Interim Report
to the 86th Texas Legislature

House Committee on Natural Resources

December 2018

HOUSE COMMITTEE ON NATURAL RESOURCES
TEXAS HOUSE OF REPRESENTATIVES
INTERIM REPORT 2018

A REPORT TO THE
HOUSE OF REPRESENTATIVES
86TH TEXAS LEGISLATURE

LYLE LARSON
CHAIRMAN

COMMITTEE CLERK
SHANNON HOUSTON

Committee On
Natural Resources

December 20, 2018

Lyle Larson
Chairman

P.O. Box 2910
Austin, Texas 78768-2910

The Honorable Joe Straus
Speaker, Texas House of Representatives
Members of the Texas House of Representatives
Texas State Capitol, Rm. 2W.13
Austin, Texas 78701

Dear Mr. Speaker and Fellow Members:

The Committee on Natural Resources of the Eighty-fifth Legislature hereby submits its interim report including recommendations and drafted legislation for consideration by the Eighty-sixth Legislature.

Respectfully submitted,

Lyle Larson, Chairman

Dade Phelan, Vice Chairman

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TABLE OF CONTENTS

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on its Interim Charge #1 related to Hurricane Harvey and flooding in general on October 4, 2017 in Houston, Texas. The following individuals testified on the charge:

Mark Allen, Jasper County
Yvette Arellano, Texas Environmental Justice Advocacy Services
Laura Blackburn, Self; League of Women Voters of Texas
Jim Bradbury, Texas Ag Land Trust and Texas Land Trust Council
Jeff Branick, Jefferson County
Bech Bruun, Texas Water Development Board
Stephen Carlton, Orange County
Stephen Costello, City of Houston
Ed Emmett, Harris County
Alicia Garcia, Texas Environmental Justice Advocacy Services
Larry Goldberg, American Society of Civil Engineers
Griselda Gonzales, American Society of Civil Engineers Texas Section GAC
Lisa Gonzalez, Houston Advanced Research Center
Ramiro Gonzalez, City of Brownsville
John Hofmann, Lower Colorado River Authority
Jace Houston, San Jacinto River Authority
Keith Jordan, Self
Gloria Leal, Nicholas and Crystal Zuniga
Robert Mace, Self; Texas Water Development Board
Jordan Macha, Bayou City Waterkeeper
Dave Martin, Self; City of Houston, District E Residents and Representative Huberty
Evelyn Merz, Houston Regional Group Sierra Club
James David Montagne, Sabine River Authority of Texas
Russ Poppe, Harris County Flood Control District
Paul Price, Newton County
Bob Rehak, Self
Bernard Ryan, Self
Warren Samuelson, Texas Commission on Environmental Quality
Adrian Shelley, Self; Public Citizen
Michael Sterling, U.S. Army Corps of Engineers
Jeff Walker, Texas Water Development Board
Gareth Young, Self

The House Committee on Natural Resources held a public hearing on its Interim Charge #2 related to Hurricane Harvey and flooding in general on April 17, 2017 at 2:00p.m. in Austin, Texas. The following individuals testified on the charge:

John Dupnik, Texas Water Development Board
Blair Fitzsimons, Texas Ag Land Trust
Jace Houston, San Jacinto River Authority
Laura Huffman, The Nature Conservancy
Scott Jones, Galveston Bay Foundation
Kelly Keel Linden, TCEQ
Allen Messenger, Self; ANB Cattle
Bill Mullican, CDM Smith
Lori Olson, Texas Land Trust Council
John Otto, Texas Rebuild Commission
Russell Poppe, Harris County Flood Control District
L'Oreal Stepney, Texas Commission on Environmental Quality
Joshua Stuckey, Self; Harris County

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #10 to hear an update on the State Flood Assessment on October 16, 2018 in Waco, Texas . The following individuals testified on the charge:

John Dupnik, Texas Water Development Board

The following section of this report related to flooding is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

In late August 2017, Hurricane Harvey devastated the middle and upper Texas coast, unleashing 34 trillion gallons of rainfall, or 94 times the conservation storage of Lake Travis, causing unprecedented flooding and property loss.[1] The hurricane resulted in the deaths of 82 Texans, and caused $125 billion in damages, including Louisiana.[2] Further, damages to critical infrastructure, such as bridges, roads, water treatment plants, critical care facilities, schools, and power plants, led to vital service interruptions, causing ripple effects throughout the economy in the affected areas and nearby regions long after floodwaters receded.

Though Texas has experienced flooding throughout its history and ranks second only to Louisiana in property loss due to flooding, the extent of the loss of life and property the state experienced as a result of Hurricane Harvey, along with six other federally-declared flood declarations since 2015, call attention to the need for a clearer understanding of flooding in Texas, from the events themselves to the data, policies, and resources needed to mitigate them.[3]

In light of the devastation experienced as a result of Hurricane Harvey, the committee was given two interim charges related to flooding. Immediately following the hurricane, the Speaker issued the committee its first charge to evaluate the role of regional entities in developing projects to control flooding, mitigation efforts that would reduce the impact of future flood events, and strategies to fund those efforts, and the response of public entities that own or operate dams, including how such entities make decisions regarding dam and reservoir operations during large-scale rain events, coordinate with state and local emergency management officials, and communicate with the public. Subsequently, the Speaker also asked the committee to study the development of the initial State Flood Assessment by the Texas Water Development Board, science and data needs related to flood risk and to responding to flood events, the best methods of providing state financial assistance for flood infrastructure needs, opportunities for improved collection and storage of flood flows for future supply needs, and the role of voluntary land conservation efforts in preventing and mitigating flooding.

BACKGROUND

Overview of Hurricane Harvey

On Aug. 23, 2017, Harvey—which had been downgraded to a tropical wave—re-formed into a tropical storm. And because of ideal conditions in the Gulf of Mexico, the storm quickly gained power and was already a Category 4 storm before making landfall, near Rockport, on Aug. 25. The hurricane first moved to the northwest before turning back to the east as a tropical storm, circling around Victoria, going through Matagorda Bay, and then back into the Gulf of Mexico on Aug. 28. The tropical storm stayed close to the Texas coast before making landfall again to the east of Beaumont in Louisiana, on Aug. 30. In its report on Harvey, the National Weather Service observes that parts of the state received “more than 40 inches of rain in less than 48 hours,” and that “Cedar Bayou in Houston received a storm total of 51.88 inches of rainfall, which is a new North American record.” That rainfall record—and the record for any United

States storm—was smashed after the weather service reevaluated its data. Nederland, in Jefferson County, recorded 64.6 inches of rain from Aug. 24 to Sept. 1.[4]

Hurricane Harvey encompassed three separate events: the hurricane event near Rockport, Texas in the Coastal Bend region, a wind event as the storm moved toward Greater Houston, and finally another flooding event as the storm made a second landfall in Southeast Texas.[5] The devastation was far-reaching and affected vast swaths of the state. [6]

Flood Risk to the Economy

Commerce exists near water when flows are considered dependable, but flood events can disrupt a local economy, both in the immediate aftermath of an event and over longer time periods. A recent analysis by Standard & Poor's Financial Services (2018) notes that improper planning for weather-related risks can impact a municipality's credit rating, with specific emphasis on hazard impacts to the local population and the associated tax base. This analysis also calls out the importance of realistic financial assumptions and projections that account for the disruptions caused by natural hazards and the benefits from implementing mitigation strategies to increase resiliency. Further, recurrent flooding may discourage long-term investments by the government and private sector alike.[7]

For example, Jefferson County produces approximately 10% of the gasoline in the United States, including about 20% of the diesel fuel, 50% of the commercial aviation fuel, and 50% of the military aviation fuel, and is home to the world's largest military port. About 60% of the water that flows out of the State of Texas and into the Gulf of Mexico comes from the Sabine-Neches waterway, and yet, Calcasieu Parish in Louisiana, Orange County, Jefferson County, Chambers County, and Harris County together are responsible for providing for the bulk of the country's energy needs. While flood projects are expensive, cost-benefit analysis should take this important impact into account. Because of the interruption in refining capacity, it cost the American consumer $2.9 billion due to the refineries being down and the Sabine-Neches Port being shut down due to shuttling, which is the third largest port in the United States.[8]

Types of Flooding[9]

It is important to note the different types of flooding due to the different strategies needed to prepare for and mitigate their impacts. The primary types of flooding that impact the state are summarized below.

Riverine flooding – Abundant rainfall can result in more runoff entering a river channel than can be contained within its banks. When water levels exceed the capacity of a channel, the river overflows onto adjacent lands, called the floodplain. On steep, narrow floodplains, these excess overflows can create flood conditions suddenly (see flash flooding below). Where land is flat and floodplains are more expansive, greater volumes of runoff are required to cause flooding, the impacts of which may take hours or days to reach locations downstream (see slow-rise flooding below).

Flash flooding – A type of riverine flooding, flash flooding is characterized by a short timelag (less than six hours) between the rain event and rapidly rising water levels (NWS, 2018b). Flash flooding can occur anywhere rainfall intensity exceeds the infiltration capacity of the soil, causing rapid surface runoff. Areas with large amounts of impervious cover, exposed bedrock, or other solid surfaces that reduce infiltration and increase runoff, are especially susceptible to flash flooding.

Slow-rise flooding – This second type of riverine flooding occurs when rain events near the top of the watershed, or far upstream, cause flooding that continues unabated downstream, impacting communities where no rain fell. For example, slow-rise flooding occurs along the Guadalupe River. When intense rains in the Hill Country cause the river to swell in New Braunfels, the City of Victoria, located 230 river miles downstream, can expect floodwater to arrive roughly one to two days after it passes underneath IH-35.

Coastal flooding – Low pressure systems may gain strength as they travel across the warm waters of the Gulf of Mexico, sometimes developing into tropical storms or hurricanes. As these systems approach the Texas coast, stronger winds combined with changes in water surface elevation can produce a storm surge that drives ocean water inland across the flat coastal plain. High tide events also may cause frequent, localized flooding of low-lying coastal lands.

Stormwater flooding – This type of localized flooding occurs when rainfall overwhelms the capacity of engineered drainage systems to carry away rapidly accumulating volumes of water. It typically dissipates quickly, except in situations such as when pumping equipment fails due to loss of power, inflows exceed pumping or conveyance capacity, or debris blocks the passage of water. In urban settings, the solid surfaces of buildings and streets (also called impervious cover) prevent rainfall from soaking into the ground. This creates runoff which contributes to stormwater flooding.

Structural failure flooding – Though uncommon in Texas, failure of man-made infrastructure, such as dams or levees, can occur when intense or extensive rainfall results in the uncontrolled release of floodwaters. Failures may arise if a rain event exceeds the design capacity of a structure, such as when Callaway and McGuire dams failed in Robertson County in May 2004.

Development of the State Flood Assessment

To gain a greater understanding of flooding and how it affects our State, the 85th Legislature funded the state's initial State Flood Assessment, to assess risks and role and envision the future of flood planning in Texas.[10] In April of 2018, the Natural Resources Committee Chairman sent a letter to Peter Lake, Chairman of the Texas Water Development Board, requesting that the assessment also include estimated funding costs for mitigation to aid in the Legislature's deliberations during the 86th Legislative Session.[11] A draft flood assessment was released in September of 2018 and a final version was released in December. The information that came out of the assessment relies heavily on surveys and listening sessions with stakeholders, mostly local floodplain administrators.[12]

The report identified three pillars of flood management: mapping, planning, and mitigation.

Stakeholders surveyed and prioritized how they would like to see state resources directed for these activities in the following order:

1.) Financial assistance to implement flood mitigation activities
2.) Improved flood risk mapping and modeling
3.) Financial assistance for flood mitigation and planning.[13]

The following is a summary of the three pillars of flood management identified in the report, along with analysis and recommendations:

Mapping:

Flood hazard maps are a critical tool for managing flood activities, including identifying where the flood prone areas exist, and where to dedicate resources and implement strategies. They also play an important role in conveying flood risk. Currently, the maps that serve this function are the FEMA Flood Insurance Rate Maps, or FIRMS. All participants in the National Flood Insurance Program (NFIP) are required to regulate in accordance with these FIRMs.[14]

However, there are some drawbacks to using these maps. FIRMs are limited in application, as they are regulatory maps designed for insurance purposes. They are static, meaning that changes in development and how that affects how water moves through watersheds is not reflected. They also only look at riverine and coastal flooding, and while those are major problems in the state, stakeholders also indicated challenges with stormwater or urban flooding, which the FIRMs mostly do not represent. Development of the FIRMs is a very time-consuming process, meaning that the pace of development often outpaces the development of these maps. Nevertheless, these are the primary means for conveying flood risk in communities, and guide how communities implement flood strategies.[15]

FIRMs have been updated to varying degrees throughout the state. Some areas have no maps or only paper maps, some areas have maps that are greater than 10 years old, most areas with digital maps have are 5-10 years old, and a few are less than 5 years old. In order to update maps for the entire state, the cost would be $604 million.[16]

However, some watersheds have begun or have recently completed the mapping update process, for example, all of the Guadalupe and Neches river basins and other individual watersheds, reducing the need to invest in a complete remapping of the state, at this time.[17] A true cost for developing and updating all FIRMs in Texas is yet to be determined, but example costs from recent mapping activities ranged from $1.2 million for the Lower Colorado Cummins basin (most of Bastrop and Fayette counties) to $2.6 million for Upper Brushy Creek (most of Williamson County). [18]These estimates include both state or local in-kind services and existing data and modeling products as well as federal grant funding.[19]

Atlas 14, compiled by the National Weather Service, provides estimates of the maximum rainfall that can be expected for most locations in the United States based on historical rainfall measurements. The recently updated Atlas 14 Volume 11, which includes Texas and incorporates data from Hurricane Harvey, shows increases of more than 5 inches for the 1

percent annual chance, 24-hour rainfall event in areas near Houston as compared to existing historical records. Elsewhere in Texas, new rainfall estimates may differ significantly. Del Rio, San Antonio, Austin, and Corpus Christi are some of the areas where the depths of rainfall associated with many storms are expected to increase.[20]

New analyses will be required to determine and revise the extent of flood inundation that can be expected and the appropriate design standards for infrastructure. In general, in areas where rainfall estimates go down, there will be greater confidence that existing infrastructure will perform as intended. Increased rainfall totals over a short time span means that storms will have more significant impacts than previously predicted translating to larger discharges of water in drainage ditches and under bridges, larger volumes of water in detention ponds and behind flood control structures, and larger floodplains associated with a specific duration and frequency of storm.[21]

Planning:[22]

There is no comprehensive flood planning ongoing currently in the state. However, planning is occurring at various scales. At the state level, the Texas Department of Emergency Management, or TDEM, produces the Texas Hazard Mitigation Plan every five years, and looks at weather-related hazards and strategies to address those hazards. It addresses flooding, but also addresses other hazards such as wildfires and tornadoes, and is not a comprehensive flood plan. As of July 2018, 117 counties have communities with FEMA-approved hazard mitigation plans covering about 81 percent of the state's population. Many communities currently have an expired local plan or no approved plan. Barriers to creation of local hazard mitigation plans are similar to those reflected in our survey of stakeholders: limited financial resources, lack of staff dedicated to this process, and difficulty navigating the process.

Local hazard mitigation planning, given its focus on addressing all types of natural hazards and its voluntary nature, is not sufficiently scoped to provide collaborative, watershed-based strategic flood planning. The process as carried out is important but limited. Further, participating entities vary, leaving no guarantee that participants with flood risks or expertise will be included.

Most flood planning is not occurring on a regional or watershed scale. At the watershed scale, the San Antonio River Authority is an example of watershed-scale planning. They've developed a sophisticated program to develop modeling, mapping, and mitigation efforts for flooding in that basin.

Most flood planning occurs at the local scale. TWDB administers the Flood Protection Grant Program by providing local entities funding for local flood planning efforts.

Stakeholders showed a strong preference for watershed-scale planning for the future of flood planning in Texas, and provided input as to what this process might look like. They indicated it would be important to identify and prioritize projects, much like is done in the State Water Plan, assess upstream and downstream impacts, and develop consistent policies and guidelines to require communities following some and evaluate future changes that could occur in the

watershed, such as development.

Mitigation:

Mitigation encompasses activities that reduce the severity of flooding impacts, which are categorized into structural and non-structural strategies. Structural mitigation generally refers to physical barriers to water, including dams, levees, hard grey infrastructure, and detention ponds. Examples of non-structural strategies include outreach programs, enforcement of ordinances, and early flood warning systems. Communities typically deploy a combination of these strategies.[23]

Relying on responses from stakeholders, the State Flood Assessment estimated that flood mitigation costs over a 10-year period for the entire state will range from $31.5 billion-$36 billion. This figure does include costs for disaster recovery, large-scale projects such as the coastal spine, or high-hazard dam repair. Taking into account estimated available local funds over that period ($7.1-$8.2 billion) and available non-local funds ($2.3-$5.3 billion) for flood mitigation efforts, the statewide funding shortfall is $18-$26.6 billion.[24]

While the State Flood Assessment can and should be used as a tool to help policymakers envision the flood needs of Texas and the state's role in flooding issues moving forward, it should be noted that much of the data points and analysis conveyed in the report is limited to the group of floodplain administrators surveyed. More analysis should continue to ensure state resources are used effectively. Additionally, the state may benefit from a more robust and comprehensive look at flooding issues in light of Hurricane Harvey.[25]

Overview of Roles and Responsibilities Related to Flooding

As the State Flood Assessment points out, the responsibility for flood planning, mitigation, protection, warning, and recovery is diffuse amongst many local governments and special purpose districts, and the federal government, with the State primarily supplying data, administering financing programs, overseeing emergency response, and recovery. Overlapping jurisdictions based on political rather than watershed boundaries and differing missions among the various entities create a multi-layered, complex environment, which sometimes leads to unclear responsibilities and uncoordinated efforts.[26]

The following table developed by the Texas Water Development Board as part of the State Flood Assessment provides a broad overview of select entities and their primary and secondary flood-related roles.[27]

		Stream gaging	Weather forecasting	Flood insurance rate mapping	Flood inundation mapping	National Flood Insurance Program Floodplain regulation adoption and	Hazard mitigation planning	Emergency operations planning (State and Local)	Dam/reservoir management	Levee management	Stormwater and drainage management
Local	City governments	P		S	S	P	P	P	P	P	P
	County governments	P		S	S	P	P	P	P	P	P
	Special purpose districts	P		S	S	P	P	S	P	P	P
	Councils of government			S			P	S			S
State	Texas Commission on Environmental Quality						S	S	S	S	S
	Texas Department of Transportation	S					S	S			P
	Texas Division of Emergency Management				P		P	P			
	Texas General Land Office						S	S			
	Texas State Soil & Water Conservation Board						S	S	S		
	Texas Water Development Board	P		S	P	S	S	S			
Federal	Federal Emergency Management Agency			P	P	S	S	S			
	National Weather Service		P	S	P			S			
	U.S. Army Corps of Engineers	S			P			S	P	P	P
	Natural Resources Conservation Service								S	S	
	U.S. Geological Survey	P		S	P						

Entities that have primary roles (P) are in charge of and/or take the lead on a noted activity. Entities that have secondary roles (S) provide data collection or technical support or have a regulatory responsibility. Dark gray fill indicates all entities in the category take on the responsibility; whereas, light gray fill indicates that some, but not all, entities in the category take on the responsibility. Special purpose districts include river authorities, soil and water conservation districts, water control and improvement districts, flood control and improvement districts, municipal utility districts, and levee improvement districts. Here, the Texas Water Development Board also represents the responsibilities related to the Texas Natural Resources Information System.

DISCUSSION AND CHALLENGES

Science and Data Availability and Needs Related to Flood Risk and Responding to Flood Events

As previously mentioned in this report, much of Texas is either unmapped or uses out-of-date maps, leading to widespread confusion. Mapping is the first step in identifying and communicating flood risk. FEMA's insurance maps show the boundary of inundation for the 1 percent annual chance flood event— commonly referred to as the 100-year flood and often misinterpreted as the line between safe and not safe. However, these maps may not reflect flood conditions based on the most current topographic, land use, or rainfall data. Creating flood risk maps using the most recently collected scientific data and models for all watersheds in the state could cost up to $604 million. Stakeholders prioritized up-to-date flood risk mapping, including collection and distribution of supporting data and addressing local drainage issues.

Sound science and data, identified as core elements of effective planning, are needed to inform flood-related decision making. As such, the TWDB has requested an additional $4.45 million in appropriations from the 86th Texas Legislature to support the agency's current efforts to gather data and monitor conditions across the state and to develop new initiatives that will further our understanding of flooding in Texas and our capacity to share that information.

Specifically, the funding requested would allow the TWDB to develop hydraulic river models for priority watersheds; update reservoir flood pool measurements; expand the TexMesonet earth observation network; acquire high-resolution land surface (lidar) data to better predict floodplains and flooding levels; develop coastal circulation and rainfall-runoff models; and create a web-based flood dashboard/water data hub. The information developed through these efforts will assist flood forecasters, emergency responders, local governments, and all Texans in making informed decisions when preparing for, responding to, and recovering from floods. With better data and better science, Texas can continue working toward the common goal of protecting lives and property from the next flood event.[28]

Further details on many of these activities currently funded through the Floodplain Management Account are below:

TWDB Floodplain Management Account (GR-D 0330) - 2016/2017* and 2018/2019 Biennia**

2016/2017 are Expended/Encumbered | 2018/2019 are Budgeted

Purpose	Description	2016-2017 Expended/Encumbered	2018-2019 Budgeted
TexasFlood.org	TexasFlood.org and the Flood Viewer (map.texasflood.org) are resources designed to provide Texans and emergency responders with information to make informed decisions before, during, and after floods. Funding is used to maintain and support the ongoing development of these sites.	$124,779	$245,704
Flood Gages	Flood gages are instruments deployed to measure the height of water in a river, stream, or lake. Depending on the type of gage and information collected at the gage location (such as stream shape and flow), this height of water can also be used to estimate the rate of water flow at the gage or storage volume remaining in a lake. Flood gage data is a critical component of flood forecasting. Funding is used to support and expand the state's network of flood gages.	$1,908,055	$2,216,000
Flood Forecast Modeling	The National Weather Service identified the need for additional surface-water flow modeling at key USGS gage sites as a high priority. The National Weather Service uses these models when determining whether to make flood warnings, and the models influence how flood projections are shown on their website. In response, the TWDB is funding modeling at critical sites identified by the National Weather Service in order to provide improved forcasting throughout Texas.	$200,000	$200,000
LiDAR	LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system— generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. LiDAR coverage is a key component of floodplain mapping, and LiDAR data is used in the delineation of floodplains and in predicting flooding levels. ***The 2018-2019 Budgeted $1.25M for LiDAR includes $749,247 in federal funds.	$0	$1,249,247
TexMesonet	The National Weather Service identified the need for additional climatic information to better predict flooding. The TexMesonet seeks to address this need by installing additional weather stations across Texas and by working with local and regional stakeholders to get their weather station networks online and available to the National Weather Service and citizens.	$928,065	$1,519,874

*2016/2017 represents emergency funds from the Governor's Office (Fund 0453)
**2018/2019 includes $1.7M in General Revenue funding

Flood Planning and the Role of Regional Entities in Developing Flood Projects

Mitigation without proper mapping and coordinated planning may be ineffective, or worse—intensify flood impacts in upstream or downstream communities. Effective planning includes core elements: data, models, and sound science; an inclusive vetting structure; defined levels of

acceptable risk and standardized benchmarks; and quantifiable outcomes.[29] According to the State Flood Assessment, stakeholders strongly favor a watershed-scale planning process for coordinating and guiding local efforts related to short-term and long-term flood planning, mitigation, and response.

Current Planning Efforts

Since 1983, the TWDB has provided state financial assistance, requiring up to a 50:50 cost share, to communities to conduct detailed studies of known or potential flood-prone areas to better inform the development of flood protection strategies through structural and non-structural solutions. This grant program allows communities to conduct hydrologic and hydraulic studies of current and future conditions and to identify potential mitigation solutions, including estimated costs and benefits. The process ensures opportunities for broad stakeholder education and input for each project, as well as consistency with relevant plans, laws, and regulations. Between 1995 and 2017, over $20 million in state funding, in addition to $30 million provided in local matching funds, was committed to flood protection planning in Texas through this program. Further, communities have been able to leverage their efforts from these flood protection planning studies to obtain additional funding through FEMA Flood Mitigation Assistance grants.

Considering any future flood planning efforts, there are elements of the TWDB's flood protection planning grant program that can be modeled—elements such as inclusive stakeholder forums, multi-jurisdictional cooperation, modeling flood risk under future development conditions, identifying structural and non-structural solutions, and requiring local financial contribution through dollars or in-kind services.

Harris County Flood Control District

The Harris County Flood Control District is a unique special purpose district created by the Texas Legislature in 1937 in response to devastating floods that struck the region in 1929 and 1935. The District is funded by an ad valorem tax rate of 2.8 cents per $100 evaluation. The District has worked closely with the U.S. Army Corps of Engineers on the development of flood control projects in its jurisdiction.[30] Noting that the District has significant infrastructure and expertise related to flooding, some suggested that adjoining counties could enter into interlocal agreements with the District to provide planning services and serve as a conduit to seek federal reimbursement, rather than creating a new entity.[31]

Regional models

In a few cases, communities are moving towards an integrative approach that factors in hydrology, hydraulics, water quality, and open land areas at the watershed-scale to collectively address drainage issues.

San Antonio River Authority

The San Antonio River Authority has implemented holistic watershed planning across the basin to assist the responsible local entities to manage land use change and

maintain water quality. The effort also includes incorporating FEMA's Risk Mapping, Assessment, and Planning (RiskMAP) approach to identifying flood risk for every watershed in the basin. Funding for these initiatives is supported by the San Antonio River Authority's ability to levy an ad valorem tax, which is limited to $0.02 per $100 of assessed property valuation. Through the Bexar Regional Water Management Partnership, San Antonio River Authority, Bexar County, the City of San Antonio and 19 suburban cities partnered to develop planning documents to address regional flooding (watershed master plan and capital improvement plan) and data (computer models, financial models, and network databases). They then prioritized projects by watershed and funded 56 projects at an estimated $500 million over a 10-year period.

North Texas Council of Governments

The North Central Texas Council of Governments developed a voluntary 16-county watershed management initiative with "a goal to allow for sound development through regional consistency; to recognize cost savings associated with the investment in effective watershed management to reduce or prevent flooding; to slow water quality decline; and to avoid loss of opportunity that is a result of rapid growth."[32] NCTCOG coordinates with local governments and other stakeholders to identify opportunities to improve watershed protection.

River Authorities' Role in Flood Planning[33]

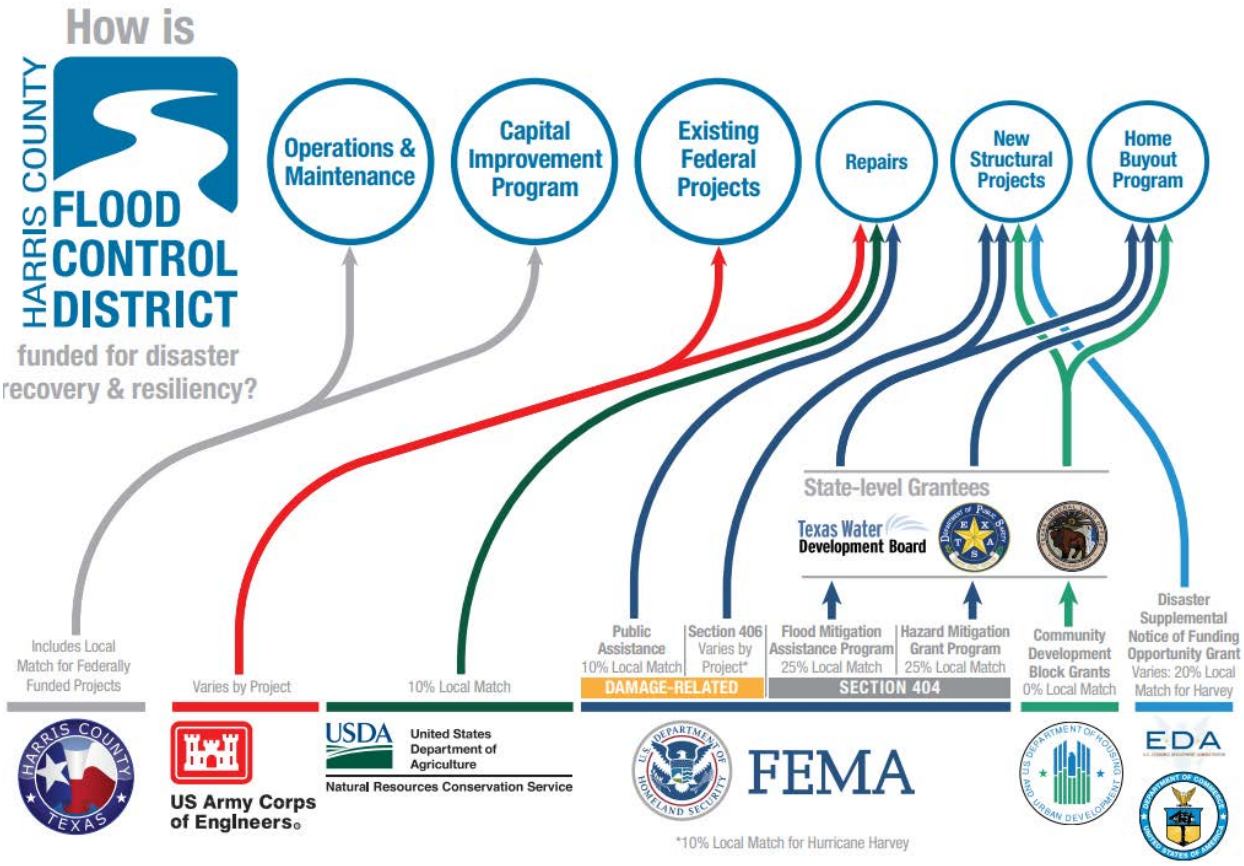
Some stakeholders have looked to river authorities to serve as a regional coordinator of watershed-based flood plans. Areas of the state that lack sufficient local resources to effectively address flood management and planning could benefit from increased partnership and coordination with the river authority in their area. Depending on the local needs, river authorities could fill this role through interlocal agreements for specific services, coordination of regional studies, or the provision of direct staff services through full-time employees or consultants. These services could assist in various aspects of the three parts of a flood risk reduction system (planning, predicting, and responding), especially in providing expertise and assistance in obtaining state and federal funding, which should be provided through the Texas Water Development Board, Federal Emergency Management Agency, or the United States Army Corps of Engineers.

Most, but not all, river authorities and other Chapter 49 special districts have the legal authority to partner with local entities with flood control responsibilities (cities, counties, drainage districts, levee improvement districts, storm water control districts, soil and water conservation districts, certain water districts, etc.) to carry out flood management activities. The legislature should consider expanding or, where necessary, creating the legal mechanisms for river authorities and special districts to partner with local entities as needed in the various roles of flood risk reduction within their basins. This would include the ability of river authorities to act as conduits to apply for and manage Texas Water Development Board funding not only for flood protection studies, but also for flood infrastructure funding and construction.

Best Methods of Providing State Financial Assistance for Flood Infrastructure Needs

Flood mitigation, which is any activity undertaken to prevent or reduce the impacts of flood events, is needed and can be expensive. Flood mitigation is primarily a local activity that could benefit from greater state and regional participation. Estimated from the State Flood Assessment, an additional $18.0 to $26.6 billion is needed to complement existing funding for flood mitigation in Texas.[34] Advocates noted that while the state has a water plan and associated funding streams as with the State Water Infrastructure Fund for Texas (SWIFT), the state does not have a grant or revolving fund for emergency flood damage reduction.[35]

Funding for flood management efforts in Texas is currently complex and disjointed. Local entities with flood control responsibilities (cities, counties, drainage districts, levee improvement districts, stormwater control districts, soil and water conservation districts, certain water districts, etc.) generally focus their funding on strategies related to local drainage and development standards, but these efforts often miss important, regional strategies. Large-scale regional strategies, such as flood control reservoirs, do not have sufficient, dedicated funding sources and often benefit numerous local entities, which increases the complexity of funding and implementing the strategy.[36] The following graphic from the Harris County Flood Control District helps to illustrate the myriad different agencies involved in developing and maintaining projects designed for disaster recovery and resiliency. The Harris County Flood Control District noted that projects carried out with the U.S. Army Corps of Engineers generally involved a federal contribution of 60-70 percent and local match of 30-40 percent.[37]



In October 2017, the Governor's Commission to Rebuild Texas requested $61 billion in federal appropriations above current federal expenditures for rebuilding public infrastructure damaged or destroyed by Hurricane Harvey and for projects designed to mitigate the impact of future storms on the Texas Gulf Coast. Congress responded to this request with a significant amount of federal funding in the Bipartisan Budget Act of 2018, which included $90 billion in disaster aid for Texas, Florida, and Puerto Rico. Thus far, Texas has received the following federal funding for Harvey recovery activities, including:

- The U.S. Army Corps of Engineers Civil Works Long-Term Disaster Recovery Investment Program received $4.9 billion for five ongoing construction projects and five new-start construction projects in Texas, along with $15.1 million for five studies.
- As administered by the Texas Department of Public Safety, FEMA will provide an estimated $1 billion for hazard and flood mitigation projects through the Hazard Mitigation Grant Program.
- The Texas General Land Office is administering $5.024 billion in Community Development Block Grant–Disaster Recovery funds provided through the Department of Housing and Urban Development for Hurricane Harvey recovery.

Current state financial assistance *grant* programs are not funded at levels sufficient to meet the needs of historic flood management efforts, much less the increased needs since Hurricane Harvey. Further, existing state financial assistance *loan* programs designed to fund structural and non-structural flood mitigation measures (such as restoration of levees, raising of bridges and roads, or removal of structures from the floodway) have not seen patronage due to lack of a subsidy for incentives or a revenue source to pledge for debt issuance. Most local entities await limited federal grant funding for such projects. An effective state financial assistance source for flood mitigation grants and loans is necessary to support local efforts to mitigate the losses from flood events.

Ultimately, funding for flood management efforts will have to be a combination of local, state, and federal dollars. Some efforts can and should be funded at the local level, but many flood projects are simply too large to be absorbed by local entities. Respondents to the State Flood Assessment survey describe needing anywhere from 0 to 100 percent of project costs covered by outside financial assistance. Small communities and regions that are primarily rural indicated the highest need for non-local funding. When asked what types of financial assistance stakeholders might pursue, the most preferred choices were either a 90/10 cost-share program (90 percent non-local contribution/10 percent local match) or a 75/25 cost-share program. Less popular but of equal interest to about 20 percent of respondents are programs with either a 50/50 cost-share or a zero percent interest loan. Few stakeholders opted for assistance via market rate loans, subsidized loans, or state participation in projects. Nearly 40 percent of respondents did not know what mechanism to choose.

<u>Existing Funding for Flood Mitigation Administered by TWDB:</u>

FEMA Flood Mitigation Assistance Grants:

The grants are historically awarded $20-40 million each year to the TWDB as a pass-through for communities to elevate, relocate, acquire, or flood-proof structures or establish drainage projects. Provides planning grants to communities to develop or update the flood hazard component of a jurisdiction's Multi-Hazard Mitigation Plan and project grants for mitigation through acquisitions (buyouts), relocations, floodproofing, or elevations of structures insured under the NFIP.

Clean Water State Revolving Fund:

Stormwater management activities are broadly eligible under CWSRF, including both structural and non-structural measures. Specific activities mentioned in EPA guidance include:

- Structural or engineered control devices and systems to manage, reduce, store, and/or treat stormwater
- Sea walls
- Levees/dikes/berms
- Relocation/elevation of certain assets or entire an facility above current/projected flood stage
- Installation of flood attenuation, diversion, or retention infrastructure
- Floodwater pumping systems
- Infiltration basins
- Permeable pavement
- Municipality-wide stormwater management planning
- Stormwater "best management practices" that manage, reduce, treat, recapture, or reuse municipal stormwater

Capacity: For SFY 2019, $525,000,000 is made available, including reserved funds for Emergency Relief, Green projects, and Disadvantaged Communities. There isn't a reserve specifically for flood projects.

The CWSRF 2019 funds for Emergency Relief can be applied to infrastructure damage resulting from a flood event. $5,000,000 is offered as principal forgiveness to eligible Emergency Relief projects (up to $800,000 per project). At least $53,000,000 is also available for Emergency Relief financing at 0% interest. Half of the funds available as principal forgiveness and 20% of the funds available at 0% financing are reserved for Disadvantaged/Small/Rural communities as defined in the CWSRF 2019 Intended Use Plan.

*DFund***:**

Like CWSRF, structural and nonstructural flood control activities are eligible for DFund financing, including the development of floodplain management plans. Eligible projects include: retention basins, enlargement of stream channels, modification or reconstruction of bridges, acquisition of floodplain land for use in public open space, relocation of residents of buildings removed from a floodplain, public beach re-nourishment, flood warning systems, and control of coastal erosion.

Capacity: $6 billion evergreen bonding authority.

Response of Public Entities Who Own or Operate Dams

Background

Texas has more than 4,000 regulated reservoirs. Over 200 of these are considered major reservoirs, and are owned and operated by a myriad of federal, state, and local entities. The U.S. Army Corps of Engineers (USACE), river authorities, and regional water districts are the most common reservoir owners and operators in Texas. In some instances, reservoirs are owned by one entity and operated by another; usually a local sponsor in partnership with USACE. Nearly 90 percent of Texas reservoirs serve a water supply function, but some also include varying degrees of flood control as well. Very few major reservoirs, especially those operated by local entities, act solely in a flood control capacity. Barker and Addicks Reservoirs, owned and operated by USACE, are two examples of reservoirs designed exclusively for flood control.[38]

Hurricane Harvey resulted in widespread inundation of areas that had never previously experienced flooding. Some areas downstream from reservoirs whose gates were opened during the event have raised questions about the role of reservoirs during flooding events, the role of dam operators during flooding events and how they make decisions to open a dam, and the role of dam operators to communicate those decisions to the public.

In response to concerns expressed by the Lake Houston region downstream of Lake Conroe located on the West Fork of the San Jacinto River, the San Jacinto River Authority has implemented a temporary seasonal lowering strategy in order to create more capacity in the reservoir to absorb flood flows during hurricane season. Beginning on April 1st, SJRA will lower gradually reduce to and maintain the level of Lake Conroe at 200’ msl (one foot below normal pool). Starting on June 1st, begin to capture flows to restore normal lake elevation.

In the fall season starting on August 1st, SJRA will gradually reduce the level of Lake Conroe with a goal of reaching 200’ msl (one foot below normal pool) by August 15th. After August 15th, SJRA will continue gradually lowering the level of Lake Conroe with a goal of reaching (and maintaining) 199’ msl (two feet below normal pool) by August 31. Starting on October 1st, SJRA will begin to capture flows to restore normal lake elevation. The Authority has also undertaken other efforts to assist with flood management, including creating a Flood Division.

The purpose of this section of the report is to analyze the role of reservoirs for flood control, the role of reservoir operators during floods, and the concept of pre-release as a flood control strategy.

Reservoir Operations

Water Supply Reservoirs

The vibrant and burgeoning Texas of today exists because of the water supply reservoirs built

by past leaders of the state. While considered visionary today, they were built after the painful lessons of drought; first in the early 1900s, followed by the 1930s and then in the 1950s. The dams they built throughout that time and in following years to secure the state's water supply have a simple purpose: capture water when it is available and store it for use during long, hot summers and all-too-frequent droughts. There are 150 dedicated, water supply reservoirs in Texas.

Most existing water supply reservoirs are intended to be maintained as full as possible, a necessity that is fundamental to water planning in Texas. To use dedicated water supply storage for flood control usually requires abandoning – even if temporarily – some portion of a water rights holder's water supply. If that supply is temporarily abandoned and drought develops, parties dependent upon stored water may not have enough to meet demand.

However, water supply reservoirs operated according to their design do not cause flooding. The same volume of water that was behind a water-supply dam before a flood began will be there when the flooding is over, as stored water is not released during storm events.[39] Only additional water that would have flowed down river had the dam never been built is allowed to pass. This is called run-of-the-river operations, and is not intended to provide flood control benefits. Because those reservoirs release no more floodwater than would have flowed down river in their absence, their operations do not result in the inundation of additional downstream private property.

However, even though it is not the intent of their design, in most rainfall events, water supply reservoirs operating on a run-of-the-river basis provide some flood mitigation benefit by reducing the peak flow passing through the reservoir. Most water supply reservoirs have additional capacity above their normal pool elevation that is designated for temporary storage during a storm event. This temporary storage allows the reservoir to store some stormwater, which means that the peak flow rate being discharged from the reservoir will be lower than the peak flow rate entering the reservoir. When this happens, water supply reservoirs can reduce the peak flow rate during storm events, providing unintended flood mitigation benefits.

Flood Control Reservoirs

There are eight major, dedicated flood control reservoirs in Texas. In exact contrast to water supply reservoirs, flood storage must be maintained as close to empty as possible to provide storage for capturing water during large storms to reduce the amount of flow in the river downstream of the reservoir. Captured flows are then released slowly over time, once the peak of the storm has passed, in order to free-up storage necessary to mitigate flooding from the next big storm. Releases are measured to minimize downstream flooding while protecting the reservoir's integrity.

Dual Purpose Reservoirs

Thirty-five reservoirs in Texas have storage allocated to both water supply and flood control. However, the storage associated with each is clearly defined and is dedicated for that purpose. The storage dedicated to water supply is maintained as close to full as possible, and the storage

dedicated to flood control is maintained as close to empty as possible.

Reservoir Design

The structural integrity of a dam is threatened if more water is captured than the reservoir (including the dam) was designed to hold. For this reason, some reservoirs are designed with emergency overflows to safely allow excess flows to pass over the dam. Other reservoirs use control gates or valves to pass stormwater, which allow for controlled releases.

In water supply reservoirs, there is often very little storage available between maximum design impoundment and the top of the gates. This distance is sometimes referred to as freeboard and should not be considered extra storage, as it is unsafe to operate in that manner. A reservoir that attempts to indefinitely impound stormwater without an emergency spillway will eventually overtop at the lowest elevation across the dam, usually the top of the control gates. This kind of operation is dangerous as it jeopardizes the integrity of the dam, potentially resulting in a dam failure. For this reason, reservoir operators follow specific flood operation protocols to ensure that the dam is not breached.

Prerelease from Water Supply Reservoirs

This section briefly addresses the role, value, and limitations of prereleases from water supply reservoirs to mitigate downstream flooding. Many factors influence whether prerelease is a safe strategy, and those factors are basin and storm-specific. While prerelease may seem like a viable strategy when looking at historic storm events, the lack of certainty in weather predictions means its use could aggravate downstream flooding and place lives and property at risk that otherwise would not be. Accordingly, any legislative mandate to undertake prereleases would be, at best, hazardous and unwise.

What is prerelease in the context of a water supply reservoir? It is the discharge of stored water in anticipation of either predicted rainfall or the anticipated arrival of flood flows from upstream. Prerelease is not the same as the permanent or temporary conversion of conservation storage to flood storage. Conservation storage can be permanently converted to flood storage by constant maintenance of a lower pool elevation. Storage can also be temporarily converted to flood storage by maintaining a lower conservation pool during certain times of year (*e.g.*, hurricane season).

Prerelease is a reactive strategy, undertaken when either rain upstream has produced flood flows, or predicted rain over and around the reservoir could do so.

Factors to Consider:

The factors that influence whether prerelease may be of benefit (or detriment) include:

1. Predicted location and amount of rainfall in relation to a reservoir;
2. River-basin size and lag time;
3. Existing downstream flow; and,

4. Predicted weather conditions below a reservoir.

When rainfall occurs well upstream of a reservoir, some of the foregoing factors are more clearly established. However, when rainfall originates downstream of a reservoir and moves inland, as is the case in tropical storms and hurricanes, the impact of prerelease is much more difficult to measure. In those situations, prerelease must be approached with extreme caution to avoid exacerbating downstream flooding.

Each heavy rainfall situation is unique, and predictions of actual effects are inexact. Upstream and downstream weather forecast predictions are inherently uncertain, thus, deciding when and how much to prerelease is a game of chance with substantial risk. A well-intentioned and objectively reasonable decision to prerelease can, because of the imprecision of the predictions on which it is based, ultimately make downstream flooding worse rather than better. The primary concern must always be to avoid aggravating downstream flooding, because doing so places lives and property at risk.

Upstream Rainfall/Flooding

One potential application of prerelease exists in large basins, with precipitation occurring well upstream of a reservoir. In that situation, there is significant lag time between the flood-causing rainfall and its arrival in the downstream reservoir. This lag time enables an operator to more accurately determine the effect of upstream rainfall on reservoir levels, as flows on their way to the reservoir will likely be gaged at several intermediate locations.

Even in this case, prerelease can only be undertaken at a rate that the downstream waterway can accommodate within its banks, *i.e.*, without causing flooding by virtue of the prerelease itself. This limitation hinders a reservoir operator's ability to prerelease a sufficient volume of stored water to have a meaningful effect on downstream flooding.

The closer to a downstream reservoir heavy rainfall occurs, the less time a reservoir operator has to prerelease. This can occur in large basins with rainfall immediately upstream of a reservoir. It can also take place in small basins, with very little drainage area upstream of a reservoir. In smaller basins, which have smaller downstream waterways, the total impact of an upstream precipitation event will be realized more quickly than in a large basin with a precipitation event far upstream, leaving less time to prerelease without causing flooding.

Downstream Rainfall/Flooding

The value of prerelease is more limited, and its use far more hazardous, in the case of storms that move inland and discharge significant rainfall before reaching upstream reservoirs. The factors to consider, and the predictions they depend upon, are much less certain in these cases. Because the forecasted precipitation event originates downstream, the effect of precipitation on the reservoir cannot be gauged before its arrival as in the case of an upstream event.

The effect on the reservoir can only be estimated based on forecasted precipitation. Lag time is effectively non-existent, and downstream waterways may already be full or nearly full from

downstream precipitation that has already occurred before it reaches the reservoir. If a prerelease commences, and the downstream area is or has been hit with significant precipitation, water may overflow streams and riverbanks when it otherwise would not have. In short, in these events, the risk that prerelease could aggravate downstream flooding is high.

Hurricanes and tropical storms usually develop in the Gulf of Mexico and move inland. These storms are thus accompanied by significant downstream precipitation events before reaching inland reservoirs. While tempting from a purely visual or political perspective, the use of prerelease in these types of events is significantly more likely to place additional lives and property at risk. This is a case where the cost of making a mistake is far greater than that of inaction, because an affirmative decision that results in increased flooding is practically indefensible.

Weather Predictions

Common to both the upstream and downstream events described is the criticality of weather predictions in the prerelease analysis. In both events, weather predictions for the area downstream of a prereleasing reservoir must be given the highest priority in decision making. The banks of waterways below a prereleasing reservoir can only convey a certain amount of water before being overtopped. Any downstream rainfall once a prerelease has commenced can cause overbank flooding. The only data available at the time of the prerelease would be forecasted downstream rainfall and volume. If actual rainfall is more than forecasted, waterways already filled with prerelease flows could overtop banks. In that case, a prerelease would exacerbate flooding.

Hurricane Harvey

Many estimates exist of Hurricane Harvey's hydrologic impact. One such estimate indicates that Harvey dumped approximately 24.5 trillion gallons of water in Texas and southeast Louisiana, the equivalent of roughly 75 million acre feet of water. Texas' statewide water conservation storage is approximately 31.5 million acre feet. Hurricane Harvey could have filled all water supply reservoirs in Texas more than twice. These statistics illustrate that no amount of prerelease, and no amount of temporary or permanent conversion of water supply storage, would have appreciably reduced the magnitude of flooding caused by Hurricane Harvey.

Liability

While public safety is of the utmost importance during a major flood event like Hurricane Harvey, the use of prerelease calls into question potential legal issues that should not be ignored. A reservoir operator that aggravates downstream flooding by an objectively reasonable prerelease would nonetheless be exposed to takings liability in that case. Liability for the taking of private property by government action is a function of the guarantees of the United States and Texas Constitutions. The Legislature cannot limit that liability by statute, and thus cannot confer protection upon reservoir operators, even if the decision to prerelease is objectively reasonable.

Communications with Emergency Management Officials and the Public[40]

During a major flood event, it is critical that those who may be affected receive timely and accurate information and a clear and consistent message of what to expect. It is also important that local emergency management officials stay informed so that they can make decisions within their jurisdiction such as the need for potential evacuations. Reservoir operators can and do play a major role in providing information related to flood releases and reservoir levels to both the public and local officials.

The purpose of this section is to focus on communication during a flood event, with particular attention to the ways in which reservoir operators notify local emergency management officials and the public of reservoir conditions and dam releases.

Sources of Flooding

Not all flood events involve or are contributed to by reservoirs. Some floods occur due to heavy rainfall, runoff, and/or urban development downstream from the nearest reservoir and have no interaction with or contribution from reservoir operations. In these cases, reservoir operators typically do not provide notice because the flood event does not involve their operations. Some reservoir operators may still choose to post information regarding isolated local flooding on their websites or social media advising the public to be alert.

Additionally, there is a common misconception that the only water flowing in the river during a flood is water being released from an upstream dam. In fact, in many cases there is more water flowing in the river from rainfall and related runoff than is being released from a reservoir. It is important to remember that release information provided by reservoir operators during a flood event is just one piece of the flooding puzzle, which also includes rainfall, urban development, regular run-of-river conditions, soil moisture, and other variables.

For the purpose of this discussion, “release” means any water that passes through or around a dam in one of two ways, depending on the reservoir’s design. One method is through a fixed spillway, which allows for water to “spill” over or adjacent to a dam once the reservoir reaches a certain level. Other reservoirs have dam gates which can be raised and lowered to let water through in varying quantities. In both cases, the reservoir operator is passing flood flows through or around the dam at roughly the same or a lower rate than the flows that are coming in. For reservoirs fitted with operable or moveable dam gates, release decisions are made in accordance with site-specific reservoir operating protocols or procedures that include:

1. Flood Operations Protocol/Procedures: the majority of discharges from a water supply reservoir do not constitute an emergency. These discharges are made pursuant to the reservoir’s standard operating protocols or procedures, which are sometimes called a flood operations manual or water control manual.

2. Emergency Action Plan: Large or high-hazard dams in Texas are subject to the TCEQ Safety of Dams Program. Under this program, each regulated dam is required to have an approved Emergency Action Plan (EAP), which specifies actions to be taken and notifications to be

made in the case of an emergency associated with the dam structure. This "emergency" may or may not be associated with a flood event.

When operating according to its design, water released from a water-supply reservoir during a storm event does not cause or exacerbate flooding beyond that which would have occurred in the absence of the reservoir's existence. The same volume of water that is behind a water-supply dam before a flood release begins will be there when the flooding is over; stored water is not released during storm events. The only water that passes is water that would have flowed down river had the dam never been built. This kind of operation is called run-of-the-river and is not intended to provide flood control benefits. However, without releases, floodwater would back up and flood communities upstream of the dam. More importantly, if releases are not made and water overtops the dam, its integrity could be compromised, acutely endangering life and property downstream.

The Role of Reservoir Operators

Each reservoir operator has a unique, site-specific process in place for making information available to the public regarding releases during flood events. In many cases, reservoir operators also have active websites and social media pages that are continually updated with release information. These sites are often manned and updated 24/7 during a flood event and include information such as streamflow, reservoir elevations, and rainfall data. Most operators also maintain contact with local media outlets in certain areas that may be affected in order to get information to a broader audience. Some reservoir operators use downstream call or notification lists. These systems allow those living around or downstream of a reservoir to sign up to receive a call, text, or email when flood releases of a certain volume are occurring.

However, these systems are not foolproof and should never replace or supersede the formal emergency notification procedures of designated local partners, as discussed below. An important responsibility of reservoir operators is to notify designated local partners of reservoir conditions, especially those with the authority to order evacuations or make widespread emergency management decisions. It is important to provide clear, consistent messages in an emergency, and the sources of public information should be limited for that purpose. It can be incredibly difficult and taxing to decipher multiple messages from different entities, especially in an emergency. Each community should have a designated entity for providing "Amber Alert" type notifications to the public related to weather conditions and flooding. When too many agencies work in silos and provide one-dimensional information to the public, it increases confusion and the burden on local entities, responders, and the public.

Designated Partners

Most local governments have an Emergency Operations Center (EOC) staffed by members of its various local agencies that is activated in response to an emergency. In addition, the National Weather Service (NWS) has historically been the entity charged with providing comprehensive weather and flood data, as it is in a position to process and combine all measurable data during a flood event. These organizations should serve in the leading role of providing clear messages to the public during flood events.

Emergency Operations Centers

In Texas, mayors and county judges have responsibility for emergency preparedness and response within their local jurisdictions. Generally, reservoir operators are members of the EOCs and work directly with the emergency management coordinator in each local jurisdiction. Reservoir operators provide the coordinator with release and flow information to aid the coordinator in the decision making process.

Emergency management coordinators at the local government level are responsible for emergency response, notifications, and evacuation orders when necessary, and pass those orders along to first responders. This model could benefit from some consistency and efforts to inform the public of its role, but in most jurisdictions the local emergency management office is an effective and powerful tool to combat conflicting and incomplete information from separate entities.

National Weather Service

There are three NWS river forecast centers that cover Texas (West Gulf River Forecast Center, Arkansas-Red Basin River Forecast Center, and Lower Mississippi River Forecast Center) and provide forecasts for river levels that are based on rainfall and river conditions, including information from reservoir operators that may be making flood releases. Importantly, these forecasts also include water that is already in the river or that may be flowing into the river from another area. As such, these forecasts are more accurate and reflect a better picture of flood potential in a given area.

While the river forecast centers run the models and provide the projections, the local NWS forecast offices implement weather watches, warnings, and emergency notifications. According to the NWS, it is the sole, official voice for issuing warnings during life-threatening weather situations in the United States. The NWS forecast offices coordinate this information directly with local emergency management officials.

Opportunities for Improved Collection and Storage of Flood Flows for Future Supply Needs

According to the Texas Water Development Board, total gaged inflows to the Texas coast for 2017 were 57.8 million acre-feet, with Hurricane Harvey delivering 29 million acre-feet, or 51% of the annual inflow for 2017 in a matter of days. To put that in perspective, the total water use for the entire state in 2015 was 12.42 million acre-feet. Half of the annual flow to Galveston bay occurred in a few weeks time.[41] The amount of rainfall that fell over Texas during Hurricane Harvey could have supplied of all of the state's water needs multiple times over.

As noted in hearing testimony, the City of Houston manages water from the rooftop from the Bayou, and then their sister organization, Harris County Flood Control District, manages the resources from the water to the bay.[42] Instead of solely viewing the issue as a stormwater and riverine flood management issue, we should also be looking where water resources can be captured for water supply purposes.

As the committee discussed during the 85th Legislative Session in regards to HB 3991 by Chairman Larson, and at committee hearings over the interim, the state would benefit from the creation of mechanisms to capture and store a fraction of the flood flows that filter to the coast, so that in a drought, Texas has a strategic water reserve that can be used to meet the state's water needs.

On-Channel Reservoirs[43]

On-channel reservoirs have been used extensively as flood control measures. Local and regional stormwater detention ponds are often designed for the temporary storage of flood flows, employed as a means to reduce the effects of increased runoff generated by the impervious cover that typically accompanies urban development. And, of course, storage of floodwater inflows is a fundamental purpose for large dual purpose flood control reservoirs, such as Lake Travis on the Colorado River above Austin and Lake Whitney on the Brazos River above Waco. These reservoirs have hundreds of thousands of acre-feet of storage capacity dedicated to impounding floodwaters and reducing downstream flood flows. These flood control structures have demonstrated their significant benefits in terms of reduced downstream flooding and flood damage.

The obvious advantage of on-channel reservoirs compared to off-channel reservoirs is that on-channel reservoirs, being located directly on the channel of a river or stream, automatically capture flood flows as these flows enter or flow into the impoundment, whereas storing floodwater from a river or stream in an off-channel reservoir requires pumping and lifting the floodwater into the impoundment. Thus, a costly pump station and conveyance facilities are not needed for capturing and storing floodwater in an on-channel reservoir.

A major consideration when locating and permitting on-channel reservoirs is the increasing importance of environmental factors because of the potential impacts of new reservoirs on wetlands and bottomland hardwood forest habitat, along with aquatic health. Taking into account these factors and compensating for these impacts can be very costly and time consuming. What might be thought to be a relatively straightforward permitting process can turn into many years of studies, analyses, mitigation, and negotiations with regard to environmental concerns, particularly at the federal level.

The use of an on-channel reservoir for flood control and for reducing downstream flood impacts must be well planned and thoroughly investigated. Technical analyses must consider the size of the upstream watershed, the magnitude and duration of rainfall and flood events, the required storage capacity for effectively reducing flood flows versus available flood storage capacity, the downstream flood benefits in terms of lowered flood levels and reduced impacts, the environmental consequences and permitting requirements, and the cost of the flood control facility versus the value of the reduced flood damages. Implementation of a successful flood control project involving an on-channel reservoir can be a technically complex undertaking and can include a variety of challenging siting, construction, environmental, and economic issues.

Off-Channel Reservoirs[44]

Off-channel reservoirs received attention as a water supply strategy in the 2017 Water Plan. The 2017 regional water planning groups recommended 26 new reservoirs (with more than 5,000 acre-feet of storage), including 12 off-channel reservoirs. Off-channel reservoirs are essentially pools that are constructed away from the channel of a river or stream, but generally close enough to be filled by pumping water from that same river or stream. Off-channel reservoirs are typically constructed with earthen dikes that enclose an area of natural ground, within which water can be stored for various uses, most commonly for water supply purposes. Depending on the amount and purpose for pumping water from a river or stream into an off-channel reservoir, a water right may be required from the Texas Commission on Environmental Quality.

Off-channel reservoirs for flood control have very limited effectiveness due to the significant size of the pumping, conveyance, and storage facilities that are necessary to be effective in capturing meaningful volumes of floodwater to achieve downstream flood reduction benefits. In addition, the hydraulics of diverting flood flows from a river or stream into an off-channel reservoir present a unique challenge: to be effective, diversions must be strategically phased during the rise and fall of the flood over the course of a flood event. As such, pumping flood water from a river or stream is generally not a feasible means of reducing downstream flood levels because the water cannot be moved fast enough.

As an example, a very large pump station for diverting flood flows could have a pumping capacity of 500,000 to 1,000,000 gallons per minute, which is equivalent to a flow rate of about 1,100 to 2,200 cubic feet per second. Peak flood flows in even small rivers and streams for moderate flood events can exceed these pumping rates more than ten times. Thus, even a massive pump station would not be capable of significantly lowering the river's or stream's flow rate to levels that might produce meaningful flood reduction benefits.

As with many strategies, a major aspect of using off-channel reservoirs to lower flood flows in an adjacent river or stream is the cost of the required facilities versus the predicted flood reduction benefits. Based upon multiple studies in Texas, the cost of large pump stations, depending on supporting facilities, is estimated to range between approximately $15,000 and $20,000 per cubic foot per second of water being pumped. So, for a pump station capable of diverting 5,000 cubic feet per second of floodwater from a river into an off-channel reservoir, the cost of the pump station alone would be approximately $75 million. This estimate does not include any costs for the canal or pipeline to transfer the floodwater, nor any other costs associated with the diversion. The cost to benefit ratio of such projects can preclude their use as a flood mitigation strategy.

Aquifer Storage and Recovery (ASR)

Aquifer Storage and Recovery (ASR) is a water supply strategy in which water from lakes, rivers, storage areas, treatment plants, or aquifers is delivered into underground aquifers where it is stored for future use, at which time it is pumped out of the aquifer, often from the same well that was used to put the water underground. Most often the aquifer is recharged using wells, but there are locations in which the water is put on the ground and allowed to infiltrate or into

shallow storage chambers to recharge the aquifer. The purpose of this chapter is to highlight practical and beneficial ways in which this water supply strategy can be utilized in Texas.

There are more than 175 ASR systems installed around the country, and the number in Texas is increasing. San Antonio, Kerrville, and El Paso are currently utilizing ASR, and other water suppliers are actively studying its potential as a water supply strategy. Initial feasibility and pilot-testing studies are important, as ASR requires the right physical conditions (e.g. geology, ground slope, groundwater quality) to be feasible. It also must be economically competitive with other viable options.

The term “flood flows” typically refers to large flows in rivers, streams and lakes that overflow the banks. These flows come from rainfall runoff and include urban stormwater flows as described above. Every flood is different, depending on where the rain falls, how large an area the storm covers, the ground conditions prior to the storm, and the intensity and duration of the storm. “Control” of these large floods is typically accomplished through structural solutions like reservoirs and levees, and by protecting the floodplains from development. Recently, flood planners and water suppliers have been researching whether ASR can play a role in mitigating large-scale flooding situations.

For ASR to have any meaningful impact in an extreme flooding event, extensive off-channel storage would be required, because the rate at which water could be injected underground is so slow in comparison to the rate of flood flows. As such, the off-channel storage is actually the mechanism for mitigating the flood in this case, not the ASR system.

According to ASR Systems LLC, an international ASR consulting firm and pioneer of ASR technology, the following factors should be considered to capture a portion of flood flows and store them underground for subsequent recovery during droughts, emergencies and other times of need, thereby improving water supply reliability for Texas.

Need for Treatment. Flood water almost always needs treatment prior to ASR storage. Water stored underground through wells usually must be treated to remove constituents that would cause well clogging. In addition to fish, weeds, silt, clay and other obvious organic and particulate constituents in surface water, this includes some dissolved constituents such as entrained air and high concentrations of nutrients such as nitrogen, phosphorus and organic carbon, all of which stimulate microbial activity which can cause well clogging. Maintaining a disinfectant residual downhole, such as with a low concentration of chlorine, helps to control microbial activity. The pH of the water may need to be adjusted to control geochemical well clogging. All of this “pretreatment” has typically been provided by recharging with treated drinking water; groundwater from other aquifers or from distant portions of the same aquifer, or with highly-treated reclaimed wastewater.

ASR for Flood Flows. Operating and maintaining water treatment plants requires continuous operation. Such treatment is not easily started and stopped but flow rates and treatment chemical dosages can be adjusted to match changes in water supply, water demand and water quality. Treatment of water solely for ASR storage can be expensive. Treatment of water primarily for public water supply, and secondarily for ASR when excess capacity is available, makes more

sense. Greater reliance upon existing water treatment plants makes more efficient use of their treatment capacity and is therefore cost-effective. The marginal cost for producing more treated water during times when water demand is low and supply is high is typically very small, including only the marginal cost for power, chemicals and residuals disposal.

Bank Filtration Potential. If the geology is appropriate, treatment may also be provided with bank-filtered water, pumped from shallow vertical or inclined wells next to a river bank, or horizontal wells extending beneath a river channel. The natural treatment provided by permeable sands and other alluvial materials through which the water travels on its way from the river channel to the wells is usually quite effective for providing pretreatment for aquifer recharge through wells. Bank filtration is very common in Europe and other countries but is less common in the USA. There are some examples, primarily in the Mid-West and in California.

Use of Existing Treatment Plants. A major opportunity for ASR in Texas is to make better use of existing water treatment facilities that are typically under-utilized during wet months and flood events when water demands are low. The concept is to operate them at their full design capacity during such times and store the excess treated water in ASR wells and wellfields. This is the primary application of ASR nationwide and globally. In Texas, this is how the City of Kerrville and San Antonio (SAWS) ASR wellfields operate. What is needed from a legislative standpoint is a greater incentive to encourage this practice more widely. This could include issuance of separate water rights for increased diversions during wet weather and floods, without reducing or adversely impacting existing water rights during normal and dry periods. Such a water management practice would enable underground storage of substantial water volumes, raising groundwater levels and improving water supply reliability during droughts.

Availability During Drought. Even during the 1947 – 1957 "Drought of Record," and the severe 2011-2014 drought, there were many periods of several weeks' duration when rainfall and high flows occurred. During those times, with an appropriate regulatory framework that preserves all existing water rights but provides an incentive to water managers to capture, treat and store more water underground, it would have been possible to achieve greater replenishment of Texas aquifers and thereby improve water supply reliability.

Environmental Flows Potential. During high river flow and flood events, flows are often sufficiently high and the marginal increases in diversions to existing water treatment plants would be so small that the downstream reduction in river flow is insignificant. This would obviously need to be evaluated on a case-by-case basis, according to the environmental flow requirements for each river basin. We anticipate that any downstream adverse impact upon attainment of instream flows during flood events, and bay and estuarine environmental flows, would be insignificant. Conversely, the opportunity may exist for some limited augmenting of environmental flows during droughts by releasing a portion of the water volume stored underground. This is essentially what happens during droughts due to current operation of the SAWS ASR wellfield as part of the Edwards Aquifer Habitat Conservation Plan. That wellfield supplies a significant portion of the urban water needs in the San Antonio area during dry periods, enabling more water to flow from the Comal and San Marcos Springs.

Integrated Storage. Texas is fortunate to have many surface reservoirs, providing the opportunity to capture and store water rapidly during wet weather periods. Some of this water is subsequently lost to evaporation, transpiration and leakage, particularly during droughts. For many of these surface reservoir locations, an effective water management strategy would be to integrate surface reservoir storage with ASR storage. Surface water from the reservoir system would be treated and stored in ASR wells, replenishing aquifers that have been dewatered during the past several decades, building water supply resiliency for the future.

Cost-Effective Management Strategy. The primary driver for ASR nationwide and globally has always been its cost-effectiveness relative to other water supply alternatives that achieve the same level of yield and reliability. Capital and operating costs are typically less than half those of other water management alternatives. For some applications the cost savings are about 90%. There are now at least 500 ASR wells nationwide, in at least 25 states, and in about 140 ASR wellfields. A majority of these utilize freshwater aquifers for storage, but almost all of those have at least one water quality constituent in the storage aquifer that is not wanted in the recovered water. About a quarter of these wellfields are storing water in brackish and saline aquifers. Appropriate design and operation of ASR wells can usually overcome local water quality constraints. Texas brackish aquifers provide a great resource, whether for brackish water desalination or for storage of seasonally-available fresh water, or both.

Stormwater Capture

Stormwater typically refers to the water that runs off the ground during and after rainfall events and is captured by urban storm sewer systems or retention/detention basins (herein referred to as retention basins), or diverted directly into rivers and streams. In urbanized settings, these flows are controlled to avoid flooding structures when possible. Due to sizing and economic limitations, typical storm sewer systems are limited in capacity and generally cannot handle extreme rain events like a 100-year storm.

The most common stormwater control strategies include pipe systems to carry the water to rivers, buyout of structures in flood prone areas, protecting floodplains from development, retention basins to temporarily store stormwater until the peak of the storm has passed, and “low impact development” or “green infrastructure” strategies that replace concrete with areas that allow stormwater to percolate underground instead of running off the surface.

In some instances, stormwater that has been temporarily captured in reservoirs and retention basins can be recharged underground through wells that are drilled into local aquifers, thereby providing a water supply benefit in addition to a stormwater management benefit. Unlike ASR projects that are supplied from a reliable source of water, stormwater ASR often requires additional considerations, such as temporary storage due to the short-term duration and intermittent availability of stormwater, and water treatment, as state and federal laws include provisions to protect against the degradation of underground sources of drinking water. It also requires favorable aquifer conditions in the area of recharge.

In summary, wide-scale implementation of ASRs for water supply, flood control, and subsidence benefits will require legislative changes to the way that surface water is permitted in the state, as well as long overdue studies on areas best suited for aquifer storage and recovery projects and stormwater management wells.

Role of Voluntary Land Conservation Efforts in Preventing and Mitigating Flooding[45]

According to the Texas Agricultural Land Trust, natural landscapes are the best tool to address the velocity and volume of floodwaters. Vegetation and pervious cover, as opposed to concrete and asphalt, allow the water to be absorbed into the absorbent soil. Additionally, open spaces tend to be less densely populated, with the result that flooding, when it does occur, has far less economic impact than highly developed areas. A report published by The Nature Conservancy and Texas A&M Galveston in December, 2016, entitled "Protecting Open Space & Ourselves: Reducing Flood Risk in the Gulf of Mexico Through Strategic Land Conservation," demonstrates the need for these strategies. The report maps those Gulf Coast watersheds that are likely candidates for flooding and identifies areas of high opportunity for land conservation.

More specifically, the tool most often used to protect open space is the conservation easement. The conservation easement is a voluntary agreement, negotiated between a landowner and the easement holder, possibly a governmental entity or a trust. Conservation easement programs exist at the federal, state, county and city levels for a variety of purposes. Two existing conservation easement programs in Texas are the Texas Farm & Ranch Lands Conservation Program, which was created to protect the state's productive agricultural lands, and the Edwards Aquifer Protection Plan, which protects recharge areas over the Edwards Aquifer. Counties and cities around the country have used the conservation easement as an alternative to zoning and regulation for land use control. Given the nature of the transaction, it's a lower cost approach that does not require a full purchase, carries tax benefits and enjoys potential cost sharing. Furthermore, because the easement transaction is typically between the landowner and a non-profit land trust which is specifically organized to hold conservation easements, the governmental entity has no ongoing maintenance or overhead obligations.

Minnesota is an example of a state that has used the conservation easement at several levels to mitigate potential impacts from floods. Since 1986, the state has invested more than $200 million dollars to help improve water quality, wildlife habitat, and flood attenuation on private land through the Reinvest in Minnesota Reserve (RIM) Program. The program compensates landowners for granting conservation easements on economically marginal, flood-prone, environmentally sensitive, or highly erodible agricultural lands. In partnership with the USDA Natural Resources Conservation Service (NRCS), the county Soil and Water Conservation Districts, land trusts and other conservation organizations, the state has purchased more than 6,000 conservation easements covering more than 250,000 acres since the program began. Meanwhile, at the county level, Dakota County created the Vermillion Corridor Plan, with the goal of developing a continuous corridor of perennial, native vegetation along the Vermillion River to mitigate flooding while protecting farmland and wildlife habitat.

Projects like Minnesota's are typically funded through bond monies. However, there are a number of resources at the federal level for open space protection. In the late 1990s following

flooding along the Mississippi River, the federal Hazard Mitigation Grant Program, now administered by FEMA, began to offer funds to buy conservation easements on farmland in Illinois. FEMA also administers a voluntary Community Rating System (CRS) which provides an opportunity to use open space protection to meet multiple objectives including flood risk reduction. In this program, the community gets points for flood mitigation activities and can earn discounts on their resident's flood insurance premiums. Open space protection is a creditable CRS activity but is often underutilized.

Analysis of Strategies Employed by Flood-Affected States[46]

Mapping:

Several states have taken an alternate route to flood hazard mapping. The Iowa Flood Center completed a statewide inundation mapping project over the course of six years by developing their own hydraulic models and mapping all streams that drain an area greater than one square mile. Iowa collected the elevation (lidar) and related channel-specific data necessary to complete mapping studies that meet FEMA quality standards. In this way, the Iowa Flood Center ensured the information was made available to the public relatively quickly (via a web portal used only for non-regulatory purposes such as emergency response and preparedness planning) while also advancing efforts by NFIP participating communities to pursue updating their local FIRMs.

North Carolina chose a different path to flood hazard mapping. In 2000, North Carolina became a Cooperating Technical State, as opposed to partnering community, and undertook full responsibility for collecting updated flood hazard data and for maintaining current FEMA approved FIRMs. Through a three-phased Statewide Floodplain Mapping Program, local, state, and federal partners committed the financial, staffing, and technical resources necessary to successfully provide updated maps for every watershed within a ten-year time-frame.

Planning:

Coordinated watershed-based planning occurs throughout the nation but appears in different forms among the states. Statewide flood planning, in the format of a cyclical, multi-regional evaluation to identify projects, is a relatively uncommon process. Instead many states have chosen to focus on specific tasks, such as statewide mapping or policy implementation, to build strong floodplain management programs that can provide services and mitigation beyond those of FEMA and the NFIP alone. California, Illinois, Iowa, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, and West Virginia have published formal plans related to watershed-based or statewide flooding concerns, floodplain management, or flood hazard mitigation operations.

California, in partnership with the U.S. Army Corps of Engineers, has completed the most extensive flood planning effort in the nation, the outcome of which yielded California's Flood Future Report, a comprehensive overview of the state's risk of flooding, approaches for mitigating risk, recommendations for action, and existing financial investment as well as an estimate of future financial need based on input from regional entities (CDWR, 2013).

In 2014, using $4.9 million in state funding, Minnesota initiated a watershed-based pilot program to comprehensively address water resources issues, to include flooding, within six watersheds—with a goal of implementing the program statewide by 2025. The program operates on a 10-year planning cycle, requires 10 percent local matching funds, and is based on formal, voluntary partnership agreements among entities in a given watershed. The purpose is to encourage these entities to work collaboratively to identify policies, projects, or strategies to protect, enhance, or restore their basin. An approved plan (whether individually or as part of this initiative) allows access to state funding. Without an approved plan, entities will only have access to limited, competitive grant funding. Long-term funding for the program is provided by revenue from a three-eighths of one percent increase in the state sales tax.

Nebraska similarly completed a statewide Flood Hazard Mitigation Plan, which is used in part to determine whether local mitigation activities are effective. The Iowa Watershed Approach program coordinates watershed management authorities and encourages local watershed-based planning through voluntary interlocal agreements. Most existing flood plans, however, do not recommend specific projects for funding and are not supported by dedicated state funding sources. Maryland's flood damage vulnerability assessment, for example, requires communities to submit annual lists of projects and watershed wide flood damage plans to receive supplemental state funding, but the associated grant program does not have a dedicated, reliable funding source.

Other states without formal, comprehensive flood plans emphasize specific programs related to flood warning or mapping. Iowa, for example, emphasizes real-time flood warning and inundation mapping capabilities, published via web-based viewers for both the public and decision-makers. North Carolina focuses on floodplain mapping; as a FEMA Cooperating Technical State, they assume ownership of their FIRMs and publish associated hazard data, models, maps, and risk assessments. Oklahoma and New York, on the other hand, developed statewide mesonets (weather monitoring networks) focused on gathering and providing weather data to inform both flood response and drought forecasting.

Through state code, Wisconsin, Washington, and Florida seek to lower flood risk by restricting building construction in flood prone areas. For example, Wisconsin requires structures to be constructed to the Flood Protection Elevation, which is 2 feet above the base flood elevation. Florida requires uniform, comprehensive land use policies of all jurisdictions and enforcement of the state's minimum building codes (Brody et al., 2009).

Funding:

Funding sources used by states to implement and maintain floodplain management activities are as varied as the programs described above. All states utilize available federal funding, though some, such as Florida, have implemented activities that enable access to greater post-disaster federal funding. Many strong state programs across the U.S. were developed following natural disasters, whether directly through federal funding or through each state's own commitment to improve preparedness.

Following disastrous flooding in 2008, Iowa used a combination of a $15 million grant from the U.S. Department of Housing and Urban Development (HUD), $2.2 million from the U.S. Army Corps of Engineers Planning Assistance to States, existing state and federal commitments for lidar data collection, and a portion of $2 million in state floodplain management funds (allocated over several years) to support floodplain mapping and the production of FIRMs for 86 percent of the state. Iowa also took advantage of a $97 million HUD disaster resilience grant to create the Iowa Watershed Approach program. The Iowa Flood Center, founded following the 2008 floods, continues the state's efforts to map floodplains, provide flood-inundation maps, and maintain a network of stream flow sensors for communicating potential risk of flooding to the public. The state provides an annual budget of approximately $1.2 million, which is combined with significant funding from other federal and state agencies, to support the center's research and ongoing operations.

California has utilized bonds, a partnership with the USACE, and state investment to support its comprehensive regional and statewide planning process, as well as a floodplain mapping program. North Carolina responded to Hurricane Floyd in 1999 by allocating $25 million the following year to establish a floodplain mapping program. The state has since partnered with FEMA to become a Cooperating Technical State. In the first nine years of the program, North Carolina mapped 100 percent of watersheds, investing a total of about $70 million and receiving $73 million from FEMA. The state maintains this program via a transaction fee associated with the recording of deeds and mortgages.

In May 2018, Louisiana's Governor created a Council on Watershed Management to encourage interagency collaboration and the implementation a watershed-based floodplain management program. The resulting Louisiana Watershed Initiative serves to coordinate floodplain management and mitigation, including outreach, data management, policy development, technical assistance, and planning, across federal, state, and local entities. Using $1.2 billion in funding from HUD, the state will begin implementing a variety of activities for strong floodplain management.

RECOMMENDATIONS

Provide more grant funding for planning and study needs, such as the development of floodplain maps, models, gages, and other useful tools.

Invest in coordinated, watershed-based flood planning to meet state flood risk management policies and goals.

Amend Texas Water Code Chapters 15 and 49 to expand the scope of existing Texas Water Development Board flood-related grant funding to include design and construction of flood mitigation infrastructure.

Provide state grant and highly-subsidized loan funding for the implementation of flood mitigation measures, including to meet local match requirements for federal dollars.

Set aside Rainy Day funds (as with SWIFT/SWIRFT) and create a new subchapter for grants and loans under Texas Water Code Chapter 15 and/or grants under Texas Water Code Chapter 16, Subchapter I, to be administered by the Texas Water Development Board.

Provide express legislative authorization for local taxing jurisdictions to contract with river authorities to construct and maintain regional flood mitigation projects and use local tax dollars to repay loans or other indebtedness incurred by a river authority. This will allow local taxing jurisdictions the ability to combine efforts and financial resources to take advantage of loan programs for large-scale projects.

Authorize the Texas Commission on Environmental Quality to permit intermittently available flood flows in reservoirs and aquifer storage and recovery projects for water supply, and well as study the ability for stormwater to be captured for water supply.

Encourage collaboration between flood control managers and water supply managers to capitalize on opportunities to capture stormwater and flood flows for water supply, as other states have accomplished.

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #3, evaluating the status of groundwater policy in Texas, subsection (g), emerging issues in groundwater and surface water interaction, on May 23, 2018 in Brady, Texas. The following individuals testified on the charge:

Phil Chavanne, Selah Springs Ranch
Richard Cordes, Menard County
Robert Davee, Self; Friends of the San Saba
Angelina Deans, Hickory UWCD #1
Cary Dupuy, Comptroller of Public Accounts
Charlie Flatten, Hill Country Alliance
Larry French, Texas Water Development Board
Ronald Green, Self; Southwest Research Institute
Joshua Grimes, Carollo Engineers, Friends of the San Saba River
Ryland Howard, Self; Self
Novice Kniffen, Self
Robert Mace, The Meadows Center
Kathy Mews, Self
Gerald Nobles Jr., L Bar Ranch
Clinton Robertson, Texas Parks and Wildlife Department
Carlos Rubinstein, Self
Carolina Runge, Menard County Water Control and Improvement District
Kimberly Wilson, Texas Commission on Environmental Quality

The House Committee on Natural Resources held a public hearing on its Interim Charge #3, evaluating the status of groundwater policy in Texas, including subsection (a), progress and challenges in encouraging coordination and consistency in aquifer-wide management and permitting practices; subsection (b), developments in case law regarding groundwater ownership and regulation; subsection (c), potential improvements to the existing groundwater permitting process, including those contemplated in HB 31 (85R); subsection (e), the designation of brackish groundwater production zones and related research; and subsection (f), groundwater data and science needs, on June 5, 2018 in Canyon, Texas. The following individuals testified on the charge:

Kody Bessent, Plains Cotton Growers, Inc.
Gregory Ellis, Self
Shauna Fitzsimmons-Sledge, Self
Larry French, Texas Water Development Board
Russell Johnson, Self
Marvin Jones, Quadvest Water & Sewer

Rick Kellison, Texas Alliance for Water Conservation
Todd Lovett, Panhandle Producers and Royalty Owners Assoc.
Edmond McCarthy, Self
Roland Ruiz, Edwards Aquifer Authority
Sarah Schlessinger, Texas Alliance of Groundwater Districts
Judy Stark, PPROA Panhandle Producers & Royalty Owners Association
Hope Wells, San Antonio Water System
CE Williams, Panhandle Groundwater Cons. District

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #3, evaluating the status of groundwater policy in Texas, subsection (g), emerging issues in groundwater and surface water interaction, on September 13, 2018 in Del Rio, Texas. The following individuals testified on the charge:

Dell Dickinson, Self; Devil's River Conservancy
Larry French, Texas Water Development Board
Ron Green, Self
David Honeycutt, Self
Robert Mace, The Meadows Center for Water & the Environment
James McBee, Self; Gurley McBee Ranch
Beau Nettleton, Val Verde County, Precinct 3
Randy Nunns, Self; Devil's River Conservancy
John Shepperd, Texas Foundation for Conservation
Jeff Weigel, The Nature Conservancy
Steven Young, INTERA Inc.

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #3, evaluating the status of groundwater plicy in Texas, subsection (b), developments in case law regarding groundwater ownership and regulation, and subsection (d) the appropriate consideration of the service area of water supplier when groundwater resources are allocated based on surface ownership, on September 27, 2018 in Brownsville, Texas. The following individuals testified on the charge:

Alan Day, Brazos Valley Groundwater Conservation District
Gregory Ellis, Self
Larry French, Texas Water Development Board
Ronald Gertson, Self; Texas Rice Producers Legislative Group
Bret Griffith, TSCRA
Neil Hudgins, Coastal Bend Groundwater Conservation District
Morgan Johnson, Self
Joe Jones, Coryell City Water Supply District
Wade Oliver, Self; INTERA Inc.
Sarah Schlessinger, Texas Alliance of Groundwater Districts
Greg Sengelmann, Gonzales County UWCD
Doug Shaw, Upper Trinity Groundwater Conservation District
Ronnie Skerik, Menlow Water Supply Corporation

Brian Sledge, Sledge Law Group PLLC
Kent Watson, Wickson Creek Special Utility District
Lara Zent, Texas Rural Water Association

The following section this report related to groundwater is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

The purpose of this chapter of the Interim Report is to evaluate the status of groundwater policy in Texas. Before analyzing what options the Texas Legislature might consider in terms of new legislation regarding groundwater, it is first necessary to understand the evolution of groundwater law in Texas as well as the status of the current law on important groundwater issues.

In 1904, the Texas Supreme Court adopted the English common law rule of capture as the law for groundwater in Texas. Thereafter, over the course of the next 100 years, Texas courts continued to uphold the rule of capture in terms of allocating groundwater rights and liabilities between adjacent landowners.[47] Then, after suffering droughts in 1910 and 1917, the citizens of Texas voted to enact Article 16, Section 59 of the Texas Constitution, which granted the Legislature both the authority and the duty to provide for legislation regulating the state's natural resources, including groundwater.

In response to its directive to provide for management, the Texas Legislature has declared local groundwater conservation districts the preferred method of groundwater management and regulation in Texas.[48] While the Legislature first exercised its constitutional authority to create districts in 1949, the majority of such districts that exist today were created after 1997 following the passage of Senate Bill 1, which revamped Chapter 36 of the Texas Water Code in an effort to improve regulations of groundwater by local districts. However, as the demand for groundwater continues to increase, so do questions regarding the extent of districts' authority to regulate in light of the common law rule of capture and other ownership principles.[49]

Sub-charge A: Progress and challenges in encouraging coordination and consistency in aquifer-wide management and permitting practices;

Local Management by Groundwater Conservation Districts

Texas has a long-standing history of groundwater policy especially as it relates to the protection of private property rights. In addition, Texas is arguably the most diversified state in the U.S. in terms of agriculture, groundwater production, weather and geography. [50] Each aquifer and even subdivision of an aquifer within the state is distinctively different. Varying geologic formations, recharge rates, usage and groundwater quality require different management strategies.[51] As a result, unlike other natural resources in the state, such as oil and gas or surface water, which are regulated by single state agencies, groundwater is regulated by approximately 100 different groundwater conservation districts with local jurisdiction over one or more counties in the state.

Districts are statutorily required to conserve and protect the groundwater resources as well as protect the private property rights related to groundwater within their jurisdiction pursuant to their statutory powers and duties as set forth in Chapter 36 of the Texas Water Code and their respective enabling legislation, if any.[52] Chapter 36 directs districts to adopt and enforce rules to regulate and manage the groundwater resources using the various regulatory tools provided in Chapter 36.[53] One fundamental tool districts utilize in achieving those statutory mandates is the regulation of groundwater production through the issuance of permits.[54] Specifically, a district

must adopt and enforce groundwater allocation and permitting regulations that are designed to achieve the planning goals established for the aquifers for which the district has management responsibility[55]—the desired future conditions ("DFCs") for the aquifers, which are developed and adopted on a regional basis in each groundwater management area in the state.[56]

The vast majority of districts in Texas have adopted groundwater allocation and permitting regulations through the promulgation of rules. While districts' groundwater allocation and permitting regulations must comply with all requirements and procedures provided in Chapter 36, these regulations are also tailored to address local hydrogeologic conditions as well as the needs of the local communities that depend upon the long-term availability of the groundwater and the property rights of the people who own that groundwater. Due to the great diversity in hydrogeologic conditions, local needs, and patterns of groundwater use throughout the state, districts generally utilize different production allocation methods to determine how much groundwater each permit holder may be authorized to produce under his or her permit. [57]

However, the proliferation of single and multi-county districts sharing regulatory authority over common aquifers and their varied approaches to management have drawn criticism from certain groundwater rights owners and water planners for the patchwork regulatory framework created by such a system.[58] Advocates for local management of groundwater resources by districts note that districts must necessarily develop and adopt regulations necessary to manage and regulate local needs and conditions, and operate in accordance with Chapter 36 and their respective enabling legislation.[59]

The Joint-Planning Process

Concerns about regulation of groundwater based on political boundaries instead of hydrological boundaries caused the 79th Legislature to pass House Bill 1763 in 2005, mandating a regional joint-planning process for groundwater conservation districts within designated Groundwater Management Areas ("GMAs"). Delineated by the Texas Water Development Board, there are sixteen GMAs today, which cover the entire state of Texas. The boundaries of the GMAs generally coincide with the hydrogeologic features of the state's major aquifers. The legislation directs districts in each GMA to establish DFCs for each aquifer in their area, requires the Texas Water Development Board to calculate the Modeled Available Groundwater (MAG) for each aquifer in those areas, and requires both the districts and regional water planning groups to use that MAG amount for water planning purposes. In 2011, the Legislature added a definition for "desired future condition" to mean "a quantitative description, adopted in accordance with Section 36.108, of the desired future condition of the groundwater resources in a management area at one or more specified future times."

As a result of HB 1763, Chapter 36 of the Texas Water Code now places much emphasis on the joint planning process between districts in a GMA and mandates that districts within a GMA engage in joint planning to develop and adopt DFCs. Districts located within the boundaries of a GMA are required to share and review each other's management plans, and representatives from each district are required to meet at least annually to conduct joint planning to review management plans, the accomplishments of the management area, and proposals to adopt new or

amend exiting DFCs. At least once every five years, the GCD designated representatives are to, after a prescribed public process, adopt DFCs for relevant aquifers in the GMA.

Once DFCs are adopted, the TWDB uses groundwater availability models to model the available groundwater for each district in a GMA. This amount is called the Modeled Available Groundwater, defined as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108." Embodied throughout Chapter 36 is the mandate that districts' rules must be designed to achieve the DFCs established for the aquifers. Districts are mandated to issue permits up to the point that the total volume of groundwater produced by permitted wells and exempt wells will achieve the applicable DFCs to the extent possible.[60] In issuing permits, a district is required to manage total groundwater production on a long-term basis to achieve the applicable DFCs and to consider the amount of modeled available groundwater, estimates of exempt use, the amount of groundwater authorized by permits previously issued by the districts and how much of that it actually produced, and annual precipitation and groundwater production patterns.[61] A district is subject to review and action by the Texas Commission on Environmental Quality if: (1) its rules are not designed to achieve the DFCs; (2) its rules will not adequately protect the groundwater in the management area; or (3) the groundwater in the management area is not adequately protected due to the district's failure to enforce substantial compliance with its rules.[62]

The High Plains and Panhandle region is a good model for how districts within a GMA work together to develop a ground-up approach to aquifer-wide management. There is local management of ground water resources through districts and communications through the GMA joint-planning process as well as through the regional water planning process. There are similarities in the rules adopted by each district in the GMA, and to the extent the rules are different, the districts have provided good reason for those differences. The belief is that there is no single management strategy or policy which can fit all districts even in a confined area due to, but not limited to diverse aquifer and subdivision of an aquifer conditions, water demand variations and climatic conditions.[63]

Many view the current structure of groundwater management in Texas through groundwater conservation districts and the GMA joint-planning process as a working success to provide for the conservation, preservation, protection, recharging and prevention of waste of water resources. Furthermore, to continue to enhance upon the success in conservation and utilization of groundwater resources, it is believed vitally important to continually recognize and support local management of groundwater resources through groundwater conservation districts.[64]

Critics of this joint-planning process argue that the DFCs adopted by the GMAs and the individual districts are being "reversed engineered," meaning districts are starting with the MAG or pumping scenarios to run the models to give them the DFCs rather than staring with the DFCs. In other words, districts are running the models based on groundwater production sufficient to support existing use and likely increases in local use and then selecting the modeled impact of that level of production as their desired future condition.[65]

However, some technical experts have contended that groundwater availability models are generally not capable of being run by just inputting the end result, or the DFC, that is wanted, such as desired water level drawdowns or some other DFC, and asking the model to provide a number for how much can be produced annually to achieve such conditions. In order to run most models, the modeler must have a pumping file with groundwater volume pumping inputs and the locations of those inputs. And groundwater pumping does not occur uniformly and equally across the aquifer, which is why it is so important to have good information on where historical pumping has occurred and in what amounts, and to carefully predict the locations and amount of future pumping. Thus, most models necessarily require the pumping inputs on the front end and the resulting aquifer conditions on the back end, not vice-versa.

Additionally, while the intent of the joint-planning process was to have groundwater conservation districts managing the same groundwater resource apply consistent requirements across the resource, some believe that the GMAs are using this process to create an artificially low groundwater availability numbers through the MAG. Similarly, some also believe the current DFC process is putting vast quantities of producible groundwater off limits and serves as justification for telling landowners who have historically conserved their groundwater by not using it that they are now severely restricted in their right to use their groundwater. Allowing historic local users that have not conserved the resource to continue to use it.[66]

In response, the Legislature revised the planning process to outline the criteria to be considered when selecting the DFCs and the goals to be achieved in the planning process. Specifically, the legislation directs districts to consider nine statutory criteria prior to adopting proposed DFCs, including consideration of the Total Estimated Recoverable Storage ("TERS") in the resources they are managing. The Texas Water Development Board has now provided each groundwater management area with reports detailing the Total Estimated Recoverable Storage in the aquifers within the groundwater management area. However, critics of local management complain that the consideration of TERS did not result in any change in the outcome: DFCs did not change and vastly different rules continue to exist.[67] Some believe that the districts in a GMA should be required to establish a single DFC for each aquifer in the GMA, and should be required to have spacing and production rules that are the same across the aquifer.[68]

With respect to TERS, districts explain that the reason for this is that the calculation of TERS, as stated by the TWDB, does not factor economic or hydrogeologic conditions or impacts. Studies have shown that in many parts of the state where aquifer conditions are confined the production of less than one percent of TERS would result in the elimination of artesian pressure, which would result in the elimination of those aquifers as a viable water resource. As a result, the socioeconomic impacts and impacts to private property rights that would occur with the conversion from confined to unconfined conditions as water levels are lowered due to pumping outweighed the positive aspects of producing more groundwater based on TERS. For example, in GMA 8, as you move deeper and deeper into the confined portions of the subcrop in each aquifer, drilling costs increase, water quality tends to deteriorate, pumping costs to lift the water to the surface increase, and hydraulic conductivity decreases. Because of these changing characteristics as the aquifers dip from northwest to southeast, it is necessary to maintain higher artesian head levels in terms of depth to the top of the aquifer as you move

downdip in the subcrop portions of the aquifers in order to maintain confined artesian conditions in those portions of the subcrop that are updip. Such drops in water levels would also render many existing pumps to encounter dry conditions, requiring pumps to be lowered where possible and, in some instances, deepening the well or abandonment of the well entirely and the loss of the economic investment in the well.

DFC Appeals Process

The Legislature anticipated issues concerning the DFC process, and built in a process by which DFCs could be appealed by those affected by them. However, the process to appeal DFCs has changed over the years.

Prior to the 84th Legislative Session, the method for challenging DFCs was set forth in Section 36.108(l), Texas Water Code, which provided that a person with a legally defined interest in the groundwater can bring a petition to appeal the DFCs before the Texas Water Development Board to assert that the districts did not establish a reasonable DFC for the groundwater resources. However, this process was changed with the passage of HB 200 during the 84th Legislative Session, which changed the process of appealing DFCs to a contested case hearing process. Under the new legislation in Section 36.1083 of the Texas Water Code, an "affected person" may file a petition with the groundwater district requiring that the "district contract with [SOAH] to conduct a hearing appealing the reasonableness of the DFC." Following a contested case hearing, the SOAH administrative law judge prepares a Proposal for Decision that includes findings of fact and conclusions of law and a recommendation to the district. The district board of directors must then review the Proposal for Decision and render a final decision or order on the petition to appeal the DFCs.[69] If the final order finds that a DFC is unreasonable, within 60 days the GMA must reconvene for the purpose of reviewing the unreasonable DFC by following the procedures in Section 36.108, Texas Water Code, to adopt new DFCs applicable to the district that received the petition appealing the DFCs.[70] The district's final order may be appealed to a District Court in the affected district under a substantial evidence standard of review.

Some are critical of this administrative appeal process, preferring a process that would enable a petition to directly appeal the DFCs in District Court without having to exhaust administrative remedies by first appealing the DFCs through a contested case hearing before SOAH and wait on a final order from the district. Moreover, even if a district finds that a DFC is unreasonable, the district must go through the entire GMA DFC process before adopting new or revised DFCs. Thus, critics of this appeal process complain that a district will most likely be involved in the next five year planning cycle before any appeal of its prior cycle DFCs can be resolved. With that said, it is arguably better to try to affect the next round of planning that to challenge the most recent DFCs.[71]

Efforts by Groundwater Conservation Districts to Conduct Rules Comparisons

After several years of discussions about the joint-planning process, policymakers have questioned whether districts based on political boundaries can appropriately regulate a resource

that crosses the lines of political boundaries, and why districts over a common aquifer have different rules.

The membership of the Texas Alliance of Groundwater Districts (TAGD), which represents eighty-five local groundwater conservation districts, have taken seriously a discussion on similar rules and how they might work to minimize differences. In that effort, TAGD has hosted six public panel discussions on similar rules in San Marcos, Conroe, Beeville, Ft. Stockton, Amarillo and Salado. In each of those panels, district members from different GMAs looked at a series of regulatory parameters, and discussed where they were different, where they were similar, and where there were opportunities to be more similar. In addition, TAGD has formed a legislative subcommittee on similar rules that is looking at efforts by the districts within each GMA, which are delineated based on the boundaries of the aquifers, to work together to compare their rules.

So far, TAGD has found that at the districts within at least nine of the GMAs have started a formal process of comparing rules. In this work, GMAs are comparing parameters such as spacing requirements, permitting rules, exemptions, permit term lengths, administrative requirements, fee structures, and metering requirements. To assist other GMAs, the similar rules subcommittee will be putting together a template similar rules analysis for others to use.[72]

In addition to managing and regulating based on local needs and conditions, districts must also develop rules consistent with their enabling legislation. Often, differences between districts' rules are a result of differences in their respective enabling legislation, affecting for example their funding, exemptions, or existing uses with investment backed expectations. This combination of districts' individual enabling legislation and unique local conditions, such as hydrogeological variances, results in differing regulatory frameworks. Most often, the aspect of regulatory frameworks discussed focuses on the permitting rules used by districts. Some of those permitting rules include:

- Acre-Feet/Acre to determine production amounts
- Reasonable Use
- Historic/Existing Use
- Acre-Feet as a permitting cap
- Hybrid approaches[73]

To better understand the consistency and coordination of aquifer wide management within the Ogallala Aquifer, the Panhandle GCD surveyed the other districts in GMA #1 and found a high rate of consistency between the districts. Panhandle GCD found they were 96 percent consistent with Hemphill, 93 percent with North Plains and 92 percent with High Plains, excluding non-applicable answers. While there are differences, those are explained through the different rules and management required for the unique needs of each district. For example, Panhandle exports to High Plains and North and High Plains are more heavily irrigated than Panhandle and Hemphill.[74]

TAGD has observed districts work through the interim to identify opportunities to increase the similarity and consistency of their rules. While GMAs already have a history of collaboration, both in terms of financial and research investment, the effort to cross examine

rules shows further collaboration and willingness to find opportunities to make regulatory frameworks more similar. Examples of opportunities that have been identified include:

- Making terminology or definitions in rules consistent
- Sharing administrative templates, such as application forms
- Determining template language for procedural rules[75]

Districts can always make improvements and be more consistent with their neighbors. Proponents of local management argue that such a system is probably the most difficult way to go about it, but it is the most responsive to producers and the best way to protect private property rights.[76]

Sub-charge B: Developments in case law regarding groundwater ownership and regulation;

Applicability of Oil and Gas Legal Principles to Groundwater

In response to legislative inquires regarding the application of oil and gas law principles to groundwater law in Texas, the Texas Water Conservation Association (TWCA) Groundwater Committee was tasked with analyzing the issue and developing a white paper that committee's diverse membership could endorse. Specifically, as further addressed herein, the white paper analyzes the court's application of oil and gas law to groundwater, including an analysis of correlative rights and co called "user-based rules."[77]

When it comes to ownership principles of oil and gas and the relationships between owners of different estates in real property: oil and gas law principles apply to groundwater. However, the courts and other legal authority have clearly stated that oil and gas is differentiable from groundwater in the context of management and regulation due to the inherent differences in the resources. Those differences are in the nature of the resources, goals for regulating production, and in how the resources are regulated.[78]

There are three cases in which the courts have applied oil and gas law to groundwater law, the most notable being *Edwards Aquifer Authority v. Day,* 369 S.W.3d 814 (Tex. 2012). In *Day*, the Texas Supreme Court stated that the ownership principles and ownership-related principles of oil and gas law apply to groundwater. Accordingly, the Court held that groundwater, like oil and gas, is owned in place beneath the ground.[79]

The other two cases where courts have applied oil and gas legal principles to groundwater in the context of ownership deal with relationships between the owners or lessees and lessors of severed estates. In *Del Rio v. Clayton Sam Colt Hamilton Trust*, 269 S.S.3d 613 (Tex. App.–San Antonio 2008, pet denied), the court held that the groundwater estate, like in oil and gas, can be severed from the surface estate and sold as a real property right, rejecting arguments that it was not a vested right. Then, most recently, in *Coyote Lake Ranch, LLC v. City of Lubbock*, No. 15-0572, 2016 WL3176683 (Tex. May 27, 2016), the Texas Supreme Court applied the accommodation doctrine from oil and gas law to groundwater law, which addresses the relationship between a mineral estate owner and a surface estate owner regarding access to the

land surface to recover minerals. The court found that the accommodation doctrine had worked well in the oil and gas context and found no reason why the doctrine should not be applied to resolve conflicts in the relationship between the owner of a severed groundwater estate and the surface estate owner.[80]

In considering other oil and gas legal doctrines that may be extended to groundwater law, the most widely discussed since the Texas Supreme Court's decision in *Edwards Aquifer Authority v. Day* in 2012 has been the correlative rights doctrine. However, it is important to distinguish how the term "correlative rights" is commonly used in the vernacular in Texas water circles from how the courts use the term. In groundwater circles throughout the state, the term "correlative rights" has been commonly used to describe a type of regulatory approach that limits groundwater production based solely on acreage ownership, but this is not what "correlative rights" means under the law, nor is it how correlative rights are recognized in the oil and gas industry. Correlative rights of landowners in a common reservoir just means that their rights in the groundwater or the oil and gas are co-related to the rights of the other landowners overlying the reservoir. In other words, correlative rights relates to the concurrent rights of owners in a common source of supply.[81]

In *Day*, the Texas Supreme Court stated that "correlative rights between the various landowners over a common reservoir of oil or gas have been recognized through state regulation of oil and gas production that affords each landowner the opportunity to produce his fair share of the recoverable oil and gas beneath his land . . . [s]imilarly, one purpose of [groundwater regulation] is to afford landowners their fair share of the groundwater beneath their property."[82]

In oil and gas, the Railroad Commission of Texas recognizes the concurrent rights of landowners to afford landowners the opportunity to produce their fair share through well spacing rules (designed to limit the number of wells and locate wells in certain positions to maximize recovery of a field, requiring minimum distances between new wells and existing wells and between new wells and property lines), well density rules (assignment of acreage to producing wells for efficient and total recovery), and production allowables. However, while the Railroad Commission is required to establish monthly production allowables for all wells or leases, production has been unlimited during the last 50 years because production allowables are set so high that they are highly improbable to exceed. Thus, in comparison, the Railroad Commission's recognition of "correlative rights" with respect to oil and gas is not consistent with how that term is being used with respect to groundwater.[83]

In *Day*, there is no statement from the court that clearly requires or implies that groundwater regulation should limit production based solely on surface acreage over an aquifer. To the contrary, the court's opinion recognized that groundwater regulation should take into account other considerations in affording landowners their fair share of the groundwater beneath their land in the common resource. Specifically, the court explained that groundwater regulation must consider allowing landowners the ability to recover their reasonable investment-backed expectations,[84] noting also that "[g]roundwater regulation must take into account not only historic use but future needs, including the relative importance of various uses, as well as concerns unrelated to use, such as environmental impacts and subsidence."[85] These other factors that must be taken into consideration in groundwater regulation that affords owners the

opportunity to produce their fair share are in essence "user based rules," including but not limited to regulations that protect historic and existing use, regulations based on beneficial use or reasonable non speculative demand, and regulations based on site-specific conditions (such as impacts to springs etc) or site-specific testing. [86]

As a result, correlative rights and so-called "user-based rules" are not mutually exclusive concepts. Ultimately, to the extent that factors other than surface acreage ownership are allowed to be taken into consideration in order to afford landowners their "fair share," as prescribed by the court in *Edwards Aquifer Authority v. Day*, correlative rights and so-called "user-based rules" should not necessarily be mutually exclusive concepts in terms of permissible groundwater regulation.[87]

Production allocation methods utilized in permitting

Post *Day*, districts have struggled with how to allocate groundwater production in areas of limited groundwater availability, where demand frequently exceeds available supplies that can be produced if DFCs are to be achieved as mandated by statute. In many cases, the water demand by existing permitted users and exempt users alone exceeds the amount of groundwater available for production within a district, yet *Day* indicates that new users with an ownership interest in the groundwater also have a right to access some portion of available groundwater. Thus, districts grapple with the potential threats of takings lawsuits from new users if their groundwater allocation and permitting regulations go too far in the way of protecting historic users, and from historic users if regulations impact their ability to recover their reasonable investment-backed expectations. The following regulations are the primary groundwater allocation methods used by districts in trying to strike a balance between these competing demands. Often times, districts adopt a regulatory scheme that utilizes a hybrid approach incorporating two or more of these allocation methods.[88]

Regulations based on existing or historic use

The most common groundwater allocation method utilized by districts throughout the state is to permit groundwater production based on historic or existing use. Section 36.116(b) of the Texas Water Code provides that "[in] promulgating any rules limiting groundwater production, the district may preserve historic or existing use before the effective date of the rules to the maximum extent practicable consistent with the district's management plan under Section 36.1071 and as provided by Section 36.113." Under Section 36.113 of the Texas Water Code, "[t]he district may impose more restrictive permit conditions on new permit applications and permit amendment applications to increase use by historic users if the limitations: (1) apply to all subsequent new permit applications and permit amendment applications to increase use by historic users, regardless of type or location of use; (2) bear a reasonable relationship to the existing district management plan; and (3) are reasonably necessary to protect existing use."

Many districts in the state were not created until demand for groundwater in an area was already creating problems that needed to be addressed. This coupled with the fact that many landowners had already exercised their unrestricted right to produce groundwater under the rule of capture and created reasonable investment-backed expectations related to groundwater

compelled most districts across the state to accommodate those pre-existing users and adopt permitting regulations that protect individual existing or historic uses of groundwater occurring prior to regulation. Moreover, in recent years, the Texas Supreme Court has made clear that failure to protect these landowners' investment-backed expectations can subject districts to regulatory takings lawsuits.[89]

Regulations that permit groundwater production based on historic or existing use take many forms, including requiring permit applicants to prove up the amount of their historic use, or simply grandfathering certain wells in terms of their production capacity or from well spacing requirements that were adopted after the wells had already been drilled and completed. Districts that adopt this type of regulatory approach typically give greater protection to the historic users to recover their investments in their water wells and the economic activities associated with those wells, and allocate production of additional groundwater availability in the districts to new users based on surface acreage, reasonable non-speculative demand, site-specific hydrogeological analysis, or other factors listed herein.[90]

Regulations based on acreage owned or leased

Multiple districts in Texas, specifically in the more rural parts of the state, utilize a regulatory approach that allocates groundwater production based on the amount of surface acreage owned or leased over an aquifer. Pursuant to Section 36.116(a)(2)(B) of the Texas Water Code, a district by rule may regulate the production of groundwater by "limiting the amount of water that may be produced based on acreage or tract size." Additionally, in regulating groundwater production based on acreage or tract size, a district has the permissive authority to consider the service needs or service area of a retail public water utility.[91]

This surface-acreage based approach to groundwater allocation is predominant in areas like West Texas where agricultural irrigation is the primary use of local groundwater resources. In such areas it makes sense to allocate groundwater to a farmer based on how many acres of crops will be irrigated, and under this approach, the more land owned and irrigated above the aquifer, the greater the groundwater allocation. This method of groundwater allocation provides uniformity in the treatment of landowners regardless of their status as historic, existing, or future users, so that all property owners in a geographic area overlying the same common pool are authorized to produce or conserve the same amount of groundwater per acre owned as their "fair share."

Production allowables per acre were historically driven by how much groundwater the prevailing crops cultivated in the area required while still promoting water conservation. However, after the imposition of the DFC process by the legislature in 2005, production allowables are now often also derived by considering the modeled available groundwater (MAG) number—in essence, the amount of groundwater available for production—in order for a district to be calculated to achieve DFCs over the planning horizon.[92] In many areas, the purely mathematical production allowable per acre derived from dividing the MAG by the number of surface acres located over the aquifer results in an allowable so small that no landowner would have sufficient groundwater supplies to meet the irrigation demands of any common crop. Moreover, this approach to groundwater allocation is particularly difficult in the more urban and

suburban areas of the state, where groundwater is primarily used for municipal, industrial, and commercial purposes and where the typical user only owns a small parcel of land on which the well is located and adjacent tracts are already densely developed. This approach also typically fails to account for substantial variations in aquifer conditions, where some landowners are located over parts of an aquifer with sparse groundwater resources while others are located over areas of the same aquifer with substantial groundwater resources. [93]

Regulations based on beneficial use or reasonable, nonspeculative demand

Another common groundwater allocation method utilized by districts is to permit groundwater production based on beneficial use or reasonable, non-speculative demand. This type of regulatory approach usually requires a technical evaluation of the amount of groundwater applied for and the amount reasonably determined necessary to meet that demand (e.g. an applicant applies for a permit for 1000-unit residential subdivision, and the amount of groundwater authorized is limited to the amount reasonably needed by that many households based on technical data). This demand analysis establishes the amount of groundwater realistically needed to support the applied-for use while also promoting conservation.

Districts often utilize this type of allocation system in an effort to strike a balance between the rule of capture and acreage-based permitting regulations. Because in many parts of the state, specifically urban and suburban areas, groundwater availability is limited, this method of allocating groundwater production is used to prevent speculative permitting, so that the groundwater can be made available and permitted where demand is demonstrable to allow for maximum beneficial use of the resource. Additionally, in urban and suburban areas, public water systems and other large groundwater users with small land holdings supply property owners in the area all the water they need, and most property owners do not need or want a water well on their property. Thus, rules allocating groundwater production based on reasonable, nonspeculative demand are appropriate for permitting these municipal, industrial, and commercial users.

Although any person seeking to produce groundwater must own or lease the groundwater rights associated with the tract of land from which production is sought, authorizing groundwater production based on demand bears little or no relation to groundwater interests owned. As a result, rules that account for use rather than surface acreage owned in permitting decisions has been complained of by some as unlawful and without statutory authority. This method of allocating groundwater production has also been criticized for promoting groundwater production and not conservation, as the method may encourage waste by rewarding those who seek to withdraw water now, rather than those who seek to conserve the water for environmental reasons or future use.[94]

Regulations Based on Site-Specific Hydrogeologic Conditions or Site-Specific Testing

Other groundwater allocation methods include permitting rules that take into account site-specific hydrogeologic conditions or site-specific testing. These types of rules typically apply to applications for larger wells, and require application of the best available science to perform a technical evaluation of the hydrogeologic conditions and hydraulic properties of the aquifer in

the immediate vicinity of the proposed well site as well as off-site impacts, including impacts to existing wells and/or desired future conditions. Rather than applying blanket assumptions and estimates of groundwater availably, this process allows for property owners to be permitted based on the specific groundwater resources and conditions located underneath their property while also protecting the property rights of existing and future users by managing conditions in the common pool. These types of rules are often coupled with a reasonable non-speculative demand evaluation and are especially prevalent in aquifers where the physical availability of groundwater resources varies substantially from one parcel of land to another.

Well Spacing Regulations

One of the most common regulatory tools used by groundwater districts in Texas is the imposition of well spacing regulations.[95] Minimum well spacing distances may be required from adjacent property lines and from wells in existence at the time a new well is drilled.[96] However, well spacing regulations are designed primarily to prevent interference between wells by attempting to minimize the impacts on neighboring wells from the cone of depression that is created in an aquifer in a radius around a producing well.

Districts that utilize this regulatory approach typically adopt minimum well spacing distances that are directly proportional to the production capacity of the well to be drilled—the larger the capacity, the greater the required setback distances from property lines and existing wells.[97] Well spacing regulations are effective in minimizing well interference in the outcrop areas of sand-based aquifers, where cones of depression are comparatively narrow in radius, they are less effective in deep confined aquifers and karst limestone aquifers where the cones of depression can extend laterally in orders of magnitude several thousand times wider. Also, while rigorous well-spacing requirements do have some effect on limiting total aquifer production by limiting the size of a well that can be placed on a particular parcel of land, they typically cannot be relied on in most aquifers as the sole means of ensuring that total pumping from an aquifer will be limited to a level that will achieve the applicable DFCs, and are not truly a method of allocating groundwater in that sense.

Finally, many districts, especially in urban and suburban settings, implement well spacing through the imposition of a minimum tract size requirement.[98] Under this approach, parcels of land must be of a certain size, unless grandfathered by a district, in order to be eligible to have any well drilled on them. This method of well spacing is typically designed to address the proliferation of residential subdivisions in which the developer sells small residential lots to prospective homeowners without centralized water or sewer services, where each homeowner is expected to install a water well and septic system and is usually unaware of the water supply problems that can often be expected with such high-density well drilling.[99]

<u>The fair share doctrine and takings liability</u>

As previously stated, in 2012, the court in *Day* said that, as with oil and gas, one purpose of groundwater regulation is to afford each owner of water in a common, subsurface reservoir a fair share.[100] However, due to the differences between oil and gas and groundwater, the court expressly stated “regulation that affords an owner a fair share of subsurface water must take into

account factors *other than surface area*."[101] According to the court, groundwater regulation must consider allowing landowners the ability to recover their reasonable investment-backed expectations, noting also that "[g]roundwater regulation must take into account not only historic use but future needs, including the relative importance of various uses, as well as concerns unrelated to use, such as environmental impacts and subsidence." Thus, counter to popular belief, the *Day* case does not mandate an acreage based regulatory approach to be used by districts to avoid takings claims. Rather, districts are more susceptible to takings liability if they do not protect landowners' reasonable investment-backed expectations. To date, no other case law exists in which courts have defined a property owner's "right to a fair share."[102]

HB 3028[103] by Rep. Burns, which was born out of a desire to protect private property rights, proposed to amend Chapter 36 of the Texas Water Code to define "fair share" as a reasonable quantification, based on the best available science, of the amount of groundwater in place beneath each tract of land overlying an aquifer, subdivision of an aquifer, or geologic formation that may be produced under applicable DFCs and the operating and hydrogeological conditions of the area, and without resulting in the confiscation by uncompensated drainage of the fair share of groundwater in place under other tracts of land. The qualification of each landowner's amount of groundwater production was intended to protect private property rights; however, some landowners, specifically historic use permit holders, argued the bill favored new users at the expense of historic or existing users, and it is the historic or existing users who have the greatest investment backed expectations with respect to their continued production of the groundwater.

Additionally, technical experts noted that it would be difficult to apply a one-size-fits-all approach to permitting groundwater production in the state due to extreme variations in hydrogeologic conditions, even within the same aquifer.[104] For example, the Upper Trinity Groundwater Conservation District (UTGCD) is unique compared to other districts, even districts within the same GMA, due to its location on the northwest edge of the Trinity Aquifer and the large number of shallow exempt domestic wells completed each year. In the UTGCD there are more domestic and livestock wells drilled each year than any other district in the state, and the vast majority of these wells are completed into the shallow outcrop portions of the Trinity Aquifer Group. Although there are other Districts that manage large portions of the Trinity outcrop, the slope and thickness of the formation within UTGCD's boundaries is such that averaging simulated drawdown for the outcrop and subcrop in the DFC statement applicable to the other districts in GMA 8 would not provide a meaningful measurement for groundwater management purposes for the people that live within the UTGCD, and thus two different DFCs were adopted by GMA 8 for UTGCD with respect to the outcrop and the subgroup. Accordingly, because of the geology of the four counties that make up the UTGCD, the District must necessarily manage and regulate production from the Trinity Aquifer on an outcrop/subcrop basis.[105]

Some believe that from a legal perspective, to make any fundamental change in one of the permissive groundwater allocation tools that have already been utilized by districts in adopting their rules and issuing their permits under those rules by deleting such a groundwater allocation tool or by mandating that all districts have to utilize one particular groundwater allocation tool would be disastrous to this state, its economy, and the investments of landowners, farmers, industry, businesses, retail public utilities, and others that have made substantial economic

investments in the permits they have been issued under the groundwater conservation districts that have already been developed and implemented under the current statute.

They further argue that requiring more uniformity in groundwater allocation regulations may have been a good idea for the legislature to pursue from the inception of groundwater conservation districts in 1949, but it is not a good idea in 2018 now that regulatory systems have been adopted, permits have been obtained, and economic investments have been made under those permits. It would be tantamount to the legislature dissolving the prior appropriations system for surface water in 2019 and telling the TCEQ it needs to go forward and reallocate all water rights under some legal doctrine. Under either scenario, there would be enormous economic chaos and losses, lawsuits, and takings claims. The way that the legislature designed Chapter 36 and the groundwater regulatory system in Texas was to create a statutory toolbox for groundwater allocation and permitting, and to allow local district to develop and implement a regulatory system utilizing the tools that work best and make the most sense in the local area and considering local hydrogeological conditions, in order to protect investments and property rights of all landowners in the area. Any statutory change to that framework at this point in time would have much more negative impacts to property rights and the economy than whatever good could be accomplished by such a change.[106]

Finally, it was argued that because the authority to regulate is different from ownership, to the extent the regulation of groundwater by a district as applied to a particular landowner constitutes a taking, the district's regulation that resulted in that taking is not considered invalid. Said differently, a district has not acted beyond the scope of its regulatory authority (or exceeded its statutory authority) if the implementation of its rules results in a taking; rather it just means that because groundwater is owned in place, the landowner is entitled to compensation for the diminished value of his property as a result of the taking. [107]

Still, others believe that it is the role of the Legislature, rather than the judiciary, to codify a fair share doctrine.

Case Law Update

City of Conroe, et. al. v. Lone Star Groundwater Conservation District & Conroe, et. al.

The Lone Star Groundwater Conservation District (the "District") was created by the Texas Legislature in 2001 primarily in response to the increased water costs of pumping associated with declining water levels in the Gulf Coast Aquifer as a result of the continued population and economic growth in Montgomery County, immediately adjacent to and north of Harris County. Additionally, the District was created to prevent further land subsidence from occurring in the southern portions of the county.[108]

Once the District was created it adopted its first management plan and rules. Largely because of the hundreds of feet of declines in the artesian water levels in many parts of the county, the District adopted a management goal for the Gulf Coast Aquifer of sustainability—to try to arrest those falling water levels. The District's rules are based primarily on protection of historic users. Knowing that it would take some time for its water users to secure alternate sources of water, the

District adopted the first phase of its District Regulatory Plan in 2006, placing all water users on notice that it would ultimately be reducing pumping to sustainable levels in 2016- a ten-year heads up.[109]

Between 2006 and 2016, the District adopted other intermediate rules, basically requiring large users to develop plans for how they would ultimately reduce their pumping and showing progress towards that through the submission of individual or group Groundwater Reduction Plans, similar to what the Subsidence Districts had done to reduce pumping. It's important to note that the water users were left to decide how to comply with the pumping reductions during the 10-year period—Lone Star did not dictate any particular source of supply or conservation strategies. The result was the submission and ultimate approval of 32 different individual and group Groundwater Reduction Plans, only one of which was the San Jacinto River Authority's plan to provide surface water from Lake Conroe.[110]

As originally created by the Legislature, the District had an appointed board to give major stakeholders a seat at the table to help fashion the regulations that they would all have to live under. And, it is important to note that the District's rules and regulatory plan were adopted unanimously by the Board, including by directors appointed by the City of Conroe. But, as surface water was much more expensive than groundwater, and as monthly retail water bills started to go up and residents began to complain, the consensus decisions began to disappear. Ultimately, in the fall of 2015, just before the pumping reductions of 2016 went into effect, the City of Conroe and some investor-owned utilities sued the District, its board of directors, and its general manager challenging the validity of the District's rules. Those rules, in essence, required historic users prior to 2009 to cut back their pumping by 30 percent of 2009 levels starting in 2016.[111]

Much of the first year or two of the lawsuit dealt with sorting out the Plaintiffs numerous claims in its various petitions. The District never challenged whether the Plaintiffs could bring a claim against the District to determine whether its rules and regulations are valid under Chapter 36 and its own enabling legislation, which for Lone Star has numerous express grants of authority that do not apply to other groundwater conservation districts. The Plaintiffs filed 18 claims, many of which were incorrectly aimed at the board of directors individually and the general manager, which legislation passed in 2015 forbade such lawsuits. So, the District and the directors and general manager, who had to hire a separate law firm to represent them separate and apart from the District itself, challenged the ability of the Plaintiffs to pursue many of the claims. Only two of those original 18 claims are left in the lawsuit now, and the District's directors and general manager are presently trying to recover the attorney's fees, which totaled several hundred thousand dollars of taxpayer money which should never have been incurred in the first place under the important attorney's fee provision under Chapter 36 that we visit about frequently in this committee. Now, the only two claims actively being litigated are whether in fact the District is operating within its statutory authority. In April, there was a summary judgment hearing on this issue before the district court.[112]

In September 2018, the district court granted the Plaintiffs' motion for partial summary judgment and denied the District's motion for partial summary judgment. The District subsequently filed with the 9th Circuit Court of Appeals a petition for an interlocutory appeal of

the lower, district court's decision. The 9th Circuit Court of Appeals granted the District's petition, and the case is currently pending before the appellate court.

City of Conroe, et. al. Appeal of the DFCs adopted by the Lone Star Groundwater Conservation District

In the middle of the litigation, many of the same plaintiffs and one other city also appealed the Desired Future Conditions for Lone Star adopted in early 2016 by Groundwater Management Area 14 and in August of 2016 by the District. The basic claim was that the DFCs were unreasonable because they restricted pumping to sustainable levels, and there's a whole lot of groundwater in storage in the aquifer.[113]

As set forth in statute, that DFC appeal was before an administrative law judge at the State Office of Administrative Hearings. Lone Star was already in the third-year of a three-year scientific study requested by the City of Conroe at the time the DFC appeal was filed to determine if additional groundwater could be safely pumped from the Gulf Coast Aquifer in Montgomery County. Lone Star's Board of Directors had pleaded with the plaintiffs publicly not to pursue the DFC appeal, because the Board publicly committed to go pursue additional changes to the DFCs if the results of the technical study supported it. Shortly before the hearing was to begin, the Lone Star board received the results of the three-year study and, as it had previously publicly committed, adopted a new management strategy that would allow additional pumping from the Jasper layer of the Gulf Coast Aquifer and directing its general manager to go pursue those changes in the DFCs with GMA 14.[114]

This decision by the Board ultimately led to a settlement of the DFC appeal shortly before the hearing was to begin. The important take-away from this appeal is an issue in the DFC-appeal language in Section 36.1083 that doesn't seem to acknowledge the hydrogeologic reality that changing the DFCs for one district could have very substantial impacts on adjacent districts. The language says that, if a district's DFCs are determined to be unreasonable, that determination doesn't impact the DFCs of the other districts in the GMA. However, what the districts decide to do to change that one DFC could have very profound impacts on the other districts in the GMA. In the Lone Star example, the proposed changes increase total pumping from around 64,000 acre-feet per year to approximately 100,000 acre-feet per year over the 50-year DFC planning horizon. Most of that increased pumping is in the Jasper layer of the Gulf Coast Aquifer, and would have major impacts on the surrounding districts and counties, who understandably want to take a close look at it under the 9 statutory factors and its impact on their counties before just simply agreeing to it. So, what GMA 14 has done right now is agree to consider the results of the Lone Star DFC appeal and Lone Star's recommended changes on an expedited basis while at the same time working on the third, five-year cycle of the DFCs.[115]

End Op, LP, and Lost Pines Groundwater Conservation District v. Meyer, et al.[116]

In the Lost Pines GCD case four landowners (three individuals and local environmental interest group) filed requests for a contested case and/or party status in any contested case proceeding conducted in connection with an application to produce 54,000-acre feet of groundwater from 14 wells to be constructed in Bastrop and Lee Counties by the applicant End

Op LP. Aqua Water Supply Corporation also filed a hearing request with the District on the End Op application. End Op opposed the 4 landowner's requests, but not Aqua's.

The Lost Pines GCD referred the case to the State Office of Administrative Hearings, including the landowner's requests for party status. The Administrative Law Judge (ALJ) conducted a one-day evidentiary hearing on the party status issue. Following the conclusion of the hearing, the ALJ issued an Order denying the landowners party status who had argued that pursuant to Section 36.002, Texas Water Code, that recognize landowner's property rights in and owner of the groundwater beneath their property, they had "standing" to contest the End Op application. The landowners argued that their ownership rights gave them the right to participate in a contested case standing to protect what they alleged was the deprivation or divestment of their property interest, which they described as a "taking" without any compensation as the result of the drainage of groundwater from beneath their property that they alleged would occur if the End Op permit was granted.

In a nutshell, they argued that mere ownership of land overlying the aquifer from which the applicant End Op sought to produce groundwater gave them a justiciable interest and standing. They did not need to assert or demonstrate any actual or eminent damage or harm to their property or other lawful right to gain standing. Nor did they need to prove that the alleged harm was within the jurisdiction of the Lost Pines GCD or redressable by the District. The evidence of record showed that there were no existing wells or use of the groundwater. There was no evidence of intent or plans to drill wells or seek permits. Evidence was also presented that the landowners in some interests were not eligible (if not prohibited) under the District Rules from obtaining authority to drill or operate a well, and that arguments that End Op's pumping might affect flows in the Colorado were hypothetical rather than actual or eminent and, moreover, represented concerns of the general public, not particularized injuries to the claimant's legal rights based upon the asserted ownership in the groundwater underlying the alleged affected piece of property.

Citing the criteria prescribed in Section 36.415(b)(2), Texas Water Code, the Supreme Court's decision in *EAA v Day*, and the Austin Court of Appeal decision in *City of Waco v. TCEQ*, 346 S.W.3d 781 (Tex. App. – Austin 2011), reversed on other grounds, 423 S.W.3d 409 (Tex. 2013), the Administrative Law Judge (ALJ) found that the landowners had failed to demonstrate the requisite justiciable interest to gain standing to participate as a party in the contested case on the merits of the End Op application. The Lost Pines GCD affirmed the ALJ's Order and denied the landowners party status.

The landowners appealed the District's ruling, and the District Court in Bastrop County. On January 4, 2018, the District Court agreed with the landowners, and issued an Order:

I. reversing the Lost Pines GCD rulings denying the landowners party status,
II. reversing the Order granting End Op a permit to produce 46,000-acre feet of groundwater from 14 wells in Lee and Bastrop County, and
III. remanding the case for further proceedings on the application in which the landowner be allowed to participate as parties.

Unlike the detailed Order issued by the ALJ in support of his recommendation, the District Court's Order provides no analysis of the error it found. End Op and the Lost Pines GCD have appealed that ruling to the Austin Court of Appeals. The Parties are also scheduled to conduct a settlement mediation this month.

Fort Stockton Holdings, LP v. Middle Pecos Groundwater Conservation Dist., et al.[117]

This case is still in the initial stages and demonstrates the need to address "timing" of when a person or entity should be required to seek and obtain party status. In the suit filed by the Cockrell Investment Partners LP, there are several contentions involving denying of requests for a contested case in a hearing on rules proposed by the Middle Pecos GCD, an application to amend a permit by reducing the volume of groundwater permitted to be produced under Historic and Existing Use Permits, and an application for a new production and export permit on remand to the District by the Court of Appeals pursuant to a settlement by the parties.

Fort Stockton Holdings LP (FSH) was denied party status on remand for a hearing to consider a permit application filed in 2009 and initially denied by the District in 2011. The FSH permit was well known within the District from the time it was filed in 2009. The District conducted multiple hearings on the permit in 2010 and 2011, and provided published and mailed notice on the contested case hearing it conducted on the application. The Cockrell partnership did not seek to obtain party status until the application came back to the District on remand almost a decade after the application filed and more than seven years after the District conducted a week long public and duly noticed contested case on the application with the District Board sitting as the finder of fact during 2010 and 2011.

The Cockrell partnership not only had the benefit of the published and mailed notice, the President to the District's Board of Directors during the entire process was the General Manager of the Cockrell's Pecan Orchard outside of Fort Stockton, Texas and adjacent to the FSH proposed well field. The President attended all of the hearings on the FSH application, including the meeting at which the Board voted unanimously to deny the permit in 2011. The President continued in that role, and was named as a defendant in the FSH appeal of the District's decision to deny FSH's permit. The personal firsthand knowledge of and opportunity to protest the FSH permit and seek party status was fully available to the Cockrell partnership, however, no effort to seek party status was ever sought, much less sought timely.

Advocates argued that no person or entity should be allowed to hide behind the log and not seek party status timely. To grant Cockrell party status on remand, would require the District, the applicant and the multiple persons and governmental entities who had sought and participated as parties in discovery, multiple preliminary hearings and the week long contested case hearing. This would present an extreme hardship on all affected, not to mention a great expenditure in both time, money and other limited and valuable resources.

These two lawsuits have spurred discussion about who should receive party status in a lawsuit and whether or not legislation is warranted to clarify this issue. Some advocate that the Legislature should act to clarify and strengthen the language of Section 36.415 to avoid a proliferation of frivolous requests for contested cases that will tax the resources of local

groundwater districts, as well as jeopardize the protected property rights of groundwater owners seeking to beneficially use their groundwater resources pursuant to permits authorized pursuant to the requirements of Chapter 36, the rules of the local groundwater district and the protections they are intended to afford to our aquifers and other groundwater owners and permittees by the Texas Legislature.

LULAC v. Edwards Aquifer Authority

In 2012, the League of United Latin American Citizens (LULAC) and the San Antonio Water System (SAWS) filed a lawsuit against the EAA challenging the constitutionality of it's board governance under the One-Person One-Vote principle. The EAA is composed of 15 single member district elected directors. The board does not conform to the One-Person One-Vote principle. The governance was an negotiated arrangement to create a fair balance of interests and user groups across the region that have a direct interest in the resource by the Legislature in 1995. There disparity that happens today happened on day one, it has just been exacerbated by population growth. In 2014, there was a hearing on motions for summary judgements. This year the judge issued a notice indicting that he was issuing a stay and those involved could expect a ruling in the near future. In June, of this year, a U.S. District Court Judge upheld the composition of the board. It's unclear if there will be an appeal. If there were a reversal of this decision in the future, it is likely that the issue will come before the Legislature for a resolution. The Legislature is the body that set up the governance structure and the EAA board does not have the authority to change itself.[118]

This case gets at the heart of how to provide fair representation for a region where the rural areas of supplying most of the water for the urban areas, and is likely to be replicated throughout the state.

Uvalde County Underground Water Conservation District v. Edwards Aquifer Authority

Earlier this year, the Uvalde County Underground Water Conservation District filed a lawsuit against the EAA in regards to the way it administers historical irrigation rights. The EAA set up the allocation of these rights through the permitting systems. Irrigators applied for their water based on historic use and were allocated 2 acre-feet per acre of historically irrigated land with the provision that half of water had to stay appurtenant to the land. Seventeen years ago, the board faced pressure from local constituents who came to the them with concerns of farm land that was being converted to some other use. In one particular case there was a Walmart being built on a constituent's property. The question arose: what happens to the water tied to that land? At the time, through rule making, the EAA adopted a way for landowners to come to board to seek conversion of historically irrigated groundwater to sever it from land and put it to some other use so they could maintain their interest in that property right. Over time the rules have been updated and modified by the board as they dealt with the realities of the marketplace. Last year the rules were amended to provide more clarity, this resulted in the Uvalde District lawsuit. The legal question of the lawsuit is: did the EAA board have the legal authority in developing rules that allow for the base irrigation groundwater to be converted to an unrestricted use and to be severed from property? The city and county of Uvalde has intervened with district and the EAA has held meetings to negotiate a settlement. Recently, Uvalde CD has filed for a motion of summary

judgment. EAA believes the lawsuit will end in one of two ways, either settled in courts or in a negotiated agreement that comes back to the Legislature.[119]

Tx. Att'y Gen. Op. No. KP-0216 (2018): Limitations on Existing and Historic Use Permits Clarified

Questions regarding the limitations on existing or historic use permits and the scope of a groundwater conservation district's authority to amend an existing or historic use permit were answered in an Attorney General opinion issued September 26, 2018.[120] Specifically, the Attorney General addressed the question of whether a district's rules may prohibit an amendment to an existing or historic use permit that seeks to change the authorized use of groundwater under the permit. Citing the Texas Supreme Court's decision in *Guitar Holding Co. v. Hudspeth Cty. Underground Water Conservation Dist. No. 1*, 263 S.W.3d 910 (Tex. 2008), the Attorney General concluded that a change in the purpose of a proposed use of water under an existing or historic use permit constitutes a new use, even if the new use would occur within the district.[121] The opinion confirmed the Court's holding that under Texas law, "[a] district's discretion to preserve historic or existing use is . . . tied both to the amount and purpose of the prior use."[122]

The Attorney General further explained that while a district may accept a surrender of a portion of right to produce groundwater under an existing or historic use permit and allow the holder to retain the remaining rights not surrendered, a court would likely determine that the uniformity requirements in Chapter 36 of the Texas Water Code preclude any district rules that would give an advantage to an existing or historic use permit holder who seeks new use approval that is not available to other new use permit applicants.[123] In summary, the opinion clarified that a district has the authority and discretion to limit not only the amount of groundwater production under existing or historic use permits, but also to limit the authorized use under such permits to the original, permitted purpose of use for which the historic protection was afforded.

Sub-charge C: Potential improvements to the existing groundwater permitting process, including those contemplated in HB 31 (85R);

While a majority of groundwater conservation districts work to enact rules that respect property rights, it has been noted that certain districts hold the view that their purpose is to block access to anyone outside of their immediate community from using groundwater for future water supplies, and have used permitting tactics that would unduly deny groundwater rights holders access to permits. HB 31 (85R) by Chairman Larson sought to limit the ability for such abuses to occur. Namely, the legislation sought to 1) eliminate export permits going forward, while grandfathering existing export permits, 2) where an existing export permit expires before the related operating permit issued for production of the water to be exported, it provides that the export authorization in such a circumstance is extended on or before expiration to a term that aligns with the term of authorized production, 3) lays out requirements for deeming and application administratively complete 4) vests a district's rules at the time of a permit application, and 5) sets up a framework by which a moratorium can be instituted, providing that a moratorium can be no longer than 90 days, and will require a public notice, public hearing, and written justification.

Groundwater Conservation Districts' Efforts

The Texas Alliance of Groundwater Districts (TAGD), through data collection, has found that the permitting rules of members is more of a hybrid approach. In an effort to more seriously look at the streamlining of permitting, the TAGDs' Legislative Committee formed a subcommittee looking at permitting issues during the interim. This subcommittee's objective is to review all permit related discussions from the 85th Legislature, and consider their impact on GCD operations. Some of the topics this subcommittee is considering include streamlining permits, moratoriums, export permits, permitting considerations including CCNs, and special permit conditions. The subcommittee is currently working to produce a white paper that will seek to summarize various permitting considerations and how GCDs might use them.[124]

GCDs support efforts to improve administrative efficiency and nondiscriminatory treatment in permitting frameworks. It is important, however, that those efforts do not preclude a GCD from requesting appropriate application requirements needed to make sound, science-based decisions. Synchronization of groundwater applications for operating and exporting permits is permissible under current law and provides for appropriate consideration of permit terms, automatic approvals, transported volumes, and groundwater ownership.[125]

In adopting the well spacing and groundwater production rules that comprise the regulatory framework in which permitting decisions are made, a GCD must select a method that is appropriate and based on hydrogeological conditions and local needs. In permitting decisions, a GCD must consider its management plan, adopted DFCs, and water availability. In making those permitting decisions and in adopting its rules, a GCD may consider factors; including well spacing, production limits, surface acreage ownership, beneficial use, historic or existing use, the service needs or service area of a retail water utility, and unreasonable effects on groundwater and surface water resources. These considerations allow GCDs to make permitting decisions based on differing local needs and aquifer conditions.[126]

Special permit conditions are an important management tool used to address unique factors, facilitate permit approvals, and to negotiate agreements of terms. Special conditions are usually applied in permitting situations where the groundwater production impacts are not known or may be significant. In these cases, a GCD can issue a permit with special conditions to allow for monitoring of those impacts and adjustment of the permit. The use of special permit conditions provides an important mitigation tool that can be used by GCDs to ensure efficient permit processing, utilization of science and site-specific hydrogeological conditions, as well as a way to stay out of the courts.[127]

Additional Efforts

Interested parties are working on initiatives in an effort to bring certainty and efficiency to the development of water resources. The Texas Water Conservation Association established a Groundwater Committee to work on building a consensus on a number of water issues bringing together a large of group of diverse interest.[128]

It is important to alleviate as much uncertainty with GCD permitting to ensure that district's are not impeding needed project development and state's economic growth. At the same time we know we have to balance district's mandate to manage resource and conserve the resource. More certainty in groundwater district regulation will do both. This will benefit the groundwater owner in their project planning and financing as well as the GCDs as they establish a regulatory framework and protect private property rights. [129]

Past legislative efforts like HB 2378 (85R) and HB 31 (85R) worked to create a more predictable and timely process for the administration of GCDs. These efforts remain important improvements.[130] As previously discussed, HB 31 made statutory changes related to the regulation of groundwater to address certain groundwater conservation districts that have violated private property rights by unduly impeding, delaying, or denying the issuance of groundwater permits.[131] HB 2378 addressed the circumstance where a groundwater export permit expires before the related operating permit issued for production of the water to be exported. The bill provided that the export authorization in such a circumstance is automatically extended on or before expiration to a term that aligns with the term of authorized production.[132]

Sub-charge D: The appropriate consideration of the service area of a water supplier when groundwater resources are allocated based on surface ownership;

Chapter 36 of the Texas Water Code grants groundwater conservation districts (districts) the authority to regulate the production of groundwater in order to protect the aquifer, control subsidence, prevent interference between wells, protect water quality, prevent waste, and achieve the desired future conditions adopted for the aquifer.[133] Section 36.116 of the Texas Water Code authorizes districts to regulate the production of groundwater by setting production limits on wells; limiting water production based on acreage or tract size; limiting water production from a defined number of acres assigned to an authorized well site; limiting maximum production on the basis of acre-feet per acre or gallons per minute per well per site; managed depletion; or any combination of these methods.[134] In regulating groundwater production based on acreage or tract size, Section 36.116(c) of the Texas Water Code grants districts the permissive authority to consider the service needs or service area of a retail public water utility:

> In regulating the production of groundwater based on tract size or acreage, a district may consider the service needs or service area of a retail public utility. For the purposes of this subsection, "retail public utility" shall have the meaning provided by Section 13.002.[135]

This current language in Section 36.116(c) of the Texas Water Code represents a legislative compromise that was reached in Senate Bill 2 in the 77th Texas Legislature, Regular Session, in 2001, to allow, but not require, a district to "consider" a retail public utility's service needs or service area when regulating groundwater production by tract size or acreage. The current language provides flexibility for a district to consider the interplay and balance between limited groundwater availability, the needs of public water suppliers and their legal obligation to provide water to the landowners within their service area, the private property rights associated with the groundwater, the best available science, and potential takings liability.

Pursuant to Section 36.116 of the Texas Water Code, multiple districts in Texas, specifically in the more rural parts of the state, have adopted a regulatory approach that allocates groundwater production based on the amount of surface acreage owned, or groundwater rights leased, over an aquifer. These districts vary in terms of how they permit groundwater production for utilities. Several districts permit retail public utilities based on the acreage in their service area so long as that acreage is contiguous to their well site, excluding all acreage associated with an individual landowner's permitted well within that service area, and to the extent more acreage is required to support production by the utility, the utility would have to acquire the acreage or the right to produce the groundwater just like any other landowner in the district. However, other districts require utilities to acquire the acreage through sale or lease or receive written authorization from the landowner to secure the acreage necessary to produce the amount of groundwater needed under the utility's permit.

Legislation was filed in the Texas Legislature in 2015[136] and in 2017[137] that would have eliminated districts' permissive authority in Section 36.116(c), replacing it with the statutory mandate that all districts shall consider the service needs or service area of a retail public utility when regulating production by tract size or acreage. This proposed legislation was supported by the Texas Rural Water Association (TRWA), a trade association with a membership of approximately 750 member water and wastewater systems, the majority of which are non-profit water supply corporations, water supply districts, and small cities, and other retail water utilities. The proposed legislation was opposed by several groundwater conservation districts and landowner interest groups.

TRWA, its members, and other utilities have taken the position that utilities have unique needs due to their legal obligation to provide water to their customers, and therefore, in regulating groundwater production based on acreage, districts should be required to permit utilities based on the acreage in their service area. More than 500 TRWA members rely on groundwater as their source of water supply, and 115 of those currently lie within a district that limits groundwater production based on acreage. The customer base of these utilities range from hundreds of customers to hundreds of thousands. It is unlikely that a utility could acquire on a voluntary basis the water rights owned by every customer it serves. Involuntary acquisition of those water rights through condemnation has been discouraged by the legislature through the imposition of legal impediments that may be difficult or impossible for a utility to achieve. In any event, in most cases, the cost of acquisition would be passed back to the customers whose water rights were acquired through higher water rates. Thus, considering the potentially high legal and real estate transaction costs associated with the acquisition of a landowner's water rights multiplied by hundreds or thousands of landowners in the service area, the landowners would end up with a net financial loss, because the amount of the increase in water rates would necessarily be higher than the compensation to be paid to landowners since the water rates must also account for the legal and real estate transaction costs. TRWA's members and other individual utilities are concerned that if districts are not required to consider the service needs or area of utilities in allocating groundwater production based on acreage, then utilities will be unable to secure the acreage needed to support the amount of groundwater production required to meet increasing demands resulting from population growth throughout the state.[138]

Other stakeholders have taken the position that the districts should be prohibited from considering the service needs or area of a retail public utility when regulating groundwater production based on tract size or acreage. The Texas Legislature and courts have determined that groundwater rights are real property rights, and therefore, in order to protect landowners' private property rights, those stakeholders believe the utilities should be required to legally acquire the water rights associated with the acreage necessary to support the utilities' groundwater production. Otherwise, the stakeholders feel that the utilities may be authorized to produce more than their "fair share" of the common resource.

Districts with existing regulatory systems are concerned that any change in the statute would result in the potential proliferation of regulatory takings lawsuits against districts. Texas courts have held that well owners with reasonable investment-backed expectations are entitled to compensation if regulations go too far in limiting groundwater withdrawals. Similarly, legislation mandating how all districts must regulate groundwater produced by retail public utilities statewide would unravel many existing regulatory schemes already in place, which would ultimately impact the property owners and permit holders that rely on such existing rules and their investment-backed expectations associated with the production of the groundwater under such permits and rules. Districts may be held liable by a property owner if mandated to issue a permit to a utility based on the utility's service needs or service area, or by a utility for limiting its permit if mandated to require the utility to purchase or lease all the water rights from adjoining property owners to support its continued production of groundwater, thus creating additional litigation and confusion in the law. As a result, most districts and many other stakeholders support the current language in the statute, which provides flexibility for a districts to consider the interplay between limited groundwater availability, the public water supply needs, the private property rights associated with the groundwater, the best available science, and potential takings liability.

Sub-charge E: The designation of brackish groundwater production zones and related research;

With over 2.7 billion acre-feet of brackish groundwater throughout Texas, brackish groundwater desalination has tremendous promise as a future water supply to help reduce demand on freshwater resources. [139] Desalination technology has advanced rapidly over the past decade, yet our state lags behind states to the east and west in terms of embracing this readily available innovative water technology.

The use of brackish groundwater resources to meet municipal demand will lessen pressure on fresh groundwater resources and improve water security throughout Texas; however, the lack of data on its availability and the local regulatory environment surrounding brackish groundwater are challenges for the Legislature to address.

<u>Modeling Brackish Groundwater Production Zones: An Overview of HB 30 Studies</u>

The first priority to catalyze the development of this resource was to speed up the process of mapping the highly productive brackish aquifer formations by designating Brackish

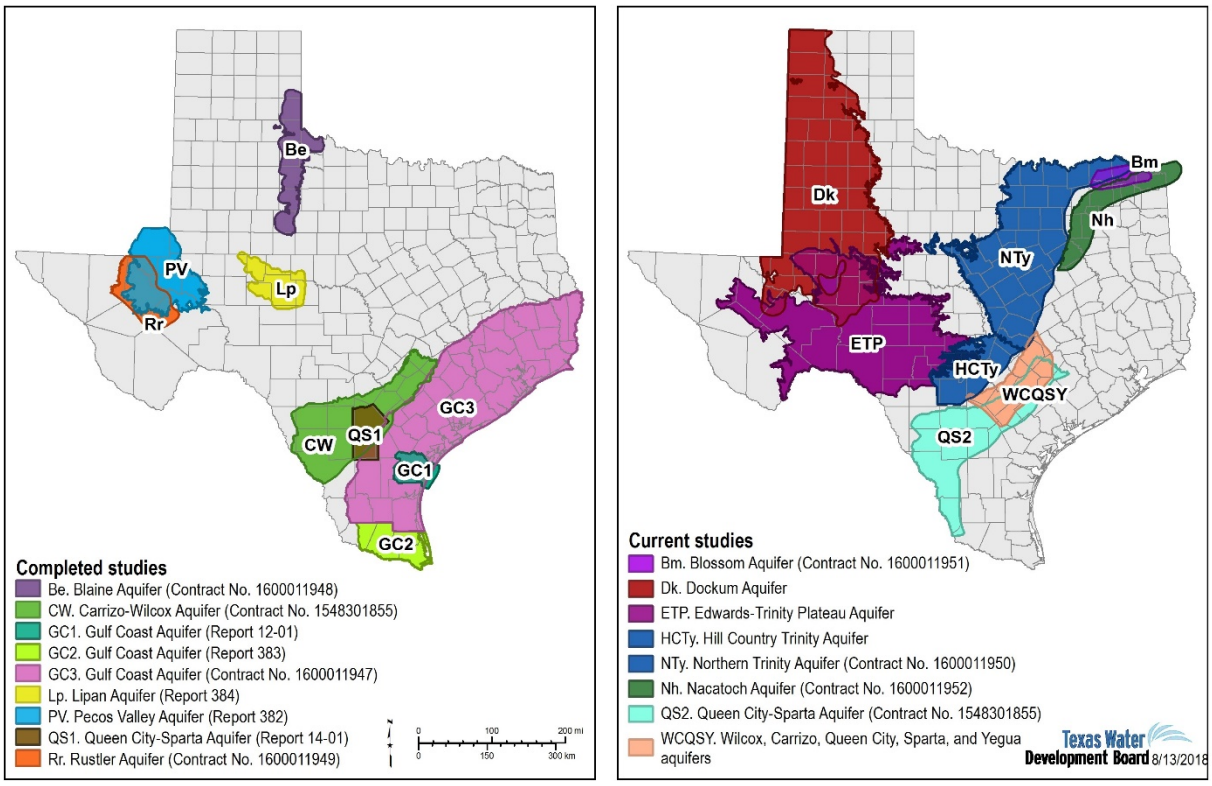
Groundwater Production Zones (BGPZs), which was accomplished during the 84th Legislative Session with the passage of HB 30.

TWDB began studying brackish groundwater supplies after the Legislature created the BRACS program in 2009. HB 30 provided funding to accelerate the completion of these studies, and also tasked the Board to identify Brackish Groundwater Production Zones, which must meet the following criteria:

- Separated by hydrogeologic barriers sufficient to prevent significant impacts to water availability or water quality in any area of the same or other aquifers
- Does not already serve as a significant source of water supply for municipal, domestic, or agricultural purposes at the time of designation of the zones
- Distanced from wastewater injection wells or disposal wells
- Able to provide brackish water over a 30 to 50-year time period

Here is an overview of which aquifers have been completed, which are currently in progress and which are slated for study in the future.

Brackish Resources Aquifer Characterization System (BRACS) Program



2016 Designations:[140]

The Carrizo-Wilcox Aquifer was studied in 2016 and TWDB identified one area of brackish groundwater production zone. The depth of zone ranged from 1,400 to 3,800 feet deep. TWDB also identified about 140 feet of low permeability shale that separates the potential production zone from overlying fresh water. There is an estimated 43,000 acre-feet of brackish groundwater that could be produced from that area per year.

In the Gulf Coast Aquifer four potential brackish groundwater production zones were identified. Three in far south Texas and one in central part of the aquifer that straddles Austin and Colorado counties. TWDB estimates about 48,000 acre-feet of brackish groundwater that could be produced from those four zones per year.

TWDB identified three potential brackish groundwater production zones in the Rustler Aquifer. The geometry was a little different in this aquifer, barriers included low permeability formations and faults. 15,000 acre-feet of brackish groundwater was identified that could be pumped from the three zones.

In the Blaine Aquifer, no brackish groundwater production zones were recommended because the aquifer is already serving as a source of brackish water supply by existing domestic and agricultural users.

2019 Designations:

TWDB staff are 90 percent complete with their recommendations for brackish groundwater production zone designation for the Blossom, Lipan, Nacatoch, and Northern Trinity aquifers. The Board will consider these recommendations at a March 2019 Board Meeting.

- The Blossom Aquifer has two to three areas for designation as brackish groundwater production zones. Currently, TWDB staff are working on calculating groundwater volumes for the zones and aquifer.
- The Nacatoch Aquifer has one large area for designation as a brackish groundwater production zone. Currently, TWDB staff are working on calculating groundwater volumes for the zone and aquifer.
- The Lipan Aquifer has no areas for zone designation because there are not sufficient hydrogeological barriers in the aquifer that separate brackish and fresh water. Additionally, brackish groundwater in the aquifer is already serving as a source of water for the surrounding area.
- The Northern Trinity Aquifer has 15 areas for designation as brackish groundwater production zones, with two to four zones designated in each of the five hydrostratigraphic units. Available volumes of groundwater are:
    - fresh - 472 million acre-feet,
    - slightly saline - 487 million acre-feet,
    - moderately saline - 703 million acre-feet, and
    - very saline - 399 million acre-feet.

Studies Currently Underway

The bill also requires the TWDB to complete evaluations on the remaining major and minor aquifers by December 1, 2022. TWDB has said that will require additional time to complete them all.[141]

Aquifers currently under study are the Trinity Aquifer, Edwards-Trinity Plateau Aquifer, Dockum Aquifer, additional areas of the Carrizo-Wilcox and the overlying Queen City-Sparta Aquifers. TWDB expects most of these studies to be done in 2020. Once these studies are complete, this will represent most of the aquifers that TWDB was required to study. TWDB stated they will need more time and resources to complete all the major and minor aquifers to fulfill the requirements of HB 30.

Future Studies

Funding for the HB 30 studies was vetoed in the budget passed by the 85th Texas Legislature, which makes the completion date laid out in HB 30 of 2022 for all the specified aquifers impossible. Even with continued funding next session, the timeline is already now four years behind. Without any additional legislative appropriations, staff will finish studying all aquifers that meet House Bill 30 criteria by 2032 and finish studying the remaining aquifers that do not meet House Bill 30 criteria by 2042. As we see our state slip into a drought, these data points become even more critical for communities facing shortages and in need of developing alternative water supplies.

The following aquifers remain outstanding for study without additional funding:

- Capitan Reef Complex Aquifer
- Ellenberger-San Saba Aquifer
- Hickory Aquifer
- Wilcox, Carrizo, Queen City, and Sparta Aquifers
- Woodbine Aquifer
- Yegua-Jackson Aquifer

<u>Additional Efforts to Study Brackish Groundwater Resources</u>

Local groundwater districts, like the High Plains Underground Water Conservation District (HPWD), are conducting their own studies of brackish groundwater resources. The HPWD Board approved a scope of work for the study of the Dockum Aquifer to learn more about the resource and the role it could play in diversifying the water supply needs of the area in April 2015. While partnerships between the local districts and the state could enhance the work of entities there are concerns about landowner protections, there is some hesitancy that state involvement and a state designation of an area could mean landowners lose their water rights or control. Communication will be crucial as we move forward in identifying future water resources. Local entities and the state should utilize each other to share funds and information that will help with this strategic planning.[142]

Setting up a Regulatory Framework for Brackish Groundwater Production Zones

HB 2377 85(R) by Chairman Larson attempted to build upon the efforts of HB 30. The bill would have provided a stable regulatory structure in those identified production zones and would have incentivized producers to develop a project over more scarce fresh water.[143] The bill passed the House and Senate and was vetoed by the Governor.

Following the efforts of HB 2377, members of Texas Alliance of Groundwater Districts and the Texas Desal Association came together to discuss how both parties can continue to encourage brackish groundwater production and permitting in Texas. As a first step, members from both associations have participated in a two-day workshop of practical discussions on how different approaches affect each party from a regulatory and operational perspective. TAGD and Texas Desal intend to continue their dialogue and build stronger communications.[144]

Additionally, discussions have taken place at the Texas Water Conservation Association Groundwater Committee about potential changes to the bill to clarify its intent and address the Governor's concerns. These discussions are ongoing.

Sub-charge E: Groundwater data and science needs;

Groundwater, along with surface water, is important for maintaining the viability of the state's natural resources, health, and economic development. The projected doubling of the state's population by the year 2060, coupled with the constant threat of drought, makes it imperative that Texas develop effective plans to meet future water needs. Effective planning, however, requires accurate assessments of the availability of water, and assessing the availability of groundwater is often much more difficult than assessing that of surface water.[145]

Groundwater is difficult to observe and measure because it resides below the land surface and responds to rainfall much more slowly than rivers and lakes do. Aquifer systems are complex due to flows into and out of the aquifer, the interaction between surface water and groundwater, and the uncertainty of aquifer properties.[146]

Because of this complexity, computer models are excellent tools for assessing the effect of pumping and droughts on groundwater availability. Groundwater Availability Modeling (GAM) is the process of developing and using computer programs to estimate future trends in the amount of water available in an aquifer and is based on hydrogeologic principles, actual aquifer measurements, and stakeholder guidance.[147]

GAMs include comprehensive information on each aquifer, such as recharge (amount of water entering the aquifer); geology and how that conveys into the framework of the model; rivers, lakes, and springs; water levels; aquifer properties; and pumping. Each model is calibrated to ensure that the models can reasonably reproduce past water levels and groundwater flows.[148]

The Texas Water Development Board (TWDB) has utilized GAMs for almost the last 20 years. There are 28 current models and 6 alternatives. Since 2001, the Board has contracted 57 research and model projects for a total of $18.8 million. Have models for all major aquifers and

most minor ones. Models are updated as new information becomes available, the modeling code is updated, and/or the objective for the model is changed. Aquifer data for a model is available for many other projects and studies.[149]

Current contracted GAM research and model projects include the GMA 13 - Southern Carrizo-Wilcox salinity mapping project (UT Bureau of Economic Geology), fault study and update to GMA 12 (Central Carrizo-Wilcox) (INTERA), and working on a revised and conceptual model of the Trinity Hill Country (Southwest Research Institute). Current TWDB in-house projects are updating the Gulf Coast model update (GMA 15 and GMA 16) and the update of the northern portion of the Edwards Balcones Fault Zone.[150]

Real time recorder well network

TWDB has a statewide network of 200 wells that are instrumented with automatic data coordinators. Regular intervals are recorded every 5-10 minutes and are available on their website. This allows a real time look at what is happening. The program has proven to be useful in looking at the impacts of development in certain areas. This allows us to see what the behavior of the aquifer is and gives us a better understanding of aquifer dynamics.[151]

TWDB also records wells and springs in their groundwater database, which is online and always available. TWDB has 135,00 records of individual wells and 2,100 springs. With the help of Groundwater Districts and the USGS, TWDB regularly measures 12-15,000 wells a year. This information is helpful when looking at short and long-term trends.[152]

TWDB Data Uses

TWDB hosts the Water Data for Texas website and Water Data Interactive (GW Data Viewer) to provide information to the public and decision makers that is accessible and understandable. These sites have proven to be helpful tool in getting out information on groundwater data, reservoir conditions, recorder well data, and submitted driller reports.[153]

Texas Water Data Initiative

The Texas Water Data Initiative is an effort hosted by the Mitchell Foundation to advance water data in Texas. Members of the initiative, including the Texas Alliance of Groundwater Districts (TAGD), participated in the recent Texas Water Data Workshop. The workshop focused on sharing and integrating water data with statewide and national experts.[154]

As part of this effort, TAGD was awarded a grant by the Mitchell Foundation to study how GCDs are currently collecting water data, and identify opportunities for improvement. To do this, TAGD has hosted six stakeholder workshops across the state to learn about how GCDs collect and use water data in their management, and how they can help improve our knowledge of groundwater resources in Texas.[155]

In response to both the national and statewide discussion on the importance of data and science, TAGD's Legislative Committee assigned one of its subcommittees to the subject. In an

initial survey to identify our most urgent groundwater data and science needs, the following were identified as initial considerations:

- Increased groundwater withdrawal data collection
- Expanded groundwater monitoring/observation wells
- Updated groundwater availability models
- Groundwater/surface water interaction modeling
- Increased groundwater quality data
- Increased understanding of recharge estimates
- Improved data collection tools
- More data on ASR[156]

Texas Alliance for Water Conservation

The Texas Alliance for Water Conservation has been looking at how to help production agriculture as far as their use of water is concerned. Currently, producers are using about 90 percent of water extracted from the aquifer. The focus for TAWC is how they can help producers determine ways to use less water from aquifers and at the same time remain sustainable and profitable.[157]

Unique to the TAWC project is a partnership of area producers, data collection technologies, and collaborating partners that include: industries, universities, and government agencies. The project uses on-farm demonstrations of cropping and livestock systems to compare the production practices, technologies, and systems that can maintain individual farm profitability while improving water use efficiency with a goal of extending the life of the Ogallala Aquifer while maintaining the viability of local farms and communities.[158]

All production-related decisions are made by the producers involved in the project. The project field sites involve more than 6,000 acres throughout the counties of Floyd, Hale, Lamb, Lubbock, Crosby, Castro, Parmer, Swisher and Deaf Smith. These sites represent the range of agricultural practices including monoculture cropping systems; crop rotations; no-till, limited-till and conventional tillage practices; land application of manure; and fully integrated crop and livestock systems.[159]

Since 1950, the Ogallala has seen a reduction of 50 percent of storage as far as saturated sand is concerned. This has forced producers to learn how to deficit irrigate. They look at the maximum water demands of their specific crops and what they are able to supply. This has given TAWC the opportunity to work with producers on when the most appropriate times to apply irrigation to get the maximum benefit per increment of water.[160]

The TAWC (project) was funded through a competitive grant in 2004 – SB 1053 appropriated $6.2 million funded for 8 years (2005-2012) and extended through April 2014 administered by the TWDB. In 2014, funding was renewed for additional $3.6 million for 5 years (2014-2019) with project expansion and administered by TWDB. The project is producer driven and Board directed. The objectives of the project are to develop and demonstrate new

technologies and management tools that use less water while maintaining profitability, identify effective cropping systems and impact producer decision-making.[161]

Data Analysis & Technology Transfer

The project sites are being intensely monitored for water use, soil moisture depletion, crop productivity, and economic return. Each site is equipped with instruments to determine total water applied from the aquifer, solar radiation, temperature, rainfall, and timing. Also being monitored are the amount of irrigation events as well as soil moisture. Integrated central processing controller equipment is being utilized to record, store, and transmit all data to a single database accessible to project participants. Risk management specialists with Texas A&M AgriLife Extension analyze data gathered from producers' field records to calculate economic return from irrigation. Data gathered over the past 10 years of the TAWC Project have been used to develop free online tools producers can access to enhance their irrigation management.[162]

TAWC shares it's information and solutions through free web-based management tools.

- ET tool: When and how much water to apply
- Resource Allocation Decision aid tool: match available water to crop for best economic return
- Heat Unit calculator: regional cotton & corn heat unit tracking
- Irrigation calculators: gpm, time and contiguous acre calculators[163]

Sub-charge F: Emerging issues in groundwater and surface water interaction, in particular in area of increasing competition for scarce resources.

The growing use of water resources and greater frequency of droughts, with associated impacts to streamflow, are placing a greater focus on groundwater and surface water interactions in Texas. Among the regulatory issues affected by surface water-groundwater interactions in Texas are managing water rights along a river, complying with the Endangered Species Act (ESA), implementing environmental flow recommendations, and obtaining bed and banks permits. A question central to all these regulatory issues is how to quantify the impacts of groundwater pumping on the availability of surface water. This question is at the center of several recent studies, conflicts and lawsuits in Texas involving the Rio Grande, San Saba, Colorado, and Brazos rivers. The situation on the San Saba River resulted, in part, in an interim charge the House Natural Resources Committee to evaluate "emerging issues in groundwater and surface-water interaction, in particular in areas of increasing competition for scarce resources."[164]

Traditionally, surface water and groundwater have been treated independently when managing these resources in Texas. However, these two resources are often hydrologically connected. In some instances, surface water serves as a source of flow that can change the chemistry and availability of groundwater. Conversely, groundwater can increase the flow volume and affect the chemistry of surface water. In some cases, the same stretch of river may lose flow to the aquifer in one season and gain flow from the aquifer in another season. As the demand for water and the need for new water supplies increase in Texas, understanding the

hydrologic connection between surface water and groundwater becomes integral to developing policies and strategies to effectively use and manage these two resources.[165]

The Texas Water Development Board's (TWDB) 2016 report on surface water-groundwater interactions in Texas made several key points:

- An estimated 9.3 million acre-feet of groundwater flows from major and minor aquifers to surface water in an average year. This represents about 30% of the average surface water flow in Texas. To put that in perspective, the entire water use for the State of Texas for all uses in 2015 was approximately 12 million acre-feet.
- Aquifer interactions with surface water vary regionally and within each aquifer. Between 14% and 72% of streamflow over aquifer outcrop areas is due to groundwater discharge from major and minor aquifers.
- The largest groundwater contributions to surface water occur in East Texas, the Hill Country, and around major springs in West Texas.
- The aquifer with the most groundwater discharge to surface water is the Gulf Coast Aquifer, with an estimated 3.8 million acre-feet per year.

Besides indicating that surface water-groundwater interactions can significantly affect streamflow, the TWDB report indicates that local geology and meteorological conditions are important factors that affect surface water-groundwater interactions.[166]

The Texas Water Code recognizes that surface water and groundwater resources are hydrologically connected, at least locally, and requires that regulatory authorities consider this when issuing permits. TWC §36.113(d)(2) requires that GCDs, when evaluating groundwater permits, consider whether "…the proposed use of water unreasonably affects existing groundwater and surface water resources or existing permit holders…" Similarly, TWC §11.151 states "in considering an application for a permit to store, take, or divert surface water, the commission [TCEQ] shall consider the effects, if any, on groundwater or groundwater recharge." Statute recognizes the potential interconnectivity between groundwater and surface water but (1) doesn't specify what level of interaction would spark action on a permit, (2) doesn't require any action by the regulating body, and (3) doesn't coordinate the regulatory realms of TCEQ from the surface water perspective or GCDs from the groundwater perspective.[167]

Given the volume of water affected by this dynamic, and the varied regulatory schemes governing these two types of water, this dynamic will continue to cause challenges across the state. During the interim, the Natural Resources Committee studied ongoing challenges with groundwater-surface water interaction in the San Saba River Basin and Val Verde County.

San Saba River

During the 85th Regular Session, the Natural Resources Subcommittee on Special Purpose Districts held a hearing on HB 3846, legislation filed by Rep. Murr, who represents the upstream counties in the San Saba River basin, which proposed the creation of a 9-member board to manage water usage in the river. Both upstream and downstream users ultimately brought

forward concerns about how this would work, which led in part of the committee's review of this issue and similar dynamics throughout the state.

At the Natural Resources Committee's interim hearing in Brady on May 23rd, the committee heard invited and public testimony from upstream and downstream landowners in the San Saba River basin, state agencies, hydrologists and other experts, and the public.

Since 2011, the TCEQ has received complaints alleging shallow groundwater wells are being used to pump surface water in the form of underflow from the San Saba River. The area identified is a 40-mile reach between Menard and Brady, where numerous wells within one mile of the river are completed in the alluvial deposits, which are believed to be a lateral extension of the river. From July to October in six of the past 15 years, and for every summer from 2011 to 2015, the river has gone dry along the 40-mile reach. In 2015, TCEQ Investigation Report Number 1254241 presented findings from its hydrogeological investigation and determined that some of the groundwater wells were illegally capturing state waters and that, for future pumping to continue, the well owners needed to obtain the appropriate surface water rights.[168]

The perspective of downstream riparian landowners in McCullough and Mason Counties who are frustrated by a diminished flow in the San Saba River in recent summers contend that farmers upstream in Menard County are pumping from shallow alluvial wells that have a direct impact on surface water supplies, instead of groundwater, for the purpose of irrigating pecan and hay, both water-intensive crops, and are draining the river before it reaches their property. The perspective of those upstream in Menard is that diminished flow in the San Saba can't be conclusively traced to their wells, and natural shifts in the climate, cracks in the riverbed and brush along the banks could also be contributing factors.

Additionally, the general perspective of downstream landowners is that TCEQ has not gone far enough to take enforcement action against those who the agency has recognized as pumping from alluvial wells to protect the flow of the river, and enforced priority calls made by Domestic & Livestock users. Those upstream dispute the assertion that their actions have impacted the river and strongly feel that to restrict their access to water, upon which their livelihoods and the survival of the county depend, would be government overreach.

TCEQ has the authority to investigate complaints about unauthorized surface water use and take enforcement actions. It also evaluates priority calls made by senior water rights holders, when someone with an older or "senior" water right asks to TCEQ to suspend "junior" water rights in the basin to ensure access to their appropriated water.

The law provides for exemptions for which a user is not required to get a permitted water right to use surface water, the most common exemption being for Domestic & Livestock use. D&L users are given the highest priority and their use takes precedence over other water rights in the basin. They can impound water from a river or stream without a permit as long as the amount diverted is less than 200 acre-feet in a 12 month period. D&L use includes water used for livestock, to meet household needs, or to irrigate a lawn or garden. Many downstream riparian landowners in the San Saba River basin have D&L rights, and provided testimony that TCEQ is

inadequately protecting this right that the law views as superior to appropriated water rights upstream.

TCEQ provided testimony, cataloging its response to numerous complaints in the San Saba River Basin. Of 88 complaints filed from 2012-2016, 20 resulted in enforcement actions that were resolved, and 7 that were still ongoing at the time of the report.

The agency also explained its actions in response to 7 priority calls in the basin from 29 individual D&L users from 2012-2016. In 6 of the 7 calls, TCEQ did not suspend water rights because theoretical additional water in the stream resulting from a curtailment either would not have reached the downstream users in sufficient quantities to be used for their intended purposes (also known as a futile call) or there was still sufficient water in the river to meet the needs of D&L users making the calls. TCEQ did suspend water rights as a result of a priority call in the basin in August of 2013. The agency received a call from two D&L users in the basin as a result of low flow in the river and suspended 66 water rights junior to 1900 for a 6-week period.

TCEQ or the Legislature can appoint a watermaster to serve as a referee in a river basin or portion of a river basin. TCEQ recently evaluated whether or not the Colorado River basin or any of its tributaries, including the San Saba, merited the appointment of a watermaster to ensure compliance with water rights by monitoring stream flows, reservoir levels, and water use. The agency recommended against the creation of a water master program for the San Saba.

The committee also heard testimony from the Endangered Species Division of the Comptroller's Office and the Texas Parks and Wildlife Department about their research on the freshwater mussels that live in the San Saba River. The U.S. Fish and Wildlife Service is evaluating whether or not they will designate the mussels as threatened in this stretch of the river which could also trigger water use curtailments. Among the factors that could affect future actions is the threat of federal regulation. The San Saba is home to five species of mussels that the U.S. Fish and Wildlife Service is considering listing as endangered. If any one of those mussel species is found to be endangered, it could mean restrictions on water use from the San Saba.[169]

Devils River

The Texas Water Development Board (TWDB) completed an overview of the hydrogeology of Val Verde County and assed the feasibility of employing hydrologic triggers to manage the aquifer. This study stemmed from discussions in 2016 between lawmakers, agencies, local stakeholders and organizations concerned with groundwater management in the area.[170] Rep. Poncho Nevárez played a significant role in conception of the project. Rep. Nevárez requested the TWDB assemble and analyze available hydrogeologic information concerning Val Verde County, the Devils River and San Felipe Springs. He also requested that the study assess the feasibility of employing hydrologic triggers to manage the aquifer.[171]

TWDB compiled and evaluated available groundwater information on Val Verde County aquifers, including the Devils River watershed and the San Felipe Springs. The feasibility of using hydrologic triggers as a tool to manage aquifers in the county was also assessed. Texas

Commission on Environmental Quality and Texas Parks and Wildlife Department served as agency co-stakeholders.[172]

The main source of groundwater in Val Verde County is the Edwards-Trinity (Plateau) Aquifer. The Rio Grande, Amistad Reservoir, Pecos River, Devils River, and San Felipe Creek flow through the county and are regional areas of discharge for groundwater. The surface water and groundwater systems are often connected.[173]

Val Verde County does not have a groundwater conservation district, but is included in groundwater management planning as part of Groundwater Management Area 7 – with 33 counties and 21 groundwater conservation districts. Unmodified rule of capture applies in the absence of a groundwater conservation district. Groundwater district representatives voted to adopt new desired future conditions (DFC) for all of Val Verde County in 2018, specifying that total net drawdown should maintain an average annual flow of 73 to 75 million gallons per day (81,800 to 84,000 acre-feet per year) at San Felipe Springs. However, there is not current mechanism in place to monitor groundwater conditions or enforce this management goal for the Edwards-Trinity (Plateau) Aquifer.[174]

Upon completion of their study, TWDB found:

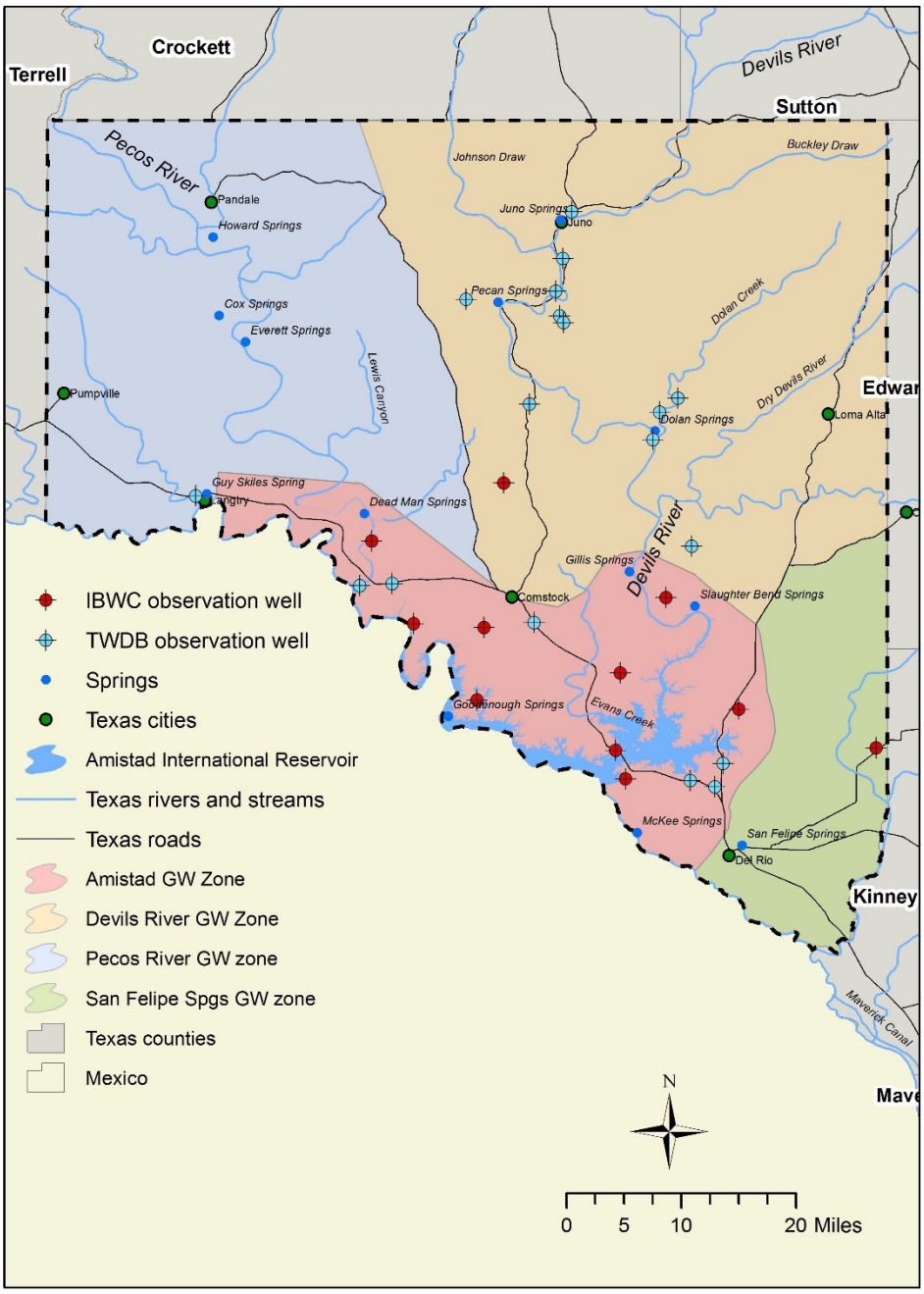
- Groundwater discharge from the Edwards-Trinity (Plateau) Aquifer sustains flow in the Devils River.
- The Amistad Reservoir influences groundwater elevations and springs (including San Felipe Springs) discharge both north and east of the lake. Reservoir water has progressively mixed with groundwater in the area east of the lake over time.
- Groundwater levels in areas away from Amistad Reservoir show no particular trend.
- Limited amount of work has been done to directly correlate aquifer levels to streamflows. Work is ongoing and results expected to improve understanding.
- The county does not currently have a shortage of groundwater. Groundwater pumping is estimated to be around 5,000 acre-feet per year, compared with a modeled available groundwater value of 50,000 acre-feet per year. This does not include the water supplied to Del Rio from San Felipe Springs.
- Baseflow in the upper Devils River, which is entirely from groundwater discharge, has remained essentially the same for at least the last 100 years.
- However, future persistent droughts and/or possible groundwater development (as modeled) could lower groundwater levels and reduce flow in Devils River and San Felipe Springs.[175]

TWDB found that index wells and hydrological triggers would be feasible strategies for groundwater management in Val Verde County. Hydrologic triggers could include aquifer levels, springflows, streamflows, or a combination. Management zones, focused on watersheds, would be a technically feasible and appropriate option for groundwater management as well. Both additional field data and improved groundwater flow modeling would assist the development of groundwater management strategies. TWDB recorder wells, combined with existing water well data from long-term monitoring, can provide a reasonable basis for developing hydrologic triggers for portions of the county. Additional technical and stakeholder input is needed to

develop management objectives before specific trigger values based on groundwater levels can be determined.[176]

Based on TWDB's review of available data, Val Verde County has sufficient hydrogeologic variability to support the establishment of aquifer management zones in the event a groundwater conservation district is established. Four separate groundwater management zones, based on approximate watershed boundaries, could be defined in Val Verde County. Groundwater contributing to flow in the Pecos River, Devils River, and Sycamore/San Felipe Creek drainages occupies generally separate flow systems. Threatened and endangered wildlife populations in each of these drainages may need to be managed separately, while the Sycamore/San Felipe Creek system also supports the Del Rio water supply. The area around Amistad Reservoir probably also requires special management considerations. Groundwater near the reservoir is strongly influenced by reservoir levels and pumping in these areas could draw water from the reservoir, which could be incompatible with management of the binational Rio Grande and the needs of Texas users who rely on water from Amistad Reservoir.[177]

More detailed hydrogeological assessment will be needed to define the boundaries of the groundwater drainage basins and of the area of potential surface water impact around Amistad Reservoir. Additional water level monitoring through the establishment of a representative monitor well network will be integral to defining management zones and supporting other potential groundwater management objectives. Additionally, groundwater geochemistry, and micro-particulate analysis may all play a role in refining the boundaries of possible management zones.[178]



Past efforts to create a groundwater conservation district have left private landowners with many concerns. Landowners continue to fear they will not be fairly represented or treated equitably by a district.[179] Additional concerns from stakeholders include outside factors coming in and degrading the area.[180] One of the biggest concerns is commercial use of groundwater and how it will affect the Devils River and it's surrounding communities.[181] Another consensus from stakeholders was the archaic nature of the rule of capture. Rule of capture is believed to open the door for exploitation of the resource and it doesn’t help with conservation.

There is agreement between stakeholders that more science and data is needed before coming to a conclusion on an appropriate groundwater management for Val Verde County.[182] Additionally, the findings of TWDB's study of the area has created consensus that different

management areas of the county is needed because of it's diversity. Val Verde County, and the Devils River Basin in particular, demonstrate unique physical characteristics that necessitate management of the resource by design rather than a template. Groundwater in Val Verde County is as diverse as the surface water basins, species, communities and economies it supports. Managing a resource such as this requires in-depth understanding of its intricacies and availability.[183]

Managing groundwater in the Edwards-Trinity (Plateau) Aquifer will involve consideration of historical groundwater usage, consideration of private property interests, complex groundwater-surface water interactions, and ecological and species habitat concerns.[184] It is incumbent of stakeholders of Val Verde County to craft a management strategy that not only protects the State's surface waters and their contribution to the Rio Grande, but also the rights of landowners and the needs of local communities.[185]

RECOMMENDATIONS

Amend Chapter 36 of the Texas Water Code to enact reforms to the groundwater permitting process that will protect the private property rights of groundwater rights owners, including but not limited to those outlined in HB 31 (85R).

Amend Chapter 36 of the Texas Water Code to provide for the alignment of groundwater export and production permit terms.

Amend Chapter 36 of the Texas Water Code to establish a regulatory framework for brackish groundwater production in brackish groundwater production zones as designated by the Texas Water Development Board, as contemplated in HB 2377 (85R).

Reinstate funding for the completion of the studies and designations of brackish groundwater production zones by the Texas Water Development Board.

Provide funding to the Texas Water Development Board to study the influence of groundwater production on surface water resources in order to develop solutions to address their interaction.

WATER MARKETS

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on its Interim Charge #4 related to water markets on October 16, 2018 in Waco, Texas. The following individuals testified on the charge:

Ken Kramer, Sierra Club-Lone Star Chapter
Chloe Lieberknecht, The Nature Conservancy
Charles Porter, Self
Rodney Smith, Stratecon Inc.
Jo Karr Tedder, Central Texas Water Coalition
Kim Wilson, Texas Commission on Environmental Quality

The following section of this report related to water markets is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

SB 1, enacted by the Texas Legislature in 1997, envisioned that Texas would develop a water supply that could meet increasing demand, predominantly through voluntary redistribution of existing water supply. With some notable exceptions, such voluntary transfers within water markets have not widely occurred. Texas could benefit from the expansion of water markets that allow market participants to value water based on voluntary exchange, accurately assess available information about state natural resources to more rigorously estimate current and future demand, and to determine optimal strategies to supply the water we need.[186]

The public policy benefits of water markets are numerous. One of those benefits would be the opportunity to move surplus, or newly developed water where available to where it is needed. Market based transactions can also assist in securing water for the environment. As articulated by the Western Governors' Association and Western States Water Council, water transfers are voluntary and flexible by nature. Voluntary transfers decentralize decision-making, provide economic incentives for water conservation, allocate water to new uses, and drive investment. In a functioning water market, potential buyers and sellers of water rights could take into account such considerations related to a transaction as size, cost, timing, distance, duration, means of conveyance, water quality, groundwater recharge, local government, and the environment.[187]

While drought conditions will ultimately drive the advancement of water markets, the committee was asked to evaluate the potential for water markets in Texas, including specific policy recommendations that could enable such expansion.

BACKGROUND

Water markets are considered to be voluntary mechanisms that stimulate the flexible transfer of water, more efficiently use water within a system, and if well designed, can also have environmental benefits.[188] Generally, water market strategies can range from water banking, short-term water leases, fallowing agreements, non-diversion agreements, acquisition of rights (either permanent or leased), and other demand reduction and water management strategies. The key is that an agreement about water use between a willing seller and a willing buyer.[189]

Limited trading has occurred in Texas relative to other western states, but two of the largest water deals in the United States have occurred in Texas, including the $110 million water sale between Mesa Water and the Canadian River Water Authority. In 2014, the Texas water market accounted for approximately14 percent of total value traded annually across the western United States. Average annual trading activity from 2010 - 2014 was $58 million compared with a combined $355 million in all other western states. Of the total value of water traded from 2010-2014, 69 percent occurred in the Edwards Aquifer market, 21 percent in the Lower Rio Grande, and 10 percent in other areas.[190][191] As of 2017, the Texas water accounted for approximately 6 percent of the total value traded annually across the western United States, at a value of $45 million, compared with $725 million in the western United States. This reduction in the value traded in Texas since 2014 can be attributed to the San Antonio Water System (SAWS) exit from

the market for permanent acquisitions and its reduction of annual lease volume of Edwards Aquifer groundwater. [192]

Like most states, the Texas water market is not a single market but rather a collection of highly regionalized markets. Each takes on its own characteristics based on local supply and demand conditions, the types of water entitlements traded, and the regulatory environment. As a result, trading activity and the type of trades and pricing can vary significantly across market regions. The two most active markets include the Edwards Aquifer Authority region (groundwater) and the Lower Rio Grande River (surface water). Combined, these markets represent about 90 percent of the total value traded over the last 5 years.[193]

Overview of Texas Water Markets:[194]

Active

- Lower Rio Grande - Active market for sales and leases of surface water rights.
- Edwards Aquifer - Active market for sales and leases of groundwater entitlements.

Developing

- Colorado River: Some recent small surface water trades for municipal use with one large transaction in the last 10 years.
- Brazos River: Trading has been limited for surface water but growing demand within region.
- Austin Region: High growth area with growing water demands. Limited surface water trading with some groundwater transactions.

Early Stage

- Upper Rio Grande: Sporadic surface transactions in urbanizing area.
- Panhandle Region: Previous large trade with unclear future needs.
- Dallas Region: Highly urbanizing area with long term water needs and large water infrastructure projects.
- Houston Subsidence: Shifting supply source creating potential for market growth.
- Philanthropic funded efforts statewide to identify and secure market-based water right transactions for environmental benefits.

Market Participants[195]

The makeup of market participants in Texas is similar to that in most other western states water markets. On the supply side, the majority of water sold or leased into the market was supplied by the agricultural sector followed in a distant second by investor owned supplies. Investor participation in the market is a relatively new development. In the mid-2000s several institutional back investment funds were actively assembling portfolios of water supplies in several western states. Most of these funds are now exiting their investments.

On the buyer side, the largest acquirer of water is the municipal sector. However, the agricultural sector is a close second. This is somewhat unique to Texas. In most other states, the municipal sector typically represents the majority of the volume traded in the market, though that is shifting in some states with the increase in agricultural commodity prices over the last few years. Nearly absent from the Texas market are environmental transactions, which have become an important though relatively small part of the overall western US water market.

From 2013-2017, 92 percent of the total volume of water in market transactions in Texas was supplied to the agricultural sector and 8 percent by urban areas. In that same time period, 76 percent of the water was acquired by the urban areas in those transactions, 18 percent by the agricultural sector, and 6 percent by environmental interests.

Western States Market Comparison[196]

Texas has an established but limited water market with most of the trading activity concentrated in two primary market regions. In comparison to other western states, the Texas water market is a sizeable market both in terms of the volume and value trade. California is the largest water market in the US with average annual trades in excess of $250 million. Water in California is predominately traded through annual leases or “spot market” transactions. During times of drought, the spot market has become an important supply for municipal water providers and high valued agricultural growers that need supplemental supplies.

By contrast, the Arizona and Colorado markets are closer in size to the Texas market but are considered to be more developed. In these states, the water market has become a primary way of meeting new demands or securing temporary supplies during times of drought. The water markets in these states tend to cover a larger geographic region. Most of the established markets are located in populated and urbanizing areas. In addition, the markets in other states tend to have more diversity in the types of water entitlements traded and the form in which transactions occur. The form or type of transactions is an area of market development where we are seeing significant innovation. There is a lot of interest in transaction structures and agreements that provide for water sharing. These include various types of interruptible or dry year option leases as well as rotational fallowing leases. The development of these innovative approaches to water management are the result of the emergence of an active and functioning water market.

Surface Water Markets

Surface water is regulated by the state according to the Prior Appropriation, or "first in time, first in right" doctrine, (except for the middle and lower Rio Grande), long utilized in all western states. Since most of Texas’ surface water is already appropriated through water rights held in perpetuity, market-driven water transfers could offer an effective tool for optimal allocation of scarce water resources. Many of the water rights are currently underutilized. Thus, the opportunity exists for voluntary market transfers that could provide both temporary and permanent supplies of water to meet Texas’ needs.[197]

The Rio Grande Water Market and TCEQ Watermaster Program[198]

The Rio Grande below Amistad Reservoir is a unique system in Texas. Under provisions of the Texas Water Code applicable to the middle and lower Rio Grande, temporary water transfers have created a reasonably effective water market. All water rights are allocated based on U.S. storage in Falcon and Amistad Reservoirs and have a priority based on the type of use rather than a priority date unlike the prior appropriation system governing the rest of Texas surface water. Below Amistad Reservoir, the highest priority of use is domestic, municipal, and industrial uses (DMI); the second priority is the system or operating reserve which bears all conveyance and evaporative losses of the system; and the last priority is agriculture. The basin is a "closed system." Water cannot be "imported" into the system from other sources due in large part to an existing treaty between the United States and Mexico. The watermaster based monthly allocation process similarly and appropriately hinders the importation of water into the system treating all water as available for all users rather than a single individual purchaser.

Through the TCEQ's watermaster program, known offers to sell water rights, as required by certain water code provisions, are posted on the watermaster's webpage. Known availability of water to sell for a specific period, known as a "wet water transaction," is similarly available by calling the watermaster's office. While the watermaster is not part of the transaction, this repository of available water for sale at a temporal price range incentivizes the water market. Water supply data is well documented and communicated to all users. Agricultural water can readily be severed from its intended place of use (land) and sold to a willing buyer within the system. All conversions from lower end uses (agricultural) which are not guaranteed by the system must be effectuated via a prescribed conversion reduction in allocated amount of either 40 percent or 50 percent. These conversion reductions also address system over-allocation and ensure system balance. System balance also assists in ecosystem health via ability to maintain water in storage and at least minimal flow in all segments at and below Amistad Reservoir. Except for water transfers from the upper Rio Grande to the middle and lower system, all other transactions and change of ownership transfers do not require public notice.

System efficiency and water marketability are also aided by the watermaster's authority to utilize flows in the river to meet demands for water without necessarily requiring a corresponding release from the reservoir. This example of active water management, supported by timely data, enlarges the potential use of water held in storage that can be made available for future use or to support a market transaction.

This water market works efficiently because the owner of a water right in the middle and lower Rio Grande can, for a defined term, sell a portion or all of his water right to another person who will put it to beneficial use in the main stem of the Rio Grande. These transactions do not require public notice and can move water up and downstream without any reliability impact to other users. Transactions that change the type of use from a lower end use (agricultural) to a higher end use result in a system benefit due to the conversion of the type of water use permitted. This type of transfer of use from agriculture to domestic or municipal use results in a guaranteed right and increases its value. These types of market transactions establish well-recognized "valuations" of water to be sold, which assist willing sellers and buyers in arriving at an agreeable transaction end point.

As seen from the Rio Grande and also observed from water markets throughout the west, reservoirs and reservoir systems typically provide the most effective mechanism to market surface water. This example could guide our view of how Aquifer Storage and Recovery projects could also incentivize market transactions.

Surface Water Market Strategies to Benefit the Environment

Increased off-channel diversion and consumption, changes of use between basins, and reduced return flows can all have an effect on our streams, lakes, bays, and estuaries.[199] Not all environmental stakeholders embrace the concept of water markets, or individual policies designed to encourage their expansion.

However, the largest water market in the world is the $13.9 billion Murray-Darling Basin water market located in Australia. The Murray-Darling Basin Balanced Water Fund aims to improve water reliability for farmers while returning water back to parched wetlands, serving as a model for other water scarce regions.[200]

Similarly, as has been noted in other western states, increased awareness and proper valuation of water promotes conservation and movement of water to higher end uses. River segments and ecosystems benefit from such activities.

Several years ago, the Texas Nature Conservancy began scoping how they could apply lessons learned from the Australia water market to Texas's regulatory and ecological conditions, including how they can use innovative financing tools. They have two active projects in Texas, and are focused on surface water at this time.[201]

Central Texas

The Nature Conservancy has focused this work on the Upper Colorado River Basin, which is an area of the state that can go dry at peak demand times. It is also a place where relatively small amounts of water at critical times can make a significant environmental impact, and where they see opportunities to increase agricultural efficiencies to free up additional water.[202]

The goal of this project is to reduce on-farm water use, improve economic outcomes for farmers, and improve water allocations to the environment, all at the same time. To do this, they are working with partners to use emerging new technologies and innovations to demonstrate on-farm improvements that will improve soil management and water losses and increase agricultural efficiencies, while putting water back in the river. With this on-going project, they are looking at innovative financing to assume some of the risk of on-farm conversions to demonstrate benefits and dedicate water to the environment.[203]

Coastal Texas

For the last three years, The Nature Conservancy has partnered with The Meadows Center for Water and the Environment, National Wildlife Federation, Ducks Unlimited, and the Harte Research Institute on the Environmental Flows Initiative. This project has focused on using a

water market strategy to provide freshwater inflows to support our bays and estuaries. The health of our bay and estuary systems depend on freshwater inflows for habitat and productive fisheries, and the economies that depend on them.[204]

The Conservancy is working on possibilities in the Galveston, San Antonio, and Matagorda bay systems. It aims to use funding from Deepwater Horizon Oil-spill fines to restore the health of affected areas, and are also exploring other funding mechanisms. Generally, this project is focused on leased or purchased water rights that could be managed and dedicated to the environment.[205]

TCEQ vs. Texas Farm Bureau: Implications for Curtailments During Water Shortages

From 2009 to 2015, the state experienced dry conditions. During that time TCEQ promulgated rules that set forth about how it would suspend and curtail water rights during those dry times. These rules allowed TCEQ to exempt public water systems and power generation facilities from suspensions and curtailments. In 2012, TCEQ received its first priority call from DOW Chemical, a senior water rights holder in the Brazos basin. TCEQ suspended water rights, but exempted public water systems and power generation facilities pursuant to its rules. The Texas Farm Bureau sued on behalf of and this action went to court. In 2013 a District Court declared the TCEQ Drought Curtailment Rules invalid for the following reasons:

1. The rules exceed TCEQ's statutory authority because they allow exemption of preferred uses from a curtailment or suspension order, and such exemptions are not in accordance with the priority of water rights established by Texas Water Code Section 11.027; and

2. Exemption of junior water rights from a priority call and curtailment or suspension order is not authorized by TCEQ's police power or any general authority to protect the public health, safety or welfare.[206]

The judgement was affirmed by the 13th Court of Appeals, and TCEQ's petition for review was denied by the Texas Supreme Court. As a result, TCEQ's ability to respond to priority calls could be compromised as follows:

- TCEQ will not be able to manage its response to a senior call in a manner that takes into account concerns about public health, safety, or welfare; therefore, TCEQ will not be able to exempt preferred uses, such as municipal uses or power generation, if they have a junior priority date; and

- Curtailed water right holders that lack sufficient alternative sources of water will either have to purchase water from a supplier, apply for an emergency permit under Texas Water Code Section 11.139 if unappropriated water is available, or apply for an emergency transfer of a water right under Texas Water Code Section 11.139. An emergency transfer of a water right requires the payment of fair market value of the water transferred and payment of damages caused by the transfer.[207]

Following the court's decision, on July 31, 2018, and in light of dry conditions at the time, TCEQ sent a notice to water rights holders and encouraged public water systems, particularly those who may have relied on its previous rules, to review their Drought Contingency Plans.

A critical component of water purchase and redistribution based on a 11.139 petition is the valuation of the water and due compensation. This falls within the responsibility of the Texas Commission on Environmental Quality. More effective water markets would greatly assist in arriving at the proper valuation of water – in sub-basins in particular – and could make state intervention to value water less necessary.

More active surface water markets within the Brazos River basin and others could help to address potential transfers of rights to meet shortages during future droughts.

Groundwater Markets[208]

Any discussions about groundwater markets in Texas must be divided into three categories: 1) water governed by the Edwards Aquifer Authority; 2) water regulated by other GCDs; and 3) water under land located outside of a district. Due to varying regulatory structures, the potential for markets in each category varies.

A primary issue that arises when discussing sale and transport of groundwater, as with surface water, is the physical impediments associated with moving water from a seller to a buyer. Texas is geographically large and annual precipitation rates range from less than fourteen inches of rainfall per year to above fifty-four inches ranging from west to east. This means that areas of plenty and areas of need can be vastly far apart. Population corridors are essentially located near two interstate highways that quadrisect the state.

A truly statewide market is only a possibility if water can be moved great distances. Currently, no infrastructure exists for such a project. Even an evaluation of regional water sales requires extensive construction budgets. For example, the city of San Antonio completed a contract to transport 50,000 acre-feet of groundwater annually from a nearby aquifer. At a total cost of $3.4 billion, much of the projected expense is dedicated to the acquisition of water rights, permits and right-of-way easements. The cost of constructing the 142-mile pipeline is estimated to be $885 million.

Additionally, there is not a centralized marketplace where buyers and sellers can come together and make these transactions. Currently, the purchasing or leasing of water rights is a private contract transaction with no recorded data on price. This scenario leads to missed transaction opportunities when buyers are not matched with sellers. Also, because these transfers are private, there is not consistent pricing to reflect valuation.

Despite these impediments, several large groundwater transactions have taken place around the state. Most commonly, the buyer is a city looking to diversify water sources. One example can be found in the Texas panhandle where T. Boone Pickens purchased the groundwater right associated with 211,000 acres of land for $130 million. The water rights have

been estimated to yield up to 12,276 acre-feet of water annually. He then sold those rights to the Canadian River Municipal Water Authority to be used by Amarillo and Lubbock citizens, who overly the same aquifer.[209] Pickens hoped to find a buyer further away such as San Antonio or Dallas, but the price was too high. Most recently, there is the San Antonio project discussed above.

1) Edwards Water Market

The Edwards water market has been the most successful Texas groundwater market to date for several reasons. First and foremost, the aquifer is managed closely by a regulatory agency and there is a limited amount of water permits available. Although initial permits were essentially free, over time the value has increased because no new permits will be issued while demand for the water continues to increase. Unlike in other GCDs, where it is often easier to purchase land and apply for a new permit, all the Edwards permits have already been issued. Second, there are fewer impediments to transfers in the Edwards meaning fewer opportunities for a transfer application to be denied – particularly for a change in withdrawal location. In practice, permits will only be denied if the water is not present due to a previous transfer of the same water or other title inconsistencies.

Generally, a transfer permit is easier within the Edwards than in other regulated aquifers because of the aquifer's characteristics. Water moves very quickly through the aquifer and recharges more like a lake than a subsurface aquifer. Because of its confined nature, the aquifer has a very consistent drawdown across its expanse, meaning that one neighbor cannot pump another dry by drawing down the aquifer regionally. Instead the aquifer can be managed as a whole. This provides more opportunities to use water throughout the aquifer.

When the EAA first formed, water could be transferred on paper between users located on opposite sides of the aquifer shifting the point of withdrawal without an issue. A few years ago, a limitation was added because of concerns about large water transfers from west to the east that might negatively impact spring flow. This is referred to as the Cibolo Creek Prohibition 63. This rule puts additional obligations on water transfers from west of Cibolo Creek to a user on the east side to show that the spring flow will not be impacted. Interestingly, this rule has created a market within the market. Water east of the creek is twice the price (up to $10,000 an acre-foot) because the purchaser takes free of the limitation. There is no issue with water being moved from east to the west.

One major limitation of the Edwards market is the prohibition on exportation of water for use outside the aquifer. That being said, because of San Antonio and other nearby municipalities, the population within the EAA jurisdiction is considerable. An additional weakness in this market is the various types of exempt wells, which are not metered. These include domestic or irrigation wells, federal facilities and limited production wells. While not requiring a permit application, the owners of limited production wells are required to meter and report. Domestic and livestock wells, which can pump up to 25,000 gallons a day, do need to be registered and cannot have a pump capable of exceeding the daily amount. Otherwise, they are not regulated. Despite these exemptions, water permit values in the Edwards have increased consistently since the formation of the EAA. Original permits were issued for free or requiring only a small filing agree. Now

they can sell for transfer at $5,000 to 10,000 per acre-foot depending on location and type of permit.

An additional limit on transfer is applied to irrigation water. The majority of Edwards permits were issued based on historic use. Many of these were for irrigation purposes. While most permit types can be freely transferred, only a portion of these permits can. As mentioned above, fifty percent of an irrigation permit is considered a base permit that is limited for use on the land on which it was historically used. The other fifty percent is considered unrestricted and can be transferred throughout the Edwards Aquifer for any desired use. This limits makes half of all irrigation permits unavailable for market transfers outside of being included in a sale of the surface estate.

Unlike in other GCDs there is more of a marketplace in the Edwards. While the EAA does not manage or track sales, they do provide a location on their website for willing sellers to list their permits. Transactions from this website are usually short-term leases for small amounts of water. Purchasers using the website generally wish to acquire that water for use in a drought year, particularly when their permits are reduced by drought management obligations prescribed in the EAA Act. Large water purchases, to the extent that they occur, are accomplished using a similar mechanism as other GCDs. A buyer simply contacts permit holders based on the quantity needed and proposes a sale. All transactions are completed through private conveyance using a warranty deed. Although the EAA does not track pricing, they do ask for voluntary reporting, with mixed success. EAA officials estimate the current price is $5,000 per acre-foot.

2) GCD Water Market

Although not as ideal as the Edwards, markets within other GCDs have some promise. As the regional planning process continues and GCDs are required to permit groundwater to meet their DFCs there is a possibility of an Edwards-like market forming. Ideally, the Modeled Available Groundwater (MAG) information provided by TWDB would create enough information to create a cap on pumping and allow the market to work as it has in the Edwards. Unfortunately, many GCDs are permitting in a way that is not sustainable. For now this limits market activity and keeps prices low.

Perhaps the biggest threat to the development of markets in these areas is the lack of consistent regulation. In most Texas aquifers, other than the Edwards, multiple GCDs manage the same aquifer. Although the regional planning process aims to require districts to coordinate their management by identifying the aquifer DFC, the reality is often that each district permits differently. While one GCD attempts to limit the allocation of permits, a neighboring GCD may have a much less stringent regulation system.

Permitting rules are promulgated by a publically elected board of directors, who often have no scientific expertise and are vulnerable to political influence. Another weakness of buying water from within a GCD is the risk of someone accessing the same aquifer water from a neighboring area free from any regulation. In that case, even the best run GCD can be undermined by unfettered pumping in nearby areas. Even within the districts or groups of districts that are more stringent, most do not require metering or reporting of water use by permit

holders, which limits their ability to really manage the aquifer. Finally, the same issue presented above concerning exempt wells is present in all GCDs. This cumulative lack of data suppresses the value of existing permits because there is no guarantee there will be yield over the life of the permit.

Current permitting rules can create obstacles to market efficacy. Permits are often limited based on user, location and purpose. Because a permit can also be limited based on well spacing or surface ownership, a project developer will have to acquire water, by lease or purchase, from several landowners to have enough water for the full project. Another issue is obtaining a permit for the lifetime of the water project. Many permits are for terms as short as one year. This impedes the ability to sell water to a buyer requiring a firm yield for many decades.

As mentioned above, the lack of an organized or central marketplace is another substantial impediment to market transfers. Currently, within GCDs if someone wishes to purchase an existing permit, the only way to locate a potential seller is to request a list of permit holders from the GCD and contact each directly with the request. If a seller is located and a deal is made, the GCD does not track the price of the transfer. Therefore, there is no known value for permits in any given location.

The *Guitar* ruling also impacts any potential water market within a GCD. By stripping a historic permit of its uniqueness when transferred, sales, except for use on the original tract, are dissuaded. This rule along with other transfer limitations that may exist in a GCD create a situation where a buyer might be better off just purchasing tracts within the district and applying for new permits. This type of arrangement recently occurred in El Paso, Texas when the city purchased ranch property 100 miles away to gain groundwater rights. The city is considering similar purchases from even further away.

Despite existing legal challenges to their implementation, groundwater markets have promise for sustainable management of groundwater in Texas. GCDs with appropriate legal authority and a desire to manage declining groundwater levels may use well-structured water markets as the primary method to reallocate groundwater entitlements from one party to another. In addition, a GCD may itself create a fund to purchase groundwater entitlements, in order to reduce the quantity of outstanding permits and thereby discontinue unsustainable extractions on a voluntary basis, so that the cost of doing so is fairly borne by all groundwater users and stakeholders rather than certain individuals.

3) "Rule of Capture" Market

Unlike the previous two scenarios, in areas without groundwater conservation districts, there is no regulation to manage pumping. In these areas, buying and selling usually takes two forms. A surface estate holder can separate the water rights from the surface estate and sell them to a buyer who intends to move and sell the water to third party. Second, a water marketer can actually purchase a small surface estate, which still includes the groundwater, and install her own pump to use the water locally or for export.

While a market is possible under these conditions, it has its weaknesses. First, the incentive in right of capture areas is to pump first and pump more in order to beat the competition and maximize the return on investment. Pricing water can also be difficult in an unregulated market because there is no known cap or quantity of supply. When water is plentiful, it follows that the price will be low. The fact that there are no protections of the source may be a disincentive for a purchaser because there is no guarantee the water will be present over the long term.

New Limits on Historic Use Permits

In an opinion issued this year on a question over the ability to change the use of a historic use permit as discussed in *Guitar Holding Co. v. Hudspeth County Underground Water Conservation District No. 1*, the Office of the Attorney General suggested there were legal limits on the ability for a permittee to change the use of an historic or existing permit to another use, including export. If a landowner seeks to sell groundwater that was permitted for agriculture or use other than it is being purchased for, that may be considered a new use and the landowner may be required to apply for a new permit, depending on the rules of the district. This may hinder the ability for larger groundwater permit holders to sell their water out of this district.[210]

DISCUSSION AND CHALLENGES

Water Planning

The focus of the water planning process in Texas is from the bottom up, based on the 16 regional water plans. The Texas Water Development Board has limited regulatory authority to alter the regional plans. Cooperation between the 16 water planning regions should be encouraged to coordinate water availability for communities in the growing areas in and outside of these regions. Innovators have used entrepreneurial solutions to build large scale conveyance projects that have not been identified in the State Water Plan. The planning process should be more engaged with the water needs of Texas and to do so, it must be a plan that truly envisions solutions to statewide needs, across arbitrary regional lines.

Need for Conveyance and Connectivity

Similarly, an integrated network of pipelines, pumping stations, reservoirs, and other works for the conveyance of water between willing sellers and willing buyers will be needed as markets develop. Just as the grid in the electricity market provides efficient delivery to its customers, a similar network for water will allow for conveyance and connectivity of water from water right holders with excess supplies, or from areas of relative abundance, to areas of relative shortage.

The development of a water grid, including a study of existing infrastructure from third parties with unused capacity that could be used to convey water, should be developed. This high level document will catalyze project development by utilities and private sector interests. As in any water market, water right holders will be compensated for the water leaving the area of origin. Absent such efforts, water conveyance costs due to a non-existent conveyance

infrastructure will disincentivize water movement and transactions as conveyance at some point can exceed the purchase price of water.

Surface Water Regulations

For water transactions, time is of the essence. Uncontested water transaction are taking up to 300 days to process and contested cases are taking 900 days.[211] This is too long for a market to exist.[212] About three years ago, TCEQ had a backlog of 354 permits. Over the last biennium, TCEQ has conducted a critical review of water rights permitting and change-of-ownership processes that resulted a reduction in its backlog.[213] TCEQ has the backlog down to less than 180 days now. On average, the Commission receiving about 125 water rights per year.[214] The Legislature should continue to monitor this progress and encourage policies that result in a timely process for surface water permits.

TCEQ should also consider how it will enforce senior calls by water rights holders under the new ruling made in the *TCEQ vs. Farm Bureau* case. It is imperative that all parties work with TCEQ over the next two years to ensure water resources are available for all parties in the next drought.

Interbasin transfers of surface water have long been envisioned as a key water supply strategy. The rationale is straightforward. When one region of the state faces a water shortage, the water-short region acquires water from a region with excess water resources. Thus far, the prospect of interbasin transfers under current law has sparked major controversy within the basins of origin. Some residents in the basin of origin worry that the interbasin transfer may deprive them of needed water and economic opportunity in the future. Others in both basins worry about potential environmental impacts of the transfer regarding stream flows, water quality, and potential influx of non-native aquatic organisms. However, when interbasin transfers are allowed to fully function within a market based on voluntary exchange, the rights holders in the area of origin can arrive at an agreement of mutual value with the potential buyers in the receiving basin. Owners in the area of origin need not agree to a price until they feel adequately compensated for their water. A socioeconomic analysis commissioned by the TWDB found that a selected group of interbasin transfers produced substantial economic benefits for the basin of origin that ranged from $68 billion to $1.3 trillion.[215]

Nonexempt surface water interbasin transfers carry a junior priority date to all existing water rights within the basin of origin. The Texas Water Code provides that “any proposed transfer of all or a portion of a water right under this section is junior in priority to water rights granted before the time application for transfer is accepted for filing.” In other words, the provision terminates the seniority of the water right in the basin of origin when it is sold to a buyer in another basin. The seniority of a water right largely determines the economic value of the right. Without even a relatively senior priority date, the buyer of the water right in the receiving basin has no certainty whether the water right can ever be exercised. The junior rights provision reduces or even eliminates the market value of almost any water right that might be purchased for use in another basin and thus reduces the possibility of interbasin transfers from taking place.[216]

Since the junior rights provision strips water rights of their seniority, and therefore part of their value, persisting gaps between supply and demand for water exist throughout the state and underscore the need for legislation to facilitate interbasin transfers while protecting basins of origin.[217] The issue of interbasin transfers will not diminish, nor will the voices of the opponents and supporters of such mechanisms. The legislative approach to interbasin transfers must consider and balance the needs of all citizens of this State, while ensuring that water is available for future generations of Texans.

Groundwater Regulations

Certain groundwater permitting reforms would encourage transactions in GCD water markets. When transporting groundwater out of the jurisdiction of a GCD, a permittee must often acquire two permits, one for the production of the groundwater, and one for export. The permit terms of the two permits may be different, meaning that the authorization to export groundwater may expire prior to production authorization. This creates unnecessary uncertainty for project developers investing hundreds of millions of dollars in major water projects. Extension of export permit terms to coincide with production permit terms will reduce this uncertainty without jeopardizing a district's ability to manage an aquifer.

RECOMMENDATIONS

Encourage regulatory schemes that facilitate groundwater and surface water transactions and don't impede the movement of water from areas of abundance to areas of scarcity, while protecting the area of origin, including interbasin transfers and syncing permit terms for groundwater export and production permits.

Develop a water grid that identifies water supplies that could be used to provide for rapidly growing areas and underserved rural areas, including methods for conveyance, in order to facilitate the development of water markets.

Require that the 16 Regional Water Planning Regions meet and produce a report to the Legislature on efforts to cooperate on water projects that benefit areas outside of their regions.

WATER AWARENESS AND EDUCATION

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #5 related to water awareness and education on October 16, 2018 in Waco, Texas. The following individuals testified on the charge:

Linda Christie, Tarrant Regional Water District
James Clifton, Harbinger A.I.
Michael Harman, Harman Friday, Inc.
Marise McDermott, Witte Museum
Dana Nichols, San Antonio Water System
Heather Shipley, University of Texas San Antonio and Witte Museum

The following section of this report related to water awareness and education is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

Texas is one of the fastest growing states in the country; however, our water supply isn't. According to the US Census Bureau, more than 1,000 people are moving to Texas each day. This rapidly expanding population is causing many of our existing water resources to become overburdened. The amount of water available for use remains the same, yet the 2017 State Water Plan shows that, under record drought conditions, the demand for water surpasses current supply.[218]

If trends continue, our water supply will significantly reduce over the next 50 years, and everything we love about the state will start to disappear: the economy, recreation, our way of life and much more. It is a serious issue, but one that most people don't understand because when they turn on their faucet, water still comes out.[219]

The 2017 State Water Plan projects that by 2070, 30 percent of new water supplies will need to come from water conservation to help meet the needs of a population that will have grown by 70 percent. To meet that goal, Texans will need to reduce water consumption. A water awareness campaign could help accomplish that behavior change.[220] Additionally, recently there has been an interest in evaluating how cultural attitudes could change by encouraging more water-related curriculum in public schools.

Texans need to be able to connect the dots in order to understand that the water in their lakes and rivers or underneath their feet may be the water coming out of their faucets. They also need to understand there is a cost for storing, treating, and moving that water because many communities will need to create additional water supplies that will increase water rates.[221]

The committee was tasked with evaluating the potential value of a statewide water campaign and water education curriculum in order to change Texans' attitude and thus their behavior to use water more wisely.

BACKGROUND

According to a survey by Baselice and Associates, 72 percent of Texans do not know where their water comes from. Additionally, 87 percent feel it would be beneficial for Texas residents to increase their awareness of water conservation through a campaign similar to "Don't Mess with Texas," which is one of the longest running advertising campaigns in Texas history and greatly curtailed littering over the last three decades (www.dontmesswithtexas.org).[222]

For years various organizations have tried to develop educational programs that focus on water conservation; however, they pursue their missions with little or no coordination, and they rarely interact with enough people to gain substantial traction with a large set of the general public.[223]

In 2003, the Texas Legislature created the Water Conservation Implementation Task Force to evaluate and recommend conservation measures in Texas. As part of that effort, a coalition of

water industry organizations financed the initial market research for a water awareness campaign, which resulted in the Water IQ brand. The donations for that research were channeled through a Texas Water Development Board (TWDB) fund.[224]

In 2007, the Texas Legislature gave the TWDB statutory authority to conduct a statewide conservation public awareness program, contingent on legislative appropriations. To date, no funds have been appropriated. The extent of the TWDB's work on Water IQ has largely been confined to creating a website and licensing the logo to local utilities and municipalities. Over the years, several communities have used the Water IQ brand, but currently North Texas Municipal Water District is the primary Water IQ user. There has never been a coordinated statewide campaign with Water IQ.[225]

At the TWDB's Water for Texas 2017 Conference, Roy Spence, a founder of Austin's successful GSD&M advertising agency, challenged the water industry to educate Texans on the water issues facing the state. He also offered to help with that work.[226] The Meadows Center for Water and the Environment at Texas State University and the TWDB began meeting in July 2017 with Spence and part of the team that created the "Don't Mess with Texas" anti-litter campaign, to explore working together in a unique and unprecedented partnership to address this educational challenge on a statewide level through the development of a water education campaign.[227]

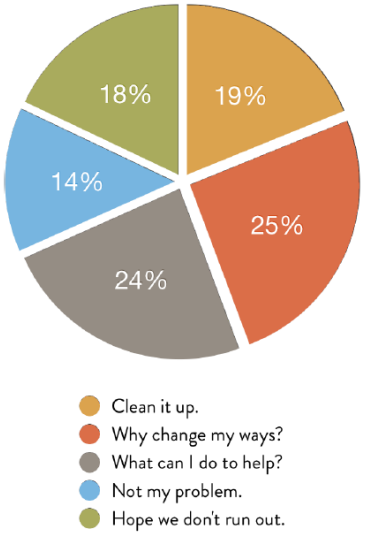
In January 2018, The Meadows Center received financial support from the Ewing Halsell Foundation to execute a contract with Harman Friday and Harbinger AI, two advertising firms in Austin that work closely with GSD&M, to establish the strategic framework for a statewide education campaign with guidance from Roy Spence. The Meadows Center and the TWDB also signed an Interagency Agreement to ensure adequate coordination and communication throughout the campaign's development.[228]

"Texas--Do or Dry" Campaign

The value of water in Texas changes throughout the state. This varies by region, industry, politics, and many other factors. A single communication platform will not resonate effectively with all parties, so the first phase of the campaign's development focused on Harbinger AI creating a proprietary artificial intelligence (AI) system that can deliver specific outcomes to specific audiences. The AI system examined data from Texans across the state to develop five audience groups based on beliefs and opinions towards water to increase effectiveness. This allowed the AI system to identify the most receptive and influential audiences to change behavior and opinion by shifting from a one-size-fits-all approach to a one-to-one approach.[229]

The greatest value of AI to the campaign is its ability to measure the effectiveness of campaign placements in real-time and offer feedback. The more information the AI system has, the more ways it can look at how individuals make decisions. The algorithm can learn over time as the campaign data is collected to become increasingly effective and drive better results for the campaign. Periodic evaluations of the campaign's objectives versus results gathered from the AI system can also be used to determine if corrections or new creative is needed.[230]

Based on the results of a 50-question survey, they found that Texans fall into one of five categories with a 90 percent accuracy. The breakdown and descriptions of the five groups are represented in the graphic below.[231]



19% **CLEAN IT UP**
Prideful Texans. This is the group who remembers "Don't Mess" from the beginning and sees dirty water an an extension of pollution.

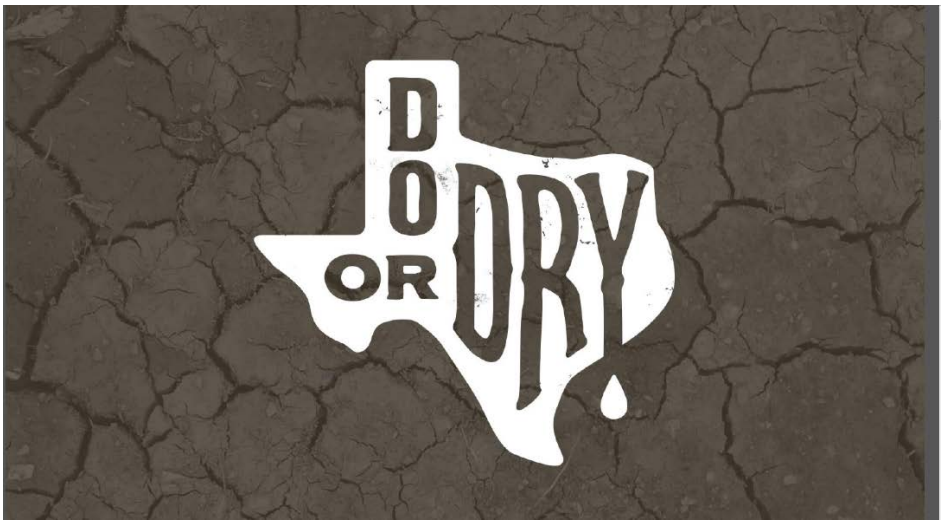
25% **WHY CHANGE MY WAYS?**
This group does things the same way they always have ... but they respond to practical advice when they understand the benefit.

24% **WHAT CAN I DO TO HELP?**
Most likely to take action and will appreciate tips and information. These are the champions of the cause, most educated on issues.

14% **NOT MY PROBLEM**
Resistant to change and don't appreciate the problem. This group would be the most difficult to convert.

18% **HOPE WE DON'T RUN OUT**
Understand supply issues (may have experienced drought). Eager for information from state and wants others to be aware.

The result of Harbinger's efforts was a creative brief that points Harman Friday in the direction to meet the creative and messaging objectives of the Texas Water campaign. Harman Friday continued working closely with Harbinger to develop a scalable creative platform that encourages Texas citizens to respect Texas' precious water resources and take action to conserve it. Harman Friday presented three different creative concepts to decision-makers and stakeholders in the Texas water community, and the team chose *Do or Dry* as the final creative concept. The final creative concept was then incorporated into a pitch deck that can be used to raise funds with a larger group of stakeholders and constituencies in 2019.[232] The following logos were proposed to be the basis for the campaign. The phrasing is intended to encapsulate the elements that were attributed with making the "Don't Mess with Texas" campaign successful by combining Texas pride plus action.



Funding

While no final estimate of the "Do or Dry" campaign has been proposed, both private and state funds have been discussed as options by stakeholders. The "Don't Mess with Texas" campaign, which served as an inspiration point for "Do or Dry", as received state funding since its launch in 1986. Texas Department of Transportation reports that $61,397,743 has been spent on the effort.[233]

TCEQ's Take Care of Texas Campaign

"Take Care of Texas" is a statewide campaign from the Texas Commission on Environmental Quality (TCEQ) that provides information on Texas' successes in environmental protection and encourages all Texans to help keep our air and water clean, conserve water and energy, reduce waste, and save money. The campaign serves as TCEQ's primary mechanism to meet legislative requirements for outreach and education efforts for waste reduction, recycling, K-12 and air quality. Originally created in the 1990s, the program continues to grow and expand its reach through an updated website, a strong social media presence, and contests for elementary, middle and high school students.[234]

The TCEQ's Take Care of Texas program has tapped rising country music star Cody Johnson to perform on public service announcements that began airing on Texas TV in May 2018.

The program includes a website which features an animated house where you can discover tips to do your part, six animated games for kids, a pledge feature for individuals and organizations (37,011), TV and radio PSAs featuring Cody Johnson, Kevin Fowler and Rick Trevino, environmental success stories, and a place to share your ideas to Take Care of Texas. The website had 128,793 visits FY18.[235]

Take Care of Texas also distributed 842,617 publications in FY18 and has 35,855 subscribers to their monthly electronic newsletter (News You Can Use). Social Media engagement for the program had 6,053 likes on Facebook, 1,683 Twitter followers, 1,265 Instagram followers and on YouTube 43,701 TCOT related video views.[236]

Additional program components:

- Booths/Conferences 50-60 per year. Most are multi day events.
- K-5th Grade Art Contest with 16 Regional winners, with one Grand Prize winner chosen. Samsung Austin Semiconductor awards 15 tablet computers and 1 laptop computer to winning contestants.
- 6th-12th Grade Video Contest with 3 middle school winners awarded GoPro Camera equipment, and 3 high school winners awarded $500 to $2,500 scholarship by Waste Management of Texas, Inc.
- Proud Partner Program – inviting businesses to do their part to Take Care of Texas.
- HEB partnership – Provide gift certificates and electronics for Take Care of Texas contests.[237]

Take Care of Texas[238]

Fiscal Years 2018 and 2019 as of 10/31/18

	Fiscal Year 2018 Budget	Fiscal Year 2018 Expenses and Encumbrances	Fiscal Year 2019 Budget	Total Budget Fiscal Years 2018 and 2019
General Revenue Fund	240.622	239.716	226.122	**466,744**
General Revenue Fund - Dedicated				
Clean Air Account No. 151	325.016	299.354	269.573	**594,589**
Water Resource Management Account No. 549	95.062	78.555	98.752	**193,814**
Waste Management Account No. 549	-	-	33.125	**33,125**
Hazadous and Solid Waste Remediation Fee Account No. 550	-	-	17.500	**17,500**
Texas Emission Reduction Plan Account No. 5071	25.118	26.484	60.874	**85,992**
Other Funds				
License Plate Trust Fund No. 0802	1.106	1.106	487	**1,593**
Total State Funds	**686,924**	**645,215**	**706,433**	**1,393,357**
Federal Funds	175.000	175.000	175.000	**350,000**
Total State and Federal Funds	**861,924**	**820,215**	**881,433**	**1,743,357**

Local Water Campaigns/Programs

Tarrant Regional Water District (TRWD)

The Tarrant Regional Water District (TRWD) is a wholesale water supplier that serves 2.1 million people in it's 11 counties service area.[239]

In 2009, TRWD joined with City of Dallas for a regional campaign where they shared creative costs and were able to have a more robust media buy. Over time, TRWD and Dallas learned that customers prefer a light hearted or tongue and cheek message, scare tactics don't work and a 'drought' message is not as powerful as year round consistent messaging.[240]

TRWD and Dallas' goal is to impress upon the value and preciousness of water with a little bit of humor. Examples of prior messaging include, "Water is beautiful", "Save Tarrant/Dallas Water", "Lawn Whisperer" and "Water is Awesome: Use It. Enjoy It. Just Don't Waste It." Scare tactics resulted in negative reactions, causing some resentment and refusal to adopt the recommended water efficiency measures. TRWD noted that a year round consistent messages has caused residents to adopt water saving measures. A "drought" message doesn't convey the need to save water during times of rain and sometimes damages credibility with customer cities.[241]

TRWD saw a 38 percent reduction in demands due to water conservation. This reduction allowed the TRWD to postpone segments of their $2.3 billion integrated pipeline. The need to connect to existing supplies can be postponed, because the demands aren't necessary for that connection in the near future. By not connecting to those supplies allows a period of delay for the next installment of debt and allows customers cities to pay off existing debt and thereby stabilize their water rates. Reducing debt is a huge benefit to customer cities because they pay the cost for construction [242]

San Antonio Water System (SAWS)

San Antonio has been doing conservation for 25 years. [243] Due to a federal lawsuit in the early 1990s that limited overall pumping from the Edward's Aquifer, the city's primary water source, San Antonio was forced to implement conservation measures, recognizing that they had a diminished access to supply. SAWS treats conservation as part of water supply and requires innovation, analysis, evaluation, and change.[244]

SAWS has seen a water demand decrease by 50 percent over the last 40 years. What that means is conservation is their largest supply of water. This decrease in demand has saved water and in turned saved waste water too. The savings kept SAWS from having to build more water supply and also millions of dollars for the treatment of waste water.[245]

Community-wide messaging for SAWS includes traditional messaging such as radio spots, bill inserts and press releases. Messaging related to programs relevant to all customers include landscape coupons, a rewards coupon, eNewsletter, and watering rules for year round, time of day and drought times. Since plumbing codes have taken care of indoor water conservation when it comes to municipal water use, the focus is all about outdoor water use now.[246]

One project that had unintended consequences for SAWS was their rain barrel program. Last January, SAWS gave out 6,000 rain barrels to over 3,500 individuals within one day at

subsidized rates ($27). When the program was later analyzed, it was found that the participants engaged less in additional conservation and used 4 percent more water. Additionally, 34 percent of those surveyed decreased their water use, but 91.2 percent believed they had actually decreased it. And 63 percent had actual increased their use, but only 8.8 percent believed they increased.[247]

SAWS decided to revamp the program to a WaterSaver Rewards Program that requires individuals to sign up for the program before they can get a rain barrel. Individuals receive conservation information through SAWS approved events and activities to earn points and get coupons. After three rewards individuals are sent a $30 rain barrel coupon. Additional coupons can be earned depending on the number of points/rewards an individual has.[248]

SAWS is moving move toward targeted messaging based on relevance to the individual. One program, the irrigation design rebate, is specifically offered to those who have irrigation systems. SAWS pays up to $5,000 cash if an individual reduces of removes irrigation system. The second is a partnership with Uplift and Plumbers to People. This is a suite of programs for low income and senior customers and helps homeowners to fix leaks.[249]

A third campaign involved targeted direct mail based on customer use. SAWS targeted homes that used 15,000 gallons of water average a month in the summer and winter. These homes were sent a mailer advising them to reduce water in winter and offered a free irrigation consultation. 7 percent of those targeted took advantage of the irrigation consultant. And of that 7 percent, 53 percent used less water in the following winter and 18 percent less in the summer. Overall, this mail campaign resulted in a 28 percent water reduction use for those homes targeted.[250]

Water Education

Texas requires the Texas Essential Knowledge and Skills (TEKS) to be covered in every public school**.** Water-related TEKS exist for Science and Social Studies classes at the elementary and middle school levels, and in the high school electives "Aquatic Science" and "Environmental Science".

- Elementary and middle school Science classes: students are required to learn about conservation of natural resources and materials, but water conservation is only specifically mentioned in Kindergarten and 2nd grade.

- Elementary Social Studies classes: students are required to learn how humans use and modify the physical environment. For example in 2nd grade, students must identify ways people can conserve and replenish natural resources.

The State Board of Education (SBOE) has legislative authority to adopt the TEKS for each subject of the required curriculum. SBOE members nominate educators, parents, business and industry representatives, and employers to serve on TEKS review committees.[251] TEKS on a given topic are reevaluated every five years on a rotating basis. SBOE gave final approval on April 21, 2017, to the streamlined science TEKS for K-8 science and four high school science courses. The streamlined TEKS will be effective on August 27, 2018 and implemented in

classrooms beginning with the 2018-2019 school year.[252] The Texas Legislature has only mandated two topics be incorporated into public school curriculum: substance abuse and personal finance.[253] By and large, TEKS are developed through the aforementioned SBOE process.[254]

Often, textbooks do not include specific information on recycling and conserving water, so teachers are encouraged to supplement the textbooks with outside curriculum to meet the standards. It is not required that teachers do this. Non-profit organizations or governmental organizations often create this supplemental curriculum for teachers. Some water entities work as community partners offering field trips or demonstrations at school to highlight the importance of water. Examples of organizations that have developed water curriculum or educational resources include:

- Texas Water Development Board
- Texas Commission on Environmental Quality
- Texas Parks & Wildlife Department
- River Authorities
- Groundwater Conservation Districts
- Municipal and regional water suppliers
- Councils of Government
- Meadows Center for Water and the Environment
- Water Education for Teachers (WET)

One challenge lies in getting curriculum into the hands of teachers. Dallas Water Utilities started a school based education program in 2006 through a partnership with UNT. From 2006-2017, 5,500 presentations were given to 470 schools with over 145,000 students and 12,000 teachers participants. Students at the elementary level receive hands-on TEKS aligned lessons presented by certified teachers from UNT. Almost 50,000 middle school students have seen or interacted with exhibit modules, that serve has a museum on wheels at over 500 presentations in 70 middle schools. At the high school level 300 students participated in a summer water conservation research internship program. Dallas estimates that this education program has saved 22 billion gallons of water.[255]

SAWS has an award winning education program, Impact H2O, that has been going on the last 20 years. Impact H2O's mission is to affect change in the community by developing a water literate citizenry. Impact H2O has an education program for K-12 that is TEKS standardized, a leadership program for teachers, and community components like the Rain to Drain tour.[256]

DISCUSSION AND CHALLENGES

Crafting a Water Campaign That Works Statewide

Historically, local entities have developed messages and campaigns tailored to their local conditions and water challenges. However, use of such tools vary greatly across the state and generally only large entities have the resources available to take on such efforts on a meaningful

scale. Smaller entities that lack funds to launch campaigns that bring about conservation and/or greater understanding of our water resources may benefit from having access to a statewide campaign housed in a central location.

While on the one hand it makes sense to execute a statewide campaign based on the success of the "Don't Mess with Texas" campaign, water is more complex. There are different types of water and many different providers in an array of geographical areas. Just within the Dallas-Fort Worth region there are three major raw water suppliers that serve different communities and each develop their own supplies. One example of this complexity occurred in the DFW area when the North Texas Municipal Water District experienced a water supply crisis after the Army Corp of Engineers cut off their access to Lake Lavon. TRWD and Dallas did not have the same crisis impact their supplies. However, with one media market in the region conflicting messages were being sent to residents. The North Texas Municipal Water District were telling their customers to immediately implement extreme water conservation measures, while TRWD customers in the area were not affected and told to continue to use water efficiently. This was the source of the reluctance by TRWD and Dallas to use the current state wide campaign "Water IQ."[257] Because of the reservoir specific messaging required for "Water IQ", when North Texas Municipal Water Districts started using the "Water IQ" message, communities throughout the metroplex thought Lake Lavon was a sole source supply for the entire region.[258]

The "Do or Dry" campaign could help Texans understand the need for the prudent use of a limited resource so that they will be motivated to change their behaviors and attitudes to help move the state toward meeting its water supply needs, but also may cause confusion or not be taken seriously during times of flood or in water rich areas.

A message that values Texas water can work in small towns or large cities and can cause positive change in the efficient use of water which would benefit the entire state. There is value for a statewide umbrella message with local control and flexibility to work with available water resources and media markets. The campaign needs components that allows smaller providers to get creative messaging that they wouldn't be able to fund themselves as well as allow larger providers to tailor and have the message fit their media markets. The message should be carefully considered and stay away from shock value.[259] It should work in collaboration with the individual regional messaging taking place or be adapted as the sole campaign in areas with limited resources.

Opportunities to Collaborate with Existing Campaigns

While water conservation is one goal of Take Care of Texas, the campaign is not solely focused on water. One advantage of the campaign is its existing infrastructure and reliance on private dollars for funding. There may be opportunities to collaborate with the TWDB, the Meadows Foundation, local water supply entities, and other non-profits to collaborate on the water portion of the campaign, including creating targeted messaging, to achieve goals. The campaign could be scaled and expanded as successes are demonstrated. Goals of the campaign should be clearly defined as part of this process.

Funding Recommendation

While TWDB and/or TCEQ should serve as a central location to house the campaign information as a resource, funding for the campaign's development and execution is most appropriate from private sources at this time.

Advancing Water Education in Texas

There should be a much greater emphasis on water education in public education to initiate a cultural change on how water is perceived in Texas. As seen with the introduction of recycling education in the 1980s, creating behavior changes start with reaching students at a young age. Curriculum should focus on where water comes from, both locally and from a statewide perspective, and the water supply challenges facing Texas.

Many lesson plans that align with existing TEKS and the concepts mentioned above could be currently be used by teachers. Outreach to Education Service Centers, which serve in part as a clearinghouse for lesson plans, and to school districts could help get lesson plans into the hands of teachers to enhance lessons from aquatic science, to watershed mechanics to the fundamentals of groundwater and surface water.[260]

Water is and will continue to be our biggest obstacle when it comes to economic sustainability. We all have an individual responsibility to conserve as much water as possible in our homes, businesses and other areas. Working to educate citizens on the importance of sustaining our water resources through awareness campaigns and water curriculum is a worthwhile goal.

RECOMMENDATIONS

Water awareness campaigns have demonstrated their effectiveness in conserving water and increasing overall understanding of the importance of water resources and should be encouraged on local and broader scales. However, the goals of the "Do or Dry" campaign need to be more clearly defined. The message that is developed as part of a statewide campaign should also be one that large and small communities can incorporate into their existing strategies based on local conditions. A privately-funded pilot of the project could demonstrate its potential impacts, and if any public funding is warranted in the future.

Amplify curriculum in public schools like was done with waste recycling in the early 1990's. Water education should be part of a cultural transformation in regards to our state's future water strategy. State agencies and non-profit entities who have developed TEKS-aligned water education curriculum should conduct outreach efforts to school districts, education service centers, and other avenues that could get materials into the hands of teachers.

EXPEDITED CCN DECERTIFICATION

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #6 related to expedited CCN Decertification on September 27, 2018 in Brownsville, Texas. The following individuals testified on the charge:

Pat Allen, Green Valley Special Utility District
Tammy Benter, Public Utility Commission of Texas
Sherilyn Dahlberg, Sharyland Water Supply Corporation
Joe Freeland, City of Tyler
Morgan Johnson, Maxwell Water Supply Corporation
Terry Kelley, Texas Rural Water Association, Johnson County Special Utility District
Trey Lary, Allen Boone Humphries Robinson LLP
Scott Norman, Texas Association of Builders
Melissa Rich, Blackland Water Supply Corporation
Michael Taylor, Crystal Clear Special Utility District
Lara Zent, Texas Rural Water Association

The following section of this report related to expedited CCN decertification is produced in large part form the oral and written testimony of the individuals listed above.

INTRODUCTION

The urbanization of rural areas has brought challenges in regards to determining the best way to provide for the delivery of water and wastewater service that honors private property rights and encourages development, while also encouraging investment in water planning and infrastructure through regional water suppliers. In previous legislative sessions, after studying examples of landowners being held captive by a utility's CCN without being provided adequate water service, the Legislature passed SB 573 in 2011 to provide relief to landowners who wished to receive service from another utility, by creating an expedited decertification process through the Public Utility Commission of Texas (PUC) for release from a CCN. Recently, rural water suppliers have argued that the expedited decertification process established in 2011 have undermined their mission, disincentivized regional water planning, and have been interpreted by the PUC to mean that water suppliers cannot receive compensation for land decertified from their CCN, unfairly denying them compensation for efforts made to provide service before land was decertified from its CCN.

The committee was tasked with evaluating the results of the expedited decertification process created under SB 573 (2011) and the process for resolving disputes around this process.

BACKGROUND

A Certificate of Convenience and Necessity (CCN) grants a CCN holder the exclusive right to provide retail water and/or sewer utility service to an identified geographic area. The Texas Water Code requires a CCN holder to provide continuous and adequate service to the area within its CCN boundary. Municipalities and districts normally are not required to have a CCN; however some municipalities and districts do have a CCN. A district or municipality may not provide services within an area for which another utility holds a CCN unless the district or municipality has a CCN itself for that area.[261]

Historically, state law provided very little opportunity for landowners to be removed, or decertified, from CCNs. Thus, landowners were unable to be decertified from CCNs to which they never consented. Unfortunately, this led to widespread abuse and certain utilities demanded unconscionable payments from landowners in order to be removed from CCNs.[262]

Prior to 2005, the standards to apply for and receive a CCN were very low. Anyone could obtain a CCN by filing a very short application, a map of the proposed service area, and a $100 filing fee without any proof of the applicant's ability to serve the property. A landowner's property could be encumbered by a CCN without his or her knowledge or consent. Private landowners felt they were held captive by CCN holders, some of whom were unable and unwilling to provide adequate service to a landowner, yet were unwilling to release the property from the CCN.[263]

In 2005, Rep. Bill Callegari introduced House Bill 2876 to address these widespread abuses. The major elements of the reform included the following concepts:

- Strengthened standards for new and amended CCNs.
- Notice to landowners of tracts 25-acres or larger for new or amended CCNs.
- An expedited 180-day administrative procedure for landowners of 50-acre or larger tracts to be removed from a CCN upon a showing of certain findings.
- Clarified factors to be considered in an award of compensation to a CCN holder upon decertification of land.
- Comprehensive mapping and filed notice of CCNs in county deed records[264]

Despite the reform efforts, landowners noted that abuses by CCN holders continued. The expedited decertification procedures proved to be cumbersome, lengthy and expensive, and the stories of delayed development and greenmail payments to be released from CCNs continue.[265]

In 2011, Sen. Robert Nichols passed Senate Bill 573 to provide further reform to CCN decertification, creating the "expedited and streamlined" CCN decertification process. When enacted, the bill allowed landowners in the 34 affected counties (now 32) to petition and automatically release property from a CCN upon demonstrating that the property is (1) 25 acres or more and (2) not currently receiving service from the CCN holder. Counties affected have a population of at least one million, a county adjacent to a county with a population of at least one million, or a county with a population of more than 200,000 and less than 220,000 that does not contain a public or private university that had a total enrollment in the most recent fall semester of 40,000 or more, and not in a county that has a population of more than 45,500 and less than 47,500. SB 573 did not change any of the provisions establishing compensation for decertified utilities. If a CCN holder can demonstrate an investment of funds for facilities to the land in question (even if no services are actually being provided), the CCN holder is entitled to compensation).[266]

During recent legislative sessions, rural water suppliers have asserted that compensation under SB 573 is not being fairly awarded. Meetings among stakeholders over the interim have aided in the advancement of conversations surrounding this issue.

Agency Oversight/Statutory Regulation over CCNs[267]

Public Utility Commission

The Public Utility Commission (PUC) considers applications for certificates of CCNs. There are two avenues for decertification from a water or sewer CCN under Texas Water Code Section 13.254. Section 254 (A-1) allows the owner of a tract of land that is 50 or more acres and not in a platted subdivision and is not receiving water or wastewater service to be released from a CCN. However, the streamlined or expedited decertification process created by SB 573 is the focus of this report.

The statute also allows for a streamlined expedited release of an area from a CCN in Water Code, Section 13.254(a-5). Under the (a-5) streamlined expedited release method, the owner of a tract of land located in a qualifying county that is at least 25 acres or more and that is not receiving water or sewer service may petition for streamlined expedited release of the area from a CCN. Unlike the expedited release petition process in Section (a-1), the provision in Section

(a-5) is not applicable to all parts of Texas and applies to only 33 counties. A petition filed under the streamlined expedited release provision in Section (a-5) shall be granted by the PUC within 60 days after the date the landowner files the petition. The PUC may require compensation by the petitioner to a decertified CCN.

When the PUC issues an order for the expedited release of area under Section (a-1) or under the streamlined provision in Section (a-5), the PUC's order identifies what property is rendered useless or valueless, if any. If the PUC determines that no property was rendered useless or valueless due to the decertification, then a proceeding to determine the amount of compensation for the useless or valueless property is not necessary. Since the PUC adopted its own rules governing the process, the PUC has not determined that any property has been rendered useless and valueless by a decertification.

The PUC adopted rules regarding the determination of property rendered useless or valueless in Chapter 24.113(n) of the PUC's rules. The rules specify that a CCN holder has the right to intervene and a right to a determination of what is rendered useless and valueless property. If the CCN holder fails to intervene, then the PUC presumes there is no useless or valueless property as a result of the decertification. The CCN holder and the petitioner may reach an agreement regarding what property is rendered useless or valueless and may agree on the amount of compensation for such property. If the current CCN holder and the petitioner reach an agreement, the agreement can be presented to the PUC at an open meeting for consideration and action. This has happened in 36 cases out of 147 cases at the PUC or its predecessor Agency.

Once the area is released from a CCN, either under Section (a-1) or (a-5), another retail public utility may not serve the area without first providing compensation for any property that is rendered useless or valueless to the decertified CCN holder as a result of the decertification. The determination of the monetary amount of compensation, if any, is determined at the time another retail public utility seeks to serve in the decertified area and before service is actually provided. Once a prospective utility provider files a notice of intent to serve the area with the PUC, the procedural clock starts and most deadlines for determining the amount of compensation are tied to the date of this notice. From this date, the PUC has 90 days to determine the amount of compensation for any property identified as being rendered useless or valueless.

The amount of compensation is determined using an independent appraiser. Within 10 days after filing a notice of intent to serve the area, the prospective utility provider files a letter identifying an appraiser that he and the former CCN holder have agreed upon together. The appraiser is limited to only appraising the property that was rendered useless or valueless. When the parties agree to the appraiser, the prospective utility provider is responsible for paying for the appraisal and the appraisal is due within 65 days from the date the notice of intent to serve the decertified area is filed with the PUC.

If the prospective utility provider and former CCN holder are not able to agree on an appraiser, then the prospective utility provider files a letter stating they will each engage their own appraiser at their own expense. In this scenario, the appraisals are due to the PUC within 60 days from the date the notice of intent to serve the decertified area. After receiving the appraisals, the PUC appoints a third appraiser to make a determination of the compensation

within 30 days. The determination may not be less than the lower appraisal or more than the higher appraisal. Each retail public utility covers half the cost of the third appraisal.

The statue and PUC's rules specify that the valuation of real property rendered useless or valueless shall be determined according to the standards set forth in Chapter 21 of the Property Code governing actions of eminent domain. The value of personal property rendered useless or valueless is determined according to various factors outlined in this section of Water Code.

In each scenario, whether the utilities agreed on an appraiser or if a third appraiser is used, the PUC is bound by the independent appraiser's valuation of the useless or valueless property. Moreover, a CCN holder that has land removed from the CCN area may not be required to serve the land that is removed.

Expedited Decertification Statistics[268]

The PUC compiled the following data on the number of petitions for expedited decertification since the passage of SB 573 in 2011. Of 15 petitions for expedited decertifications, 147 have been approved, 60 have been either denied, dismissed, returned, closed or withdrawn, 1 has been overturned, and 7 are currently pending. The PUC has awarded compensation in 3 of those cases, in 36 cases a settlement agreement on compensation was reached, in 13 cases no compensation was granted by the agency, and in 95 cases information is not available on compensation. Of the petitions filed, 31% were petitions to be decertified from water supply corporations, 31% from water districts and authorities, 26% from investor-owned utilities, and 12% from cities.

Streamlined Expedited Releases (SERs)

Texas Water Code § 13.254(a-5) Petitions Filed w/ Commission as of 9/14/2018	
Approved	147
Denied/Dismissed/Returned/Closed/Withdrawn	60
Overturned	1
Pending	7
Total	**215**

Compensation	
Compensation Awarded by Agency	3
Settlement Agreement on Compensation	36
No Compensation Granted by Agency	13
No Information for Compensation	95
Total	**147**

Filings by Entity Type			
Entity Type	**No. of Entities**	**Total Filings**	**% Filings**
Water Supply Corporations	23	67	31
Water Districts and Authorities	15	67	31
Investor-Owned Utilities	16	56	26
Cities	14	25	12
Total	**68**	**215**	**100**

DISCUSSION AND CHALLENGES

Challenges for Rural Water Suppliers[269]

The Texas Rural Water Association is a trade association with a membership of approximately 750-member water and wastewater systems, the majority of which are non-profit water supply corporations, districts and small cities. As urban areas have expanded, many of these systems have met the demands of that growth, serving high density subdivisions in urban and suburban areas. For the most part, these systems are not taxing entities, solely deriving their revenue from rates and fees.

As with other types of utilities, these water suppliers have depended on the protection of a defined service area to invest in costly infrastructure with the assurance that they will be able to

pay for the investment as customers come on to the system. For cities, limits often define their service area, for municipal utility districts and other developer districts, it's their district boundaries. For rural systems, it's their state-granted CCN. Having a defined area to serve remains critical to justify the investment in costly infrastructure and water resources required to operate these systems.

From the perspective of the Texas Rural Water Association, legislation has eroded this protection for the systems with CCNs, starting with legislation passed in 2005 that took into consideration a utility's ability to serve prior to decertification. In 2011, SB 573 created a mechanism whereby a landowner can automatically decertify an area regardless of the utility's investment and ability to provide service. Although a utility's service area may now be picked apart, the obligation to provide service remains the same. The system capacity requirements dictated by the Texas Commission on Environmental Quality remain the same.

The way SB 573 has been implemented by the Public Utility Commission, systems are being decertified that have the ability to serve at an urban standard, have made significant investments in infrastructure, have infrastructure in close proximity to the property being decertified, and have significant water resources in place to serve the area. SB 573 has become an automatic process regardless of utility's capacity to serve. The argue that the high rate of approval by PUC and low number of instances in which compensation is awarded is evidence that the process is too far slanted in favor of landowners.

They further argue that it is in the public interest that these rural systems remain solvent and continue to invest in infrastructure and water resources to ensure that there is service available in these areas into the future. Second, decertification has an impact on current customers. Current customers have been have been partially, or in some cases fully, funding the necessary investments to accommodate future growth through their water rates. New customers, when they materialize, share in the utility's fixed costs, including debt, and help offset future cost increases. As a result, everyone benefits from economies of scale. However, when the new customers connect to someone else's utility instead because of decertification, and the utility isn't compensated for these lost customers, water rates need to increase to existing customers.

As expedited decertification applications are being processed, in various cases the PUC appears to have created an unwritten rule concerning “property not receiving water service” as it sidesteps the existing definition for water service in accordance with TWC. The PUC has been granting decertification for any property that is not receiving flowing water service. But the definition of “service” in Chapter 13 is very broad. It includes almost anything a utility has done towards providing service to a property.

A newer trend is observed today as some municipalities direct property owner/developers who contemplate new platting or subdivision development within the ETJ which overlaps the CCN holder’s service area. The decree from municipalities is that water utilities will be “city provided”. This unfair leveraging within the ETJ forces the P.O./developer to make application for decertification even when the developer expresses they would rather work with the existing water provider whose system is nearer and readily capable to accommodate. There is a practical solution when development includes sewer service. When the utility can readily supply water

service they can also provide the billing service for the city's wastewater collection and remit monthly payment to the city. They note several mechanisms employed by cities, including refusing to provide sewer service, not approving plats, not approving the formation of a PID, and others, as ways to require decertification. In a number of these cases, the utility that was decertified was the more capable service provider and had facilities in closer proximity. In one case, the landowner was unable to get service from the city after being required to decertify and had to request that the PUC put their property back in the service area of the original utility, at great cost to all parties involved.

The city which stipulates this undercuts the rational and purpose of Chapter 13 with respect to the neighboring rural water utility. If cities can refuse to allow development unless the developer agrees to the city being the water service provider, then cities are systematically impacting rural customer's rates as the decertified utility's viability slowly erodes.

Challenges for Landowners and Developers

From the landowner and developer standpoint, SB 573 provided critical reforms and established a fair and equitable balance between landowners and utilities. Landowners, developers, and homebuilders believe that the process of "expedited and streamlined" release is working and is successful.[270]

For developers, water is the most limiting factor in their industry and prior to CCN reforms growth was limited. In fast growing areas of the state, facilitating development is the primary interest. [271] The need for a decertification process for the amount of growth that is happening in the state was crucial to keep the economic engine of Texas moving. CCN reforms were needed to protect property owners and to ensure water services for development came at a fair price.[272] Landowners don't care where the service comes from, they just want to receive adequate service at a reasonable and fair price.[273] There is agreement that utilities are due compensation and that there be a fair process available for the CCN holders, so they are not left with nothing. However, prior to reforms CCN holders were holding property owners hostage with high costs and not providing services.[274]

Advocates for landowners also note that decertification is not the first choice. If a water utility has adequate supply and the cost of treatment and distribution and reasonable, a developer will want to do business with that utility instead of going through the process of seeking to be decertified from the utility's CCN. In most instances, a landowner will work with the local utility to make the arrangement work. The instance referenced by some in which a landowner sought to be decertified and then got back into the CCN is not the norm and doesn't represent a trend upon which law should be based. Rather, a landowner will seek decertification in two instances: when a utility can't provide service because it doesn't have adequate water resources or it's too far away, or when the cost of service is too high, and there's a more cost-effective water provider that can provide service. Practitioners have noted that in most instances in which a landowner petitions for decertification, the landowner and utility mutually agree that service can't be provided and no compensation is due. To get to the point of agreed to decertification, there was communication with the utility, an evaluation by engineers, and a decision by the landowner and agreement by the utility all before filing a petition for decertification. This process seems to be

the norm more so than the outlier, and compensation does not seem to be a factor in most decertifications.[275]

Most CCNs consider service to a developer as "nonstandard service" . This means the CCN utility requires the developer to pay 100% of the costs for the facilities to serve the land. Essentially, the utility tells the developer that they will serve the development at the utility's rates if you first pay to design and construct the facilities to serve the land and to pay those costs upfront. It's only a duty to serve if the landowner will pay for all the cost upfront, which is key when discussing compensation. If a landowner was going to be required to pay for the costs of setting up service, then there shouldn't be compensation due to the utility for that service. Homeowners eventually pay these costs through higher home costs, or taxes, or rates. Most decertifications.[276]

Developers have expressed that water utilities should receive compensation for the portion of improvements attributable to a specific tract of land, as long as they are fair and reasonable, unlike some of the exorbitant demands that were made prior to the passage of reforms by the Legislature. The compensation process needs to be fair, but it also needs to be quick and efficient. A central tenet of HB 2876 and SB 573 is expediting an otherwise lengthy and costly process. Any changes to the process should be mindful of time, fairness, and efficiency, and should also be data-driven. An evaluation of where, when, and in what circumstance decertifications were granted without compensation, and whether there were stranded facilities, what types of facilities, whether there was actually a dispute over compensation, and if so, why and how it was resolved, should all be considered before changing a process that seems to be working.

SB 573 has been successful in allowing landowners to easily remove land from a CCN when the utility has not planned and invested in service for the area and therefore cannot provide service at a reasonable cost. In 2017, some utilities expressed a desire to roll back most of the reforms enacted by HB 2876 and SB 573. These utilities supported HB 2187 by Rep. Eddie Lucio, III, which was heard in the House Natural Resources Committee, but not passed.[277]

Challenges for Cities[278]

Cities' primary interest in the decertification proceedings is facilitating development. Development is a very important interest group within most municipalities, and most interest from local communities to advocate on this issue has been developer-driven. However, SB 573 applies to cities just as it does rural water suppliers. With the exception of large cities, cities' land can and has been decertified through this process. Cities have given up portions of a CCN where it has made sense for a particular development.

The City of Tyler was a key proponent of SB 573. Within the City of Tyler and its ETJ, there is one water investor-owned utility (IOU) and one sewer IOU. In regard to water, the City of Tyler and the IOU providing water service have a dual CCN. Outside the city limits, the IOU provides that service. When the city annexes within its ETJ, sometimes the city provides service, and sometimes the IOU does. The City has a longstanding relationship with that IOU and provides the utility with compensation for facilities it acquires when it takes over service. In the

case of the sewer IOU, the entity provides poor service, has a horrible environmental record, and has high rates, both for its ratepayers and to developers who seek to be decertified. It's this IOU that has always driven the City of Tyler's interest in this issue as it has caused development in part of the city to come to a halt. There have been approximately 10 decertifications from this IOU's CCN and in every case the compensation was determined to be zero. From the City of Tyler's perspective, the expedited decertification process seems to be working, including the compensation piece.

There are certain utilities who might not be able to recover costs they should be owed. If the Legislature is going to reform these provisions, the City of Tyler argues that there needs to be a clear standard for what compensation is supposed to do. For example, is it supposed to protect existing customers in a utility and keep their rates from going up? Is it to not disincentivize proper planning by utilities?

One possible solution is to require advance notice of planning by utilities. Currently, planning documents for utilities or not necessarily public and therefore a developer may not know of a utility's plans to provide service to certain areas. For example, in the municipal setting, if a city is seeking to charge an impact fee, it must do an impact fee study, provide public notice, lay out where it thinks the lines and facilities are going to go over the next 10 years, work out a price, and present the price per connection to developers. It's worked out ahead of time and developers get to participate in that process. In these rural systems, a similar process doesn't exist. Requiring utilities to go through more formal and transparent planning upfront so all parties know what costs should be down the road is one option.

RECOMMENDATIONS

The expedited decertification process established as a result of SB 573 created protections for landowners that should be preserved. Any changes to the mechanism by which compensation is calculated should ensure that the process for being released from a CCN remains fair and expeditious.

WATER AVAILABILITY MODELS

PUBLIC HEARING

The House Committee on Natural Resources held a public hearing on its Interim Charge #7 related to Water Availability Models on October 16, 2018 in Waco, Texas. The following individuals testified on the charge:

Kim Wilson, Texas Commission on Environmental Quality
Bob Brandes, Texas Water Conversation Association

The following section of this report is related to Water Availability Models is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

The amount of much surface water available to permit in each river basin is determined by computer model known as Water Availability Models, or WAMs, developed by the Texas Commission on Environmental Quality (TCEQ), just as Groundwater Availability Models, or GAMs, are developed by the Texas Water Development Board to determine the availability of groundwater resources in this state. Because WAMs make predictions based on historic hydrologic trends and extremes, it is important that the data that informs these models, and ultimately inform critical permitting and water planning decisions, remain up-to-date and truly reflect the historic variability of droughts and floods.

Given that a new drought of record is likely to have been established for numerous river basins in the drought of 2011, the committee was tasked with analyzing the need to update the existing WAMs. Without these updates, basing available water supplies on droughts less severe than the drought of record would result in an overestimation of water supplies. Communities and other water users are at risk of water shortages when available supplies are overestimated.[279]

It is also important to note that the committee was tasked with evaluating, yet again, the potential for expanded water markets in Texas, as discussed in a previous chapter of this report. Quantification of the availability of surface water resources is an essential element for establishing and expanding such a market, underscoring the importance of maintaining accurate, up-to-date Water Availability Models. During the next severe drought, the efficacy of these models will be tested as we work to ensure users are able to rely on surface water permitted for a given use.

BACKGROUND

Prior to the development of the WAMs, TCEQ developed models for six river basins and used those models to determine water availability for new projects. Water availability was determined on a case-by-case basis in the other river basins.[280]

In response to drought conditions in the 1990s, the 77th Legislature implemented Regional Water Planning through the enactment of Senate Bill 1 in 1997. As part of this process, the Legislature sought a standardized method for evaluating water availability across the state, and Senate Bill 1 directed TCEQ to develop new Water Availability Models for 22 of the State's 23 river basins. Funding for the additional basin, the Rio Grande, was authorized in 2001.[281] Beginning in 1998 with the Sulphur River basin and concluding with the Rio Grande basin in 2004, TCEQ developed a model engine and data sets for each of the 23 basins across the state. The Legislature appropriated $12.6 million over several biennia for this effort. With these funds, TCEQ contracted with Texas A&M University to develop the model engine and various consulting firms to develop data sets that would be used in the models.[282]

TCEQ has not received any direct appropriations for WAMs since 2003. TCEQ has also not submitted any Legislative Appropriation Request for WAMs to the Legislature. A small amount each year is taken out of TCEQ's general operating costs each year for to fund updates to the

model engine itself and updates to the data sets have been very minor and have been done in-house.[283]

During the 85th Legislative Session, the House Natural Resources Committee approved SB 696, which would have funded an update of the WAMs for a portion of the Brazos River basin, the Guadalupe/San Antonio River basin, the Sulphur River basin, and the Rio Grande basin, however the legislation did not reach the floor of the House of Representatives for a vote.[284] The fiscal note for SB 696 was $2.5 million.[285] TCEQ estimates that the cost to update the WAMs for all basins is approximately $8 million.

Science Meets Policy: What is a WAM?

A WAM is a computer-based simulation predicting the amount of water that would be in a river or stream under a specified set of conditions. The model used by TCEQ consists of two parts: the modeling program, "WRAP" (Water Rights Analysis Package) and text files that contain basin-specific information for WRAP to process.[286] Basin-specific data files include: computational node connectivity, water rights priorities and descriptions, naturalized historical hydrology, historical reservoir net evaporation rates, and program operation commands.[287]

WAMs also include water rights management strategies, environmental flow requirements and interstate compact requirements. The WAM uses prior appropriation accounting to determine how much water a water right can impound or divert. Water availability is calculated by taking the amount of flow in the stream and subtracting the amount of flow appropriated to other water rights. The amount of water available for appropriation is limited by the amount of the instream flow requirement.[288]

TCEQ staff use water availability models in evaluating water rights applications to help determine if water would be available for a newly requested water right or amendment, or if an amendment might affect other water rights, by running the model in one of two ways.[289] These are:

Full Authorization simulation model:

- All water rights utilize their maximum authorized amounts
- Used to evaluate applications for **perpetual** water rights and amendments

Current Conditions simulation model:

- Includes return flows
- Used to evaluate applications for **term** water rights and amendments[290]

If water is available, these models estimate how often water would be available.

Hydrologic databases for WAMs typically extend from 1940 through the late 1990s and exclude the more recent extreme droughts that could be instrumental in establishing the yield of existing and future water supply projects. The basic output from WAMs is the monthly supply of water available to individual water rights within a particular basin, considering water rights in

priority order and actual historical monthly streamflows over a long period of record at specific locations throughout the basin.[291]

In addition to being used by TCEQ to determine available supply for new appropriations and amendments, assess impacts on other water rights, and satisfy environmental flow standards, WAMs are also used in the regional water planning process by Regional Water Planning Groups and the Texas Water Development Board, to determine existing surface water supplies for water user groups and specific projects (under drought of record conditions), investigate potential surface water supplies for recommended projects and strategies (under drought of record conditions), and incorporate environmental flow standards into future project evaluations.[292]

WAM Updates Currently Underway

There are ongoing projects to update naturalized flows[293] in three river basins:[294]

Brazos River basin:

The Brazos River Authority (BRA) performed about 80% of the necessary updates to the naturalized flows in the Brazos Basin through 2015 as part of a drought study required by its application for the System Operation Permit.[295]

BRA spent an estimated $380,000 on developing updated naturalized flows as part of the Drought Study required for the review of its application, focusing on larger water rights (1,000 acre-feet/year and greater), reservoirs (10,000 acre-feet and greater), and wastewater discharges (2 million gallons per day historical discharge and greater), which have the most significant impacts on the flow naturalization process. This analysis comprised 80% of the basin, which was sufficient for the purposes of the permit application. It would have taken substantially more time and funding to fully naturalize the flows, and the results likely would not have been much different.[296]

However, without fully naturalizing the flows for the entire basin, TCEQ cannot use this data for regulatory purposes.[297] The cost to complete the remaining analysis and fully extend the hydrology in the Brazos would cost $288,000.[298]

The request for the remaining funding need to finalize the Brazos WAM was included in SB 696 from the 85th Regular Legislative Session.[299]

Colorado River Basin:

The Lower Colorado River Authority (LCRA) was required to update the naturalized flows in the Colorado River basin under the TCEQ Order approving LCRA's Water Management Plan (WMP). LCRA updated the naturalized flows in the Colorado Basin through 2016; however, the process of updating the WMP is ongoing at this time.[300] The recent update to extend the Colorado Basin naturalized flows through year 2016 cost LCRA about $160,000 to perform, including $100,000 in consultant costs and $60,000 in staff time.[301]

The update included the full river up to the adjacent coastal basins.[302] Therefore, TCEQ can use this data for regulatory purposes.[303]

Sulphur River basin:

The River Bend Water Resources District has chosen to fund updates to the naturalized flows in the Sulphur River Basin, using data through 2017. TCEQ is currently working with the River Bend Water Resources District to ensure that what is developed can be used for regulatory purposes.[304] Previously, the Sulphur River basin had been listed among the high priority basins based on projections about a new drought of record for the basin and the potential for development of water supply projects in the basin.[305] The cost of this project to River Bend Water Resources District is estimated to be $236,000.[306]

Prioritization and Cost:

When determining a prioritization of projects, TCEQ's focus is on where the occurrence of a new drought of record might be most likely. Additional criteria include the existence of proposed new water supply projects and strategies, and the condition of underlying and support data files for existing WAMs. Top priority on upcoming projects for TCEQ are the Neches River basin, the Red River basin, the Rio Grande basin, and completing the Brazos River basin. The cost of these projects is estimated to be $2 to $2.5 million. Potential water supply projects in the Neches River and Red River basins make these ideal candidates for WAM updates. Additionally, TCEQ will only be able to use the naturalized flow data for the Brazos River basin for permitting decisions when the full update has been completed.[307]

The Texas Water Conservation Association (TWCA) has many members that have experience and use WAMs on a daily basis. Numerous TWCA members were involved in the development of the original models in the 1990s. With this expertise, TWCA has developed its own priority list for updating WAMs. The top five basins on the priority list have had new droughts of record since the late 1990s when the last database ended that are in the current WAMs and have proposed projects that need to be subjected to the most recent hydrological data. The total cost to complete their full priority list is $8 million.[308]

Suggested priorities from TWCA for extension of hydrologic data bases for existing WAMs:[309]

PRIORITY	BASIN	WATER RIGHTS	PRIMARY CONTROL POINTS	HYDROLOGIC PERIOD OF RECORD	YEARS TO EXTEND THRU 2017
1	Red River	400	31	1948-1998	19
2	Nueces River	255	41	1934-1996	21
3	Rio Grande	876	43	1940-2000	17
4	Guadalupe-San Antonio Rivers	1,120	46	1934-1989	28
5	Brazos River/San Jacinto-Brazos	1,200	77	1940-2015	20 [1]
6	Trinity River	1,020	41	1940-1996	21
7	Neches River	330	20	1940-1996	21
8	Lavaca River	55	7	1940-1996	21
9	Sabine River	192	18	1940-1998	19
10	Cypress River	84	6	1948-1998	19
11	San Jacinto River	200	17	1940-1996	21
12	Canadian River	38	6	1948-1998	19
13	Colorado River	1,263	43	1940-2016	1
14	Colorado-Lavaca Coastal	30	1	1940-1996	21
15	Neches-Trinity Coastal	108	4	1940-1996	21
16	Trinity-San Jacinto Coastal	17	2	1940-1996	21
17	Lavaca-Guadalupe Coastal	6	2	1940-1996	21
18	San Antonio-Nueces Coastal	21	6	1948-1998	19
19	Brazos-Colorado Coastal	25	2	1940-1998	19
20	Nueces-Rio Grande Coastal	78	29	1948-1998	19
21	Sulphur River	56	6	1940-2017	0 [2]

Notes:

[1] The Brazos River/San Jacinto-Brazos Coastal WAM has partially updated hydrology through 2015 that has been developed by the Brazos River Authority pursuant to requirements of Water Use Permit 5851.

[2] The Sulphur River Basin WAM is being updated by Riverbend Water Resources District and should be completed by the end of 2018.

These priority basins identified by both TCEQ and TWCA are mostly identical except for the TWCA's inclusion of the Nueces River in the top five priority basins, where TCEQ has identified the Neches River. TWCA's inclusion of the Nueces River in the top five is based on analysis that there have been parts of the basin where new droughts of record definitely have occurred and there are some proposed projects that could be impacted. While the same may be said for the Neches River, the need does not appear to be as pronounced.[310]

DISCUSSION AND CHALLENGES

New Drought of Record

The "drought of record" is one important component that is incorporated into models. Existing WAM datasets typically reflect 1940 to the late 1990s, and in this time period, the drought of record was 1951-1957, therefore this is the drought incorporated into all WAMs at present. However, a new drought of record has likely occurred in many basins since the end of

the WAM database, 2011, which was the driest year since the beginning of official precipitation records (1895) for half of Texas.

These priority basins identified by both TCEQ and TWCA are mostly identical except for the TWCA's inclusion of the Nueces River in the top five priority basins, where TCEQ has identified the Neches River. TWCA's inclusion of the Nueces River in the top five is based on analysis that there have been parts of the basin where new droughts of record definitely have occurred and there are some proposed projects that could be impacted. While the same may be said for the Neches River, the need doesn't appear to be as pronounced.

Implications for Water Supply Projects

For those basins that have experienced new droughts of record since the completion of the existing WAMs, existing or new water supply projects may be overestimating their firm yield supplies with the existing WAMs. Updated WAMs would incorporate the new droughts of record and therefore the analysis of existing and new water supply projects would reflect these new droughts with lower firm yields than they otherwise would based on the existing WAMs. This is important for planning purposes. Depending on location within basins, the firm yield of water supply projects in the Rio Grande, Nueces, Guadalupe-San Antonio, Red, Neches, Trinity and Brazos basins could be impacted.[311]

Limitations of WAMs

WAMs are fundamentally based on historical monthly hydrologic data and they are used to project how water rights would react and function if these historical conditions were to be repeated in the future. It is a given that the exact pattern of these historical data will not be repeated in the future, but to the extent that the historical data represent both typical and extreme wet and dry conditions, the WAMs are considered to provide a reasonable approximation of actual hydrologic conditions that is useful for evaluating the behavior of water rights. For this reason, it is important to update the hydrologic data base for the WAMs when conditions are known to have significantly changed, for example after the occurrence of a new drought of record. This is the only way that the firm supply from water supply projects can properly quantified and not be overstated. It is also important to note that the WAMs do not reflect long-term changes in hydrologic or climatic conditions that may be occurring or have occurred since those of the 1940-2000 period, which generally represents the hydrologic conditions included in the existing WAMs.[312]

RECOMMENDATIONS

Provide a state-supported revenue source to fund updates of Water Availability Models.

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on its Interim Charge #8 related to abandoned and deteriorated groundwater wells on September 13, 2018 in Del Rio, Texas. The following individuals testified on the charge:

Gregory Ellis, Attorney
David Mauk, Bandera County River Authority & GCD
Lee Parham, Texas Department of Licensing and Regulation
Roland Ruiz, Edwards Aquifer Authority
Sarah Schlessinger, Texas Alliance of Groundwater Districts
Greg Sengelmann, Gonzales County UWCD

The following section of this report relating to abandoned and deteriorated groundwater wells is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

For over 20 years, the state has recognized that abandoned domestic, municipal, industrial, irrigation, and livestock wells, and unplugged test-holes are a threat to groundwater quality.[313] Abandoned water wells not only serve as conduits or channels for contamination to reach groundwater, but large diameter wells can also be a hazard to human and animal life.[314] In the late 1990s, a group of water-related state agencies estimated that there were 150,000 abandoned or deteriorated water wells in Texas.[315]

In light of ongoing challenges related to remediating this threat to the state's groundwater supply, the committee was tasked with studying the hazards presented by abandoned and deteriorated wells and making recommendations to address contamination.

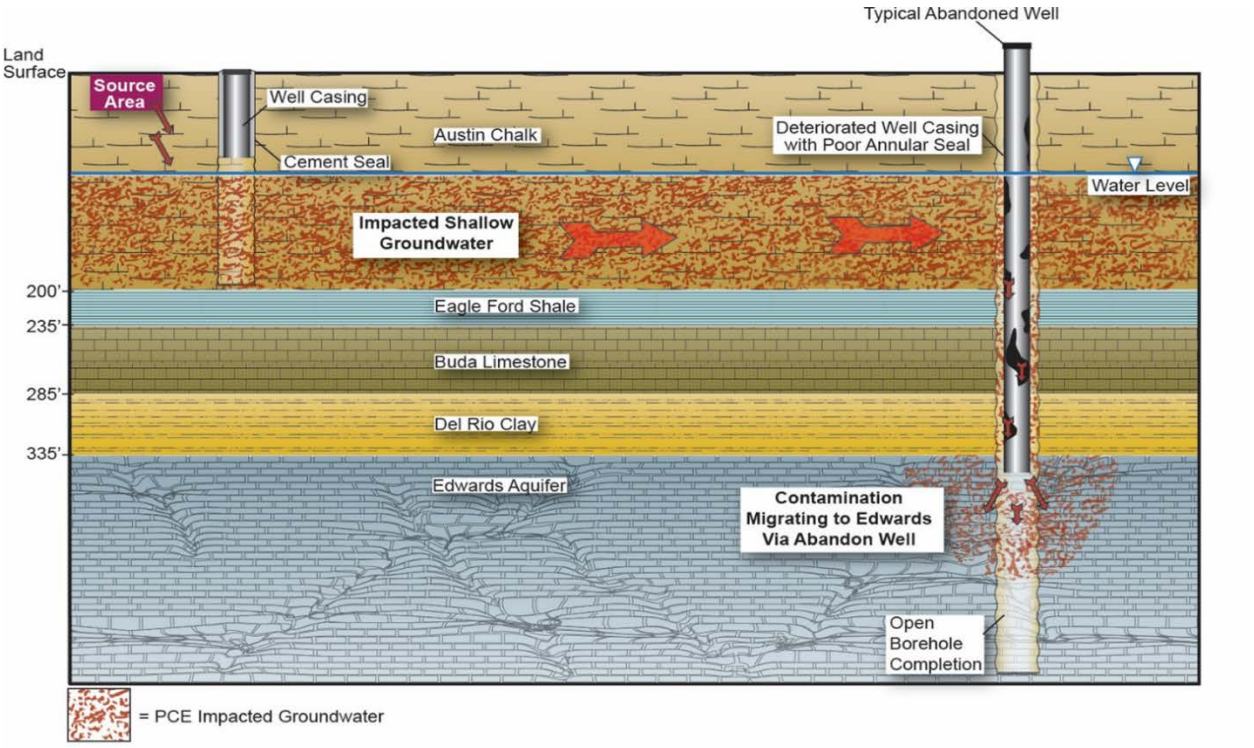
BACKGROUND

Under current law, an abandoned well means a well that is not in use. A well is considered to be in use if:

- the well is not a deteriorated well and contains the casing, pump, and pump column in good condition;
- the well is not a deteriorated well and has been capped;
- the water from the well has been put to an authorized beneficial use, as defined by the Water Code;
- the well is used in the normal course and scope and with the intensity and frequency of other similar users in the general community; or
- the owner is participating in the Conservation Reserve Program authorized by Sections 1231-1236, Food Security Act of 1985 (16 U.S.C. Sections 3831-3836), or a similar governmental program.[316]

A deteriorated well means a well that, because of its condition, will cause or is likely to cause pollution of any water in this state, including groundwater.[317] Groundwater pollution can occur when brackish groundwater is allowed to flow through broken casing or well boreholes to fresh water zones or to the surface, or when surface water runoff is allowed to flow down open wells or through improperly grouted annular space between the well bore and the well casing.[318] The most dangerous form of abandoned well is a well that is not physically capable of making withdrawals from an aquifer. Typically, these wells are also deteriorated below the surface. Because of condition or status, these wells have no value to a landowner and can be quickly forgotten, ignored, or unrecognized when changes in land ownership or development occur.[319] Abandoned and deteriorated wells across the state pose a threat to groundwater and public safety.[320]

The following illustration from the Edwards Aquifer Authority shows the mechanism by which abandoned wells can contribute to groundwater contamination:[321]



Abandoned and deteriorated water wells exist in every county in the state and are at the top of the list of potential groundwater contamination sources that landowners can identify and eliminate. State law requires landowners or other persons who possess an abandoned and/or deteriorated well to have the well plugged or capped under standards and procedures adopted by the Texas Department of Licensing & Regulation (TDLR). State law also authorizes the TDLR to assess administrative and civil penalties against persons who do not comply.[322]

Many abandoned and deteriorated wells were drilled a long time ago and are open to the environment. Groundwater Conservation Districts (GCDs) and TDLR may not have any information on these wells. Capping alone will not solve the problem because many of these wells weren't properly cased to begin with and have now deteriorated. Open or deteriorated wells serve as a direct conduit from the surface to other groundwater sources, and over time allow contaminants and pollutants to degrade the groundwater across geologic strata or formations.[323]

Abandoned and deteriorated wells can be identified by a landowner, discovered by a water-well driller, discovered by GCDs, or reported by a citizen or other governmental entity. GCD staff will engage the well owner to educate him or her on the dangers posed by such a well and the legal requirements associated with the well.[324] If the landowner chooses to not address the well, then district employees can go onto the property themselves and cap or plug the well. [325] [326]

Agency Oversight/Statutory Regulation of Abandoned and Deteriorated Groundwater Wells

Statutorily, the management of abandoned and deteriorated groundwater wells is a coordinated approach between state agencies and Groundwater Conservation Districts (GCDs):

- The definition and regulation of Abandoned Wells is the responsibility of the Texas Department of Licensing Regulation (TDLR) under Texas Occupations Code Sec. 1901.255.
- GCDs are statutorily required to enforce those regulations set out by TDLR, under Texas Occupations Code Sec. 1901.256
- Texas Occupations Code Sec. 1901.257 mandates that TDLR and the Texas Commission on Environmental Quality (TCEQ) develop a memorandum of understanding with GCDs to coordinate efforts to the investigation of abandoned and deteriorated wells.[327]

Texas Department of Licensing Regulation

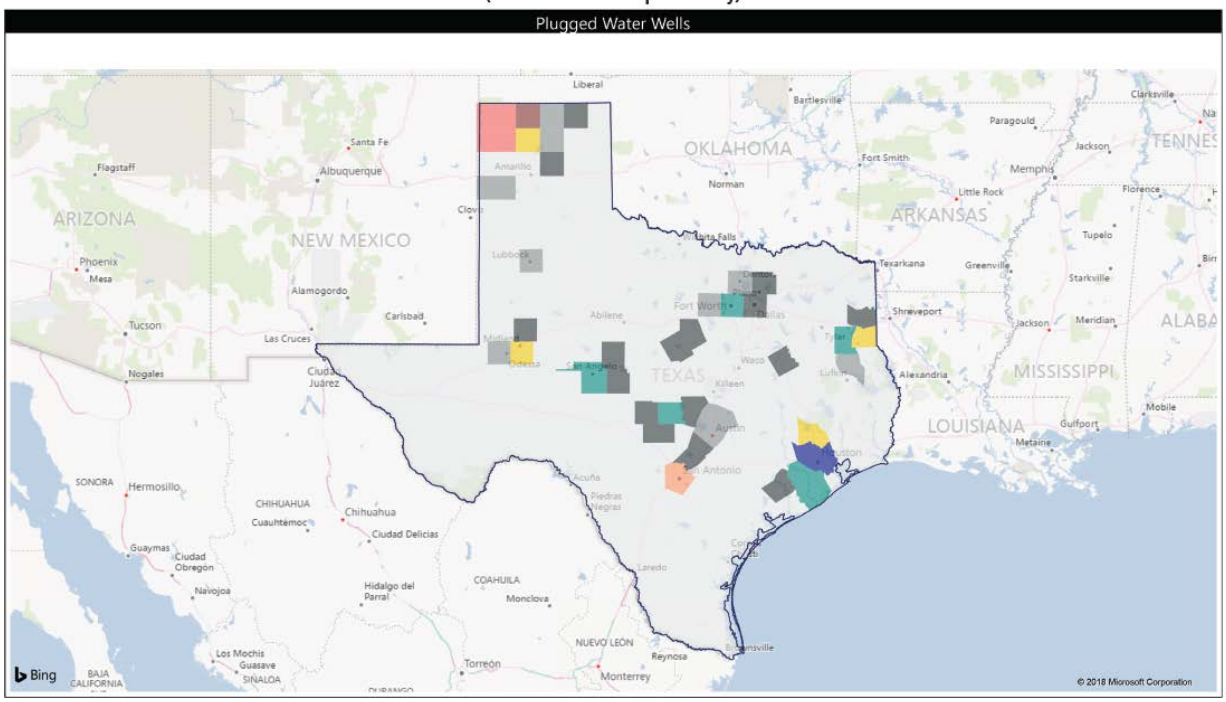
In 1997, the Texas Legislature saw a need for more efficiency in how the state collects well reports and well plug reports and passed Senate Bill 1955 (75R). Senate Bill 1955 transferred the Water Well Driller and Pump Installer Programs from the former Texas Natural Resource Conservation Commission (now the Texas Commission on Environmental Quality or TCEQ) to the Texas Department of Licensing and Regulation (TDLR).

In 2002, TDLR and the Texas Water Development Board (TWDB) developed the Texas Online Well Report Submittal and Retrieval System (TWRSRS), which contains the number of wells plugged by category. Once abandoned or deteriorated wells are brought into compliance, the landowner or licensee, whichever performs the work, is required to submit a well plugging report within 30 days of completion. Since 2002 when the system was developed, 48,279 wells have been reported to TDLR as having been plugged, as broken down in the table below.[328]

Well Type	**Number of Plugging Reports**
Withdrawal of Water	26,511
Test Well	10,932
Domestic	5,827
Rig Supply	1,551
Irrigation	1,152
Stock	1,014
Other such as Piezometer	621
Public Supply	311
Industrial	236
Fracking Supply	124
Total	**48,279**

These wells were plugged in 103 of 254 Texas counties, as indicated in the two maps produced by TDLR below. The first map indicates the concentration of plugged wells in counties where 250 or more wells have been plugged. The second map indicates where less than 250 wells have been plugged. The county with the greatest amount of wells plugged since 2002 is Harris County, with 4,250 wells. [329]

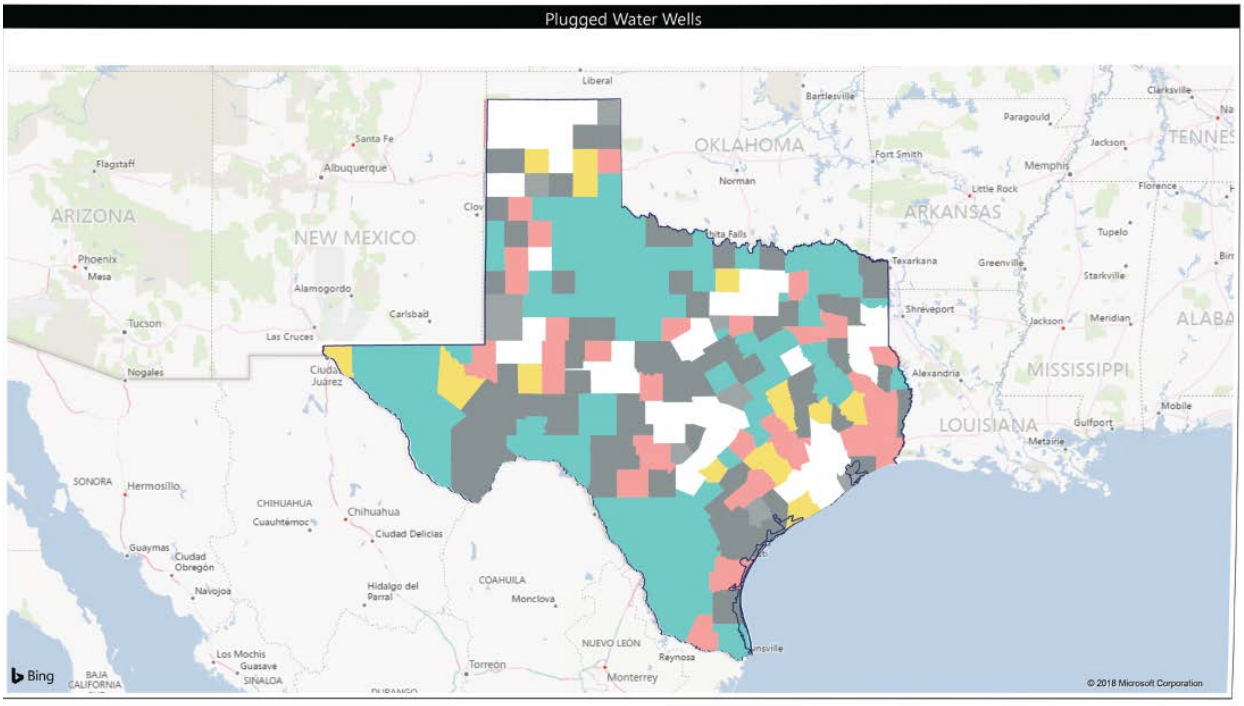
(250 or more wells per county)



Legend:

0-249, 250-499, 500-749, 750-999, 1000-1249, 1250-1499, 1500-1749, 1750-4249, 4250

(Less than 250 wells per county)



Legend:

0-49, 50-99, 100-149, 150-200, 200-249

The Texas Legislature enacted Senate Bill 279 (78R) in 2003 authorizing TDLR, TCEQ, and Groundwater Conservation Districts to enter in to a Memorandum of Understanding (MOU) to coordinate efforts relating to investigative procedures for referrals of complaints regarding abandoned or deteriorated wells.[330] As a result of legislative direction for TDLR to be more involved in the reporting process, in 2004, TDLR developed the online Abandoned Well Reporting system, giving the public and other water-related agencies and entities the ability to report concerns about possibly abandoned or deteriorated water wells. To date, TDLR has received 435 complaints on abandoned or deteriorated wells. Of 435 complaints, 49 wells have been capped (meaning non-deteriorated and for possible use in the future), 133 wells have been plugged, 27 wells have been brought into compliance, 133 wells were determined not to be abandoned, were referred to a GCD, or the well or landowner could not be located, and 93 wells are in various stages of notification, review, or investigation. [331]

As part of their ongoing efforts, TDLR's Water Well Driller/Pump Installer Program staff provides training upon request to Groundwater Conservation Districts (GCD) and TCEQ's field staff on identifying abandoned wells and reporting abandoned or deteriorated wells using the Online Abandoned Well Reporting System. Being in the field, these individuals are most likely to be in a position to recognize such a well.[332]

After inspection by TDLR or a GCD, if the well is determined to be abandoned or deteriorated, TDLR notifies the landowner or the party that owns the well, initiating a 180-day time frame for the landowner to respond as to whether they intend to plug the well, re-complete and use the well, or cap the well in the event that it’s not deteriorated as authorized by Chapter 1901.255, Occupations Code. If no response is provided, it results in a complaint through TDLR's Enforcement Division.[333]

TDLR has not made recommendations to the Legislature on how to better address the hazards posed by abandoned and deteriorated wells, however, TDLR is a member of the multi-agency Texas Groundwater Protection Committee (TGPC), which has done so. The TGPC works to find better ways to handle abandoned or deteriorated wells, to assist landowners through the *Landowner’s Guide to Plugging Abandoned Wells*, and to make recommendations to the Texas Legislature on these issues.[334]

The TPGC has recommended state-supported water-well plugging funds during previous legislative sessions, but to date the Legislature has not funded such a program.[335] In its report to the 85th Legislature, the TPGC made the following recommendation regarding abandoned and deteriorated wells:

"The TPGC recommends that the legislature provide positive incentives for landowner-initiated closure of abandoned and/or deteriorated water wells through the establishment of an abandoned water well plugging fund. Fund disbursement could be contingent upon prioritization of potential groundwater quality impacts, hazards, and the landowner’s assets. Further, the plugging fund program should be administered by the TDLR, the agency currently responsible for the oversight of water well drillers, well drilling, and well plugging. The TDLR should work cooperatively with local GCDs to disburse monies for the plugging of abandoned and/or deteriorated water wells located within GCD jurisdiction. Furthermore, the funds could be

disbursed on a regional geographic model based on the areas of selection for member appointment to the Water Well Driller Advisory Council. Because of the number of abandoned wells and the ability to 'scale' the program, a cost estimate cannot be provided and has not been submitted by any member agency in a Legislative Appropriation Request.

To support the abandoned well plugging program, the TGPC recommends that an outreach program be carried out by Texas A&M AgriLife Extension Service (AgriLife Extension) in coordination with the Texas Water Resources Institute. This program would provide educational publications, websites, and other resources that could be used by county extension agents and other local and regional agencies in workshops and field days to teach the public how to properly plug and manage abandoned water wells."[336]

Groundwater Conservation Districts

GCDs are statutorily charged to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater. As direct conduits from the land surface to groundwater, management and maintenance of water wells of water wells is fundamentally important to protecting groundwater resources.[337]

Current GCD statutory authorities relating to groundwater protection include:

- Requiring registration of wells within a district.
- Ability to require a permit for the drilling, equipping, operating or completing of wells.
- Enforcement of groundwater well drilling standards meant to protect the resource from contamination or commingling.
- Ability to enter land in order to inspect and investigate conditions relating to the quality of water.[338]

Groundwater district staff attempt to educate the well owner of his or her obligations under state law and attempt to facilitate resolution of the problem well through proper well capping, or preferably, proper well plugging.[339] While landowners are required to plug abandoned wells in accordance with Texas Administrative Code Chapter 76.1004, many GCDs offer assistance programs to aid landowners.[340]

According to the Texas Alliance for Groundwater District's 2018 GCD Index update, at least 22 GCDs indicated that they have an abandoned well plugging program, and 17 of them indicated that they offer either financial assistance or in-kind services to help landowners complete the well plugging.[341]

In the cases where a landowner has been informed of a open or uncovered well and does not address it, the GCD can go onto the property and cap or plug the well. However, the district does not have the authority to repair the well. To recoup costs, the district has the authority to put a lien on the property.[342] Currently, districts have the authority to cap or plug, but not repair a well.

DISCUSSION AND CHALLENGES

Financial Burden to Landowners and Agencies

The requirement for landowners to plus these wells represents a financial burden and provides little incentive for owners of abandoned wells to voluntarily plug them. Depending on depth and location, the cost to properly plug a well can range from less than $1,000 to more than $200,000. Costs are also associated with investigation into whether an abandoned well is deteriorated. Additional costs can include opening the well (pulling out any old pumps or obstructions) and logging the well to determine condition.[343]

Costs also vary based on the characteristics of different aquifers. In the Gulf Coast Aquifer, a sand aquifer, wells are less expensive to plug than in the Edwards Aquifer, which is a limestone, karstic formation, and more expensive.[344]

While some GCDs make match-funding available to landowners, a state funding source to assist landowners with abandoned well plugging efforts would result in an increase in the number of wells plugged and thus decrease the threats to groundwater quality.[345]

The Bandera County River Authority & Groundwater Conservation District, which has both groundwater and surface water responsibilities, does not charge for plugging abandoned wells, noting that many landowners can't afford the cost, and will often hide rather than address the problem. It costs around $700 per well for the Bandera County River Authority & Groundwater Conservation District to plug a well, and the district averages one per month. The estimate only includes cost of materials and not staff or equipment. Funds for well-plugging come out of their operating costs and the District has no dedicated staff for this effort.[346]

The Edwards Aquifer Authority provides free well logging services to owners of abandoned wells to facilitate the process of reaching compliance with state and local law. The Authority also has a financial assistance program available for landowners who agree to plug an abandoned well ($250,000/year). However, use of the program has been limited and sporadic due to the requirement that the well owner demonstrate financial need to be eligible for the program. The EAA has identified 279 abandoned or deteriorated wells in its jurisdiction. [347]

The Gonzales County Underground Water Conservation District's well plugging program began in FY 2016 and budgeted over $200,000 to assistance land owners in plugging deteriorated and abandoned wells. They developed a cost share program in which the district pays 90% of the costs and the landowner pays the remaining 10%. The District has seen well plugging costs range from $1,600 for a shallow hand-dug well to $17,000 for wells that were 2,500 feet deep. The district's registered well data base lists over 157 water wells that were completed over 40 years ago and they are systematically reviewing the wells to determine current condition and operation status.[348]

Notice and Awareness

Many landowners are unaware of abandoned or deteriorated wells on their property. It is unfortunate that these landowners inherited a problem that is not only costly, but an environmental and safety hazard. In the instance of the Edwards Aquifer Authority, in order to provide more awareness to purchasers, the Authority started applying a notice to the deed on the property that if the property were to change hands that purchasers were notified that they will an abandoned well on site that will require their attention.[349]

Educational efforts, such as the TGPC's *Landowner's Guide to Plugging Abandoned Water Wells* (TCEQ 2010) and the associated video, may initiate some abandoned well plugging.[350]

Prioritization

With the numerous abandoned or deteriorated wells across the state and the high cost associated with plugging them, prioritization of these wells is crucial. There are 279 abandoned Edwards Aquifer wells and the Edwards Aquifer Authority knows that they can not get to them all quickly. To determine priority in their jurisdiction, the Authority looks at the location, surrounding development and what kind of materials are in the area to rank each well by risk. Criteria for wells that pose the greatest threat to the Aquifer include: abandoned well conditions and proximity to contaminants and criteria for which wells can most effectively be plugged include: cost and time-sensitivity are considered.[351]

Recent Legislative Efforts

During the 85th Legislative Session, both the Texas House of Representatives and the Texas Senate attempted to address some of the issues related to abandoned or deteriorated wells and passed HB 3025 (85R) by Rep. Tracy King. HB 3025 would have adopted uniform terminology and definitions in both the Occupations Code and the Water Code, and set deadlines for capping, repairing, or plugging abandoned or deteriorated wells. It also provided GCDs the option to repair instead of plug wells, and put a lien on the landowner's property for the cost of doing so, as districts are already authorized to do for the plugging of wells. The bill also allowed the Bandera County River Authority and Groundwater District the authority to plug wells using properly-trained district employees.[352] HB 3025 passed the House by a vote of 140 Yeas, 4 Nays, 2 Present, not voting, and passed the Senate by a vote of 30 yeas, 1 nay.

On June 15, 2017 Governor Greg Abbott vetoed the bill. In the proclamation he stated:

> "HB 3025 would have authorized a groundwater district to determine when a landowner's well has deteriorated and to compel the landowner to repair the deteriorated well the district's satisfaction. If the landowner does not do so within ten days, the bill authorizes the water district to enter the landowner's land, repair the well, and send the landowner the bill. This would give groundwater districts greater discretion to infringe on private property rights and impose costs on landowners. The legitimate need to repair deteriorated wells should be addressed in a way that provides more protections for landowners."[353]

Even though GCDs already have the authority to enter a landowner's property and cap or plug these wells, the Governor's office said the bill didn't go far enough in limiting that authority.[354]

Recently, after reviewing the enrolled version of HB 3025 the Texas Water Conservation Association (TWCA) Groundwater Committee, representing numerous groundwater stakeholders, agreed to recommend several changes for consideration by the 86th Legislature. The committee's proposed bill would add a provision to allow groundwater conservation districts to cap open or uncovered wells, but does not allow the districts to assess the cost of that process against the landowner. The new version also clarifies the notice provision to make it clear a district may only take action if the landowner fails to resolve the problem within the allotted time frame. There was also a discussion on the proper timeframe for requiring a deteriorated well be plugged because it is difficult to schedule the services of a well driller on short notice. It was pointed out that the authority to plug a well would be limited to those wells causing pollution to groundwater or surface water sources, so quick action may be necessary, and the district would have the same scheduling issues as the landowner. No alternative deadline was proposed so the committee agreed to keep the deadlines from HB 3025.[355]

Finally, the committee discussed the need to fund well plugging efforts to help provide relief to landowners who may have inherited a problem well from prior owners or lessees, but the committee did not recommend a means of administering or funding such an effort.[356]

RECOMMENDATIONS

The definitions used in Chapter 1901 of the Occupations Code and Chapter 36 of the Water Code should be identical. The definition of "abandoned well" should be amended to clarify when a well is no longer in use and should therefore be plugged.[357]

Groundwater Conservation Districts should be required to determine if a well presents a present danger to human health or the environment before taking action to plug such a well, and the landowner should be given notice of that action and an opportunity to resolve the issue.[358]

Require the Texas Groundwater Protection Committee to develop well-plugging program through TDLR, including a mechanism for prioritization and potential funding mechanisms.

Direct the Texas A&M AgriLife Extension Service to conduct an outreach program in coordination with the Texas Water Resources Institute to provide educational publications, websites, and other resources that could be used by county extension agents and other local and regional agencies in workshops and field days to teach the public how to properly plug and manage abandoned water wells.[359]

WATER DEVELOPMENT OPPORTUNITIES

PUBLIC HEARINGS

The House Committee on Natural Resources held a public hearing on a specific issue related to its Interim Charge #9 related to water development opportunities with Mexico on September 27, 2018 in Brownsville, Texas. The following individuals testified on the charge:

Wayne Halbert, Texas Irrigation Council
Sonny Hinojosa, Texas Irrigation Council
Steven Sanchez, North Alamo Water Supply
Sally Spener, International Boundary and Water Commission, U.S. Section

The following section of this report related to water development opportunities is produced in large part from the oral and written testimony of the individuals listed above.

INTRODUCTION

The state has played a limited role in working to develop water supplies with neighboring states since the construction of several water projects throughout the 20th century. In 1924, Texas and New Mexico worked together to complete the Red River Bluff reservoir for irrigation and hydroelectric power. In 1944, Texas and Oklahoma jointly constructed Lake Texoma primarily for flood control, water supply, and hydroelectric power production, and in 1969, Texas and Louisiana worked together to construct Toledo Bend Reservoir for municipal, industrial, agricultural, and recreational purposes. Not only has Texas missed out on water supply opportunities due to a lack of coordination and dialogue with neighboring states, but deteriorated relationships have also led to costly legal battles over disagreements involving water from the Rio Grande that is being currently being diverted by New Mexico, and whether the Metroplex should have the opportunity to buy water from Oklahoma. In addition, the Rio Grande Valley continues to experience the economic consequences due to Mexico's inconsistent water deliveries to Texas from the Rio Grande.

Given the compression on Texas' water resources, the state should recognize water supply opportunities outside its borders, and work to foster a dialogue with the leaderships of neighboring states as a long-term water strategy. The committee was tasked with evaluating water development opportunities with neighboring states and Mexico.

BACKGROUND

Agency Oversight/Statutory Regulation of Interstate Water Issues

Texas is a party to five interstate river compacts. These compacts apportion the waters of the Canadian, Pecos, Red, and Sabine rivers and the Rio Grande between the appropriate states. Interstate compacts form a legal foundation for the equitable division of the water of an interstate stream with the intent of settling each state’s claim to the water.

The TCEQ’s Rio Grande Watermaster program (and water users in the Rio Grande) depend upon water deliveries under the 1944 Treaty. The Rio Grande Watermaster Program monitors deliveries under the 1944 Treaty to ensure that Texas receives its share of the waters of the Rio Grande. The TCEQ provides technical support for Treaty negotiation efforts with the International Boundary and Water Commission and between Texas and Mexico. TCEQ provides technical and administrative support. Examples include the following:

Technical Assistance and Support:

- Monitoring water deliveries, reservoir levels and water rights for compliance
- Conducting complex accounting of required water deliveries from/to other states
- Providing advice and support on technical and engineering activities and projects sponsored by the commissions
- Preparing reports and information for the commissioner in preparation for meetings
- Attending commission annual meetings for and/or with the commissioner

- Attending Engineer Advisor meetings to gather and provide information in preparation for the annual meetings
- Attending meetings and conferences to provide information related to the compact
- Attending meetings for federal or state projects concerning the compact issues
- Communications with other member states, state and federal agencies, and stakeholders
- Preparing and distributing commission reports, information and resolutions
- Maintaining commission documentation, data and permanent files
- Organizing and preparing materials for meetings when hosted by Texas

Administrative Assistance and Support:

- Maintaining the compact commission web pages on the TCEQ website
- Maintaining compact contact information and directories

International Boundary and Water Commission (IBWC)

The U.S. Section of the International Boundary and Water Commission (USIBWC), is a federal government agency and the U.S. component of the International Boundary and Water Commission (IBWC), which applies the boundary and water treaties of the United States and Mexico and settles differences that may arise in their application.[360]

The IBWC has two sections – the United States Section (USIBWC) and the Mexican Section. The United States Section is an independent federal commission that receives foreign policy guidance from the U.S. Department of State. The IBWC is both an engineering and diplomatic agency, seeking technical and diplomatic solutions to boundary and water issues. Current responsibilities of the Commission include determination and accounting for the national ownership of waters, operation and maintenance of international dams, and Rio Grande flood control, among many others.[361]

DISCUSSION AND CHALLENGES

Oklahoma

The State of Oklahoma, with a population of approximately 4 million, has vast a supply of excess water which flows into the Red River. While in the Red River, the water acquires a saline load which renders its use economically impracticable for municipal purposes and ultimately flows into the Gulf of Mexico, wasted for beneficial use. The Oklahoma Water Resources Board, responsible for water allocations in Oklahoma, itself confirmed in 2002 that a single river in southern Oklahoma, the Kiamichi, could supply all of the water needs of New York City, and that Oklahoma's southern river basins (all south and downstream of its major population centers) could support more than *three* New York City populations. On the Texas side of the Red River, the rapidly growing Metroplex, with a current population of approximately 8 million, faces an undersupply of water in the coming decades without the construction of major water development projects, such as new reservoirs, which will require the acquisition of thousands of

acres of land now in private hands through negotiation or exercise of the power of eminent domain.[362]

For approximately twenty years the Tarrant Regional Water District (TRWD), which supplies raw water to approximately 2 million people, has, together with other Texas water suppliers, sought to purchase surplus Oklahoma water for transportation to North Texas. For political reasons, Oklahoma has strenuously resisted such overtures, and its Legislature in fact passed a statutory moratorium on the export of water pending a "study" which has never been conducted.[363]

As a result, TRWD, filed a lawsuit against Oklahoma in 2007 alleging that the Oklahoma water embargo violated the U.S. Constitution. Ultimately the U.S. Supreme Court rendered an opinion in Oklahoma's favor based primarily upon an interpretation of the Red River Compact, an interstate compact which addresses use of water from the Red River. To this day, Oklahoma's vast excess water flows into the Red River and on to the Gulf of Mexico, with no economic value.[364]

Natural Resources Committee Chairman Lyle Larson has visited with state leadership in Oklahoma City to open up a dialogue regarding the potential for a future transaction with Oklahoma. While many interested parties have indicated an interest in selling water to Texas, political opposition in southeastern Oklahoma remains strong.

Arkansas

Informal conversations about acquiring surface water rights in Arkansas for the Metroplex region have taken place between entities in Texas and Arkansas, but there doesn't appear that any formal studies or negotiations are taking place presently.

New Mexico

The Rio Grande Compact, ratified in 1939, divided the waters of the Rio Grande among the signatory states of Colorado, New Mexico, and Texas from its source in Colorado to Fort Quitman, Texas. The compact did not contain specific wording regarding the apportionment of water in and below Elephant Butte Reservoir. However, the compact was drafted and signed against the backdrop of the 1915 Rio Grande Project and a 1938 U.S. Bureau of Reclamation contract that referred to a division of 57 percent to New Mexico and 43 percent to Texas. The compact contains references and terms to ensure sufficient water to the Rio Grande Project.[365]

The project serves the Las Cruces and El Paso areas and includes Elephant Butte Reservoir, along with canals and diversion works in New Mexico and Texas. The project water was to be allocated according to the 57:43 percent division, based on the relative amounts of project acreage originally identified in each state. Two districts receive project water: Elephant Butte Irrigation District (EBID), in New Mexico, and El Paso County Water Improvement District No. 1 (EP #1), in Texas. The latter supplies the city of El Paso with about half of its water.[366]

In 2008, after 20 years of negotiations, the two districts and the Bureau of Reclamation completed an operating agreement for the Rio Grande Project. The agreement acknowledged the 57:43 percent division of water and established a means of accounting for the allocation. The agreement was a compromise to resolve major issues regarding the impact of large amounts of groundwater development and pumping in New Mexico that affected water deliveries to Texas.[367]

But significant compliance issues continue regarding New Mexico's water use associated with the Rio Grande Compact. In 2011, New Mexico took action in federal district court to invalidate the 2008 operating agreement. In response to the lawsuit and in coordination with the Legislative Budget Board and the Attorney General's Office, the Rio Grande Compact Commission of Texas hired outside counsel and technical experts with specialized experience in interstate water litigation to protect Texas' share of water.[368]

In January 2013, Texas filed litigation with the U.S. Supreme Court. A year later, the Supreme Court granted Texas' motion and accepted the case. Subsequently, the United States filed a motion to intervene as a plaintiff on Texas' side, which was granted.[369]

As Texas develops information to support its position, evidence grows that New Mexico's actions have significantly affected, and will continue to affect, water deliveries to Texas. On Nov. 3, 2014, the Supreme Court appointed a special master in this case with authority to fix the time and conditions for the filings of additional pleadings, to direct subsequent proceedings, to summon witnesses, to issue subpoenas, and to take such evidence as may be introduced. The special master was also directed to submit reports to the Supreme Court as he may deem appropriate.[370]

A "special master" is appointed by the Supreme Court to carry out actions on its behalf such as the taking of evidence and making rulings. The Supreme Court can then assess the special master's ruling much as a normal appeals court would, rather than conduct the trial itself. This is necessary as trials in the United States almost always involve live testimony and it would be too unwieldy for nine justices to rule on evidentiary objections in real time.[371]

Motions to Intervene filed by EP#1 and EBID were referred to the special master. Following a hearing on the motions conducted August 19–20, 2016, the special master filed his First Interim Report with the Supreme Court on Feb. 13, 2017. He recommended denying the motions to intervene filed by EP#1 and EBID as well as New Mexico's motion to dismiss. The First Interim Report was also very favorable to Texas' position.[372]

The Supreme Court ruled on Oct. 10, 2017: the motion of New Mexico to dismiss Texas's complaint was denied; the motions of EBID and EP#1 to intervene were denied; the motions of New Mexico State University and New Mexico Pecan Growers for leave to file briefs as amicus curiae were granted. The exception of the United States and the first exception of Colorado to the First Interim Report of the Special Master were heard during oral arguments by the Supreme Court on Jan. 8, 2018. On March 5, 2018, the Supreme Court ruled that the United States may pursue the compact claims it has pleaded in the litigation and all other exceptions were denied.[373]

A new special master was appointed by the Supreme Court on April 2, 2018. New Mexico filed a response to Texas' complaint on May 22, 2018, denying the allegations and filed counterclaims against Texas and the United States. Responses to New Mexico were submitted on July 20, 2018. It is anticipated that discovery will commence Sept. 1, 2018, with a trial expected in the spring of 2020.[374]

In summary, Texas is arguing that by allowing southern New Mexico farmers to pump groundwater, which is hydrologically connected to the Rio Grande, New Mexico isn't sending enough water downstream to Elephant Butte Reservoir in accordance with the Rio Grande Compact. If Texas wins, the consequences for New Mexico will be significant. According to reports, New Mexico could owe billions of dollars in damages, and southern farmers could be forced to curtail groundwater pumping. Even $1 billion would represent 20% of New Mexico's annual budget. Already, in just four years, New Mexico has spent about $15 million on the case. Texas has spent approximately $10 million on the case.

In a similar case against New Mexico regarding the Pecos River, a tributary of the Rio Grande, the courts ruled for Texas and New Mexico was required to pay $10-12 million cash damages in addition to guaranteed delivery of water which meant purchasing $250-300 million worth of land along the Pecos River.

House Natural Resources Committee Chairman Lyle Larson has traveled to New Mexico to meet with members of the New Mexico Legislature and State Engineer about future collaboration to develop projects that will serve the increased water needs of both states, instead of continuing down the path of drawn-out legal disputes. These discussions are ongoing.

Louisiana

The idea of Texas buying water from Louisiana dates has been proposed in various forms. In the 1960s, Texas had a water plan that postulated that the state would one day require a direct link to the Mississippi. In 1963, the two states jointly completed construction on Toledo Bend Reservoir located on the Texas-Louisiana border in the Sabine River basin.

One of the largest man-made reservoirs in the United States, Toledo Bend was conceived, licensed, developed and primarily functions as a water supply facility, with hydroelectric power as a secondary use. Specifically, in the original license obtained for Toledo Bend in 1963 from the predecessor agency of the Federal Energy Regulatory Commission (FERC), it was stated that the project would be operated "to obtain the maximum befits from navigation, recreation, fish and wildlife, reclamation, and flood control to the extent that those uses are consistent with the primary purposes of water supply for municipal, industrial, and irrigation and hydroelectric power generation." These priorities continue to exist today.

Toledo Bend's annual water supply "firm yield" has been determined to be 2,086,600 acre-feet, half of which (i.e., 1,043,300 acre-feet) is apportioned to the Sabine River Authority of Louisiana, with the other half apportioned to the Sabine River Authority of Texas. However, the SRA-LA historically uses less than 3% of its annual water allocation, thereby failing to realize any benefits from the remaining allowable yield, which flows into the Gulf of Mexico each year.

Due to the historic lack of water sales, the SRA-LA generates revenue by releasing water for hydropower generation at a price less than $.01/1,000 gallons. Water released for hydropower generation is heavily concentrated during the summer months, resulting in more than 1 million acre-feet being withdrawn and utilized between May and September, when recreational use of Toledo Bend is at its peak.

In 2011, private interests developed a proposal to finance, sell, supply, store, transport, and distribute water from Toledo Bend Reservoir to customers in Texas. As part of the project, the SRA-LA would reserve and sell a portion of its excess, unused water allocation in Toledo Bend (up to 600,000 acre-feet) at a contracted water price is more than 25x times greater than that which is currently earned from hydropower generation. Proceeds to the SRA-LA were expected to be approximately $54 million. While the project intended to create a “win-win” scenario in which the growing water needs of Texas would be met and dollars from Texas would benefit Louisiana, which has abundant water resources, the project met political challenges in Louisiana, and ultimately failed when the Governor of Louisiana declined to authorize the project as required by state law.

Since this time, Louisiana has undertaken a water study to look at selling water to Texas. Meetings between Chairman Larson and Louisiana state leadership have taken place to encourage the development of a future sale. Discussions among the leadership of both states to improve this relationship and aid in the development of future transactions.

The 1906 Convention and 1944 Water Treaty with Mexico

Two international treaties have a major impact on water supplies available to Texas. The 1906 convention between the United States and Mexico apportions the waters of the Rio Grande Basin above Fort Quitman, Texas, while the 1944 treaty between the United States and Mexico apportions the waters of the basin below Fort Quitman.

Mexico continues to under-deliver water to the United States under the 1944 Treaty. Mexico does not treat the United States as a water user and only relies on significant rainfalls to make deliveries of water. This stands in contrast to the manner in which the United States treats Mexico with regard to the Colorado River. In fact, the United States has always supplied Mexico its annual allocation from the Colorado River. The Colorado River and the Rio Grande are both covered by the same 1944 water treaty.

A related issue concerns the accounting of waters in the Rio Grande at Fort Quitman. While the 1906 convention clearly granted 100 percent of all waters below El Paso to Fort Quitman to the United States, the International Boundary and Water Commission has allocated the waters equally between the United States and Mexico.

The committee heard testimony from interested parties at its hearing in Brownsville related to the 1944 Treaty. Under the Treaty, Mexico is required to deliver 350,000 acre-feet of Rio Grande water on a consistent basis to Texas, though it seldom complies, frequently abusing a provision that exempts compliance if they claim "extraordinary drought or serious accident", leaving farmers and cities in the Rio Grande Valley at the mercy of their release schedule.

Meanwhile, the United States has a spotless record honoring its obligation under the Treaty to provide 1.5 million acre-feet from the Colorado River, nearly five times the amount of water, to Mexico.[375]

To satisfy terms of the Treaty currently, Mexico regularly holds water in their reservoir systems at as much as 200 percent of conservation capacity rather than releasing water to the Rio Grande. At the end of the five-year cycles, Mexico also utilizes the interpretations of Minute No. 234 to accomplish compliance by transferring Mexico water in Amistad and Falcon to the U.S. account, and/or receiving credit for water the U.S. was able to utilize from other Mexico tributaries below the dams.[376]

Proponents of this last practice will argue that this is extra water for U.S. use for which there was no access prior. When in fact, the U.S. has always had access to this water which is destined for the Gulf regardless of whether the U.S. has need of it or not.[377] For the initial 50 years of the Treaty, this water was made available for either side of the river at no charge to any water accounts and with no credits to Mexico for its use by the U.S.[378] Under current practices, as sanctioned by the State of Texas, Mexico receives credit for this water, and Texas water rights holders are charged against their water accounts by the TCEQ's Rio Grande Watermaster for the use of it.[379]

For every acre-foot of water Mexico is able to utilize to satisfy its debt by accounting for water diverted below Falcon Dam, the Rio Grande system upriver is deprived of three acre feet.[380] Theoretically, Mexico could completely satisfy its delivery obligations to the U.S. using this type of water accounting, and it would "starve" the Rio Grande of at least 1,050,000 acre-feet of water per year.[381]

If these practices are allowed to continue, they will lead to disastrous consequences to the lower reach of the Rio Grande system, including reduced flows through the Big Bend area, lower water elevations and storage at Amistad and Falcon, and significant ecological consequences from the Rio Conchos to the Gulf of Mexico.[382]

The North Alamo Water Supply Corporation has developed numerous brackish desalination plants due to the unreliable nature of water from the Rio Grande due to Mexico's deficits of water deliveries over the years, and eventually the region will likely invest in seawater desalination. They have noted that if the federal government will not enforce the 1944 Treaty and ensure regular water deliveries from the Rio Grande, it should provide funding to assist in the construction of these more expensive water supply alternatives.[383]

According to a recent study by the Texas A&M Agrilife Extension Service, the loss of irrigated crop production in the Lower Rio Grande Valley region due to water shortages will result in an estimated $343.5 million loss in economic output over a five-year period.[384]

Current Status of Deliveries

The current five-year cycle began on October 25, 2015. Mexico delivered:

- 482-thousand acre-feet in year 1 of which 263-thousand acre-feet were credited to the previous cycle's debt and 219-thousand acre-feet to the current cycle;
- 565-thousand acre-feet in year 2;
  and, for year 3, 151-thousand acre-feet as of September 15, 2018.[385]

Mexico has been up-to-date in its five-year cycle deliveries to the United States and is meeting the minimum annual average specified in the treaty. Because of recent wet conditions, we are seeing Mexican reservoirs filling and we are likely to see increased deliveries from Mexico's tributaries in the immediate future as often occurs this time of year. Although there is not currently a water debt, there are concerns about the unpredictability of Mexico's Rio Grande water deliveries to the United States. [386]

Efforts to improve deliveries

In 2013, the 83rd Legislature passed HCR 55 by Rep. Lucio urging the U.S. Department of State to take appropriate action to ensure that Mexico complies with the 1944 Treaty regarding shared water resources and that it make required water deliveries to the United States a priority.[387]

Over the past several years, House Natural Resources Committee Chairman, Rep. Lyle Larson, has also sent numerous pieces of correspondence to the IBWC, members of the U.S. Senate and Congress, the U.S. Department of State, and the Office of the President urging a change in strategy at the federal level.

In April 2017, officials from the IBWC, United States and Mexico, met at the Texas State Capitol with representatives from Mexico's National Water Commission and the State of Texas and agreed to form a binational Rio Grande Hydrology Work Group. The United States representatives expressed their goal for the Hydrology Work Group to be a vehicle for increased transparency regarding basin operations and to use RiverWare modeling as a tool for basin management.

Since then, this binational Hydrology Work Group has met regularly in person and via webinar. It has developed a binational, comprehensive base model using RiverWare that incorporates infrastructure, historical records, and current system operations. The U.S. members of the Hydrology Work Group include modelers from the Texas Water Development Board and Texas Commission on Environmental Quality.[388]

In the near future, this model is expected to be ready to begin running water delivery scenarios, which consider proposed management strategies or policies under an array of hydrological conditions. That way, we will be able to see how diverse scenarios would perform in providing equitable shares of water to U.S. and Mexican users, based on historical data incorporated into the model. With these modeling results, a separate Policy Work Group, which also includes participation from the State of Texas, will be able to develop policy recommendations that could be implemented to improve the predictability and reliability of water deliveries to users in both countries.[389]

While these efforts led by IBWC, under pressure from state and federal officials, shows some promise, decades of neglect on this have left many long-time observers of this issue in the Rio Grande Valley skeptical that it will achieve a change in policy.

As another important recent update, Jayne Harkins was appointed to be the new U.S. Commissioner of the International Boundary and Water Commission by President Trump in 2018, replacing the previous Commissioner who had served in the post since 2008. New leadership at the agency may also present new opportunity for securing long-term consistent water deliveries from Mexico.

RECOMMENDATIONS

Continue to engage the state leadership in each of the states contiguous to Texas to foster cooperation in a long-term water strategy.

Pass a resolution calling on the federal government to amend the 1944 Treaty to require Mexico to commit to a firm water delivery schedule going forward, and if the federal government fails to do so, to fund water projects in the Rio Grande Valley to make up for inconsistent water deliveries from the Rio Grande.

ENDNOTES

[1] Oral and Written Testimony of Bech Bruun, Chairman, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[2] Texas General Land Office, *Hurricane Harvey: Texas at Risk* (2018).
[3] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[4] Texas General Land Office, *Hurricane Harvey: Texas at Risk* (2018).
[5] *Id.*
[6] Texas Commission on Environmental Quality, *Biennial Report to the 86th Legislature: FY 2017-FY2018* (December 2018).
[7] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[8] Oral and Written Testimony of The Honorable Brannick, County Judge, Jefferson County, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[9] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[10] Oral and Written Testimony from John Dupnik, Deputy Executive Administrator, Office of Water Science and Conservation at Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[11] Chairman Lyle Larson Letter to Chairman Peter Lake, Texas Water Development Board, April 23, 2018.
[12] Oral and Written Testimony of John Dupnik, Deputy Executive Administrator, Office of Water Science and Conservation at Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *Id.*
[17] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[18] *Id.*
[19] *Id.*
[20] Oral and Written Testimony of John Deputy Executive Administrator, Office of Water Science and Conservation at Dupnik, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[21] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[22] Oral and Written Testimony of John Dupnik, Deputy Executive Administrator, Office of Water Science and Conservation at Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[23] *Id.*
[24] *Id.*
[25] Oral and Written Testimony of Stephen Costello, Chief Resiliency Officer, City of Houston, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[26] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[27] *Id.*
[28] *Id.*
[29] *Id.*
[30] Oral and Written Testimony of Russ Poppe, Harris County Flood Control District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[31] Oral and Written Testimony of Stephen Costello, Chief Resiliency Officer, City of Houston, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[32] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[33] Texas Water Conservation Association Flood Response Committee, *Flooding in Texas: Preparation and Response*, Fall 2018.
[34] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[35] Oral and Written Testimony of Stephen Costello, Chief Resiliency Officer, City of Houston, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[36] Texas Water Conservation Association Flood Response Committee, *Flooding in Texas: Preparation and Response*, Fall 2018.

[37] Oral and Written Testimony of Russ Poppe, Harris County Flood Control District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[38] Texas Water Conservation Association Flood Response Committee, *Flooding in Texas: Preparation and Response*, Fall 2018.
[39] A rare exception to this may occur if the structural integrity of the dam is in jeopardy. Under such a scenario, it may be necessary to release stored water to save the dam. However, this is done only under emergency conditions and to prevent catastrophic flooding and loss of life.
[40] Texas Water Conservation Association Flood Response Committee, *Flooding in Texas: Preparation and Response*, Fall 2018.
[41] Oral and Written Testimony of Dr. Robert Mace, Deputy Executive Administrator, Office of Water Science and Conservation at Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[42] Oral and Written Testimony of Stephen Costello, Chief Resiliency Officer, City of Houston, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[43] Texas Water Conservation Association Flood Response Committee, *Flooding in Texas: Preparation and Response*, Fall 2018.
[44] *Id.*
[45] Oral and Written Testimony of Jim Bradbury, Ag Land Trust and Texas Land Trust Council, Public Hearing, Texas House of Representatives Committee on Natural Resources, Houston, Texas, Oct. 4, 2017.
[46] Texas Water Development Board, *State Flood Assessment- Report to the 86th Texas Legislature* (2018).
[47] *See Sipriano v. Great Spring Waters of Am., Inc.*, 1 S.W.3d 75, 78-80 (Tex. 1999), *City of Corpus Christi v. City of Pleasanton*, 276 S.W.2d 798, 799 (Tex. 1955).
[48] TEX. WATER CODE § 36.0015.
[49] Texas Water Conservation Association, *The Application of Oil and Gas Law to Groundwater: Analyzing Correlative Rights and Co-Called "User-Based Rules,"* (2017).
[50] Oral and Written Testimony of Kody Bessent, Plains Cotton Growers, Inc., Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[51] *Id.*
[52] TEX. WATER CODE § 36.0015(b) (West 2015).
[53] *See id.* § 36.101(a).
[54] *See id.* § 36.113.
[55] *Id.* §§ 36.1132(a)-(b), 36.3011(b)(7)-(9),(h)(7)-(9).
[56] *Id.* § 36.108.
[57] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[58] Oral and Written Testimony of Russ Johnson, McGinnis Lochridge, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[59] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[60] TEX. WATER CODE § 36.1132(a).
[61] *Id.* § 36.1132(b).
[62] *Id.* § 36.3011(b)(7)-(9),(h)(7)-(9).
[63] Oral and Written Testimony of Kody Bessent, Plains Cotton Growers, Inc., Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[64] *Id.*
[65] Oral and Written Testimony of Russ Johnson, McGinnis Lochridge, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[66] *Id.*
[67] *Id.*
[68] Oral and Written Testimony of Marty Jones, Sprouse Shrader Smith PC, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[69] TEX. WATER CODE § 36.1083(n).
[70] TEX. WATER CODE § 36.1083(p).
[71] Oral and Written Testimony of Marty Jones, Sprouse Shrader Smith PC, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[72] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing,

Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[73] *Id.*
[74] Oral and Written Testimony of C.E. Williams, Panhandle Groundwater Conservation District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[75] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[76] Oral and Written Testimony of C.E. Williams, Panhandle Groundwater Conservation District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[77] Texas Water Conservation Association, *The Application of Oil and Gas Law to Groundwater: Analyzing Correlative Rights and Co-Called "User-Based Rules,"* (2017).
[78] Oral and Written Testimony of Shauna Fitzsimmons Sledge, Sledge Law Group PLLC, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[79] *Id.*
[80] *Id.*
[81] *Id.*
[82] *Id.*
[83] *Id.*
[84] *Id.*
[85] *Id.*
[86] Oral and Written Testimony of Shauna Fitzsimmons Sledge, Sledge Law Group PLLC, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[87] *Id.*
[88] Shauna Fitzsimmons Sledge, *Understanding Groundwater Production Allocation and the Permitting Process in Texas, Changing Face of Water Law*, State Bar of Texas (2018).
[89] *Id.*; *see also* Edwards Aquifer Authority v. Bragg, 421 S.W.3d 118, 142 (Tex. App.—San Antonio, Nov. 13, 2013, pet. denied) (finding that the groundwater permitting regulations which interfered with the reasonable investment-backed expectations of the landowner weighed heavily in favor of the court's decision that a compensable taking had occurred).
[90] Shauna Fitzsimmons Sledge, *Understanding Groundwater Production Allocation and the Permitting Process in Texas, Changing Face of Water Law*, State Bar of Texas (2018).
[91] TEX. WATER CODE § 36.116(c).
[92] *See id.* § 36.1132(a)-(b).
[93] Shauna Fitzsimmons Sledge, *Understanding Groundwater Production Allocation and the Permitting Process in Texas, Changing Face of Water Law*, State Bar of Texas (2018).
[94] *Id.*
[95] TEX. WATER CODE § 36.116(a)(1)(A)-(C).
[96] *Id.* § 36.116(a)(1)(A).
[97] *Id.* § 36.116(a)(1)(B).
[98] *See id.* § 36.002(d)(1) (recognizing districts' authority to limit or prohibit the drilling of a well by a landowner for failure or inability to comply with minimum well spacing or tract size requirements adopted by the district).
[99] Shauna Fitzsimmons Sledge, Understanding Groundwater Production Allocation and the Permitting Process in Texas, Changing Face of Water Law, State Bar of Texas (2018).
[100] Oral and Written Testimony of Rep. Burns on HB 3028, Public Hearing, Texas House of Representatives Committee on Natural Resources-S/C on Special Water Districts, Austin, Texas, April 10, 2018.
[101] Texas Water Conservation Association, The Application of Oil and Gas Law to Groundwater: Analyzing Correlative Rights and Co-Called "User-Based Rules," (2017).
[102] *Id.*
[103] House Bill 3028, 85th Texas Legislature Regular Session, 2017.
[104] Oral and Written Testimony of Wade Oliver, INTERA, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[105] Oral and Written Testimony from Doug Shaw, General Manager, Upper Trinity Groundwater Conservation District Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, Sept. 27, 2018.
[106] Oral and Written Testimony of Brian Sledge, Sledge Law LLC, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, Sept. 27, 2018.
[107] Oral and Written Testimony of Shauna Fitzsimmons Sledge, Sledge Law Group PLLC, Public Hearing, Texas

House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[108] *Id.*
[109] *Id.*
[110] *Id.*
[111] *Id.*
[112] *Id.*
[113] *Id.*
[114] *Id.*
[115] *Id.*
[116] Oral and Written Testimony of Edmond McCarthy, Self, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[117] *Id.*
[118] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[119] *Id.*
[120] Attorney General Onion No. KP-0216, *available at* https://www2.texasattorneygeneral.gov/opinions/opinions/51paxton/op/2018/kp0216.pdf?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=%5C.
[121] *Id.* at 3.
[122] *Id.* (citing *Guitar Holding Co. v. Hudspeth Cty. Underground Water Conservation Dist. No. 1*, 263 S.W.3d 910, 916 (Tex. 2008)).
[123] *Id.* at 4.
[124] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[125] *Id.*
[126] *Id.*
[127] *Id.*
[128] Oral and Written Testimony of Hope Wells, San Antonio Water System, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[129] *Id.*
[130] *Id.*
[131] House Bill 31, 85th Texas Legislature, Regular Session, 2017.
[132] House Bill 2378, 85th Texas Legislature, Regular Session, 2017.
[133] *See* TEX. WATER CODE 36.116(a)(2)(A)-(F).
[134] *Id.* § 36.116(a)(2)(A)-(F).
[135] TEX. WATER CODE § 36.116(c).
[136] House Bill 3356, 84th Texas Legislature, Regular Session, 2015.
[137] House Bills 645 and 1318, 85th Texas Legislature, Regular Session, 2017.
[138] Oral and Written Testimony from Lara Zent, Executive Director, Texas Rural Water Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[139] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[140] *Id.*
[141] *Id.*
[142] Oral and Written Testimony of Lynn Tate, High Plains Water District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[143] Oral and Written Testimony of Hope Wells, Water Resources Counsel, San Antonio Water System, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[144] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[145] Texas Water Development Board, Groundwater Models, http://www.twdb.texas.gov/groundwater/models/index.asp (accessed Dec. 2, 2018).
[146] *Id.*
[147] *Id.*
[148] *Id.*
[149] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of

Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[150] *Id*.
[151] *Id*.
[152] *Id*.
[153] *Id*.
[154] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[155] *Id*.
[156] *Id*.
[157] Oral and Written Testimony of Rick Kellison, Texas Alliance for Water Conservation of Texas Tech University, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[158] Texas Tech University, Texas Alliance for Water Conservation, http://www.depts.ttu.edu/tawc/about.php (accessed Dec. 2, 2018).
[159] Texas Tech University, Texas Alliance for Water Conservation, http://www.depts.ttu.edu/tawc/about.php (accessed Dec. 2, 2018).
[160] Oral and Written Testimony of Rick Kellison, Texas Alliance for Water Conservation of Texas Tech University, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[161] *Id*.
[162] Texas Tech University, Texas Alliance for Water Conservation, http://www.depts.ttu.edu/tawc/about.php (accessed Dec. 2, 2018).
[163] Oral and Written Testimony of Rick Kellison, Texas Alliance for Water Conservation of Texas Tech University, Public Hearing, Texas House of Representatives Committee on Natural Resources, Canyon, Texas, June 5, 2018.
[164] *Surface water-groundwater interaction issues in Texas* by Steven C. Young, Robert E. Mace, and Carlos Rubinstein, December 2018.
[165] *Id*.
[166] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[167] *Surface water-groundwater interaction issues in Texas* by Steven C. Young, Robert E. Mace, and Carlos Rubinstein, December 2018.
[168] *Surface water-groundwater interaction issues in Texas* by Steven C. Young, Robert E. Mace, and Carlos Rubinstein, December 2018.
[169] *Id*.
[170] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[171] Texas Water Development Board, Val Verde County Groundwater Study, https://www.twdb.texas.gov/groundwater/special_projects/valverde/index.asp (accessed on Dec. 10, 2018).
[172] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[173] *Id*.
[174] *Id*.
[175] *Id*.
[176] *Id*.
[177] *Id*.
[178] *Id*.
[179] Oral and Written Testimony of James McBee, Landowner, Val Verde County, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[180] Oral and Written Testimony of Dell Dickinson, Devil's River Conservancy, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[181] Oral and Written Testimony of David Honeycutt, Self, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[182] Oral and Written Testimony of James McBee, Landowner, Val Verde County, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[183] Oral and Written Testimony of Randy Nunns, Devil's River Conservancy, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[184] Oral and Written Testimony of Larry French, Texas Water Development Board, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.

[185] Oral and Written Testimony of Randy Nunns, Devil's River Conservancy, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[186] Oral and Written Testimony by Carlos Rubinstein, RSAH2O, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[187] *Id*.
[188] Oral and Written Testimony by Chloe Lieberknecht, The Nature Conservancy, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[189] *Id*.
[190] Excludes river authority water supply contracts, and $103 million Canadian River Municipal Water Authority panhandle groundwater purchase in 2011.
[191] WestWater Presentation, http://www.waterexchange.com/wp-content/uploads/2016/02/Texas-Water-Market-PPT.pdf.
[192] Oral and Written Testimony by Clay Landry, WestWater, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[193] *Id*.
[194] *Id*.
[195] *Id*.
[196] *Id*.
[197] Oral and Written testimony by Carlos Rubinstein, RSAH2O, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[198] *Id*.
[199] *Id*.
[200] The Nature Conservancy, *Driving Sustainable Water Management with Market-based Solutions* (Aug. 2016), Giulio Boccaletti, https://global.nature.org/content/driving-sustainable-water-management-with-market-based-solutions.
[201] Oral and Written Testimony by Chloe Lieberknecht, The Nature Conservancy, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[202] *Id*.
[203] *Id*.
[204] *Id*.
[205] *Id*.
[206] Oral and Written Testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[207] *Id*.
[208] AMP Insights, *Texas Groundwater Markets and the Edwards Aquifer: A Case Study for the Political Economy of Water Markets Project* (Oct. 2016), Amy Hardberger, https://static1.squarespace.com/static/56d1e36d59827e6585c0b336/t/5805468415d5dbb1ab59a3a9/1476740751543/Texas-Groundwater-Markets-Hardberger.pdf.

[210] Attorney General Opinion No. KP-0216, *available at* https://www2.texasattorneygeneral.gov/opinions/opinions/51paxton/op/2018/kp0216.pdf?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=.
[211] Oral and Written Testimony by Charles Porter, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[212] *Id*.
[213] Oral and Written Testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[214] Oral and Written Testimony by Carlos Rubinstein, RSAH2O, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[215] *Id*.
[216] *Id*.
[217] *Id*.
[218] Memo from Meadows Foundation, Nov. 9, 2018.
[219] *Id*.
[220] Memo from Texas Water Development Board, Nov. 9, 2018.
[221] *Id*.

[222] Memo from Meadows Foundation, Nov. 9, 2018.
[223] *Id.*
[224] Memo from Texas Water Development Board, Nov. 9, 2018.
[225] *Id.*
[226] *Id.*
[227] Memo from Meadows Foundation, Nov. 9, 2018.
[228] *Id.*
[229] *Id.*
[230] *Id.*
[231] Oral and Written Testimony of Michael Harman, Harman Friday, Inc. Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[232] Memo from Meadows Foundation, Nov. 9, 2018.
[233] Email from Carlos Calle, Texas Department of Legislative Affairs, Dec. 12, 2018.
[234] Memo from TCEQ: Take Care of Texas Overview, Nov. 15, 2018.
[235] Email from Isaac Jackson, Legislative Liaison, Texas Commission on Environmental Quality on Dec. 10, 2018.
[236] *Id.*
[237] *Id.*
[238] *Id.*
[239] Oral and Written Testimony of Linda Christie, Tarrant Regional Water District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[240] *Id.*
[241] *Id.*
[242] *Id.*
[243] Oral and Written Testimony of Dana Nichols, San Antonio Water System, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[244] *Id.*
[245] *Id.*
[246] *Id.*
[247] *Id.*
[248] *Id.*
[249] *Id.*
[250] *Id.*
[251] Texas Education Agency, Texas Essential Knowledge and Skills (TEKS), https://tea.texas.gov/curriculum/teks/.
[252] Texas Education Agency, Science TEKS Streamlining, https://tea.texas.gov/Academics/Curriculum_Standards/TEKS_Texas_Essential_Knowledge_and_Skills_(TEKS)_Review/Science_TEKS_Streamlining/.
[253] Phone call with Monica Martinez, Associate Commissioner of Standards and Support Services, Texas Education Agency, Oct. 5, 2018.
[254] *Id.*
[255] Oral and Written Testimony of Linda Christie, Tarrant Regional Water District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[256] Oral and Written Testimony of Dana Nichols, San Antonio Water System, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[257] Oral and Written Testimony of Linda Christie, Tarrant Regional Water District, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, Oct. 16, 2018.
[258] *Id.*
[259] *Id.*
[260] Phone call with Monica Martinez, Associate Commissioner of Standards and Support Services, Texas Education Agency, Oct. 5, 2018.
[261] Oral and Written Testimony of Trey Lary, Allen Boone Humphries Robinson LLP, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[262] *Id.*
[263] *Id.*
[264] *Id.*
[265] *Id.*
[266] *Id.*

[267] Oral and Written Testimony from Tammy Benter, Public Utility Commission of Texas, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[268] *Id*.
[269] Oral and Written Testimony of Lara Zent, Texas Rural Water Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[270] Oral and Written Testimony of Trey Lary, Allen Boone Humphries Robinson LLP, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[271] Oral and Written Testimony of Joe Freeland, City of Tyler, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[272] Oral and Written Testimony of Scott Norman, Texas Association of Builders, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[273] *Id*.
[274] *Id*.
[275] Oral and Written Testimony of Trey Lary, Allen Boone Humphries Robinson LLP, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[276] *Id*.
[277] *Id*.
[278] Oral and Written Testimony of Joe Freeland, Texas Association of Builders, Public Hearing, Texas House of Representatives Committee on Natural Resources, Brownsville, Texas, September 27, 2018.
[279] Oral and written testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[280] *Id*.
[281] Texas Commission on Environmental Quality, Water Availability Modeling, https://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/wam_trinity10022008.pdf (accessed Nov. 6, 2018).
[282] Oral and written testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[283] *Id*.
[284] Senate Bill 696 by Sen. Perry, 85th Texas Legislature Regular Session, 2017.
[285] *Id*.
[286] Texas Commission on Environmental Quality, What is a water availability model?, https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/wam.html (accessed Nov. 6, 2018).
[287] Oral and written testimony by Bob Brandes, Texas Water Conservation Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[288] Texas Commission on Environmental Quality, Water Availability Modeling, https://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/eflows/wam_trinity10022008.pdf (accessed Nov. 6, 2018).
[289] Texas Commission on Environmental Quality, How are these models used?, https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/wam.html (accessed Nov. 6, 2018).
[290] *Id*.
[291] Oral and written testimony by Bob Brandes, Texas Water Conservation Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[292] *Id*.
[293] Naturalized streamflow represents the flow in a river that would have occurred without human impacts, such as reservoir construction, diversions, and return flows. For most Texas river systems, the naturalized flow encompasses at least a fifty-year period of record that includes the drought of the 1950s, recognized as an extremely severe drought throughout much of the state.
[294] Oral and written testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[295] Email from Isaac Jackson, Legislative Liaison, Texas Commission on Environmental Quality on Nov. 7, 2018
[296] Email from Matt Philips, Legislative and Government Affairs Manager, Brazos River Authority on Nov. 7, 2018
[297] Email from Isaac Jackson, Legislative Liaison, Texas Commission on Environmental Quality on Nov. 7, 2018
[298] Email from Matt Philips, Legislative and Government Affairs Manager, Brazos River Authority on Nov. 7, 2018
[299] Senate Bill 696 by Sen. Perry, 85th Texas Legislature Regular Session, 2017.
[300] Email from Isaac Jackson, Legislative Liaison, Texas Commission on Environmental Quality on Nov. 7, 2018
[301] Email from Tom Oney, General Counsel, Lower Colorado River Authority on Nov. 9, 2018

[302] *Id.*
[303] Email from Isaac Jackson, Legislative Liaison, Texas Commission on Environmental Quality on Nov. 26, 2018
[304] Oral and written testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[305] Oral and written testimony by Bob Brandes, Texas Water Conservation Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[306] Email from Dr. Bob Brandes, Texas Water Conservation Association, on Nov. 7, 2018
[307] Oral and written testimony by Kim Wilson, Texas Commission on Environmental Quality, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[308] *Id.*
[309] *Id.*
[310] Oral and written testimony by Bob Brandes, Texas Water Conservation Association, Public Hearing, Texas House of Representatives Committee on Natural Resources, Waco, Texas, October 16, 2018.
[311] *Id.*
[312] *Id.*
[313] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[314] *Id.*
[315] Oral and Written Testimony of Lee Parham, Texas Department of Licensing and Regulation, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[316] TEXAS OCCUPATIONS CODE, § 1901.255(a)(1).
[317] TEXAS OCCUPATIONS CODE, § 1901.255(a)(2).
[318] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[319] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[320] *Id.*
[321] *Id.*
[322] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[323] Oral and Written Testimony of David Mauk, Bandera County River Authority & GCD, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[324] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[325] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[326] TEXAS WATER CODE, § 36.118(c).
[327] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[328] Oral and Written Testimony of Lee Parham, Texas Department of Licensing and Regulation, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[329] *Id.*
[330] *Id.*
[331] *Id.*
[332] *Id.*
[333] *Id.*
[334] *Id.*
[335] *Id.*
[336] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[337]TEXAS WATER CODE, § 36.0015(b).
[338] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[339] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[340] Oral and Written Testimony of Sarah Schlessinger, Texas Alliance of Groundwater Districts, Public Hearing,

Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[341] *Id.*
[342] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[343] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[344] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[345] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[346] Oral and Written Testimony of David Mauk, Bandera County River Authority & GCD, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[347] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[348] Oral and Written Testimony of Greg Sengelmann, Gonzales County UWCD, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[349] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[350] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[351] Oral and Written Testimony of Roland Ruiz, Edwards Aquifer Authority, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[352] House Bill 3025 by Rep. Tracy King, 85th Texas Legislature, Regular Session, 2017.
[353] Proclamation by the Governor of the State of Texas on June 15, 2017 regarding House Bill 3025 85(R) 2017.
[354] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[355] Email from Greg Ellis, Attorney, Dec. 8, 2018
[356] *Id.*
[357] Oral and Written Testimony of Gregory Ellis, Attorney, Public Hearing, Texas House of Representatives Committee on Natural Resources, Del Rio, Texas, Sept. 13, 2018.
[358] *Id.*
[359] Texas Groundwater Protection Committee, *Report to the 85th Legislature* (January 2017), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/047-16.pdf.
[360] International Boundary and Water Commission, United States and Mexico- United States Section, https://www.ibwc.gov/home.html.
[361] Oral and Written Testimony of Sally Spener, International Boundary and Water Commission, U.S. Section, Public Hearing, Texas House of Representatives Committee on Natural Resources, Austin, Texas, Sept. 27, 2018.
[362] Written Testimony of Linda Christie, Government Affairs Director, Tarrant Regional Water District.
[363] *Id.*
[364] *Id.*
[365] Texas Commission on Environmental Quality, *Biennial Report to the 86th Legislature: FY2017-FY2018* (Dec. 2018), https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/057_18/SFR-057-18-X.pdf.
[366] *Id.*
[367] *Id.*
[368] *Id.*
[369] *Id.*
[370] *Id.*
[371] *Id.*
[372] *Id.*
[373] *Id.*
[374] *Id.*
[375] Chairman Lyle Larson Letter to President Donald Trump, July 2, 2018.
[376] Oral and Written Testimony of Sonny Hinojosa and Wayne Halbert, Texas Irrigation Council, Public Hearing, Texas House of Representatives Committee on Natural Resources, Austin, Texas, Sept. 27, 2018.
[377] *Id.*
[378] *Id.*

[379] *Id*.
[380] *Id*.
[381] *Id*.
[382] *Id*.
[383] Oral and Written Testimony of Steven Sanchez, North Alamo Water Supply, Public Hearing, Texas House of Representatives Committee on Natural Resources, Austin, Texas, Sept. 27, 2018.
[384] Texas A&M AgriLife Extension, *Estimated Economic Impacts of Irrigation Water Shortages on Lower Rio Grande Valley Agriculture* (June 2017), http://cnas.tamu.edu/NEW%20Publications%202017/Estimated%20Economic%20Impacts%20of%20Irrigation%20Water%20Shortages%20on%20LRGV%20Agriculture%20-%20June%202017.pdf.
[385] Oral and Written Testimony of Sally Spener, International Boundary and Water Commission, U.S. Section, Public Hearing, Texas House of Representatives Committee on Natural Resources, Austin, Texas, Sept. 27, 2018.
[386] *Id*.
[387] House Concurrent Resolution 55 by Rep. Lucio, 83rd Texas Legislature Regular Session, 2013.
[388] Oral and Written Testimony of Sally Spener, International Boundary and Water Commission, U.S. Section, Public Hearing, Texas House of Representatives Committee on Natural Resources, Austin, Texas, Sept. 27, 2018.
[389] *Id*.