy us some time while we figure out something better."

Drillers deal with drought

Power plants are not alone in feeling the strain of the drought, said Dave Burnett, director of technology for the Global Petroleum Research Institute at Texas A&M University.

"If you're an oil and gas company right now, you are still able to find wells, drill and get the water needed to get everything done, but you have to work harder and spend more money," Burnett said. "The water that you're using for your oil and gas operations is becoming more and more valuable because there's less of it. So companies have to be a lot more careful about where they get their water and how they use it and how they're preventing contamination of the groundwater resources.

"As the drought becomes more and more serious, the concerns about the existing groundwater resources become greater and greater. You want to protect what's left."

In some Texas cities, such as Grand Prairie, drought-induced water restrictions have prohibited gas companies from using city-owned water for hydraulic fracturing of gas wells.

"Companies are realizing that they have to be very aware because they are members of the community and have to take the communities' needs into account too, when they are finding their water resources," he said.

In addition to treated wastewater, brackish water is another possible water source that drilling operations are beginning to use. However, the need to seek such alternative water sources will affect oil and gas companies' bottom line and consumers. "The cost of developing the gas shale is going to go up. Water is just one more expense that is going to have to be borne," Burnett said.

"I think that very soon people will begin to realize that brackish water, although not considered a fresh water resource, is valuable too," he said. "Desalination technology is going to make that water usable and can do it for a reasonable price. I think that there will be a movement toward greater use of brackish groundwater. And I think that perhaps the oil and gas industry might lead in that."

Using alternative water sources is just one of many shifts that could occur in many industries if the current drought continues.

When asked if this drought will have policy impacts on oil and gas, Burnett replied, "It will have to. Water has been considered free for a very long time."

Drought

1990

1991 The Texas Clean Rivers Act establishes a state program to reduce nonpoint source water pollution.

1992 The Texas Water Commission declares the Edwards Aquifer to be an underground river; however, the Texas Supreme Court rules this attempt to regulate the Edwards Aquifer unconstitutional.

1993 The Texas Legislature creates the Edwards Aquifer Authority to limit groundwater pumped from the aquifer and ensure adequate continuous flows from the aquifer's two main springs—Comal Spring and San Marcos Springs, home to endangered aquatic species.

1994

Story by Courtney Smith

Drought detective

Texas A&M professor works to develop drought prediction system

Could climatologists predict drought the way meteorologists forecast the weather? If one Texas A&M University researcher has his way, the answer is yes.

Through a five-year, $486,000 research grant from the National Science Foundation (NSF), Dr. Steven Quiring, associate professor at Texas A&M, is working to develop a system that will be able to predict the occurrence and severity of drought.

Unlike earthquakes, hurricanes and tornadoes, drought unfolds at an almost imperceptible pace with beginning and ending times that are difficult to determine, wrote Dr. Todd Votteler of the Guadalupe-Blanco River Authority in a 2000 article for Texas Parks and Wildlife's magazine.

"Drought prediction is essentially using something in the climate system known as memory, and the primary source of memory is the oceans," Quiring said. Oceans are important in the hydrologic cycle because of their massive ability to store heat content. Therefore, changes in surface temperatures and evaporation rates have global implications in regard to climate and precipitation. Two well-known examples of this phenomenon are El Niño and La Niña, he said.

"However, the oceans are fairly well understood but not perfect in their ability to predict drought," Quiring said.

Dr. Steven Quiring will work with graduate and undergraduate students to develop a drought prediction system over the next five years.
Photo by Karen Riedel, College of Geosciences, Texas A&M University.

Timeline of droughts in Texas

1995 — Drought

1996 — Drought causes greater economic losses to agriculture than any previously recorded one-year drought.

1997 — Texas Legislature passes Senate Bill 1, which creates 16 regional water planning groups and requires that TWDB publish a comprehensive state water plan every five years.

1998

1999 — Drought Preparedness Council established by the 76th Texas Legislature. Drought

His research focuses on soil moisture, a secondary driver of climate variability that also serves as a source of memory. In addition, Quiring will study how drought predictions can vary over time and space.

Quiring explained that 2011 is a great example of how land-atmosphere changes have significant impact in initiating and exacerbating drought conditions. "As soils continue to dry down, there's less water available for evaporation from the soil surface, making less water available for transpiration," he said. "Essentially a positive loop forms, and in words of renowned meteorologist Jerome Namias, 'Drought begets drought.'"

But could climatologists predict drought like meteorologists forecast the weather? Quiring explained that measurements for soil moisture are sparse when compared to measurements and records maintained for temperature and precipitation. "We don't really have a good source of direct observations for soil moisture and how soil moisture has varied in the past," he said.

Through this project he hopes to identify soil moisture monitoring stations across the Great Plains and archive observation results in one central location. With combined data available from nearly 1,500 regional observation stations, Quiring and his team of graduate and undergraduate students will study each location's soil types and soil moisture and their influence on land-atmosphere changes.

Even if the project only produces a standardized, homogenized database, that will be a huge step forward, Quiring said, because that has never been done before. In addition, locations currently without any observations can be identified and tagged as high-priority areas for future data collection.

"Understanding current conditions is a key factor for making predictions, whether it's weather predictions or seasonal predictions," Quiring said. "We are trying to forecast the probability of a drought to occur." Soil moisture observation data will help improve understanding of land-atmosphere changes and their influence on drought, he added.

During the project, Quiring will work to improve the representations of these land-atmosphere interactions; determine how important they are; and develop better seasonal prediction models that can answer questions such as:

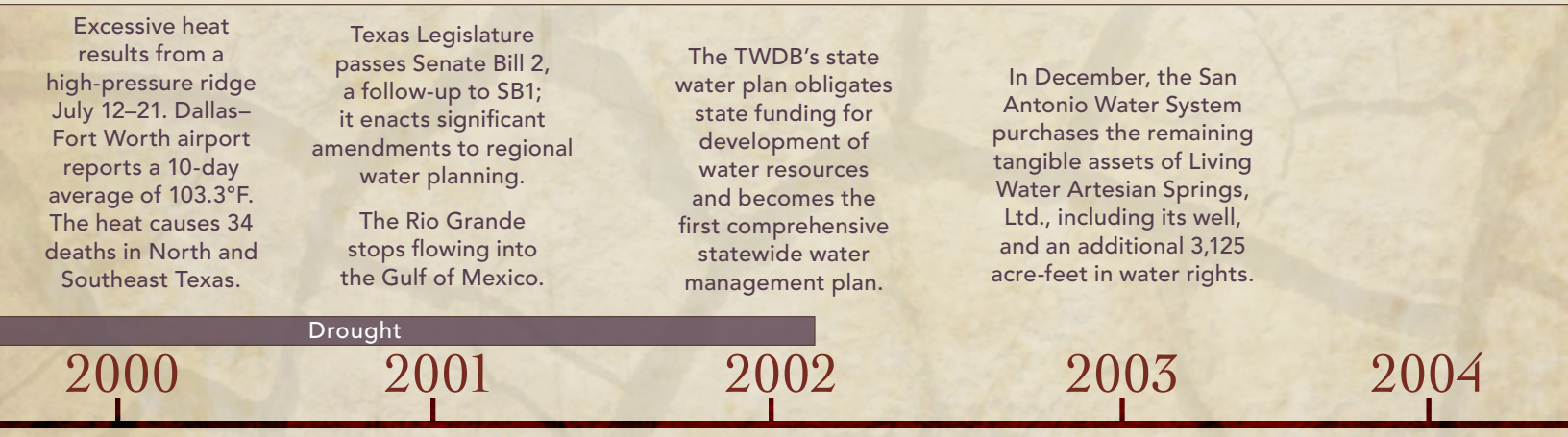
- How much influence do oceans have?
- How much influence do land-atmosphere interactions have?
- Why does soil moisture seem to be more important in some years?

"We want to improve predictions so they are accurate enough for decision makers to be confident in decisions that put their financial future on the line," he said, adding that an accurate prediction system influences all natural resources sectors, from utility companies to farmers.

Agricultural losses have made the 2011 drought the most costly on record, according to the Texas AgriLife Extension Service. Quiring believes that a drought prediction system is a needed decision-making tool for farmers and ranchers to use when deciding whether or not to let a field remain fallow until conditions are favorable for planting.

"Advanced warning of an impending drought also would allow for more water to be stored in reservoirs and for water use to decrease slowly to save up for drought," he said.

Editor's note: We'll continue to follow Quiring and his team to provide up-to-date information on the five-year project.



Story by Leslie Lee

The city of El Paso maintains four water reclamation plants.

RE-WATER

More complicated than just toilet-to-tap, water reclamation helps sustain thirsty cities

TIMELINE OF DROUGHTS IN TEXAS

2005 — Drought

Texas Cooperative Extension estimates statewide drought losses at $4.1 billion, with $1.9 billion in North Texas alone.

2006

TWDB adopts Water for Texas 2007, the state water plan.

2007 — Drought

Hurricane Ike moves ashore near Galveston on September 12 with maximum sustained winds around 110 mph, making Ike a strong Category 2 storm. The hurricane causes 12 deaths directly and 25 indirectly, along with almost $14 billion in damages.

2008

2009

Every day and all around the world, water is recycled. From upstream to downstream, one city's wastewater is eventually another city's water supply.

But in order to conserve and better manage precious water resources, some Texas cities are using innovative water reclamation technologies to speed up and improve this process.

Water reclamation involves taking effluent, or treated wastewater, and using refining processes to make it suitable for a variety of water needs such as irrigation, aquifer recharge, industrial processes and even potable water.

El Paso leads the way

Thanks to water reclamation and conservation policies, the city of El Paso has become a desert city with a sustainable water supply. The El Paso Water Utilities (EPWU) reclaimed water program is an example for municipalities across the globe.

"For many years people have come from all over to learn about what we do," said Irazema Rojas, EPWU utility engineer. "We have received calls and visits from Australia, Mexico, Atlanta, Austin."

EPWU serves about 200,000 residential and commercial customers and also operates one of the most extensive reclaimed water systems in Texas.

"Located in a desert, EPWU made a decision many years ago to think of reclaimed water as a valuable resource rather than a by-product that needs to be disposed of," the EPWU website states.

EPWU maintains four wastewater reclamation plants, and each plant yields treated effluent for nonpotable use, suitable for customers to apply to parks, sports fields, landscape nurseries, golf courses, construction projects and many other situations. Some of the treated wastewater is used for industrial processes, and EPWU recharges some of it back into the aquifer. All of the plants meet Texas Commission on Environmental Quality water quality regulations, Rojas said.

"This program started back in the 1960s, when the city began using treated effluent to irrigate the golf course," Rojas said. "And slowly the program became more aggressive, eventually using treated effluent for industrial and construction uses, in addition to irrigation."

The program has grown over the years, and now 44 percent of the EPWU reclaimed water is used for irrigation, 37 percent for industrial processes, 19 percent for aquifer recharge and small percentages for construction.

Research conducted by the Texas AgriLife Research Center in El Paso in close partnership with EPWU has frequently provided scientific support for the reclaimed water program. Through continued research, the center has produced several reports on effective uses of reclaimed water and landscape management.

According to EPWU, since its water conservation ordinance was established in 1991, its conservation and reclaimed water programs have saved 231 billion gallons of water, which is enough water to fill the Sun Bowl 6,392 times.

Reclaiming water for drinking water

Starting next year, another West Texas city will join the other municipalities taking advantage of reclaimed water resources.

October 2010-September 2011 averages 11.18 inches, the driest 12-month period recorded in Texas.

In August, the Texas AgriLife Extension Service estimates agricultural losses caused by drought to be a record $5.2 billion.

Drought

2010 2011 2012 2013 2014

The Colorado River Municipal Water District (CRMWD) will build a $13 million water reclamation plant near Big Spring that, unlike some other reclaimed water projects, will produce water for direct potable use.

"We're taking treated effluent, normally discharged into a creek, and blending it with (traditionally supplied potable) water," District Manager John Grant told Discovery News in August. In essence, the system speeds up what would naturally occur with the flow of discharged water through wetlands with more pristine results, Grant added.

In addition to four well fields, CRMWD currently depends on three lakes for its water supply: E.V. Spence Reservoir, which is at less than 1 percent of its capacity; Lake J.B. Thomas, which is at about 2 percent of its capacity; and O.H. Ivie Reservoir, which is at about 20 percent of its capacity.

The Big Spring Water Reclamation Project will provide 2 million gallons of water for the wide-reaching district, Grant told CNN in August.

"CRMWD looked at each charter city within the district and determined that the Big Spring project was the most economically viable," said Todd Darden, Big Spring's assistant city manager.

The project received some negative national news attention this summer for its plans to turn wastewater into drinking water, Darden said. "We had local meetings about the plan and those went well; we only received some negative comments when the story got picked up by larger media.

"It will be very good quality water—just as good as water out of our reservoirs and probably better," Darden said. "But I always say that if it's good enough for NASA's astronauts, then it's good enough for us."

The value of reclaimed water

As proven by El Paso's well-documented, long-term success, water reclamation technology has been effective for decades. Darden noted that Big Spring and CRMWD had considered reclaimed water as an additional drinking water source for the area as far back as the 1980s, but the cost was prohibitive at that time.

Now Big Spring officials are looking forward to making the water supply more secure, Darden said. While "toilet-to-tap" sometimes may get a bad rap, many Texans know the value of water and the value of water reclamation technology.

"When you live out here in the desert, any drop of water you can find is well worth it," said Darden, who praised the work of CRMWD. "I thank God every day that I know we'll have enough water, because of the water district."

Rojas noted the sustainability and benefits of El Paso's reclaimed water program.

"We are very proud of our system," Rojas said. "Not only is using reclaimed water advantageous to businesses because it is cheaper than potable water, but it is also important because it increases a city's ability to conserve water and therefore prolongs the life of the water resources."

TIMELINE OF DROUGHTS IN TEXAS

2020
Texas' population is projected to be 29.7 million.
Texas' projected water demand is 19 million acre-feet per year.

2030
Texas' population is projected to be 33.7 million.
Texas' projected water demand is 19.8 million acre-feet per year.

2040
Texas' population is projected to be 37.7 million.
Texas' projected water demand is 20.5 million acre-feet per year.

2050
Texas' population is projected to be 41.9 million.
Texas' projected water demand is 21.2 million acre-feet per year.

2060
Texas' population is projected to be 46.3 million.
Texas' projected water demand is 22 million acre-feet per year.

Water for Texas 2012

What is the plan?

The Water for Texas 2012 state water plan, the ninth such plan compiled by the Texas Water Development Board (TWDB), is designed to meet the state's needs for water during times of drought, according to the plan's Executive Summary. This plan is based on the "drought of record," which occurred in the 1950s. Planning starts at the regional level with 16 regional water planning groups identifying water needs and recommending water management strategies to meet these needs. These groups represent the public, counties, agriculture, industry, the environment, municipalities, small businesses, water districts, river authorities, water utilities, groundwater management areas and electricity-generating utilities. Once each planning group adopts its regional water plan, it is sent to the TWDB for approval. The TWDB then develops the state water plan based on information from the regional water plans and other sources.

Edward G. Vaughn, TWDB's chairman, wrote in a letter at the beginning of the plan: "The primary message of the 2012 State Water Plan is a simple one: in serious drought conditions, Texas does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises."

Below are excerpts taken from the Executive Summary of the *Water for Texas 2012* state water plan that highlight the most important points of water needs during times of drought. To read more, see *www.twdb.state.tx.us/wrpi/swp/draft.asp.*

How many Texans will there be?

The population in Texas is expected to increase significantly between the years of 2010 and 2060, growing from 25.4 million to 46.3 million people (see map on opposite page).

How much water will we require?

Although the population is projected to increase 82 percent over 50 years, water demand in Texas is projected to increase by only 22 percent, from about 18 million acre-feet per year in 2010 to a demand of about 22 million acre-feet per year in 2060. Demand for municipal water (including rural county-other) is expected to increase from 4.9 million acre-feet in 2010 to 8.4 million acre-feet in 2060. However, demand for agricultural irrigation water is expected to decrease, from 10 million acre-feet per year in 2010 to about 8.4 million acre-feet per year in 2060…

How much water do we have now?

Existing water supplies—categorized as surface water, groundwater, and reuse water—are projected to decrease about 10 percent, from about 17.0 million acre-feet in 2010 to about 15.3 million acre-feet in 2060.

Groundwater supplies are projected to decrease 30 percent, from about 8 million acre-feet in 2010 to about 5.7 million acre-feet in 2060.

Surface water supplies are projected to increase by about 6 percent, from about 8.4 million acre-feet in 2010 to about 9.0 million acre-feet in 2060.

Do we have enough water for the future?

We do not have enough existing water supplies today to meet the demand for water during times of drought. In the event of severe drought conditions, the state would face an immediate need* for additional water supplies of 3.6 million acre-feet per year with 86 percent of that need in irrigation and about 9 percent associated directly with municipal water uses. Total needs are projected to increase by 130 percent between 2010 and 2060 to 8.3 million acre-feet per year.

What can we do to get more water?

The strategies recommended by regional water planning groups would provide, if implemented, 9.0 million acre-feet per year in additional water supplies by 2060. Water management strategies can include conservation, drought management, reservoirs, wells, water reuse, desalination plants and others.

How much will it cost?

The estimated total capital cost of the 2012 state water plan, representing the capital costs of all water management strategies recommended in the 2011 regional water plans, is $53 billion. This amount represents about a quarter of the total needs for water supplies, water treatment and distribution, wastewater treatment and collection, and flood control required for the state of Texas in the next 50 years.

What if we do nothing?

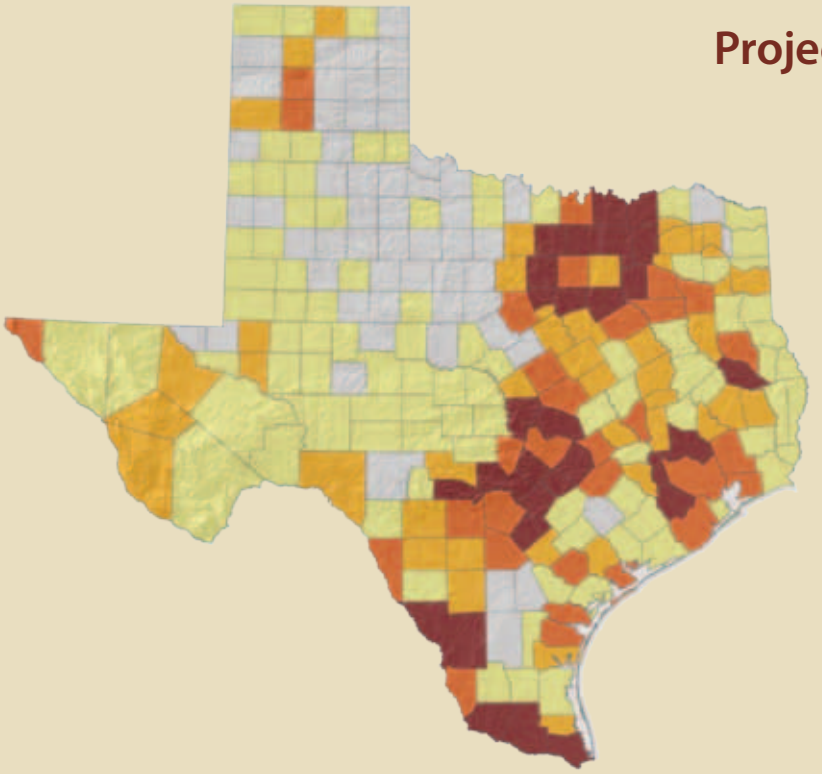
If drought of record conditions recur and water management strategies identified in regional water plans are not implemented, the state could suffer significant economic losses. If the drought affected the entire state like it did in the 1950s, economic models show that Texas businesses and workers could have lost almost $12 billion in income in 2010. By 2060 lost income increases to roughly $116 billion. Foregone state and local business taxes associated with lost commerce could amount to $1.1 billion in 2010 and $9.8 billion in 2060. Lost jobs total approximately 115,000 in 2010 and 1.1 million in 2060.

* Needs are projected water demands in excess of existing supplies that would be legally and physically available during a drought of record. Total water needs are greater than the difference in total water demand and total water supplies because not all existing supplies are available to all user groups. In East Texas there are many areas that have a surplus that cannot necessarily be shifted to where there are greater needs in the western part of the state.

Maps adapted from the Texas Water Development Board's draft *Water for Texas 2012*. Maps created by Texas A&M University Institute of Renewable Natural Resources/ Texas Water Resources Institute.

Projected Texas Population Growth

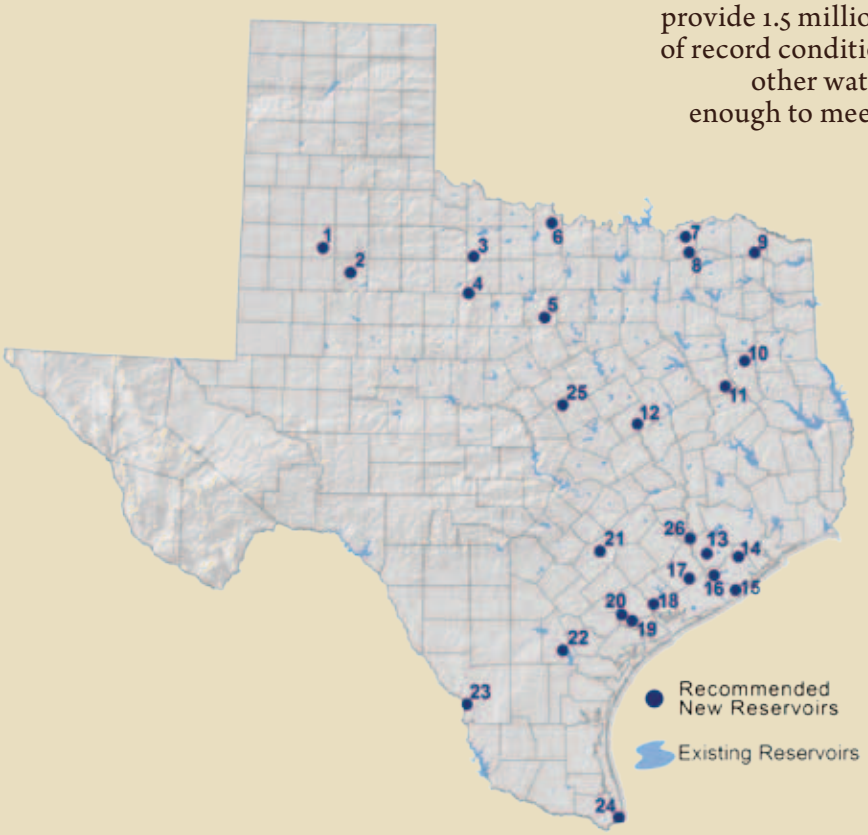
The population in Texas is expected to increase 82 percent between the years 2010 and 2060, growing from 25.4 million to 46.3 million people.



Recommended New Major Reservoirs

In 1950, the state had 50 major reservoirs; by 1980, the state had 179; and today, Texas has 188 major water supply reservoirs, with only a handful in some stage of planning or implementation.

The 2012 state water plan recommends 26 reservoirs that would provide 1.5 million acre-feet of water during a repeat of drought of record conditions in 2060. In the absence of these reservoirs, other water management strategies would simply not be enough to meet the needs of Texans during a severe drought.



1 Jim Bertram Lake 07
2 Post Reservoir
3 Millers Creek River Augmentation
4 Cedar Ridge Reservoir
5 Turkey Peak Reservoir
6 Lake Ringgold
7 Lower Bois d'Arc Reservoir
8 Lake Ralph Hall
9 Marvin Nichols Reservoir
10 Lake Columbia
11 Fastrill-Replacement Project (Off-Channel)
12 Brushy Creek Reservoir
13 Fort Bend Off-Channel Reservoir
14 Brazoria Off-Channel Reservoir
15 Dow Off-Channel Reservoir
16 Gulf Coast Water Authority Off-Channel Reservoir
17 LCRA San Antonio Water System Project (Off-Channel)
18 Lavaca Off-Channel Reservoir
19 GBRA New Appropriation (Lower Basin, Off-Channel)
20 GBRA Exelon Project
21 GBRA Mid Basin Project (Off-Channel)
22 Nueces Off-Channel Reservoir
23 Laredo Low Water Weir
24 Brownsville Weir
25 Coryell County Reservoir (Off-Channel)
26 Allens Creek Reservoir

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