Down to the Last Drop

2009 UPDATE: SPOTLIGHT ON GROUNDWATER MANAGEMENT IN TEXAS

MARCH 2009

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ENVIRONMENTAL DEFENSE FUND

finding the ways that work

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Environmental Defense Fund is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

Cover photo location: Edwards Plateau Spring

Cover photo sources: Chuck Brown, Upper Colorado River Authority

The complete report is available at www.edf.org and www.texaswatermatters.org.

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Content

Executive Summary

These are uncertain times for Texas' groundwater resources. After years of well-founded best "guestimates", local groundwater managers are currently seeking to bring more science and technical analysis to bear on defining how the state's aquifers will be managed into the future. The resulting groundwater availability decisions will determine whether these aquifers can continue to support existing uses of water, as well as whether the essential flows the aquifers provide to the state's springs, creeks, and rivers can be sustained.

At the same time, however, pressures on much of the state's groundwater resources are continuing to mount. With varying powerful and well-funded interests often vying for this limited natural resource, ensuing legal battles and resulting recent court decisions have called Texas' current legal framework for groundwater management into question.

The resulting 'perfect storm' makes this an opportune time to shore up the regulatory framework and groundwater management policies. Texas must ensure that the groundwater resources we've just begun to fully understand are managed in a way that will support the water needs of our state and our environment into the foreseeable future. This report offers a number of recommendations to accomplish this goal.

PART ONE

Part one of this report discusses two major issues related to groundwater management in several areas of the state. The first issue is the disconnect resulting from the failure of Texas law to adequately recognize the interconnectivity of surface and groundwater resources. The second issue is the current Groundwater Management Area (GMA) process and its inability to ensure the long-term viability of our state's water resources, both surface and groundwater, as it is currently structured.

Recommendations to ensure integrated management of Texas' surface and groundwater resources:

- Protection of surface water flows and existing surface water rights should be a much more integral component of groundwater availability discussions in the GMA process; groundwater districts; and in the implementation of Senate Bill 3. This means, at a minimum, more active participation by surface water interests in the GMA process and groundwater district decision-making and explicit consideration of springflow contributions to surface water flows, where appropriate, in development of environmental flow recommendations under Senate Bill 3.
- The Texas Water Development Board and the Texas Commission on Environmental Quality should work together to develop standard protocols that guide the incorporation of surface and groundwater resource data into the surface Water Availability Modeling and Groundwater

Availability Modeling analyses. The agencies should also ensure that these and other water resource modeling tools accurately reflect the interconnectivity of the resources to the greatest degree possible given currently available data.

- With assistance from the legislature, the Texas Water Development Board and the Texas Commission on Environmental Quality should prioritize state funding for developing better science in areas with a strong degree of surface and groundwater interaction, including conducting streamflow gain-loss studies where adequate data is lacking and increasing long-term monitoring of springflows.

Recommendations for modifying the GMA process to ensure the long-term viability Texas' surface and groundwater resources:

TWDB rules governing the GMA process should be revised to:

- Make it clear that the GMAs' responsibility is to determine a sustainable future condition for the aquifer, not to merely set the future condition of the aquifer according to projected water demands.

- Direct GMAs to assess how any proposed desired future conditions for aquifers that are dependent on precipitation for recharge would be affected by climatic variability, including severe droughts.

- Require that future conditions be physically measurable either directly or through an alternative measurable metric. The rules should also require the GMAs to establish protocols for monitoring groundwater resource conditions to ensure that present conditions are consistent with established desired future conditions. Individual groundwater district management plans should also be amended to incorporate applicable metrics for the aquifers under their jurisdiction.

- Include a clear mandate for GMAs to both evaluate potential impacts of groundwater pumping on – and to protect - critical hydrologic features, such as springflows and other natural discharges to the surface, artesian pressure, and lateral recharge to neighboring aquifers from proposed desired future conditions.

PART TWO

Recommendations to modernize Texas' groundwater system

- Regionalize groundwater management in areas of the state that are currently subject to major current and projected groundwater use and provide those regional authorities with adequate funding to execute their duties.

- Create a Groundwater District Enhancement Fund to provide grants to local groundwater management districts, on a competitive and as-needed basis, to help them meet critical needs.

- Provide groundwater districts with the option of securing legal representation from the Texas Attorney General if a district decision is challenged in court.

Background and Overview

Environmental Defense Fund has been working to improve groundwater management in Texas for several years, including reporting and making recommendations on major law, policy and implementation issues.

In previous reports, we focused on the state's preferred groundwater management tool, groundwater conservation districts.[1] In 2003, we looked at how districts are established, how they are funded, and how they incorporate public education into district operations. We also looked at their ability to adopt and enforce rules based on the sustainable use of the groundwater under their jurisdiction, how they defined "waste" of groundwater, and their ability to control exportation of groundwater outside district boundaries.[2]

In 2005, continuing the focus on groundwater districts, we delved into the nature of groundwater availability determinations, the issue of establishing production caps, looming large-scale groundwater exports, funding problems for both district operations and necessary groundwater research, and the issue of scale: are single county districts the best approach or does regionalization of groundwater management make more sense.[3]

This report shifts focus from the challenges faced by individual districts to broader statewide groundwater management issues.

Part one of this report discusses two issues affecting several areas of the state:

ISSUE 1:
The disconnect resulting from Texas Law's failure to adequately recognize the interconnectivity of the state's surface and groundwater resources.

ISSUE 2:
The current Groundwater Management Area (GMA) process[4] and its inability to ensure the long-term viability of our state's water resources, both surface and groundwater, as it is currently structured.

Part two of the report includes a discussion of steps the state could take modernize the current system of groundwater management.

[1] In 1997, the legislature added language to the Texas Water Code explicitly recognizing groundwater conservation districts as the "preferred method of determining, controlling, and managing groundwater resources" (TWC §36.0015).
[2] Spotlight on Groundwater Conservation Districts in Texas, Environmental Defense Fund, 2003, available at http://www.texaswatermatters.org/pdfs/groundwater_report.pdf.
[3] 2005 Update: Spotlight on Groundwater Conservation Districts in Texas, Environmental Defense Fund, 2005, available at http://www.texaswatermatters.org/pdfs/articles/conservation_districts.pdf.
[4] The GMA process was initiated by the passage of House Bill 1763 in 2005. It requires groundwater districts to meet regularly to jointly plan on shared aquifers and establish desired future conditions for major and minor aquifers within their area.

We offer these recommendations for solidifying the regulatory and management framework to create greater consistency and predictability in the implementation of state groundwater policy and to help fund critical needs of the groundwater districts charged with managing the state's groundwater resources.

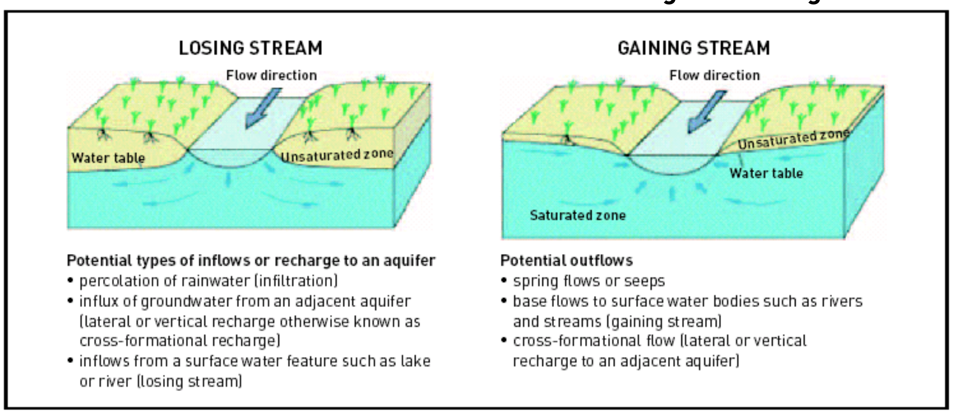
ISSUE 1: Interconnectivity of Surface and Groundwater Resources

The water cycle, which includes both surface and groundwater, is a dynamic and interconnected system. In many instances, surface water, which includes water flowing through our creeks, streams, and rivers, has its origins below the surface, just as the water stored in the aquifers below the ground has flowed or percolated downward from the land's surface at some point in the past. More research is needed across the state to completely understand the degree of interconnectivity of our water resources. However, the fact that, in many cases, our surface water resources are highly dependent on the underlying aquifers (and vice versa) is well understood and documented.

GAIN-LOSS STUDIES

Information about the relationship between rivers and creeks and the underlying aquifers can be assembled through gain-loss studies. The goal of a gain-loss study is to identify the segments of the rivers which gain water from the underlying aquifers (termed gaining) and which segments lose water to the underlying aquifer (losing) (see Figure 1). This is achieved by measuring the volume of water that is flowing in the river at strategic locations throughout the watershed. These volumes are then compared to see where the volume has increased (indication of a gaining segment and potential springflows) or decreased (indication of a losing segment or recharging of the aquifer).

FIGURE 1
Gaining and Losing Streams



Source: USGS Circular 1186

The U.S. Geological Service (USGS) has been conducting gain-loss studies across the state since the early 1900's. According to an assessment of those studies conducted by the Bureau of Economic Geology in 2005, most large streams in Texas gain, rather than lose, water during low-flow conditions (climatically dry when there is little surface runoff).[5] In fact, the assessment concluded that groundwater discharges from underlying aquifers dominates river flows throughout most of Texas during these times.[6]

[5] With the exception of the majority of stream reaches on the Edwards Aquifer, which tend to be recharge features.
[6] Groundwater-Surface Water Interactions in Texas, Bureau of Economic Geology, August 2005.

The Hill Country and Texas Plateau

The influence of springflow on creeks and rivers is strongly evident in the Hill Country and the Texas Plateau, where groundwater pours out of the Edwards-Trinity (Plateau) Aquifer through springs to form the headwaters of the Pecos, the Devils, the Nueces, the Frio, the Sabinal, the Medina, and Guadalupe, the Llano, and the San Saba Rivers. Springs and other natural discharges[7] of the Trinity Group Aquifer continue to support most of these rivers as they flow east and southeastward across central Texas towards the coast. Natural discharges of the Trinity Group Aquifer also form the headwaters of the Pedernales and Blanco Rivers.

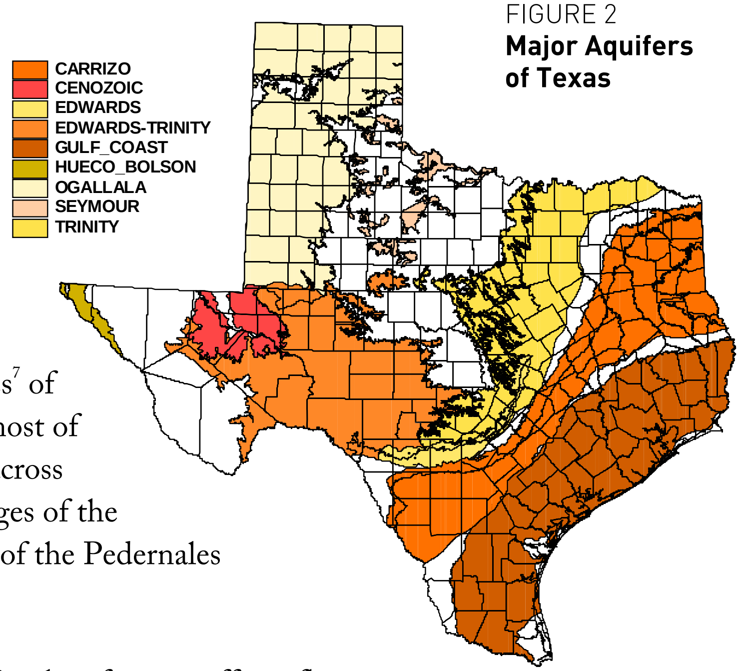


FIGURE 2
Major Aquifers of Texas

Especially during periods of low rainfall and minimal surface runoff, outflows from the underlying aquifers become the life support in maintaining surface flows throughout the state. For example, spring discharge from the Edwards Aquifer in Hays and Comal Counties becomes almost the sole source of downstream water flows in the Guadalupe River during droughts. On September 5, 2006, springflows from Comal and San Marcos springs accounted for 86% of the flows of the Guadalupe River at Victoria.[8] Farther west, up on the Edwards Plateau, stream flow data collected by USGS during the summer of 2006 show that the flow of the spring-fed Llano River accounted for approximately 75% of the water flowing into the Highland Lakes.[9]

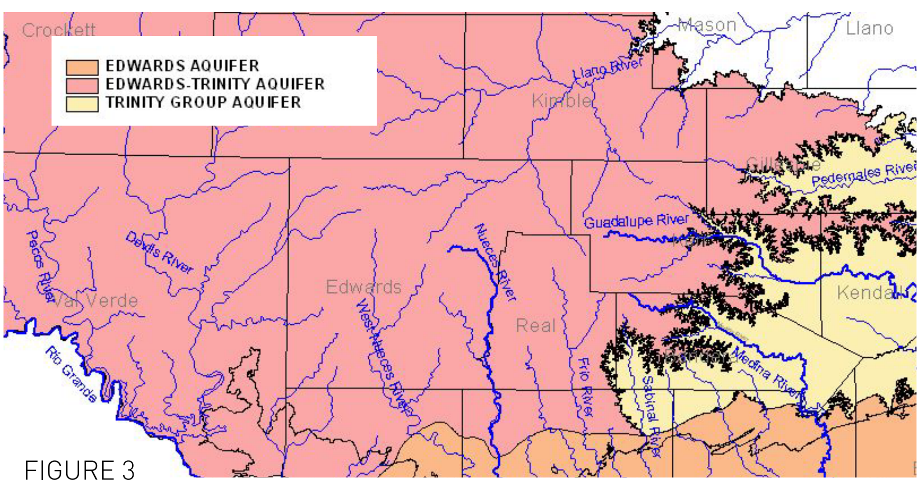


FIGURE 3
Hill Country and Texas Plateau

[7] Natural discharges can include springs, seeps and baseflows to surface water bodies such as rivers and creeks.
[8] Personal communication, Todd Votteler, Guadalupe-Blanco River Authority, 11/17/2008.
[9] *Land of the Living Waters: A Characterization of the South Llano River, its Springs, and its Watershed*, prepared for Environmental Defense Fund by Tyson Broad, 2008.

The Carrizo-Wilcox Aquifer and the Brazos River

The USGS conducted a gain-loss study and an analysis of historical streamflow measurements for the Brazos River reach from McLennan County down through Fort Bend County. Based on both the current study and the historical data, they found appreciable increases in flows of the Brazos River as it trends southeast across the Falls County line towards the city of Bryan.

Underlying that reach and supporting the flows of the Brazos are the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson Aquifers.[10] From the measurements collected in 2006, a section of the river traversing the Yegua-Jackson Aquifer outcrop[11] gained 258 cubic feet per second (cfs) in March, which accounted for approximately 30% of the measured river flow at that location. In August, another section flowing over the Carrizo-Wilcox Aquifer outcrop gained over 194 cfs, accounting for approximately 33% of the total flows.

The Canadian River and the Ogallala Aquifer

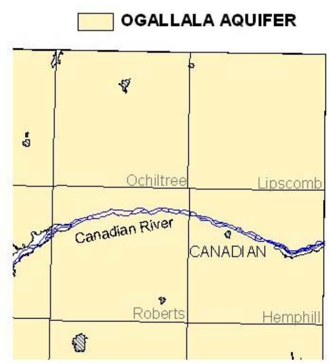


FIGURE 4
Hemphill County

Natural discharges from the Northern Ogallala Aquifer support the flows of the Canadian River as it traverses the Texas Panhandle. In the eastern portion of the Texas Panhandle where the Ogallala Aquifer has not been excessively dewatered, it also discharges to a variety of smaller streams and rivers within the Canadian River Basin. In Hemphill County, for example, numerous tributaries to the Canadian River, including the Washita River, Red Deer Creek, and Gageby Creek among others, all reportedly flow continuously even through drought periods due to natural discharges from the Ogallala Aquifer.

The Hemphill County Groundwater Conservation District (GCD) is presently collecting over 250 county-wide synoptic[12] groundwater levels to help define how high the groundwater level in the Ogallala Aquifer must remain in order for the aquifer to continue to discharge to local creeks and rivers. Future studies may include compiling stream gaging datasets to help determine the impact groundwater levels in the Ogallala have on local streamflows.

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[10] USGS 2007, *Base Flow (1966-2005) and Streamflow Gain and Loss (2006) of the Brazos River, McLennan County to Fort Bend County, Texas, 2006*, United States Geological Services, Scientific Investigations Report 2007-5286.

[11] An outcrop is an area where the geologic formation, in this case an aquifer, is in direct contact with the surface.

[12] Synoptic measurements are taken as simultaneously as possible in order to gain a representative perspective of aquifer-wide conditions at a particular point in time.

RECOGNITION OF INTERCONNECTIVITY

While two separate legal regimes regulate the management and use of groundwater and surface water, there is some recognition in the Texas Water Code[13] that the use and availability of one resource affects the other. For instance, the TCEQ is required to consider the effects of granting a surface water permit on groundwater and groundwater recharge.[14] In turn, groundwater districts are required to consider if the "… proposed use of water unreasonably affects existing groundwater and surface water resources …" when evaluating groundwater permit applications.[15] Groundwater districts must also coordinate with surface water management entities when developing their management plans.[16]

When evaluating surface water availability in the surface water permit process and groundwater availability in terms of aquifer conditions, computer models are used to simulate resource distribution and availability. To a certain degree, both the Groundwater Availability Models (GAMs) and surface Water Availability Models (WAMS) have the technical capacity to factor in flows from one resource to the other. However, the degree of accuracy of the data used varies and the effort that is undertaken to adequately portray the interdependency of the resources within the modeling efforts is not standard, required, or even guaranteed.

A report prepared for the TWDB, by an outside engineering firm about linking the surface and groundwater models concluded that "… a consistent approach and procedure is needed to represent streamflow gains and losses in the WAMs and GAMs."[17] Some of the specific recommendations included:

- the development of methodology and guidelines for simulating streamflow gains and losses in both models;
- ensuring consistency in the representation of surface water and groundwater interactions and the hydrologic properties of evapotranspiration and recharge where applicable;
- making sure that the most applicable and current data available is used in the modeling efforts; and,
- where the data is lacking, especially in areas of high priority,[18] collect additional data.

RECOMMENDATIONS

Given the interconnectivity of surface and groundwater resources in many areas of Texas, it is unrealistic to think that we can sustainably manage and regulate one resource in isolation from the other. While

[13] State statutes covering water planning and management.
[14] TWC §11.151.
[15] TWC §36.113(d) (2).
[16] TWC §36.1071.
[17] Linking the WAM and GAM Models: Considerations and Recommendations, prepared for the TWDB by HDR, May 2007.
[18] Prioritization is recommended for areas where surface water-groundwater interaction is significant; where the potential for critical in-stream flow conditions depends largely on baseflow; and for areas with the greatest likelihood of new and substantial groundwater development in the near future.

certain elements of the current law provide an opportunity for more integrated management, much more is required to ensure those opportunities are realized, including:

- Protection of surface water flows and existing surface water rights should be a much more integral component of groundwater availability discussions in the GMA process; groundwater districts; and in the implementation of Senate Bill 3[19]. This means, at a minimum, more active participation by surface water interests in the GMA process and groundwater district decision-making and explicit consideration of springflow contributions to surface water flows, where appropriate, in development of environmental flow recommendations under Senate Bill 3.
- The TWDB and the TCEQ should work together to develop standard protocols that guide the incorporation of surface and groundwater resource data into the surface Water Availability Modeling (WAM) and Groundwater Availability Modeling (GAM) analyses. The agencies should also ensure that these and other water resource modeling tools accurately reflect the interconnectivity of the resources to the greatest degree possible given currently available data.
- With assistance from the legislature, the TWDB and the TCEQ should prioritize state funding for developing better science in areas with a strong degree of surface and groundwater interaction, including conducting streamflow gain-loss studies where adequate data is lacking and increasing long-term monitoring of springflows.

[19] Senate Bill 3, which was passed in 2007, initiated the Environmental Flows Allocation Process. More information about this process is available at www.texaswatermatters.org/flows.htm.

ISSUE 2: The Groundwater Management Area Process

House Bill 1763, which passed during the 2005 legislative session, laid the framework for regional collaboration among local groundwater managers on shared aquifers. Groundwater districts located within a designated GMA are now required to conduct joint planning and establish "desired future conditions" for the groundwater resources within their area.[20]

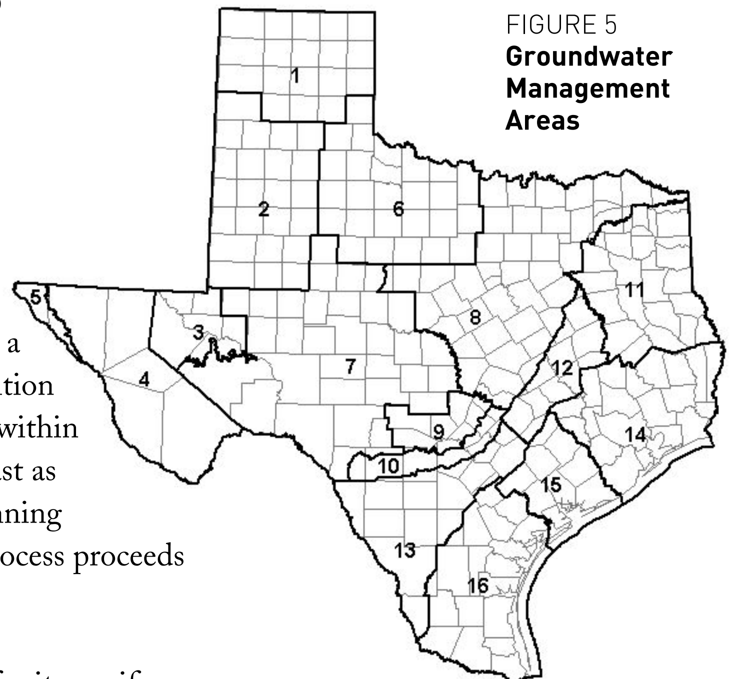

FIGURE 5
Groundwater Management Areas

DESIRED FUTURE CONDITIONS

A desired future condition, which is to be established by September 2010[21] , must be a physically possible and quantifiable groundwater resource condition such as a water level or quality, or a springflow or volume. With the desired future condition as the target goal, the GMA decides the time frame within which the condition will be met. This must be at least as long as the current Senate Bill 1[22] regional water planning period, which is 50 years.[23] Highly simplified, the process proceeds as follows:

1. The GMA adopts desired future conditions for its aquifers.

2. Based on the adopted condition(s), the TWDB derives a managed available groundwater (MAG) volume. This is the volume of groundwater that can be physically withdrawn from the aquifer, in keeping with the desired future condition.

3. The MAG is provided to the groundwater districts for incorporation into their management plans and to the Regional Water Planning Groups for use in their planning process. [24] To the extent possible, the total volume of groundwater available for permitting within a district's boundaries is then determined by the MAG volume.[25]

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[20] TWC§36.108(c), districts are required to meet on an annual basis to conduct joint planning, such as reviewing management plans and accomplishments for the management area.
[21] TWC§36.108(d).
[22] Senate Bill 1, which was passed by the Texas Legislature in 1997, initiated the state's current Regional Water Planning Process. More information about the planning process is available at www.texaswatermatters.org/water_planning.htm or www.twdb.state.tx.us.
[23] 31TAC§356.2(8).
[24] TWC§36.108(o).
[25] TWC§36.1132.

Issues facing GMAs during their desired future condition deliberation process are varied given the geographic diversity of the state, the variability of aquifer characteristics, the amount of information available on aquifer conditions and uses, and the composition of groundwater districts within each area. Below, we offer three case studies that exemplify some of the challenges arising in the GMA process.

CASE STUDIES: AN OVERVIEW OF THREE AREAS

Groundwater Management Area 8

GMA 8 covers a 45-county swath of Texas stretching from Austin to the Oklahoma border. Its boundaries include two major aquifers—the Trinity and the northern portion of the Edwards BFZ (Balcones Fault Zone) Aquifers ; and seven minor aquifers—Blossom, Nacatoch, Woodbine, Brazos River Alluvium, Marble Falls, Ellenburger-San Saba, and Hickory Aquifers. GMA 8 encompasses portions of six major river basins including the Colorado, the Brazos, the Trinity, the Sabine, the Sulfur, and the Red. While the aquifers support scattered springs throughout the area and provide flows to the rivers and creeks within these basins, the Edwards BFZ Aquifer provides the majority of springflow in Travis, Williamson, and Bell counties, with the flow of Salado Creek especially dominated by natural aquifer discharges.

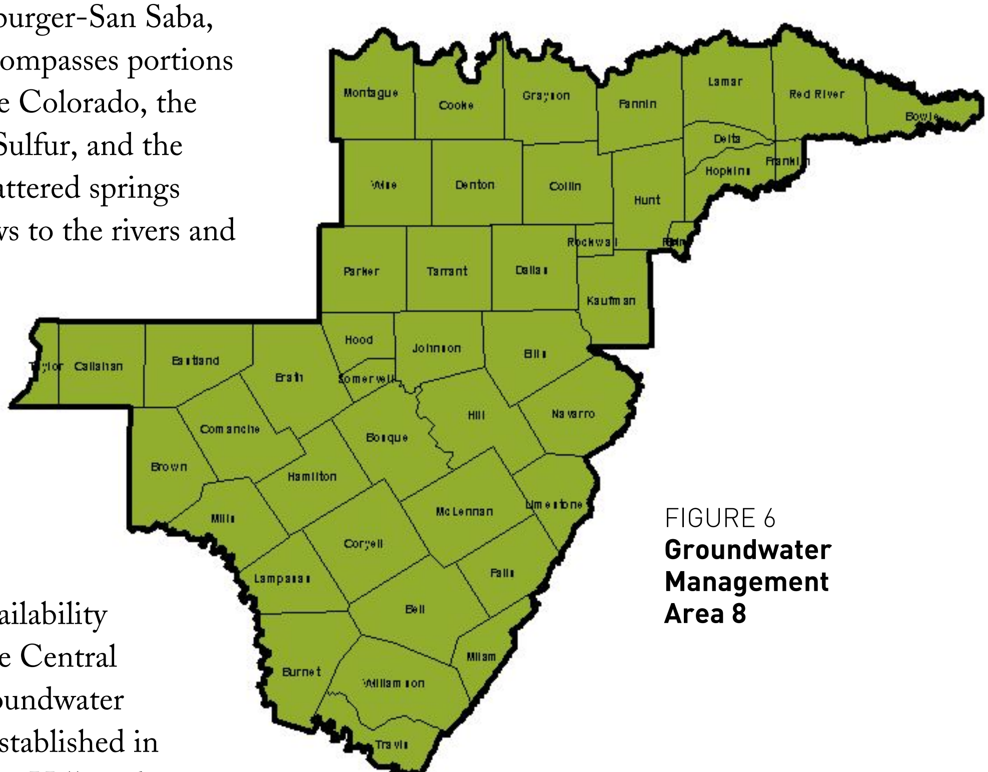

FIGURE 6
Groundwater Management Area 8

Problems relating to groundwater availability are not entirely new to this area. The Central Texas – Trinity Aquifer Priority Groundwater Management Area (PGMA)[26] was established in 2008 for Coryell, McLennan, Bosque, Hill, and Somervell Counties. Hood, Johnson, Ellis, Parker, Tarrant, Dallas, Wise, Denton, Collin, Montague, Cooke, Grayson, and Fannin were designated as the Northern Trinity and Woodbine Aquifers PGMA in February, 2009. The TCEQ is recommending the creation of a single, multi-county groundwater district over Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, and Johnson counties.

[26] A PGMA is an area designated by the TCEQ that is experiencing, or is expected to experience, critical groundwater problems within 25 years. Once designated, the TCEQ will make a specific recommendation on groundwater district creation. For more information on PGMAs, visit www.tceq.state.tx.us/permitting/water_supply/groundwater/pgma.html.

Only one third of the GMA is under groundwater district management, and of those districts, half of them were created in the last five years and two are still unconfirmed by popular vote.[27] The lack of experienced districts in the GMA put pressure on a very small group to adopt desired future conditions for a very large area, including counties that were not active participants in the process.

As of September 2008, GMA 8 had adopted desired future conditions for all its aquifers. The GMA member districts adopted two different types of conditions. For eight of the nine aquifers, the conditions were based on maintaining a prescribed volume of water in the aquifer over the next 50 years.

For the Northern Trinity and the Woodbine Aquifers, desired future conditions ranged from no decline to an approximate 527 feet decline in the average water level of the aquifer. For the Ellenburger-San Saba, Hickory, Marble Falls, Blossom, Nacatoch, and Brazos River Alluvium Aquifers, desired future conditions ranged from maintaining 82% to 100% of estimated saturated thickness[28]. [29]

For the Edwards BFZ Aquifer, the desired future conditions adopted originated from a GAM simulation of projected future pumping demands under the climatic conditions experienced during the 1950's drought of record. In general, GMA 8 adopted the lowest monthly springflow volumes resulting from this simulation. For Bell County, the desired future condition was to maintain at least 100 acre-feet per month of stream/springflow in Salado Creek, while in Travis and Williamson counties, it was to maintain at least 42 acre-feet per month and at least 60 acre-feet per month of aggregated stream/springflow across each county, respectively.

GMA 9

GMA 9 covers the heart of the rapidly growing Texas Hill Country and encompasses all or parts of Kerr, Blanco, Hays, Kendall, Bandera, Medina, Comal, Travis, and Bexar Counties. Its boundaries include three major aquifers - the Edwards BFZ Aquifer, the Edwards-Trinity (Plateau) Aquifer, and the Trinity Aquifer; and three minor aquifers – the Ellenburger-San Saba, the Hickory, and the Marble Falls Aquifer. Of these aquifers, the Trinity Aquifer in particular has been experiencing increasing pressures from growth and development and the Hill Country counties dependent on it for their water supply were designated as the Hill Country PGMA[30] in 1990.

GMA 9 includes portions of four major river basins - the Nueces, the San Antonio, the Guadalupe, and the Colorado. Within these basins, natural discharges from GMA 9 aquifers support the rivers, creeks, and springs that form the headwaters of the Sabinal, the Medina, the Blanco, the Pedernales, and the

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[27] Both McLennan County GCD and Tablerock GCD were created by the Texas Legislature in 2007. Both districts must be confirmed by popular vote in an election by 2012 ((80(R) SB 2038 for Tablerock) and (80(R) SB 1985 for McLennan) or the districts will be dissolved.

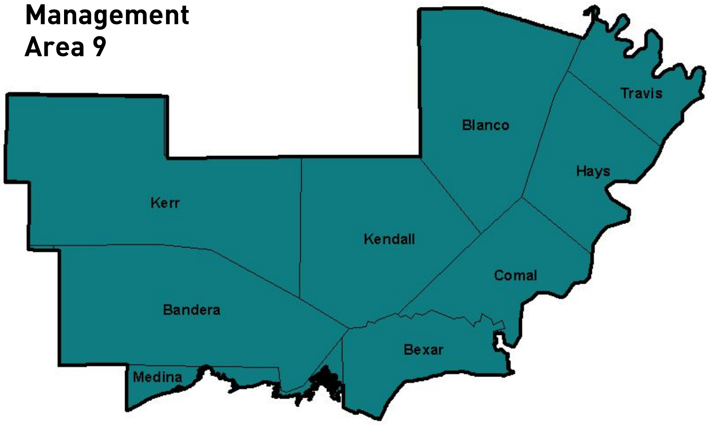
[28] Saturated thickness is the vertical thickness of an aquifer in which the pore spaces are filled (saturated) with water.

[29] Information about GMA 8 and the adopted desired future conditions is available at www.GMA8.org.

[30] The Hill Country PGMA was designated in 1990. It includes all of the GMA 9 counties, in addition to Gillespie County. The TCEQ added parts of Northern Bexar County to the area in 2001.

Guadalupe Rivers. The surface water flows emanating from this area serve as an important resource to both the local communities and to downstream surface water interests.

FIGURE 7
Groundwater Management Area 9



There are eight groundwater districts within GMA 9: Bandera County River Authority and Groundwater District, Barton Springs/Edwards Aquifer Conservation District, Blanco-Pedernales GCD, Cow Creek GCD, the Edwards Aquifer Authority, Hays-Trinity GCD, Headwaters GCD, Medina County GCD, and the Trinity-Glen Rose GCD. The portions of Travis and Comal County located within the GMA are not currently within the jurisdiction of a groundwater district.

As of December 2008, the GMA had adopted desired future conditions for four of its aquifers. They were based on either maintaining or allowing for a specified decline in the level of the groundwater in the aquifer. For both the Edwards-Trinity (Plateau) Aquifer and the Marble Falls Aquifer, the desired future condition is to maintain current water levels in the aquifers. For the Ellenburger and Hickory Aquifers, a decline of 2 and 7 feet respectively was adopted.[31]

GMA 12

GMA 12 covers all or part of 14 counties and is responsible for adopting desired future conditions for two major aquifers, the Carrizo-Wilcox and the Trinity, and four minor aquifers, the Brazos River Alluvium, Queen City, Sparta, and the Yegua-Jackson Aquifers. The area includes the Trinity, the Brazos, and the Colorado River Basins and spring and other natural discharges from the area's aquifers support the flows of these rivers and their tributaries.

The majority of the area falls under the jurisdiction of five groundwater districts including: Brazos Valley GDC, Fayette County GCD, Lost Pines GCD, Mid-East Texas GCD, and Post Oak Savannah GCD. Groundwater districts do not cover the portions of Travis, Williamson, Falls, Limestone, and Navarro counties that are included in GMA 12.

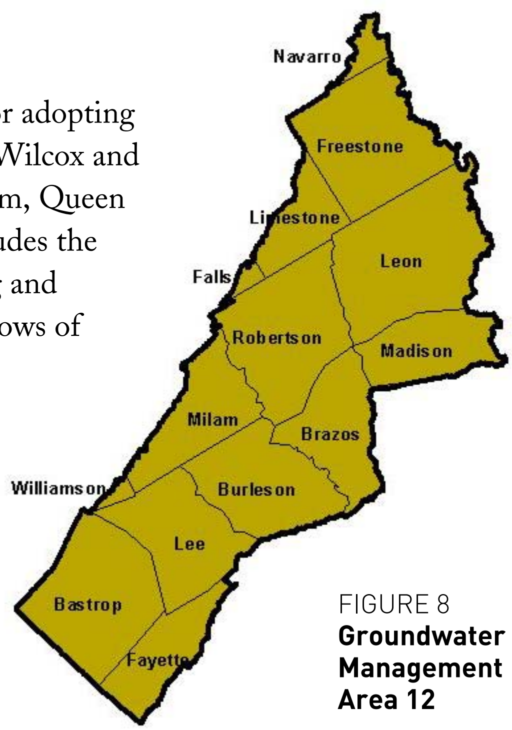


FIGURE 8
Groundwater Management Area 12

[31] Letter to Kevin Ward, TWDB, dated October 22, 2008, from Blanco-Pedernales GCD re: GMA 9 Desired Future Conditions.

Similar to other GMAs were the Carrizo-Wilcox is present, deliberations on groundwater availability from that aquifer are particularly complicated. Targeted often as a vast untapped resource, there is strong pressure from marketing interests to make sufficient Carrizo-Wilcox groundwater available to meet water demands elsewhere. To add to this, the discussions are further complicated because portions of the Carrizo-Wilcox Aquifer are under confined conditions.[32] This means that if too many additional wells are added, it could reduce the pressure that provides water to current users, causing them to have to lower or abandon their wells.

As of December 2008, GMA 12 had not adopted desired future conditions for their aquifers.

CHALLENGES FACING GROUNDWATER MANAGEMENT AREAS

As each of the 16 GMAs work through the process of adopting desired future conditions for their aquifers, there are a number of troubling commonalities that are becoming apparent within the process. The issues raised below cast serious doubt on the overall effectiveness of the GMA process for ensuring that groundwater availability decisions currently being made are in the best interest of sustaining Texas' groundwater and surface water resources into the foreseeable future.

Reverse Engineering

The adoption of a desired future condition is an opportunity for local groundwater managers to establish a goal of what they want their aquifers to look like in the future. However, some GMAs have instead taken the projected future groundwater demands (often those developed by the regional planning group) for the area, extrapolated that level of pumping to derive the potential impact to the aquifer and then adopted this potential impact as the desired future condition of the aquifer. This "reverse engineering" circumvents the central purpose of the GMA process: to determine what level of aquifer development is actually desirable, given recharge, springflow and volume of water in storage conditions.

GMA 8 used this "reverse engineering" process to develop the desired future conditions of its aquifers.[33] As a result, the majority of counties in GMA 8 are now projected to experience moderate to major water level declines in their aquifers over the next 50 years. Other GMAs, such as GMA 9, have also attempted to rely on this methodology to arrive at potential desired future conditions for their aquifers. In the case of GMA 9, not only would the Hill Country aquifers experience water level declines, the increased pumping would come at a great expense to springflows and other natural aquifer discharges to the areas creeks and rivers.

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[32] This occurs when the water bearing aquifer is both underlain and covered by impermeable layers, such as dense clay. When the upper confining layer is breached, by a well or geologic fracture, the groundwater is forced towards the surface by the artesian pressure. If more groundwater is removed from the aquifer than is replenished, a drop in the artesian pressure will occur. As a result, groundwater levels in both the aquifer and wells will be affected.

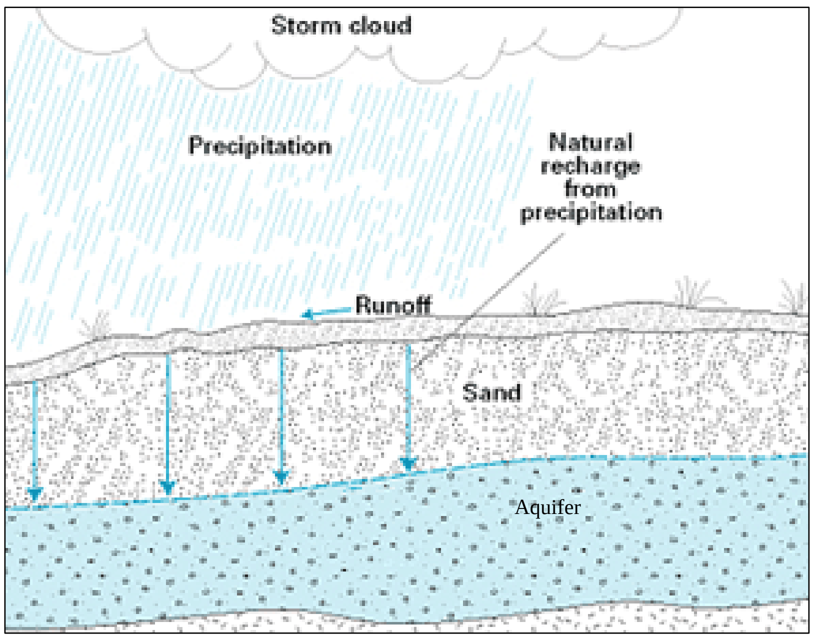
[33] Mike Massey, General Manager, Upper Trinity GCD, raised this issue at the August 5th, 2008 Senate Natural Resources hearing in Amarillo, Texas.

The discussion of potential desired future conditions should take place removed from the pressure of meeting currently projected future water demands. Nothing in the legislation establishing GMAs requires that desired future conditions be set to meet currently projected demand. A GMAs determination of desired future conditions should set the terms by which regional planning groups can evaluate how projected water needs will be met, including what mix of surface and groundwater resources and conservation and efficiency measures are appropriate.

Assessment of Prolonged Droughts and Climate Change

While there are exceptions, most aquifers in Texas are recharged through downward percolation of rainwater from the surface (see Figure 9)[34]. As the precipitation rates deviate from average conditions, due to severe droughts and other alterations in the precipitation patterns, so does the volume of groundwater stored in the aquifer and the volume that flows out through springs and other natural discharges to the rivers and creeks.

FIGURE 9
Natural Aquifer Recharge



Given Texas' long history of droughts, precipitation rates deviating from average conditions is a certainty. For instance, the current drought of record for most areas of the state, which is used as a measure for water planning purposes, occurred during the 1950's, lasted for five to seven years and was marked with about a 30 percent decrease in average precipitation.[35] More recently, Central Texas only received 25 to 50% of its normal rainfall in 2008 and Texas, as a whole, experienced its fourth driest December on record.[36]

In addition to the drought prone conditions we have come to expect from historical experience, scientists now predict that global warming may exacerbate normal drought cycles, causing longer and more frequent droughts.[37] Scientists also predict that rainfall occurring under changing global climatic conditions will come during increasingly shorter timeframes. Flash floods and higher intensity rainfall events are not always conducive to the slow downward percolation process necessary for aquifer recharge.

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[34] U.S. Geological Survey modified from http://ga.water.usgs.gov/edu/watercycleinfiltration.html.
[35] Water for Texas 2007, Volume II, Texas Water Development Board, pg. 134.
[36] This was out of 113 years of record according to Bob Rose, Lower Colorado River Authority, presentation to the Region K Regional Water Planning Group on January 14, 2009.
[37] National Research Council of the National Academies, 2005.

Despite the history of droughts and the future uncertainty of precipitation predictions, Chapter 36 of the Texas Water Code and the TWDB's administrative rules do not require GMAs to evaluate how changes in precipitation could impact the amount of water in aquifers that are dependent on rainfall for recharge. A lack of this type of assessment could have significant consequences for many of the state's aquifers. For example when evaluating the Hill Country aquifers using the Trinity Hill Country GAM, the total volume of recharge to the area's aquifers is predicted to decrease by more than half during drought of record conditions.[38]

Measurability of Desired Future Conditions

As explained previously, TWDB rules require an adopted desired future condition to be a groundwater resource condition that is physically possible and quantifiable.[39] However, there is no requirement that the chosen condition be physically measurable. Without a physical measure to gauge compliance, it is impossible to evaluate the effectiveness of management efforts in keeping with the established desired future condition.

One problem stems from the fact that the desired future condition and the resulting MAGs are derived using GAMs. Most of the GAMs provide only a regional scale estimation of the behavior of groundwater flow within an aquifer system. While an extremely useful tool, it is difficult to predict the behavior of groundwater at a specific well or spring location, given the scale of the model. For example, in GMA 8 the desired future conditions adopted for the Northern Trinity Aquifer and the Woodbine Aquifer are stated as average not-to-exceed declines in groundwater levels across whole counties. These conditions are physically possible and quantifiable in terms of this modeling tool, but there can be almost limitless combinations of water levels within an aquifer across a county that could be measured to result in a similar average county-wide water level condition. So without a more specific gauge to measure by, it would be impossible to tell whether pumping levels are actually meeting the desired future condition.

GMA 8's adopted desired future conditions for the Edwards BFZ Aquifer in Bell, Travis, and Williamson County provide another example. The desired future conditions for the Edwards BFZ Aquifer in these counties are as follows:

[38] Groundwater Availability of the Trinity Aquifer, Hill Country Area, Texas: Numerical Simulations through 2050, Report 353, Texas Water Development Board, September 2000.
[39] 31TAC§356.2(8).

TABLE 1
Edwards BFZ Aquifer Desired Future Conditions

GMA 8 County	Adopted Desired Future Condition[40]
Bell County	Maintain at least 100 acre-feet per month stream/springflow in Salado Creek during a repeat of the Drought of Record
Travis County	Maintain at least 42 acre-feet per month of aggregated stream/springflow during a repeat of the Drought of Record
Williamson County	Maintain at least 60 acre-feet per month of aggregated stream/springflow during a repeat of the Drought of Record

These creek and aggregated county-wide aquifer flows are quantifiable GAM outputs. However, there is no equivalent stream/springflow monitoring network on the ground that can replicate these same GAM outputs. Additionally, as stated, these conditions are only applicable to the aquifer during a repeat of the Drought of Record. So baring an occurrence of a drought equivalent to the drought of record, it is impossible to gauge whether pumping rates are in keeping with the desired future conditions.

The Texas Water Code currently requires a district within a GMA to "ensure that its management plan contains goals and objectives consistent with achieving the desired future conditions of the relevant aquifers as adopted during the joint planning process."[41] However, this directive does not explicitly require districts to develop a strategy to measure groundwater conditions to ensure compliance. Without a physical monitoring component to tie the desired future condition scenarios to actual physical measurable hydrologic conditions, there will be no way to gauge compliance.

Natural Aquifer Discharges

There is no explicit statutory requirement for GMAs to consider impacts to natural aquifer discharges or surface water resources in the desired future condition deliberation process. For this reason, the attention paid to these impacts has been inconsistent across the state.

As discussed previously in this report, the degree of interconnectivity between the surface and groundwater resources of the state is such that it is impossible to effectively plan for and manage one resource without consideration of and for the other. The adoption of desired future condition for the state's aquifers is no exception. Given that the GMA process is in effect establishing groundwater

[40] Memorandum Re: Desired Future Conditions of N. Edwards BFZ Aquifer, presented to Cheryl Maxwell, Administrative Manager, Clearwater Underground Water Conservation District, Administrative Agent for Groundwater Management Area 8, from Charles R. Williams, P.G. No. 526, December 14, 2007, www.gma8.org.
[41] TWC§36.108(d-2).

production levels for every aquifer, it is essential that effects of such pumping levels on the state's surface water resources be considered during the process.

RECOMMENDATIONS

Deliberations within the GMA process, including the adoption of desired future conditions, should be based on the most complete understanding possible of aquifer dynamics, including natural aquifer discharges such as springflow and other flows to creeks and rivers, cross formational flows to adjacent aquifers, and potential impacts to the area's water resources, both ground and surface.

We offer the following recommendations for modifying the GMA process to ensure the long-term viability of our state's water resources, both surface and groundwater.

The TWDB rules governing the GMA process should be revised to:

- Make it clear that the GMAs' responsibility is to determine a sustainable future condition for the aquifer, not to merely set the future condition of the aquifer according to projected water demands.

- Direct GMAs to assess how any proposed desired future conditions for aquifers that are dependent on precipitation for recharge would be affected by climatic variability, including severe droughts.

- Require that future conditions be physically measurable either directly or through an alternative measurable metric. The rules should also require the GMAs to establish protocols for monitoring groundwater resource conditions to ensure that present conditions are consistent with established desired future conditions. Individual groundwater district management plans should also be amended to incorporate applicable metrics for the aquifers under their jurisdiction.

- Include a clear mandate for GMAs to both evaluate potential impacts of groundwater pumping on – and to protect - critical hydrologic features, such as springflows and other natural discharges to the surface, artesian pressure, and lateral recharge to neighboring aquifers from proposed desired future conditions.

Between the end of the 2007 legislative session and the opening of the 2009 session, the underpinnings of Texas' current groundwater management framework have been shaken by court decisions and expensive legal battles challenging various groundwater district decisions.

LEGAL CHALLENGES

Litigation over water resources can never be eliminated, even under the best of systems. In the Texas groundwater arena, however, it is beginning to reach the point where protracted administrative and court fights are resulting in such unpredictability and conflicting rulings that consistent implementation of state policy is threatened. In the midst of this legal chaos, predictable and sustainable groundwater management is increasingly out of reach for many groundwater districts.

The legislature's historical reluctance to come to grips with potential conflicts between the "rule of capture" and regulation of groundwater through local districts is at the root of some of these legal fights. Widely differing interpretations of the "rule of capture" are now being fought out in the courts, in front of district boards and at legal conferences.[42] While the legislature could resolve at least some of the disputes, many see the issues as involving constitutionally protected property rights, and a decision by the Texas Supreme Court is likely needed to resolve the matter fully.

But the rule of capture is not the only problem. The Legislature can take a number of other steps to improve groundwater management in Texas.

ADDITIONAL CHALLENGES

Many groundwater districts do not have the resources to hire full-time staff, legal counsel or groundwater scientists, even when they face multiple pumping or export requests backed by entities with plenty of resources. These districts, often run by volunteer or low paid staff or board members who have other full-time jobs, struggle to stay afloat in a barrage of administrative and court filings. The result: some provisions of Chapter 36 are being interpreted in many different ways. At times, such conflicting interpretations block the application of good science in important permitting decisions.

The type of aquifer, pumping patterns and future use projections all vary substantially across the state and a "one-size-fits-all" approach is not warranted.[43] Nevertheless, it is difficult to guarantee either

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[42] See Appendix A, an October 20, 2008 memo to the Texas Water Development Board for a summary of two rule of capture cases decided over the interim, *City of Del Rio v. Clayton Sam Colt Hamilton Trust* and *Edwards Aquifer Authority v. Day and McDaniel*, both of which are still making their way through the court system.

[43] Texas has recognized this principle in creating river authorities to assist with surface water management. Most of the river authorities have the same basic charter, but each also has certain powers and duties specifically appropriate to the particular basin in which it operates.

water supply or environmental reliability without some degree of consistency in the basic capabilities, powers and duties of districts, especially when several districts are managing water in the same aquifer. Without additional steps to modernize Texas' groundwater system, these problems will get worse. Every year they persist, they are that much harder to fix.

RECOMMENDATIONS

The following three steps would help modernize the Texas groundwater system:

1. **Regionalize groundwater management in areas of the state that are currently subject to major current and projected groundwater use and provide those regional authorities with adequate funding to execute their duties.**

   There are some areas of the state where the current single-county groundwater districts, especially those that are well-established, are working well. They have adopted rules and management plans with broad support across the district and issued permits in accordance with those plans and rules. They do not face major controversies over increased pumping, export proposals or other issues. These districts should be allowed to continue their operation with access to additional funding and other resources of the state to meet scientific or other needs (see recommendations #2 & 3, below).

   However, in several other areas of the state, major aquifers are subject to management by a hodge-podge of single-county districts, many of which are new and have not yet had time to adopt a scientifically-based management plan, enact a full set of rules or establish and well-thought out and deliberative permitting process. This is particularly the case in the Carrizo-Wilcox, Northern Trinity, and Gulf Coast Aquifers. In each of these areas, too, there are multiple large pumping proposals on the table or in the works.

   While regionalization will be complicated and controversial, it will lead to a more consistent, predictable and sustainable framework for managing these invaluable aquifers that are currently subject to so much pressure. Creating these authorities now, versus continuing to avoid the problem, will move Texas toward a more functional and predictable groundwater management system, providing both economic development and environmental benefits.

   The regionalization should proceed based on the model of the Edwards Aquifer Authority (EAA), which—for all its fits and starts—has proven to be a successful groundwater management entity. Since its establishment in 1993, the EAA's actions have sustained water use as well as springflows, even during difficult drought periods, and provided enough certainty to create a thriving market in groundwater rights. Lessons learned in the creation and early operation of the EAA can be brought to bear in the creation of regional authorities for other major aquifers.

The regional authorities should be equipped with sufficient authority to raise the funds necessary for professional staff, scientific investigation, metering and monitoring and high quality legal analysis and policy making. Creating these authorities without an adequate funding basis would be highly counterproductive.

2. Create a Groundwater District Enhancement Fund to provide grants to districts, on a competitive and as-needed basis, to help them meet critical needs.

Districts are doing a job for the state by trying to protect and manage groundwater resources. If these districts are to make objective decisions, based on sound science and good legal interpretations of their authority, then the state has to be willing to invest state funds in their operations.[44] On the other hand, of course, state lawmakers need to know that any appropriated funds will be well-spent, which would be difficult with just a broad appropriation of general revenue to support district operations.

A middle ground would be to establish a grants program, administered by the Texas Water Development Board. Individual districts could apply for funds for the following purposes:

- Obtaining a better scientific understanding of aquifer characteristics, including the extent of groundwater/surface water interactions; relationships between overlying and underlying aquifers and other hydrogeologic factors;

- Developing better local scale models that can be used by the district in preparing management plans and making permit decisions;

- Professional assistance (technical and/or legal) in preparing a district management plan or rules;

- Contracting with a qualified hearings officer to assist in running contested permit hearings; and

- Acquiring monitoring equipment, such as meters and springflow measurement devices.

[44] The idea that groundwater districts should have to depend on permitting massive amounts of groundwater withdrawals to supply their budget needs is as counter-productive as it gets. This also may create a conflict of interest, as often underfunded districts stand to gain large sums from permit fees. See "Changing political landscape impacts groundwater issues," The Cameron Herald, 05/23/2008 where the president of Blue Water Systems, a groundwater marketing interest, told the Post Oak Savannah GCD Board that since "his company had paid over $3 million to Post Oak in permit fees" the board had an obligation, some responsibility, and some guarantee to permit holders.

The application would have to specify why the district needed such funds, and the TWDB would require reporting on the use of the funds and results achieved.

3. Provide groundwater districts with the option of securing legal representation from the Texas Attorney General if a district decision is challenged in court.

This recommendation has been made in various quarters before, but has yet to be enacted. With the explosion of permit requests for groundwater extraction, controversies over the meaning of Chapter 36 provisions and a willingness of permit applicants and opponents to take issues to court, the districts must have state-level assistance. Without such assistance, district interpretations of Chapter 36 are going to lack consistency, which could lead to a confusing proliferation of court rulings. The Attorney General could also be directed to provide guidance on interpretations of Chapter 36 and encourage districts to take consistent positions. Moreover, the mere threat of litigation that could overwhelm a district can be enough to color its decision-making, undermining the very purpose of Chapter 36 to empower the districts to protect and manage groundwater resources.

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