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A Policy Proposal for Regional Aquifer-Scale Management of Groundwater in Texas

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A Policy Proposal for Regional Aquifer-Scale Management of Groundwater in Texas

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Dedication

To my wife Geneva for her infinite patience and support.

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Abstract

A Policy Proposal for Regional Aquifer-Scale Management of Groundwater in Texas

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Management of groundwater as a common pool resource relies heavily on an institutional design that is fitted to the aquifers to be managed and is scaled to provide efficient and effective governance. Texas has committed to a decentralized system of groundwater management through Groundwater Conservation Districts (GCDs) that offers a high level of local control and area-specific adaptability. However, increasing pressures on the state's groundwater resources coupled with a strong local aversion to outsider interference has resulted in a proliferation of small single-county GCDs that are neither well fitted to the aquifer systems nor sufficiently scaled to be efficient or effective. In recognition of these challenges, the persistent response has been a slow transition towards larger-scale management. Although a full transition to centralization via state control is not likely to be politically feasible, it would also be limited in its effectiveness, recognizing the wide diversity of climate conditions, water use patterns, growth projections, and aquifer characteristics that exist across the state. Regionalization is offered as a policy proposal for an institutional arrangement and scale of groundwater

governance that provides a balance between centralization and decentralization, using institutions that are better fitted to the aquifer systems and appropriately scaled to provide sufficient funding and resources.

The merits and logic of regionalized groundwater management have been recognized as demonstrated by the establishment of the joint regional-planning process within aquifer-based Groundwater Management Areas (GMAs), using GCD representatives as the *de facto* regional groundwater planners. However, the new unfunded mandates for which the already underfunded GCDs are now responsible and the extraordinary planning process complexity that has developed may prove to be unworkable. This realization compels consideration of management through regional authorities designed using the ready-made framework of the GMAs and principles gleaned from successful models of regionalization from other states and within Texas. Such regional authorities, if provided with sufficient resources and authority, would respect the logic of fit and scale and would be better equipped to address the current and future groundwater management challenges in Texas.

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Chapter 1: Introduction and Background

Groundwater management in Texas has evolved from a passive non-management system under the rule of capture towards a decentralized system of management where Groundwater Conservation Districts (GCDs)[1] have been designated by the Legislature as the state's "preferred" method of groundwater governance. This preference for local control, however, has resulted in a proliferation of GCDs that have been established along county boundaries rather than in accordance with the hydro-geographical boundaries of the aquifers for which they were established to manage. The tendency for the creation of county-based GCDs, many of which are single-county in scale, has generated a steady drumbeat of criticism related to the inherent limitations of small-scale politically-drawn management entities and the associated hindrances to effective groundwater management in Texas. It is apparent that the preference for local control via GCDs was perhaps a political necessity in any initial effort to move away from unrestricted groundwater use under the rule of capture towards some more restrictive form of management. And while perhaps expedient to the initial foray into groundwater governance, the legacy of local control via county-based GCDs coupled with the increasing pressures on the state's groundwater resources will continue to create formidable challenges to effective management. In recognition of these limitations, the Texas Legislature has implemented a joint-regional groundwater planning process that occurs at a larger aquifer-based scale via Groundwater Management Areas (GMAs) using

[1] See Appendix 1 for frequently used acronyms.

local GCDs as the primary participants. This small step towards regional management via GMAs is an apparent attempt by the Texas Legislature to respond to criticism; however, a continued evolution with further reforms is needed to reconcile the challenges inherent in the legacy of small-scale county-based management entities.

This thesis presents the evolution of groundwater management in Texas and the more recent shifts towards regional scale planning to provide context for the current preference for local control and associated challenges. Building on this context, an analysis of potential models for regional-scale resource management is presented and concludes with findings, options, and policy recommendations for transitioning to effective regional aquifer-scale groundwater management in Texas.

1.1 GROUNDWATER MANAGEMENT IN TEXAS - FROM *EAST* TO LOCAL CONTROL

1.1.1 The Rule of Capture

Groundwater management in Texas has been slowly evolving since the turn of the 20th century. The state's initial attempt to address competing uses of groundwater began in response to a Texas Supreme Court ruling in *Houston & T.C. Railway. v. East* in 1904.[2] The product of *East* was the establishment of the common law groundwater doctrine of the rule of capture (also commonly referred to as absolute ownership) – a doctrine that in essence is a tort rule of non-liability[3] that firmed up a landowner's right to virtually unlimited pumpage with impunity. In *East*, a resident of Denison, Texas, Mr.

[2] *Houston & T.C. Railway v. East,* 98 Tex. 146, 81 S. W. 279 (Tex. 1904)
[3] M. Jones, *"Why the DFC Process is Failing - What Can Be Done to Fix it."* Paper presented at the Texas Water Law Institute, Austin, Texas, December 9-11, 2009.

W. A. East, alleged that pumpage from a much larger and deeper well that was dug by the railroad company on the adjacent property had caused his well to go dry. In judgment of the case, the court applied the rule of capture precluding any liability that might be assigned to large pumping wells that interfere with neighboring wells provided that the action was not wasteful or malicious.[4]

Prior to the *East* case, the provenance and behavior of groundwater was shrouded in myth with many, particularly those settling the Texas Panhandle of the Great Plains, conveniently believing that groundwater was an inexhaustible underground river.[5] The *East* case did little to dispel this mythology. In fact, the Court famously based its decision on the rationale used in a similar Ohio Supreme Court Case in which that court pleaded ignorance and described the existence, origin, and movement of groundwater as:

> …so secret, occult, and concealed that any attempt to administer any set of legal rules…would be involved in hopeless uncertainty, and would, therefore, be practically impossible.[6]

This ruling marked the beginning of the legal divergence between surface water and groundwater in Texas – a decision that would establish the foundation of Texas groundwater law with ramifications that are still being felt to this day.[7]

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[4] *See Sipriano v. Great Spring Waters of Am., Inc.,* 1 S.W.3d 75, 76 (Tex. 1999) ("Essentially, the [rule of capture] provides that, absent malice or waste, landowners may have the right to take all the water they can capture under their land and do with it what they please, and they will not be liable to neighbors even if in so doing they deprive their neighbors of the water's use."). *See also Friendswood Development Co. v. Smith Southwest Industries*, 576 S.W. 2d, 22 (Tex. 1978). (In addition to causing malicious injury and being willingly wastewater, the Court in Friendswood, modified the rule of capture by adding subsidense caused by pumping as an additional exception to the rule of capture.)

[5] This and other myths were useful in encouraging settlement of the American west and plains. This mythology can be exemplified by the famous notion coined by Charles Dana Wilber that "rain followed the plow." *See also* Green, D., LAND OF THE UNDERGROUND RAIN: IRRIGATION IN THE TEXAS HIGH PLAINS 1910-1970, at 165 (1973).

[6] *East*, *supra* note 2, at 281. (quoting *Frazier v. Brown*, 12 Ohio St. 294, 311 (1861)).

1.1.2 The Conservation Amendment

Shortly after the *East* case was decided, Texas experienced droughts in 1910 and 1917 that compelled Texas citizens to approve an amendment to the Texas constitution.[8] Article 16, Chapter 59, also known as the Conservation Amendment, was passed in 1917 and declared that conservation of the state's natural resources, including water, are public rights and duties. The amendment authorized the legislature to pass all appropriate laws necessary to conserve and preserve the natural resources of the state. More importantly, the courts have interpreted the approval of the Conservation Amendment by Texans as providing not only the authority, but also the responsibility to preserve and conserve the state's water resources for the benefit of all citizens.[9] It would later prove to provide frequently used grounds for inaction by courts that emphasized that this authority and responsibility is a legislative prerogative and duty rather than a judicial one.[10]

1.1.3 The Groundwater Conservation District Act of 1949

Although there was relatively minor progress relating to groundwater regulation made in the first few decades following the passing of the Conservation Amendment, the

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[7] R. Mace, C. Ridgeway, & J. Sharp, *Groundwater is No Longer Secret and Occult - A Historical and Hydrogeologic Analysis of the East Case.* In 100 YEARS OF RULE OF CAPTURE: FROM EAST TO GROUNDWATER MANAGEMENT, at 63 (W. F. Mullican, & S. Schwartz ed., June, 2004).

[8] H. Potter, *History and Evolution of the Rule of Capture.* In 100 YEARS OF RULE OF CAPTURE: FROM EAST TO GROUNDWATER MANAGEMENT, at 1 (W. F. Mullican, & S. Schwartz eds., June, 2004).

[9] B. Darling, *Texas Groundwater - Rule of Capture and Groundwater Management in Texas: Part 1,* THE WATER REPORT, at 9. (D. L. Moon, ed., April 15, 2007). (citing *Barshop v. Medina County UWCD, et al*., 925 S. W. 2d 618 (Tex. 1996)).

[10] *See* Potter, *supra* note 8 at 2. *See* also *Friendswood*, 30 (Tex. 1978) ("Providing policy and regulatory procedures in this field is a legislative function."); Pecos County Water Control and Improvement Dist. No. 1 v. Williams, 271 S.W.2d 503, 505 (Tex. Civ. App.-El Paso 1954) ("court invited legislative action to regulate water because it thought this duty legislative.").

need for groundwater management was the subject of much debate in response to concerns over excessive pumpage of water from the Ogallala Aquifer in the Texas Panhandle.[11] After extensive groundwater surveys, the Texas Board of Water Engineers (predecessor agency to the Texas Water Development Board) in 1934 produced its biennial report concluding that "there is no reason why underground water should not be subject to the same control as surface water" and calling for a law:

> first, to declare the underground water of the State the property of the State; second, to guarantee vested rights to those who already have made beneficial use of underground water; and third, to exercise proper control over future underground-water development.[12]

Bills reflecting these recommendations that would have placed groundwater under the control of the state similar to surface water were filed in each of the legislative sessions of 1937, 1941, and 1947.[13] All of these bills however, were defeated owing in large part to the united and formidable opposition of the high plainsman.[14] In anticipation of a similar bill to be supported by the Texas Water Conservation

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[11] M. Booth & R. Richard-Crow, *Regulatory Dance: Rule of Capture and Chapter 36 District Perspective.* In 100 YEARS OF RULE OF CAPTURE: FROM EAST TO GROUNDWATER MANAGEMENT, at 19 (W. F. Mullican, & S. Schwartz ed., June, 2004).

[12] D. Green, LAND OF THE UNDERGROUND RAIN: IRRIGATION IN THE TEXAS HIGH PLAINS 1910-1970, at 172 (1973).

[13] *Id*. at 172.

[14] *Id*. at 183 &181. (Green provides quotes from high plainsman demonstrating the local opposition to groundwater regulation including: "This proposition [of creating a water district] should be met with 30-30's [rifles] and its sponsors not only driven back to the City of Austin, but on south across the San Jacinto battlefield and into the Gulf of Mexico where they can get their fill of water"; "You can say you prefer local control to state control or federal control. I don't want any control by anybody but the landowner. That's like asking who you'd rather be hanged by. I don't want to be hanged"; and "All the water under my land belongs to me… nobody can tell me how to use it…If my neighbor wants to drill wells right next to me, that's all right with me. If the wells go dry, we will all run out together. I don't intend to live in a country full of Hitlerism laws.").

Association in the 1949 session, the Texas Farm Bureau prepared a counter bill that would create locally controlled groundwater districts similar to soil conservation districts. The general sentiment at the time was summed up best by a local high plainsman who was quoted as saying, "I favor no control, but if we must have it, let it be local."[15]

The Groundwater Conservation District Act of 1949 (GCD Act) that finally passed was a political compromise[16] that authorized a petition process as an optional means for establishing an entity to manage groundwater locally. The GCD Act allowed for a local petition to be filed, initiating a study to delineate the boundaries of "underground water reservoirs", which was the prerequisite step towards the establishment of a GCD within a designated "reservoir."[17] Surprisingly, the GCD Act contained many of the fundamental elements of authority available to GCDs today.[18] More importantly, the GCD Act: 1) represented a now predominant theme of favoring local governance if for no other reason than to avoid centralized control,[19] and 2) established a precedent of county-centric influence in GCD creation. The GCD Act also served to firmly establish the wedge between Texas groundwater and surface water

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[15] *Id*. at 179.

[16] E. Woodruff, Jr. & J. Williams, Jr., *Comment, Texas Groundwater District Act of 1949: Analysis and Criticism,* 30 TEX. L. REV. 862, at 865-866 (1952) ("During the past fifteen years, several attempts have been made to provide the state with comprehensive groundwater legislation. Bills that would have accomplished this objective were introduced in 1937, 1939, 1941, and in 1947. The rejection of each of these proposed measures made it apparent that if the state were to have any groundwater legislation, some retreat would have to be made from the idea of this comprehensive goal. As a result of compromises between divergent factions of groundwater users, the important and controversial Act of 1949 was passed.").

[17] The High Plains Underground Water Conservation District No. 1 was the first GCD created in 1951 under the process authorized by the GCD Act.

[18] M. Booth, & R. Richard-Crow, *supra* note 11, at 20.

[19] Green, *supra* note 12, at 182. (Green quoting the editor of the Lubbock Avalanche-Journal "The water district organization … therefore, has been called self-defense").

law/management despite the efforts of the Texas Board of Water Engineers to unify the two and the growing understanding of their hydrological linkages since the rule of capture was established.

1.1.4 The Empowerment of GCDs

There was relatively minor progress in the evolution of groundwater management between the passage of the GCD Act in 1949 and Senate Bill 1 (SB 1)[20] in 1997. Notable actions by the legislation in the interim included the passage of House Bill 2 (HB 2)[21] in 1985, Senate Bill 1212 (SB 1212)[22] in 1989, and House Bill 2294 (HB 2294)[23] in 1995. Most notably, these three bills represented a stepwise evolution towards larger scale groundwater management in Texas through regional Groundwater Management Areas (further discussion on GMAs in Chapter 3).

The system of groundwater management via GCDs was later more firmly entrenched with the passage of Senate Bill 1 (SB 1) in 1997. SB 1 was a monumental piece of legislation that had a lasting effect on many aspects of water management in Texas. One effect was modifying the "critical areas" program established under HB 2 into what is now known as the Priority Groundwater Management Area (PGMA) program for the purpose of designating areas of the State that were in need of

[20] Act of June 2, 1997, 75th Leg., R.S, SB 1 (hereinafter cited as SB1).
[21] Act of May 15, 1985, 69th Leg., R.S., HB 2 (hereinafter cited as HB 2).
[22] Act of May 31, 1989, 71st Leg., R.S., SB 1212 (hereinafter cited as SB 1212).
[23] Act of May 29, 1995, 74th Leg., R.S., HB 2294 (hereinafter cited as HB 2294).

groundwater management.[24] Further, SB 1 tasked the State agencies to study, identify, and delineate these PGMAs to initiate the creation of GCDs that were not subject to local confirmation (Figure 1).[25] Other provisions of SB 1, such as the "junior" priority date assigned to interbasin transfers of surface water rights, created significant regulatory obstacles that substantially restricted surface water supply as a statewide water supply solution.[26] These obstacles coupled with the limited opportunity for new reservoirs would have the effect of increasing the pressure on the state's groundwater resources.[27]

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[24] TEX. WATER CODE §35.007(a). ("The executive director [of the Texas Commission on Environmental Quality] and the executive administrator [of the Texas Water Development Board] shall meet periodically to identify … areas of the state that are experiencing or are expected to experience, within the immediately following 50-year period, critical groundwater problems…"). The Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB) are Texas' primary water agencies. The TCEQ is responsible for water quality regulations and surface water allocation whereas the TWDB is responsible for water-related research, planning, and project funding.

[25] G. Fipps, MANAGING TEXAS GROUNDWATER RESOURCES THROUGH GROUNDWATER CONSERVATION DISTRICTS, at 3 (2002). (The PGMA process was refined when SB 2 was passed in 2001. The process required that each PGMA designation order issued by the TCEQ must recommend that an area be covered by a GCD through creation of a new GCD or annexation into an existing GCD. GCD coverage must be provided for the designated area within 2 years of the order.). TCEQ & TWDB, PRIORITY GROUNDWATER MANAGEMENT AREAS AND GROUNDWATER CONSERVATION DISTRICTS, REPORT TO THE 82ND TEXAS LEGISLATURE (2011). (To date, 18 areas covering 118 counties have been evaluated and 8 PGMAs have been designated covering all or parts of 35 counties).

[26] TEX. WATER CODE §11.085(s). (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). See also M. Gershon, *The Recent Evolution of Texas Water Policy and Law*, SOUTHWEST HYDROLOGY, at 24 (July/August, 2003). ("… [In Texas] water is managed under a bifurcated system which often views groundwater and surface as mutually exclusive resources. Nowhere is this more prevalent than with statute restricting interbasin transfer of surface water, but not groundwater. While the legislative intent was to protect in-basin water users, a significant side effect has been the shift to a reliance on groundwater, for which there are no similar restrictions.").

[27] J. Foster, *Do Texas Groundwater Conservation Districts Matter?* 11 WATER POLICY, at 380 (2009). ("Since most of the states surface water is allocated and constructing reservoirs require significant expense on less optimal sites along with substantial opposition from local residents and environmental groups, groundwater has become the more attractive option for satisfying future water supply demands.").

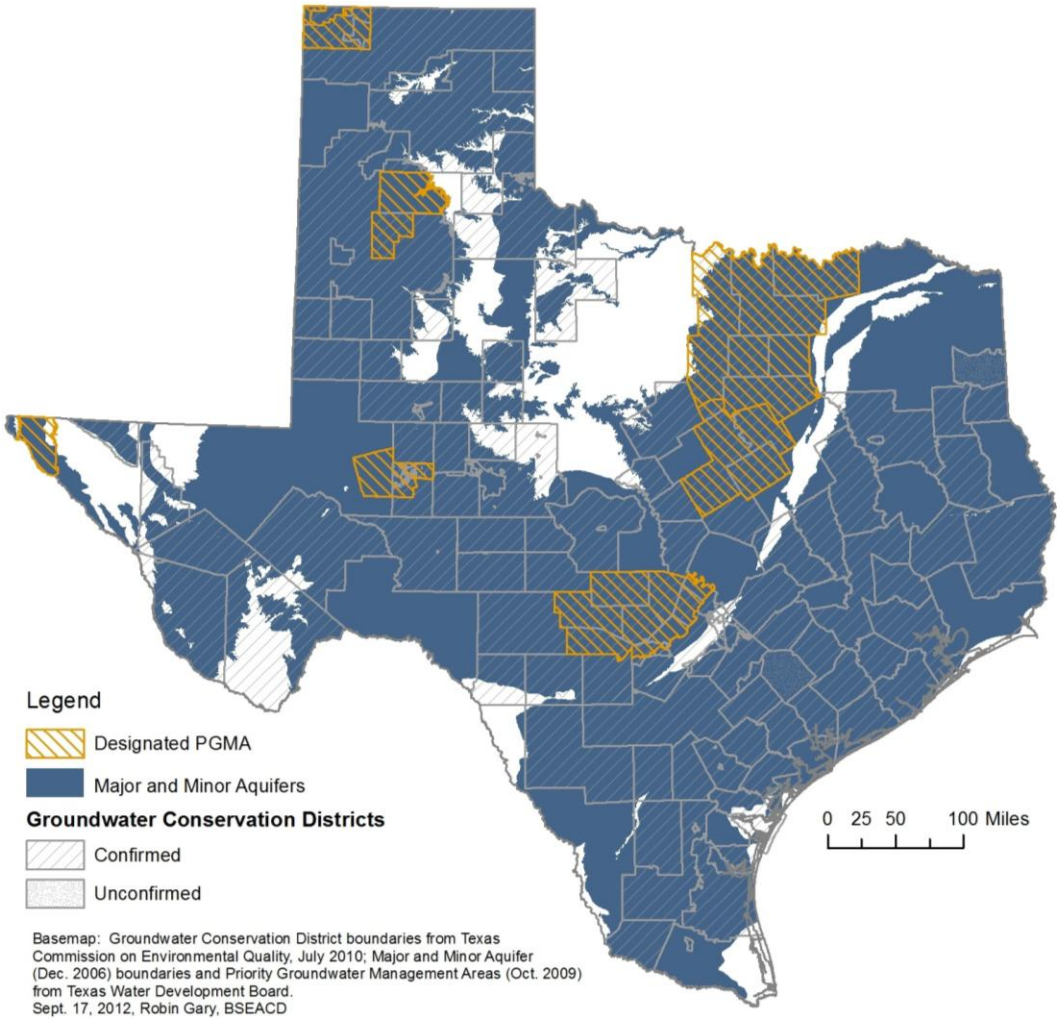

Figure 1: Map of Designated PGMAs in Texas.

But arguably the most notable effect of SB 1 on Texas groundwater management was that it statutorily designated and firmly committed to GCDs and local control as the preferred method of groundwater management in Texas.[28] The provisions of SB 1 appear to have been well timed, as they would also provide the court just enough of a rationale to

[28] TEX. WATER CODE §36.0015.

uphold the rule of capture in *Sipriano v. Great Spring Waters of America*.[29] In *Sipriano*, the question of whether Texas should continue to follow the rule of capture was taken head on. This case considered a complaint very similar to *East*, in which Henderson County landowners sued Ozarka Spring Water Company alleging that their wells were severely depleted due to heavy pumping from the Ozarka wells on nearby land.[30] This case was taken all the way to the Texas Supreme Court, where the court was specifically requested to overturn the rule of capture. [31] The court might otherwise have been compelled to consider overturning the rule of capture, but upheld it instead, stating that groundwater regulation was *a duty of the legislature* under the Conservation Amendment and by referring to the then-recent passing of SB 1 as evidence of an attempt by the legislature to fulfill this duty. In Justice Nathan Hecht's opinion, he remarked, "not much groundwater management is going on," sending a clear message to the legislature that this issue needed further attention and that it was their responsibility to do so. The court's message coupled with a convergence of certain events would lead to a proliferation of GCDs beginning in the subsequent legislative sessions in 1999 and 2001 (Figures 2 and 3).

[29] *See Sipriano, supra* note 4, at 80. ("It is more prudent to wait and see if Senate Bill 1 will have its desired effect, and to save for another day the determination of whether further revising the common law is an appropriate prerequisite to preserve Texas's natural resources and protect property owners' interests.").
[30] Potter, *supra* note 8, at 7.
[31] *See Sipriano, supra* note 4, at 75.

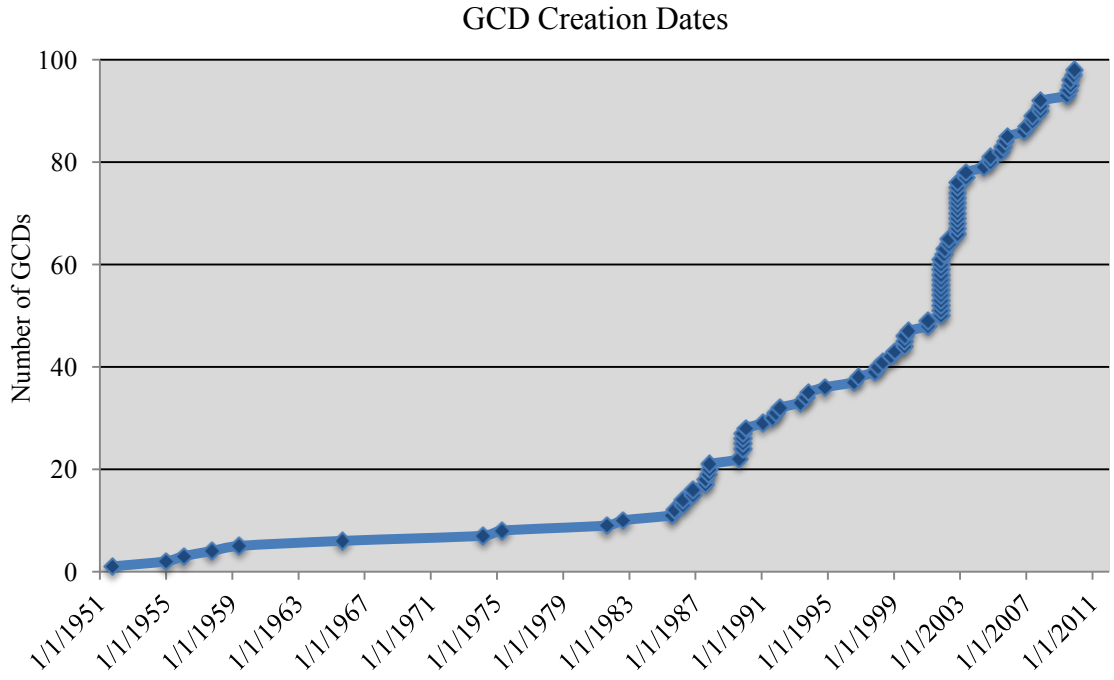

Figure 2: Chart of GCDs sorted by creation date. Chart shows the relatively slow pace of GCD creation beginning in 1951 after the GCD Act that was passed in 1949 and then the rapid proliferation of GCDs coming out of the legislative sessions in 1999 and 2001. (*See also* Appendix 2)

GCDs were further empowered as the preferred method of groundwater management with the passing of SB 2 in 2001. Although SB 2 was not as broad in scope as SB 1, it addressed many GCD-related issues, including: groundwater exports, certain authority of GCDs, and joint planning among GCDs within newly defined Groundwater Management Areas (further discussion on joint groundwater planning in Chapter 3). The authority of GCDs was clarified and substantially increased under SB 2 by 1) allowing a GCD to impose more restrictive conditions for new permits, 2) strengthening a GCD's

authority to regulate well spacing and production, 3) removing certain exemptions from permitting, and 4) allowing GCDs to impose a fee on groundwater exports.[32]

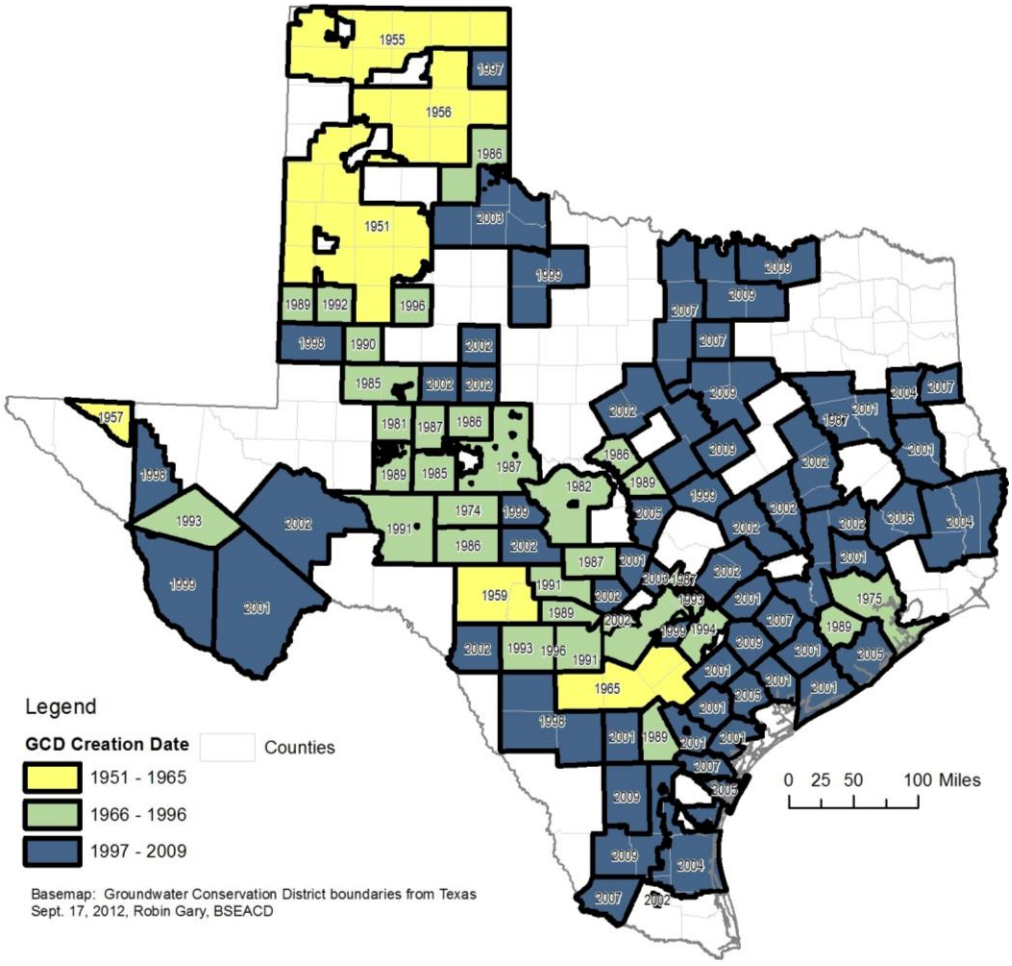

Figure 3: Map of GCDs sorted by creation date. Early GCDs in the panhandle region (indicated in yellow) were large scale and configured along aquifer boundaries. Conversely, GCDs created since 1997 (indicated in blue) are predominantly smaller scale single-county districts. (*See also* Appendix 2)

[32] Booth & Richard-Crow, *supra* note 11, at 22.

1.1.5 GCDs Today

As mentioned, the Texas Legislature has indicated a clear commitment to local control and a decentralized form of groundwater management by designating GCDs as the preferred and the only method of groundwater management in Texas.[33] GCDs have evolved substantially since the passing of the Groundwater Conservation District Act in 1949. In its present form, a GCD can be best described as a local unit of government generally created by the Texas legislature and confirmed at the local level to manage and protect groundwater. More specifically, a GCD is a political subdivision of the State that is established to:

> …provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions.[34]

The authority and the regulatory tools to accomplish this objective are provided generally in Chapter 36 of the Texas Water Code and oftentimes more specifically in enabling legislation if the GCD is created by the legislature.[35] GCDs are governed by a Board of Directors and are responsible for developing a comprehensive management plan and adopting rules to implement this plan. The plan and associated rules must be consistent with the respective regional water plan and must address the following goals: [36]

1) providing for the most efficient use of water;

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[33] *See Sipriano*, supra note 4, at 81. (Hecht, J., concurring) ("… [GCDs] are not only the preferred method of groundwater management; they are the only method presently available.").
[34] TEX. WATER CODE §36.0015
[35] TEX. WATER CODE §36.102
[36] TEX. WATER CODE §36.1071(a)

2) controlling and preventing waste of groundwater;

3) controlling and preventing subsidence (if applicable);

4) addressing conjunctive surface water management issues;

5) addressing natural resource issues;

6) addressing drought conditions;

7) addressing conservation, recharge enhancement, rainwater harvesting, precipitation enhancement, or brush control, where appropriate and cost effective; and

8) addressing in a quantitative manner the desired future conditions of the groundwater resources for the conservation of groundwater.[37]

GCDs must also adopt rules to implement the management plan, keep records of wells and groundwater use and production, permit and register certain wells, and adopt bylaws to govern administrative and financial procedures.[38] To enforce the adopted rules and permitting requirements, GCDs are authorized to seek injunctions and civil penalties for violations of any of its rules through the civil court system. GCDs are funded by revenues generated from either levying ad valorem taxes[39] or by assessing production

[37] Goal No. 8 was added in response to the joint-regional groundwater-planning process that was created by the 79the Texas legislature in 2005 via HB 1763. Further discussion provided in Chapter 3, §3.2.
[38] B. Lesikar, R. Kaiser, & V. Silvy, QUESTIONS ABOUT GROUNDWATER CONSERVATION DISTRICTS IN TEXAS, at 17 (2002).
[39] TEX. WATER CODE §36.201(b)

fees.[40] To date, there are 98 confirmed GCDs covering all or part of 174 of the state's 254 counties and the majority of the major and minor aquifers in Texas (Figure 4).[41]

[40] TEX. WATER CODE §36.205(c). (Revenue may also be augmented with administrative fees, grant funding for certain projects, or assistance from local government such as counties.)

[41] Texas Groundwater Protection Committee. *What is a Groundwater Conservation District?* (August, 2011), http://www.tgpc.state.tx.us/FAQs.htm. (providing general information on GCDs).

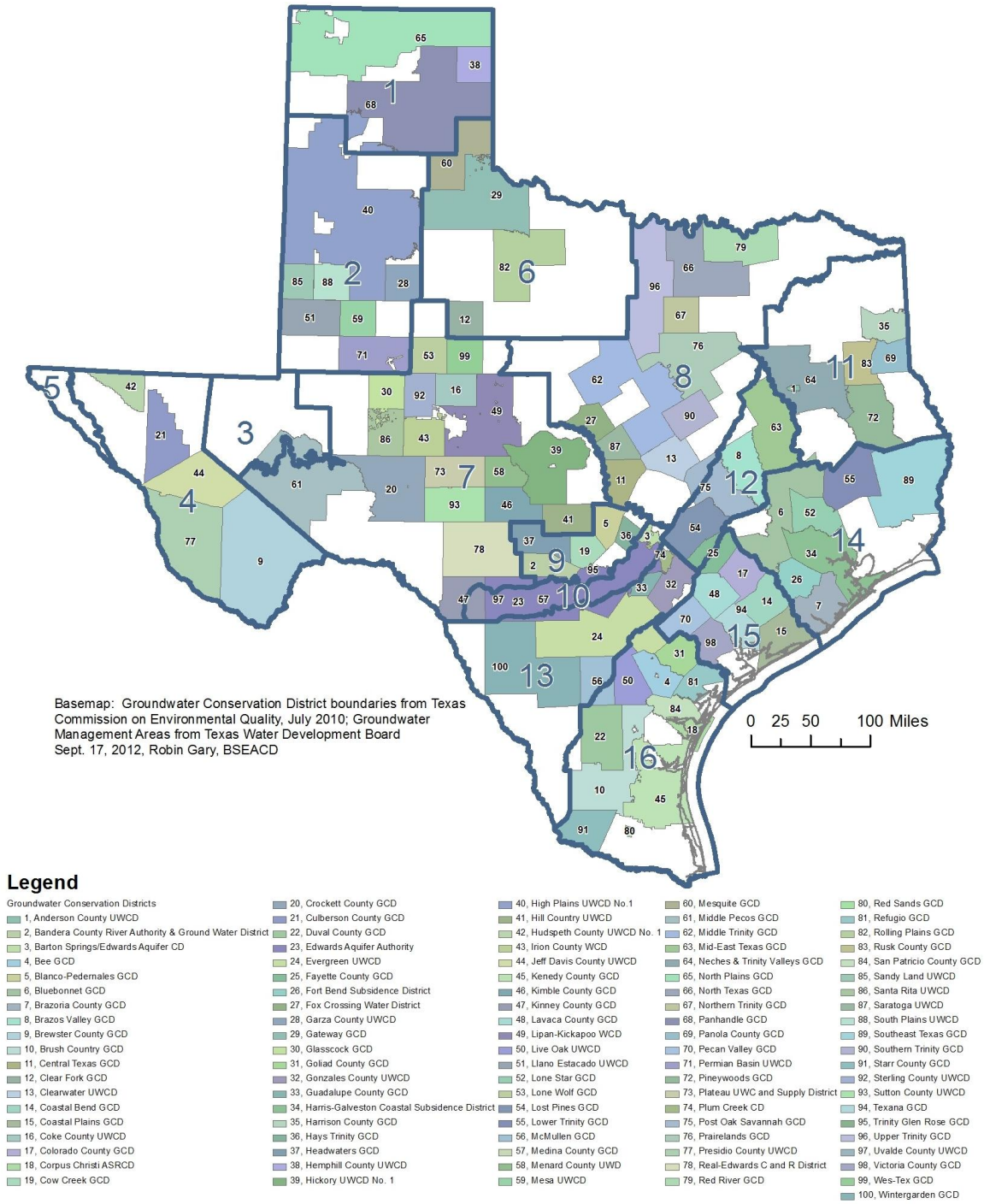

Figure 4: Map of GCDs and Groundwater Management Areas (GMAs).

1.1.6 Water Management in Texas

In summary, the evolution of the management of the water resources in Texas diverged along a bifurcated path beginning with the judgment in the *East* case where groundwater was pulled apart from surface water due in part to the ignorance of the movement and behavior of groundwater in the subsurface[42] but also because of an underlying resistance to any attempt to limit the property rights of Texas landowners.[43] This legal divergence that was more firmly entrenched with the passing of the Groundwater Conservation District Act in 1949 established a legal framework that now considers surface water as property of the state whereas groundwater is a private property right.[44] The final product in place today is a system of centralized management of surface water where any diversions of state water must first be appropriated by the state via the state agency charged with issuing water rights permits, the Texas Commission on Environmental Quality (TCEQ), and paradoxically, a system of decentralized management of groundwater where small-scale local districts with limited authority and

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[42] *See East*, *supra* note 2.

[43] *See East, supra* note 2, at 280. (quoting *Acton v. Blundell*, 12 M. & W. 324, 152 Eng. Rep. 1223 (Ex. 1843) "That the person who owns the surface may dig therein, and apply all that is there found to his own purposes at his free will and pleasure; and that if, in the exercise of such right, he intercepts or drains off the water collected from the underground springs in his neighbor's well, this inconvenience to his neighbor, falls within the description of *damnum absque injuria*, which can not become the ground of an action."); *See Also*, *Id.* at 281. ("An owner of soil may divert percolating water, consume or cut it off, with impunity. It is the same as the land and cannot be distinguished in law from land. So the owner of the land is the absolute owner of the soil and of percolating water, which is a part of, and not different from, the soil.").

[44] Act of May 27, 2011, 82nd Leg., R.S., SB 332 [hereinafter cited as SB 332]. (codified as amendments to TEX. WATER CODE Ch. 36) (SB 332 more firmly establishes groundwater as real property. TEX. WATER CODE §36.002 now states: "The legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property."). *See also Edwards Aquifer Authority v. Day*, 369 S.W.3d 814, 814 (Tex. Feb. 24, 2012). ("We decide in this case whether land ownership includes an interest in groundwater in place that cannot be taken for public use with adequate compensation…. We hold that it does.").

resources are the preferred approach. The divergence in the paths on which surface water and groundwater management evolved has generated incompatible policies that have effectively widened the gap in management logic and increased pressures on the state's aquifers and on the GCDs responsible for groundwater management. Although it is clear that this divergence was a necessary compromise at the time the two paths were set, the bifurcation of the waters in spite of their inextricable link in nature and the associated effects, will require reconciliation. (*See Also* Appendix 3 for a listing of significant events affecting Texas groundwater management.)

1.2 THE TEXAS PREFERENCE FOR LOCAL CONTROL

1.2.1 Why Local Control?

Texas places a significant amount of emphasis on local control, whether it is through GCDs, school districts, real estate appraisal districts, municipal utility districts, or the plethora of other special districts that exist.[45] The Texas Special District Local Laws Code is a good indicator of this preference with nearly 600 chapters governing and enabling the many local political subdivisions in the State. This long-standing preference for local control, particularly as it relates to groundwater governance, can be attributed to several factors, including: a strong belief in private property rights,[46] a general aversion

[45] *See* Foster, *supra* note 27, at 397.
[46] *See* R. Kaiser & F. F. Skillern, *Deep Trouble: Options for Managing the Hidden Threat of Aquifer Depletion in Texas.* 32 TEXAS TECH LAW. REV, 249, at 251 (2001); *See also* K. H. Norris, *The Stagnation of Texas Ground Water Law: A Political and Environmental Stalemate*. 22 ST. MARY'S L.J., 493, at 494 (1990).

to outsider interference via state or federal control, the related desire to preserve local autonomy and prevent the export of groundwater outside of the area of origin.

Private Property Rights

This concept of groundwater as private property and the right of unfettered use are core tenets of "The English Rule" or the rule of absolute ownership which inspired the rule of capture.[47] Ever since, this notion of absolute ownership with only limited exceptions[48] has reinforced the tightly held belief by Texans in local control and the treatment of groundwater as private property. While groundwater in the western states has evolved away from the absolute ownership doctrine towards the doctrines of reasonable use[49] and prior appropriation,[50] Texas has failed to follow this trend, largely because of the traditional Texan's aversion to governmental intervention in private property ownership matters.[51] The vigorous defense of groundwater as a private property right has taken center stage recently with landmark events occurring in both the

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[47] The classic statement of the English rule comes from *Acton v. Blundell*, 12 M. & W. 324, 152 Eng. Rep. 1223 (Ex. 1843); *See also East, supra* note 2&4, at 280.

[48] *East*, *supra* note 2, at 282. (The court left open the possibility of liability in the case of malice or wanton conduct.).

[49] J. Ashley & Z. A. Smith, GROUNDWATER MANAGEMENT IN THE WEST, at 9 (1999). (The Doctrine of Reasonable Use (also known as the American Rule) limits a landowner's right to the water beneath his or her land to that amount necessary for some reasonable and beneficial purpose on the land above the water. Under the reasonable use doctrine, the waste of water or the transportation of water off the land is not considered reasonable beneficial use if such use interferes with the right of adjacent landowners to use the water beneath their own lands for the beneficial use of those lands.)

[50] Foster, *supra* note 27, at 385; *Id.* at 9. (The doctrine of prior appropriation provides that the first appropritor of water, by putting that water to beneficual use without waste, has a right to continue that use. And such rights are superior to the rights or people who appropriate water at a later date.).

[51] *See* Kaiser, *supra* note 46, at 251.

legislature and the courts.[52] This ongoing debate has had an underlying effect on the state's approach to groundwater management as property right advocates have consistently fended off alternatives to local control in an effort to preserve local autonomy and manifested a general aversion to larger-scale regional or centralized groundwater governance – alternatives that they perceive to be a likely affront to those rights.

Aversion to Centralization

The well-documented debate over groundwater management that was building before passage of the GCD Act in 1949 described above provides a good illustration of the strong aversion to centralization or state control that was in place in the rural and agricultural communities of the Texas Panhandle.[53] In Green's book, *Land of Underground Rain*, he devotes an entire chapter to the debate that culminated in the GCD Act. In his summary of the events leading up to the Act, Green concludes:

> The District Groundwater Law enacted by the Texas Legislature in 1949 suited the wishes of most High Plainsman because it lacked any strong regulatory provisions for ground-water conservation and because it was a means of preventing a state board from controlling ground-water resources. In other words, rural interests on the High Plains supported the act because it promised an effective means for preventing rather than establishing a system of ground-water conservation.[54]

The Act was a clear defensive maneuver that served to quiet, at least temporarily, the concerns at the time over the specter of state governance and the associated effects on

[52] *See* note 44.
[53] Green, *supra* note 12.
[54] *Id.* at 188.

groundwater as private property rights. The issue, however, continued to persist and is vigorously debated even today (further discussion in Chapter 2).

While avoidance of state intervention can be a powerful motivator, the desire to preserve some semblance of local autonomy in the face of federal intervention could perhaps be more of a motivating factor. Historically, the federal government has deferred to the states to pass laws governing water, however, the courts[55] have dispelled what some refer to as the "myth of state control" by judging that state authority over water can be superseded by the exercise of federal powers over commerce and public land.[56] Such threats of federal intervention have been made with regard to Texas groundwater management in response to the belief that the major aquifer serving the Great Plains, the Ogallala, was being depleted.[57] In 1994, state and federal officials were demanding that the western states get their resource management houses in order by introducing legislation that would have required 17 western states to submit statewide management plans to the U.S. Secretary of the Interior using federally established criteria.[58] The response from Texas was that the evidence for Ogallala depletion was contradictory and that local control enjoyed strong citizen support, which was successful in preempting federal intervention.[59] It is interesting to note that there is a very distinct parallel between

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[55] *United States v. Rio Grande Irrigation Co*., 174 U.S. 690 (1899).
[56] Ashley & Smith, *supra* note 49, at 184-185.
[57] M. Somma, *Local Autonomy and Groundwater District Formation in High-Plains West Texas*, 21(2) PUBLIUS, at 54 (1994).
[58] *Id.* at 54.
[59] *Id.* at 54.

the state reforms driven by the potential threat of federal intervention and the local action in Texas driven by the threat of state intervention.[60]

The threat of federal intervention has been successful in motivating reluctant states in the west to reform water laws with perhaps the most powerful legal influence on western water policy being the federal Endangered Species Act (ESA). [61] The provisions of the ESA have the potential to affect any major water policy or project that may jeopardize the continued existence or habitat of a federally listed endangered or threatened species.[62] Faced with an immediate threat of federal regulatory action, states have chosen to reform water laws to soften the effect of federal laws and supplant the need for federal presence. State reactions, however, have typically been piecemeal, reactive, and the minimum necessary to comply with federal laws.[63] The threat of (federal) judicial regulation of the Edwards Aquifer represents an example in Texas where the state legislature reacted by passing the Edwards Aquifer Authority Act and creating a regional groundwater management entity, the Edwards Aquifer Authority, to end federal litigation. The Act, however, was narrowly aimed at the region of the San

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[60] W. Blomquist, *State Differences in Groundater Policy Adoptions, 1980-1989*, 21(2) PUBLIUS, at 101-115 (1991). (Blomquist cites Henry Hart who suggested "…that changes in state gorundwater laws and policies, and in their administration, were more likely to be driven by state political cultures and by the distribution of formal governmental power thanby the acuteness of groundwater supply or quaolity problems.").

[61] Ashley & Smith, *supra* note 49, at 209. (Colorado, Nebraska, and Wyoming were forced to negotiate water allocation issues in the Platt River due to affected whooping crane habitat in the central Platt. The Endangered Species Act (ESA) motivated major changes in water management of the Snake and Columbia Rivers after seven species of salmon were listed as endangered or threatened.).

[62] *Id.* at 209. (Section 7 of the ESA requires a consult with the U.S. Fish and Wildlife Service before any federal permits or approvals are granted to determine if a proposal would cause jeopardy to listed species. Under Section 9 of the ESA, even non-federal actions that result in habitat modification on private land can constitute a prohibited "taking" of species.).

[63] *Id.* at 210.

Antonio segment of the Edwards Aquifer and did not resolve the groundwater management issues in the remainder of the State.[64] The Edwards Aquifer Authority as an example of groundwater management reform in Texas is discussed in more detail in Chapter 4.

Local Autonomy

The strong aversion to centralized regulation is consistent with the strong desire to preserve local autonomy. The testimony offered in the hearings provided by the local citizenry over the designation of the North Central Texas-Trinity and Woodbine Aquifers PGMA (Figure 1) serves as a well-documented example offering a glimpse into the motivational sentiments behind the desire to preserve local autonomy and the fervent resistance to outside intervention of even adjacent counties.

On September 2, 2008, Administrative Law Judge Carol Wood issued a Proposal For Decision (PFD) with recommendations to designate a PGMA for the North Central Texas – Trinity and Woodbine Aquifers Area.[65] In her PFD, the debate over establishing multiple single-county GCDs over the area versus a single multi-county GCD was a central theme and is demonstrative of the deeply embedded preference for local control. The TCEQ Executive Director recommended the creation of an eight-county regional GCD to include Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, and Johnson

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[64] *Id.* at 210.

[65] TCEQ, EXECUTIVE DIRECTOR'S REPORT AND RECOMMENDATIONS TO DESIGNATE A PRIORITY GROUNDWATER MANAGMENT AREA FOR THE NORTH-CENTRAL TEXAS--TRINITY AND WOODBINE AQUIFERS AREA, SOAH Docket No. 587-07-3917 (Hearing on: September 2, 2008).

Counties funded by production fees. The judge concurred. The following points outline the arguments of those that were opposed to the single multi-county (regional) GCD that was proposed:[66]

- A single, regional GCD would ignore the political, demographic, economic, and practical differences and realities that distinguish the various counties involved, which are substantial enough to invite significant differences in perspective among the members of the governing body of the proposed GCD. For example, rural counties have characteristics that are fundamentally different from urban counties.
- For GCDs where representation on the board of directors is allocated equally by county, counties with a lesser reliance on groundwater are given equal votes as those with a greater reliance.
- Smaller counties would face a substantial loss of influence and control resulting in water policy dictated by others.
- A single, regional GCD would create inequities in service – larger more significant users would get more attention than lesser users in terms of water availability.
- Adjacent counties with vast differences in reliance on surface water versus groundwater would have equally different concerns and interests.

[66] *Id.* at 9-10.

The deliberations over the formation of GCDs in the North Central Texas PGMA provide an indication of similar statewide sentiments in the management of water in Texas. That is, a general fear of inequitable representation, infringement on private property rights, and a loss of local autonomy.

Rural to Urban Groundwater Export

Efforts to preserve local autonomy also tend to represent the division between rural and urban interests with urban interests favoring larger-scale control (either regional or centralized) that would enable the rural to urban water transfers and rural interests preferring to maintain local autonomy and control of their portions of a common-pool resource.[67] Concerns over an increase in groundwater marketing became the motivation for some communities to propose GCD creation and to adopt rules to protect against the prospects of large-scale rural to urban water transports. In 1995, the rules of the Panhandle Groundwater Conservation District prohibiting any groundwater export were challenged at District Court in Potter County.[68] The court found that, absent any express statutory authority, any rules attempting to prevent water exports were beyond a GCD's authority.[69] In 1997, in response to concerns over potential groundwater exports, SB 1 included provisions to authorize the regulation of out-of-district groundwater exports through permits. In 1999, the legislature reacted to the transport provisions of SB 1 by

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[67] *See* D. Todd, *Common Resources, Private Rights and Liabilities: A Case Study of Texas Groundwater Law*. 32 Nat. Resources J., 233, at 244 (1992).
[68] *Quixx v. Panhandle Groundwater Conservation District No. 3*, No. 79-687C, 251st District Court, Potter County.
[69] HOUSE COMM. ON NATURAL RESOURCES, INTERIM CHARGES REPORT, at 21 (2000).

proposing a number of new GCDs with authority allowing prohibitions or severe limitations on groundwater exports.[70] The authority authorized by SB 1 coupled with substantial modifications under SB 2 in 2001 allowed GCDs to impose surcharges on export (transport) permits[71] and to consider certain criteria in permitting transport, however, SB 2 stipulated that GCDs may not impose more restrictive permit conditions on transporters than would be imposed on in-district uses.[72] The modifications of SB 2 requiring equal treatment of in-district and transport permits appeared to have effectively stanched GCD creation solely for the purpose of limiting exports.

As illustrated in the build up to the GCD Act of 1949 and in the description of the North Central Texas PGMA hearings, there is a strong sentiment to accept local control only if the alternative of centralized state control appears imminent. This seems to be a recurrent theme that has played out over the years and remains in place even today. At present, the County Commissioners in Comal County are expressing a very similar sentiment in the debate over creation of a GCD in the uncovered portions of the Hill Country PGMA. The commissioners were reported to emphasize the need to be proactive in creating a GCD in order to "prevent losing local control."[73] It is remarkable

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[70] Id. at 17, 20. ("The 76th Legislature considered creating at least 30 new groundwater districts. …the abundance of districts cause concern since only 44 districts had been created and confirmed in the previous 50 years.").

[71] Production of groundwater to be used outside of a GCD is referred to as "transport", "transfer", and "export" of groundwater. These terms are used interchangeably in statute and GCD rules.

[72] TEX. WATER CODE §36.122(c)-(e)

[73] E. J. Weilbacher, *County Mulls Groundwater District Plan* (December 7, 2011) www.mysanantonio.com/community/bulverde/article/County-mulls-groundwater-district. ("In order to prevent losing local control, county commissioners emphasized the need to be proactive in creating a district, in order to design it to meet the needs of everyone affected by the move.").

that over 60 years later, this notion of "if there must be any control, let it be local" has remained unchanged and is a strong indicator of the preference for local control primarily to avoid outsider interference. There also appears to be an equally powerful motivation among rural communities to create GCDs in a defensive posture to prevent exports of groundwater to urban areas.

As evidenced by the reactions of both the courts and the legislature, the desire to preserve local control has been extremely effective in influencing political will and groundwater policy in Texas.

1.2.2 Why Single-County GCDs?

The preference in Texas for local control has been well established. The shape and form of those local entities, however, has followed a precedent that presents its own set of unique issues and challenges. The creation of GCDs has evolved to follow a template that uses county-based jurisdictions as boundaries despite the obvious conflict between natural aquifer boundaries and politically drawn boundaries at the surface. The pattern stands in contrast to the earliest development of GCDs. Of the GCDs created from 1949 to 1984, more than 70 percent were configured along multi-county lines, primarily for the purpose of managing significant portions of major aquifers threatened by overpumping (Figure 5).[74] Due to a convergence of certain events in the mid 1990s, the early precedent for larger-scale GCDs was replaced with the precedent of the creation

[74] SENATE INTERIM COMM. ON NATURAL RESOURCES. INTERIM REPORT TO THE 77TH LEGISLATURE - TEXAS GROUNDWATER RESOURCES, at 29 (November, 2000).

of single-county GCDs (further discussion in Chapter 3). The product has been a proliferation of small-scale GCDs with politically drawn boundaries (Figure 5). Of the 98 GCDs established in Texas to date, 57 (58%) encompass the area of a single county or less and the large majority are configured along county lines (Figure 5, Appendix 1).[75] The tendency to create single-county Districts can largely be attributed to: 1) the desire to preserve county autonomy, 2) the influence of county governments in the GCD creation process, 3) administrative convenience, and 4) "path dependency" once a precedent has been established.

[75] Two of the earliest GCDs created – the High Plains UWCD No. 1 and the North Plains GCD – were created when the process required that GCDs to be created within designated "underground reservoirs." These GCDs are part of the minority of GCDs with aquifer-based jurisdictions.

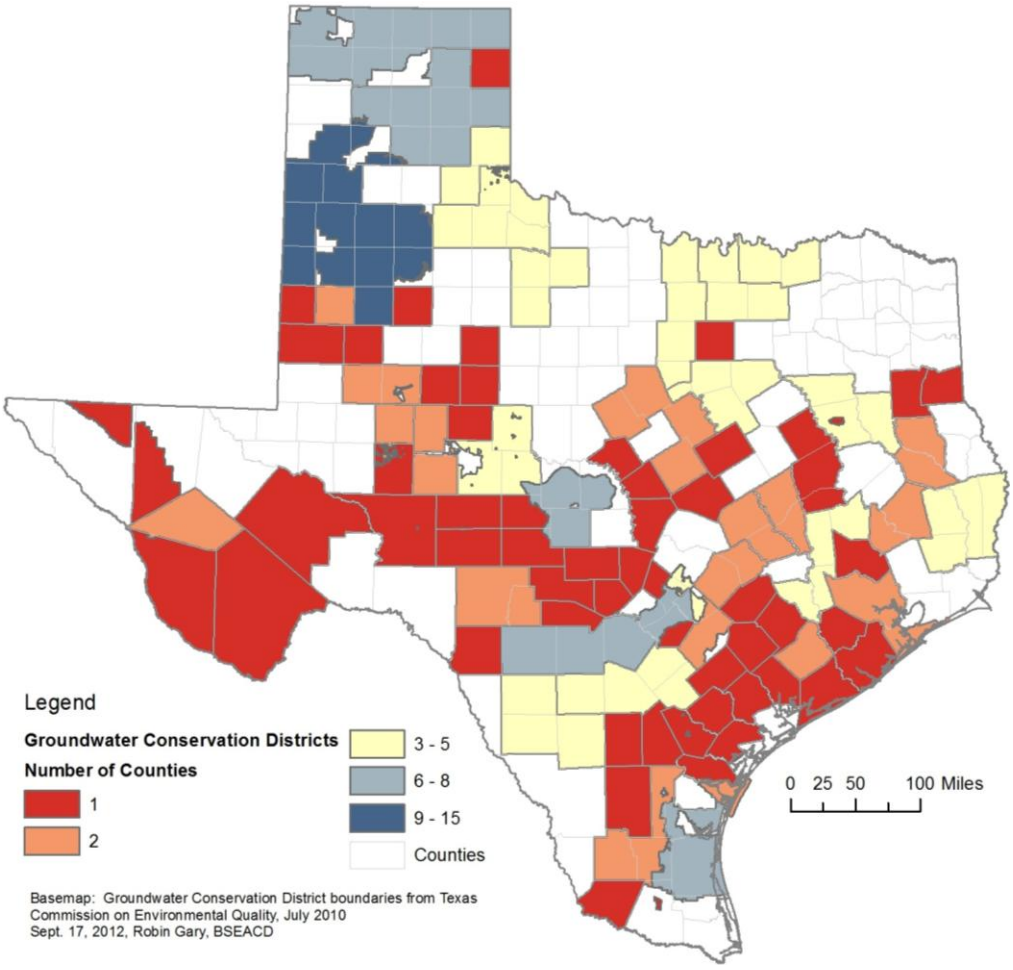

Figure 5: Map of GCDs referenced by the number of counties present in each GCD. As indicated in the GCDs shaded in red, 57 (58%) of the 98 confirmed GCDs encompass a single county or less.

Influence of County Governments

County governments have been hard-wired into groundwater management in Texas on many levels beginning with the GCD Act of 1949. The GCD Act, which created a rather complicated process for GCD creation in response to a local petition,

included a prominent role for county governments.[76] Although GCD creation could also be initiated by legislation, this option was not commonly utilized in the period just after the Act was passed.[77] The process for GCD creation via local petition under the GCD Act was a three-step process involving: 1) designation of a hydrological reservoir, 2) a decision by the local county commissioners court that formation of the district is "feasible and practical," and 3) approval by local residents by a majority vote.[78] Counties were also given sufficient latitude in disapproval of a GCD by allowing citizens of counties in a proposed GCD to be excluded from the proposed GCD if the voters of a county voted against confirmation.[79] The complexity of the petition process and the heavy reliance on local persistence throughout the process were criticized as being self-defeating and ineffective,[80] two qualities that were perhaps an inevitability considering the resistance by many locals to any form of groundwater management at the time. The structure of this petition process in its nascent form appears to be where the involvement and influence of county governments took root. Although the petition process would later be all but abandoned in favor of legislatively created GCDs,[81] the precedent for substantial county involvement and influence in GCD creation was firmly established.

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[76] *See* Snyder, S. E., *Ground Water Management: A Proposal for Texas.* 51 TEXAS L. REV., 289, at 294 (1972-1973).
[77] I*d.* at 294.
[78] I*d.* at 294.
[79] *Id.* at 294. (Snyder cites TEX. WATER CODE §§ 52.001-.401 (1972) - the provision of the Water Code dictating the process for creation of Water Control and Improvement Districts which also governed GCD creation by reference.).
[80] I*d.* at 295.
[81] R. E. Mace, R. Petrossian, R. Bradley, & W.F. Mullican, *A Streetcare Named Desired Future Conditions: The New Groundwater Availability for Texas*. THE CHANGING FACE OF WATER RIGHTS IN

The precedent of county influence that took root in the local petition process of the GCD Act in its initial form has also been maintained and statutorily incorporated into what is now the PGMA program. In its current form, the PGMA program requires that the county commissioners of all the counties of the affected area are notified upon designation of a PGMA, where the process to determine the recommended action for GCD creation begins.[82] Further, once a new GCD within a PGMA is proposed, the county commissioners are empowered to appoint a steering committee to begin the process of informing local constituents on the GCD creation process.[83] The county commissioners of a county within a PGMA are also empowered in the process to request annexation of the entire county by an adjacent existing GCD within the PGMA.[84] As an illustration of the influence of county governments in GCD formation, Figure 6 depicts the Hill Country PGMA that was established at a scale sufficient to encompass the Hill County Trinity Aquifer and the infill of single-county GCDs that occurred in response to the PGMA designation.[85]

TEXAS (REVISED), at 1, FN 5 (May 2008). ("By 2001, only 7 GCDs had been created via petition vs. 77 created via legislation.").

[82] *Id.* at 19.

[83] *Id.* at 24.

[84] *Id.* at 25.

[85] The boundaries of the Hill Country PGMA were established using a practical hybrid of county and aquifer boundaries. The county boundaries that were used roughly mimic the aquifer boundaries. More importantly, the scale was sufficient to encompass the majority of the Hill County Trinity Aquifer.

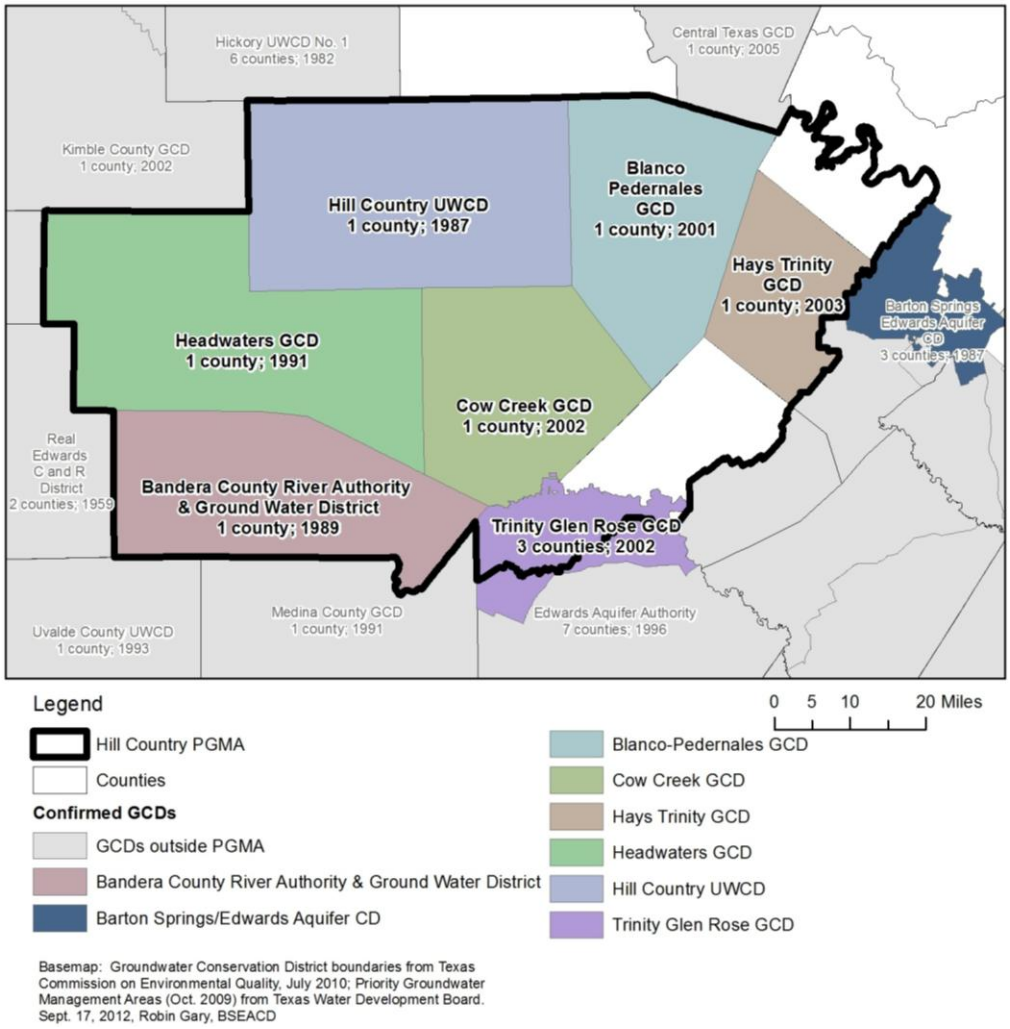

Figure 6: Map of GCDs in the Hill Country PGMA. The PGMA was created to generally encompass the Hill Country Trinity Aquifer and to initiate GCD creation. The response was infill with single-county GCDs.

Path Dependency

Although the role of counties in GCD creation through the petition process has clearly had an influence on setting the initial pattern for single-county GCDs, petitions are now rarely used for this purpose. Rather, the predominant method for GCD creation

is through legislation. A common practice in drafting legislation is to begin with modeling a bill after the enabling legislation of a standard GCD with standard authorities and the boundaries of existing structures of governance – that is, counties. This is a recognized institutional practice referred to as "path dependency" which describes the pronounced tendency of human systems to follow well-defined courses once they are launched on particular paths.[86] It becomes the standard less because of the logic and more because of the familiarity, convenience, and comfort.[87] The reaction to the prospects of urban to rural groundwater exports and to *Sipriano* in which the courts pointed to the legislature's responsibility for groundwater management was a tremendous increase in legislatively created Districts (Figures 2 & 3). It also provides a good example of this preference to follow the comfortable path. Bills filed in the 76th Legislative Session in 1999 proposed at least 30 new GCDs, the majority of which were to be configured along county boundaries and single-county in scale.[88] The legislature compromised by authorizing a reduced number of GCDs on the basis of concerns expressed by the bill's author over the single-county GCD precedent.[89] Nevertheless, the path had been established (further discussion in Chapter 3).

The points raised in the North Central Texas PGMA hearings are also clearly indicative of the rationale behind the single-county GCD precedent. Although county

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[86] O.R. Young, THE INSTITUTIONAL DIMENSIONS OF ENVIRONMENTAL CHANGE: FIT, INTERPLAY, AND SCALE, at 71 (2002).
[87] C. Allan & A. Curtis. *Nipped in the Bud: Why Regional Scale Adaptive Management is Not Blooming,* 36 (3) ENVIRONMENTAL MANAGEMENT, at 422 (2005).
[88] HOUSE COMM. ON NATURAL RESOURCES, *supra* note 69, at 17.
[89] SB 1911: Bill Analysis, 76th Leg., R.S., at 1 (1999).

boundaries appear arbitrary from a hydrological sense, such boundaries address certain political realities. That is, counties overlying one aquifer may differ in the size of their tax base, which may lead to an arrangement where well-healed counties are subsidizing other counties by bearing a greater share of the cost.[90] Similarly, there may be perceived levels of inequity where adjoining counties may use different amounts of groundwater for different reasons.[91] These differences in both funding contributions and water interests can often be the motivations for single-county GCDs for the purpose of keeping funding close and preserving very specific local interests.

The product of the GCD creation process has evolved from the petition process under the GCD Act and the PGMA program in the current statute into the current preference for legislatively created GCDs. One factor that has remained constant is the predominant practice of using counties as the basis for groundwater governance. The intimate link between GCDs and county governments coupled with perceived inequities, the administrative convenience of county jurisdictions, and the well-established legislative precedence has clearly had an influence on the current system of county dominated GCDs.

[90] HOUSE COMM. ON NATURAL RESOURCES, *supra* note 69, at 18.
[91] *Id.* at 18.

Chapter 2: Challenges of Groundwater Governance

Governance of natural resources considered to be common-pool resources, such as water, forests, and fisheries, comes with certain challenges associated with the nature of the resource. Common-pool resources are considered any resource that is subtractible and has low excludability.[92] According to Ostrom, subtractability involves the possibility of approaching the upper limit of resource units that can be produced. For groundwater, this is exhibited by the fact that all water discharged by wells is balanced by a loss of water somewhere and that in this respect some groundwater is always being mined.[93] Groundwater also exhibits low excludability meaning that it is difficult to exclude well owners from pumping water from an aquifer. This is particularly true in Texas where the rule of capture applies outside of GCD-regulated areas and even within GCDs where landowners are entitled to some access to a "fair share" of groundwater.[94]

Regardless of the institutional challenges in Texas, the nature of groundwater as opposed to surface water offers its own unique set of challenges. Some of the contributing factors include: "fuzzy" hydrogeologic boundaries that can be diffuse and difficult to define, complex connections to surface waters and other aquifers, unaccounted pumping from exempt wells and unauthorized withdrawals on private

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[92] E. Ostrom, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION, at 31-32 (1990).

[93] I. Theesfeld, *Institutional Challenges for National Groundwater Governance: Policies and Issues*, 48(1) GROUNDWATER, at 132 (2010); C.V. Theis, *The Source of Water Derived from Wells: Essential Factors Controlling the Response of an Aquifer to Development.* 10(5) CIVIL ENGINEERING, at 277–280 (1940). (Theesfeld citing Theis).

[94] *See Edwards Aquifer Authority v. Day*, 369 S.W.3d 814 (Tex. Feb. 24, 2012). ("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 (citation omitted).").

property, and adverse effects of overpumpage that can often be separated in space and time.[95] These factors can be confounded by the increasing pressures on groundwater owing to the advantages over surface water[96] as well as the institutional challenges that are affected by legal, political, economic, and cultural factors.[97]

When a common-pool resource that is subtractible and has low excludability also faces the pressures of increasing demand, what is to be done to extend the resource and ensure its long-term collective and individual benefit? Much has been written about the challenges of common-pool resource management and many believe that the size, shape, and structure of the institutions[98] designed to govern groundwater are a key component of the solution. The following section focuses on the importance of "fit" and "scales of governance" as pertinent factors generally affecting management of groundwater as a common-pool resource in Texas given the state's preference for small-scale county-based GCDs. Further discussion is provided to address the institutional challenges unique to the GCD system of governance.

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[95] A. Ross, & P. Martinez-Santos, *The Challenge of Groundwater Governance: Case Studies form Spain and Australia.* 10(4) REGIONAL ENVIRONMENTAL CHANGE, at 300 (2010).

[96] *Id.* at 300. (the advantages of groundwater over surface water include: 1) it is not subject to evaporation like surface water, 2) it moves comparatively slower, 3) it can be tapped closer to its place of use, and 4) it is generally more available, even during drought.).

[97] *See* Foster, *supra* note 27, at 380. ("Since most of the state's surface water is allocated and constructing reservoirs require significant expense on less optimal sites along with substantial opposition from local residents and environmental groups, groundwater has become the more attractive option for satisfying future water supply demands."). *See also* M. A. Gershon, *The Recent Evolution of Texas Water Policy and Law.* SOUTHWEST HYDROLOGY, at 24 (July/August 2003). ("…[In Texas] water is managed under a bifurcated system which often views groundwater and surface as mutually exclusive resources. Nowhere is this more prevalent than with statute restricting interbasin transfer of surface water, but not groundwater. While the legislative intent was to protect in-basin water users, a significant side effect has been the shift to a reliance on groundwater, for which there are no similar restrictions.").

[98] Young, *supra* note 86, at 31. (Defines Institutions as "sets of rules, decision-making procedures, and programs that give rise to recognized practices, assign roles to participants in these practices, and govern interactions among occupants of specific roles.").

2.1 THE IMPORTANCE OF "FIT"

When designing institutions for effective common-pool resource management, recognition of the importance of "fit" is a key consideration. "Fit" deals with congruence or compatibility between the natural resource to be managed and the institutional arrangements created to manage human activities affecting these systems.[99] It follows that those endeavoring to create environmental or resource management institutions should begin with an assessment of the principal properties of the resource and proceed to design and build institutional arrangements that fit the biogeophysical contours of the problem.[100] Young discusses the importance of fit as follows:

> … the effectiveness of environmental or resource regimes or, in other words, the capacity of these arrangements to prevent undesirable environmental changes and to solve environmental problems once they arise is determined in considerable measure by the degree to which they are compatible with the biogeophysical systems with which they interact.[101]

Overall, the presumption is that the closer the fit between the natural resource and institutional systems, the better the relevant institutions will perform. This is due in part to the fact that externalities associated with resource management decisions can be avoided by matching the spatial extent of those externalities with the spatial extent of the regime.[102] It stands to reason that one of the goals of finding the right fit is to avoid misfit. Challenges associated with misfit can occur when both regime shape and size

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[99] Young, *supra* note 86, at 21.
[100] *Id.* at 59.
[101] *Id.* at 55.
[102] C. G. Lathrop, *Finding the Right Fit: One Design Element in the International Groundwater Resource Regime.* 19 DUKE J. OF COMP. & INT'L L., at 414 (2009).

(areal extent) allow for myopic management decisions that fail to account for these externalities.[103] This problem speaks to the need to consider both shape and areal extent in institutional design. In other words, both institution shape and areal extent must be congruent with the resource to be managed and sufficient to avoid the problems of fit.

Ideally, resource management institutions would be designed to avoid the problems of fit. As a practical matter, however, mismatches between institutions and the ecosystem or resource to be managed are common. Avoiding the problems of fit becomes more complex when other factors (i.e. legal, political, economic, and cultural factors) take precedence over biogeophysical factors and are the driving forces in determining the boundaries of institutional jurisdictions.[104] The disproportionate weight of these factors in institutional design can oftentimes be attributed to the powerful influence of the interests of those whose livelihoods may be affected.[105] The problems of fit are compounded once politically-based institutions are established and engrained and path dependency leads to more similarly designed institutions.

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[103] *Id.* at 415; V. Galaz et al. *The Problem of Fit between Ecosystems and Governance Systems - Insights and Emerging Challenges, in* INSTITUTIONS AND ENVIRONMENTAL CHANGE: PRINCIPAL FINDINGS, APPLICATIONS AND RESEARCH FRONTIERS, at 150 (O. R. Young, L. A. King, & H. Schroeder eds. 2008). (Lathrop quoting Galez) (misfit can occur "when the [i]nstitutional jurisdiction [is] too small or too large to cover or affect the areal extent of the ecosystem(s) subject to the institution.").

[104] Young, *supra* note 86, at 70 (It is a rare instance when ecological considerations played a significant role in determining boundaries. It is not surprising that coverages of these regimes fail to match the spatial boundaries of the ecosystem [resource].); *See also* Theesfeld, *supra* note 93, at 138; W. Blomquist & E. Schlager. *Political Pitfalls of Integrated Watershed Management.* 18 (2) SOCIETY AND NATURAL RESOURCES, at 101–117 (2005). (Theesfeld quoting Blomquist & Schlager) ("the selection of boundaries is always a political act and even integrated water management has many tradeoffs. Likewise, there are no ultimate boundaries.").

[105] Young, *supra* note 86, at 22.

2.1.1 Texas GCDs and the Problems of Fit

Texas is a clear example of the power of political, economic, and cultural forces in delineating institutional jurisdictions. It is also an example of how path dependency led to the predominance of county-based districts. While the development of this preference has been well established, the challenges associated with this decision deserve further attention. These include challenges associated with the hydrological disconnect between the aquifers and the GCDs and the insufficient areal extent and scale that are typical of county-based GCDs.

Hydrological Disconnect

Applied to groundwater management, the notion of fit asserts that boundaries of groundwater management institutions must be clearly defined[106] and the shape and jurisdictional area (areal extent) must be congruent and compatible with the hydro-geographical boundaries of the aquifers.[107] Failure to recognize these boundaries can result in transboundary aquifers and the many challenges associated with joint management of a single groundwater resource. Transboundary aquifers, particularly aquifers that straddle international and state boundaries, can be extraordinarily difficult to manage.[108] Texas is fortunate in that it is of the scale of, or even larger than, many sovereign states. As such, most of its major aquifers are largely contained within its

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[106] Ross, *supra* note 95, at 300; Ostrom, *supra* note 92. (Ross quoting Ostrom).

[107] Theesfeld, *supra* note 93, at 138. ("In order to achieve the successful implementation of decentralized water resource management, the institutional arrangements have to be clearly defined and reasonably well matched with the aquifer system.").

[108] T. Jarvis et al, *International Borders, Groundwater Flow, and Hydroschizophrenia*, 43(5) GROUND WATER, at 765 (September-October 2005). ("Despite many agreements and international laws acknowledging the growing significance of ground water resources, transboundary aquifers are usually only addressed in a cursory, poorly defined manner due to a lack of consensus regarding applicable international agreements and law to international ground water resources…").

boundaries. This advantage of sufficient areal extent, however, has been undermined with the proliferation of county-based GCDs which has created a system of entities that were out-of-sync with the hydrogeography of the State's major aquifers (Figure 7). This is purely a construct of the Texas decision to ignore aquifer boundaries in favor of county boundaries. The product is multiple transboundary aquifers overlain by a multitude of the institutions that were designed to manage them.

Management of transboundary aquifers by county-based entities can pose many challenges. For example, a typical single-county GCD will more often than not only encompass a small area (or for some, no area) of the overlying land where the aquifer receives recharge to replenish the discharges from springs, gaining streams, and water wells.[109] Moreover, most of the area providing replenishment to the aquifer may be located in adjacent counties that may be managed (or not) by a GCD with very different objectives, or even more problematic, may be outside the jurisdiction of any GCD and subject to the rule of capture. This is particularly challenging for GCDs seeking to manage within their single-county jurisdiction on the basis of the principles of safe or sustainable yield.[110] In general, sustainable yield seeks to balance the volume of recharge or water coming into the system with discharge of water that leaves the system through natural means such as seeps, springs, baseflow to rivers, and through withdrawals from

[109] R. Petrossian, C. Ridgeway, & A, Donnelly, *Balancing the Checkbook Account Through House Bill 1763,* (April 3, 2007), http://www.twdb.state.tx.us/groundwater/docs/Balancing_the_Groundwater_Checking_Account.pdf

[110] S. A. Pierce, R. Mace, & J.M. Sharp, *Using an Aquifer Yield Continuum as a Guide for Groundwater Management,* at 2 (2004). (Sustainable Yield is used synonymously with "Safe Yield". Pierce cites Meinzer (1920) who defines "Safe Yield" as "the extractable volume of water equivalent to annual average rainfall.).

wells. The inherent logic to this type of management approach is conditioned on having the ability to manage and account for the only manageable component of the sustainable yield equation – withdrawals from wells. Managing for sustainability or even some level of allowable depletion[111] breaks down with small-scale county-based GCDs that do not have the power to regulate wells that are outside their district, even though such wells may draw from and deplete groundwater resources common to multiple districts.[112]

[111] TEX. WATER CODE §36.116(2)(E). (Authorizes GCDs to regulate well production in order to manage the rate of aquifer depletion.)
[112] *See* C.W. Johnson, *The Continuing Void in Texas Groundwater Law: Are Concepts and Terminology to Blame*. 17 St. Mary's L.J., at 1284 (1985).

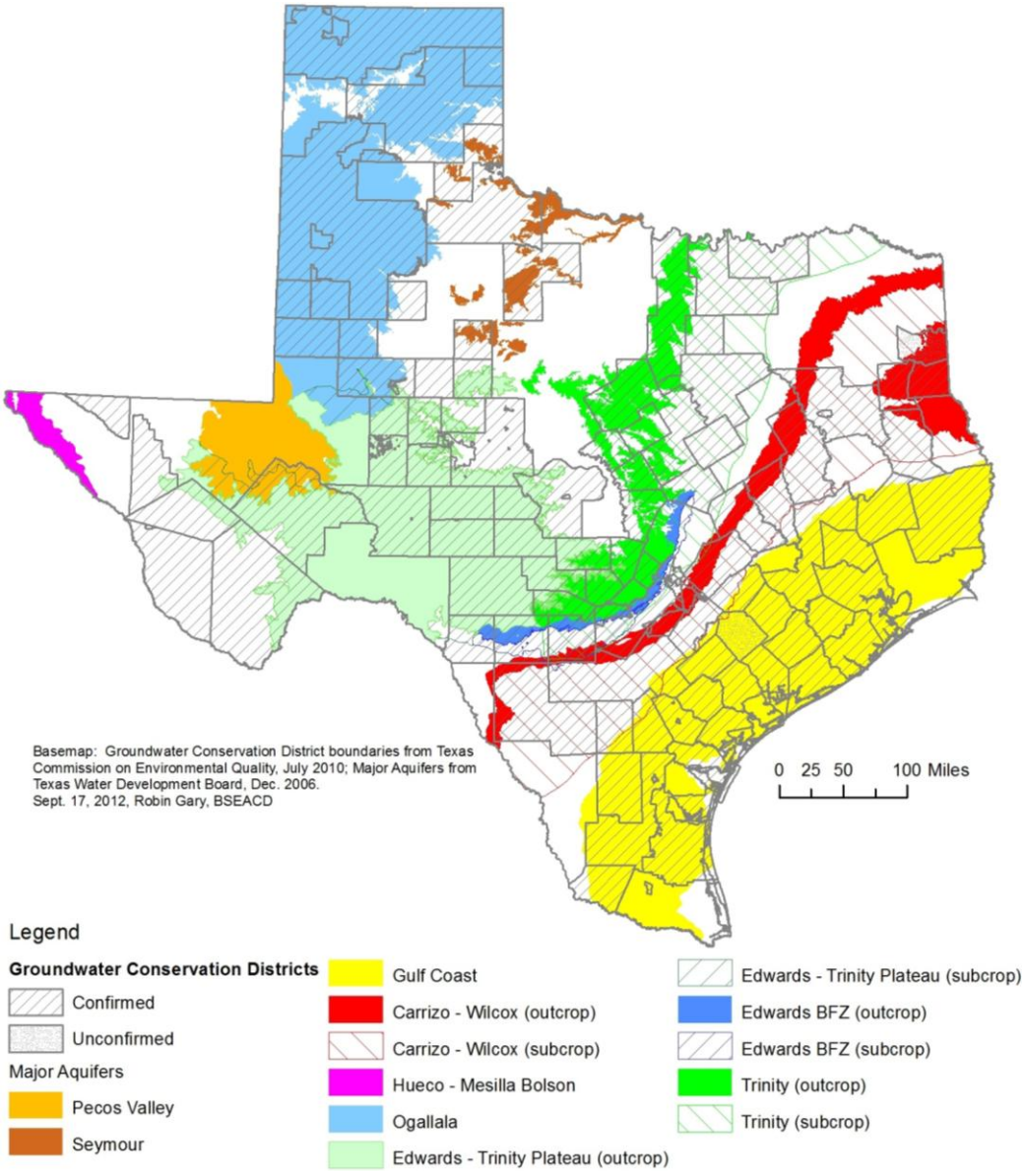

Figure 7: Map of GCDs and Designated Major Aquifers in Texas. With the exception of the GCDs created in the Texas Panhandle and over the Edwards Aquifer, the majority have boundaries that do not correspond well to the mapped major aquifer boundaries.

Insufficient Funding and Areal Extent

The importance of fit may also be applied when considering the areal extent of a GCD's jurisdiction and how that areal extent relates to a GCD's capacity[113] to fund the operations and the purpose for which it was designed.[114] Benjamin Franklin once said "We will know the worth of water when the well runs dry." It would stand to reason that this same logic would apply to creating institutions with the necessary resources and funds to prevent "the well" or the State's water resources from "running dry" or being unsustainably managed. In Texas, GCDs are generally limited to generating revenue for operating expenses by either levying *ad valorem* taxes or by assessing production fees.[115] Both of these revenue-generating mechanisms are affected by the areal extent of the jurisdiction of a GCD. The typically insufficient jurisdictional area associated with single-county GCDs exacerbated by other limitations associated with the nature of these funding mechanisms can hinder operational efficiency and limit the availability of resources and human capital needed to effectively manage the resource. Similarly, lack of resources can limit institutional resilience, which may compromise the political will of a GCD to make critical resource management decisions.

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[113] Young, *supra* note 86, at 100. (Young refers to "capacity" as "a measure of the availability of social and institutional capital as well as material resources necessary to make good on commitments…)

[114] TEX. WATER CODE §36.0015 (The stated purpose of GCDS as defined by statute is "to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI …")

[115] Revenues may also be augmented with administrative fees, grant funding for certain projects, or assistance from local government such as counties.

Funding of GCD Operations

The *ad valorem* taxation option for funding provided in the Texas Water Code authorizes the board of directors of a GCD to annually levy taxes at a rate not to exceed $0.5/$100 of assessed property valuation.[116] The actual rate set must be confirmed by a majority vote of the electorate within the GCD jurisdiction.[117] The tax rate is capped by statute and must be set considering the income available from other sources.[118] However, as a practicable matter, the proposed tax has to be set at a rate that would survive a ratification election, which can be a formidable challenge in a political climate where the simple mention of a new tax can be a nonstarter.[119] GCDs can tend to be hostages to this process by having to compromise and accept a rate that provides very limited funding. Further, it has not been uncommon for the voters to elect to participate in a district but refuse to tax themselves (at least at an appreciable rate) to provide for sufficient management or even to satisfy duties as mandated by statute. As a result, rates approved are on average an order of magnitude less than the statutory cap (Table 1). This is especially important in small single-county GCDs with relatively small jurisdictional areas or a low tax rate that cannot generate sufficient revenues to be effective or in some cases sustainable.

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116 TEX. WATER CODE §36.201((b)
117 TEX. WATER CODE §36.201(c)
118 TEX. WATER CODE §36.203
119 *See Day, supra* note 94, at 30, FN 110: ("Voter approval is often the most significant hurdle, as unwanted taxes and groundwater regulation lead to opposition to creation of new districts."). *See* Supra Note 25. TCEQ, TWDB, 2011. Table 6 at p. 39. (Since 1989, there have been 15 attempted confirmation elections for proposed GCDs that have failed.).

Statistic	Tax Rate ($/$100 valuation)
Mean	$0.060
Median	$0.020
Minimum	$0.002
Maximum	$1.440
Mode	$0.020

Table 1. Taxing Rates for Tax-based GCDs. Data represents statistics of the available data for tax rates of 45 tax-based GCDs (*see* Appendix 2). Tax rates are generally an order of magnitude less than the statutory cap of $0.5/$100 of assessed property valuation.

As an alternative to tax-based funding, a GCD may also be established with production fees as the primary funding mechanism (Appendix 2).[120] This may be a decision from the outset as established by enabling legislation or as a fallback position should a taxing option fail to be confirmed by a majority of voters.[121] Production fees are generally statutorily capped at very low rates when compared to other raw water sources. For example, the production fees prescribed by statute are $1/acre-foot for agriculture use and $10/acre-foot for all other purposes.[122] By comparison, the Lower Colorado River Authority's (LCRA) firm raw[123] water rate is $151/acre-foot.[124] Funding via production fees can also be limiting in the amount of revenue generated, especially with the statutory

[120] TEX. WATER CODE §36.205(c)
[121] TEX. WATER CODE §36.017(i)
[122] TEX. WATER CODE §36.205(d)(e). (Allows in increase of the production fee cap of up to either $0.17/thousand gallons or a rate specified in other statutes for certain GCDs.)
[123] "Raw water" refers to untreated and undelivered water supplies.
[124] LCRA. LCRA FIRM WATER SUPPLY CONTRACTS (February 18, 2009), www.lcra.org/water/supply/contracts/index.html. (retrieved September 29, 2012).

cap being so low relative to surface water.[125] Moreover, reliance on production fees can be a serious disincentive to making policy decisions and implementing rules to limit pumping. GCDs might be inclined to permit beyond a sustainable amount or to allow the dewatering an aquifer over time to generate sufficient funding for annual operations.[126] Even when an actual conflict of interest is not realized, production fee funding can create the perception of one.

Revenues generated by either *ad valorem* taxation or production fees are affected in a substantial way by the area encompassed by a GCD. Insufficient jurisdictional area is a problem of fit that affects the amount of taxes collected and the volume of water (either permitted or pumped annually) used to determine revenue from production fees. This is especially limiting in small single-county GCDs with relatively small jurisdictional areas and a low tax rate or relatively few nonexempt wells that would be subject to permitting and/or production fees. In these common examples of insufficient areal extent, GCDs typically cannot generate sufficient revenues to be effective or in some instances sustainable. Some GCDs are only resourced sufficiently enough to register wells and serve administrative functions with limited additional funding for rule enforcement, legal fees, aquifer studies, or data collection. In other words, they offer the

[125] Revenue generated from production fees based on actual pumped versus permitted volumes can also be highly variable depending on meteorological conditions.

[126] L. B. Marbury & M. Kelly, *Down to the Last Drop, 2009 Update: Spotlight on Groundwater Managment in Texas.* ENVIRONMENTAL DEFENSE FUND, at 19 (2009). ("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.").

perception of active groundwater management but are in fact governance in name only.[127] It is again an example of how the process provides ample opportunities for county governments and their electorate to influence both the decision to establish a GCD and then to fund a GCD in a manner that limits its effectiveness.

These issues of insufficient areal extent also speak to economies of scale. Single-county scale GCDs cannot fund the same level of technical and managerial staff as multi-county GCDs despite the higher tax rates that are generally needed by the former.[128] Moreover, smaller entities must cover duplicative overhead functions that could otherwise be shared in a larger scaled area, an additional inefficiency. The preference for GCDs of single-county scale is indicative of the strong influence of the effective value of local autonomy and a clear choice of autonomy over cost benefit.[129] However, what is politically acceptable in a process that is heavily stacked in favor of local governments is often ineffective and unsustainable in terms of authority and resources.

Institutional Resilience

The debate over groundwater ownership in Texas has recently been provided with some clarity from both the legislature through the passing of SB 332 and the Texas

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[127] The Hays Trinity GCD (HTGCD) is example of a GCD with specific enabling legislation (Act of May 28, 2001, 77th Leg., R.S., SB 2, Part 3) that further limits the ability to generate revenue by mechanisms available to most GCDs under TEX. WATER CODE Ch. 36. The Hays Trinity GCD has neither the authority to collect *ad valorem* tax revenue nor production fees. All revenue is generated by a one-time permitting fee plus any other secondary funding that may be available from grants and county subsidies. (See Also Appendix 2.).

[128] Somma, *supra* note 57, at 59.

[129] *See Id*. at 59, (Somma emphasizes this by pointing out that the larger-scale GCDs – The High Plains, Panhandle, and North Plains GCDs - enjoy the benefits of economies of scale by having sufficient resources at a lower tax rate than the rate of single-county GCDs.).

Supreme Court with the opinion issued in the *Day* case.[130] In short, SB 332, which became effective in 2011, recognized that a landowner has a property interest in groundwater in place subject to reasonable regulation by a GCD but also concluded that "unreasonable" regulation by a GCD may constitute a compensable taking of that property for public use.[131] For small single-county GCDs with insufficient jurisdictional area and limited resources and funding, this could open the door for takings claims from disgruntled landowners that have been unsatisfactorily affected by a GCD's regulatory decision. Takings claims can be long, complex, and expensive cases to litigate and defend.[132] Although the bar for satisfactorily demonstrating a compensable taking is high, the resources needed to defend a regulatory scheme as reasonable could exhaust the meager resources of many small, less resilient GCDs. The lack of institutional resilience to sustain legal challenges that may be associated with difficult resource management decisions may compel a GCD to err on the side of caution and relax regulations, or even avoid implementing sustainable resource management policies, in order to avoid a protracted legal defense.[133] Evidence of the potential and intent to challenge GCD

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130 *See supra* note 44.

131 *See Day, supra* note 94, at 814.

132 *Id.* at 46. (citing the Edwards Aquifer Authority ("Authority") brief: "The Authority worries that the financial burden of such [takings] claims could make regulation impossible, or at least call into question the validity of existing permits. Regulatory takings litigation is especially burdensome, the Authority notes, because of the uncertainties in applying the law that increase the expense and risk of liability." The court concurred stating: "…the expense of such litigation cannot be denied.").

133 J. Civins, *Ground(water) Breaking Decision – A Bad Day for Groundwater Management in Texas. Environmental Law Articles* (February 27, 2012), www.martindale.com/environmental-law/article_Haynes-Boone-LLP1458438.html. ("…groundwater conservation districts are left having to determine whether and to what extent their issuance of a permit constitutes a regulatory taking, if the applicant's request is denied in whole or in part. The net effect on groundwater conservation districts, most of which are not well funded

authority and examples of GCDs' unwillingness to infringe on private property rights has already emerged. For example, the Fox Crossing Water District cited SB 332 and the court's opinion as a basis for formally calling for the dissolution of the District.[134] It was also used by the Burnet County GOP as the basis for passing a resolution to be submitted for possible inclusion in the state's platform opposing GCDs' rulemaking powers.[135] Both of these examples appear to be harbingers of what is to come for GCDs, reinforcing the need for GCDs to be resilient enough to sustain while the GCDs and property rights advocates grapple with the challenge of finding a balance between responsible and effective resource management, property rights, and sustaining a healthy economy.

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and are unable to bear the costs of litigation, will be to severely chill their ability to manage groundwater because of the liabilities they may incur in issuing permits.").

[134] Fox Crossing Water District Board of Directors, A RESOLUTION, (March 13, 2012). (quoting citations from the resolution).

> Whereas Senate Bill 332 …clearly defines groundwater as real property belonging to landowners …,
>
> Whereas the unanimous decision of the Texas Supreme Court in [*Day*] clearly affirms groundwater as private property …,
>
> ***
>
> Whereas any liability that may befall Fox Crossing Water District, should the District in any action that might constitute a taking of private property under the laws of the state of Texas, would result in the necessity to impose taxes, fees or both,
>
> ***
>
> Whereas this Board believes that government is incapable of effectively managing large, complex, multi-variable systems, like groundwater … which may be affected by policies, procedures and activities completely outside the borders of said government,
>
> ***
>
> Be it resolved, that the Board of Directors of Fox Crossing Water District unanimously recommends the complete dissolution of said District effective immediately.

[135] J. Walker, *GOP Opposes Groundwater District's Rulemaking Power*. BURNET BULLETIN, (April 24, 2012, 9:00 AM), http://burnetbulletin.com/news_article.php?category_id=2&article_id=2497. ("Burnet County Republicans at their county convention Saturday approved a resolution to be submitted for possible inclusion in the state party's platform opposing groundwater conservation districts' rulemaking powers.").

2.2 SCALE OF GOVERNANCE - CENTRALIZATION VS. DECENTRALIZATION

In terms of the scale of groundwater governance, the end members are generally represented with centralized (top down) governance on one end and decentralized (local control) on the other. The merits of centralized verses decentralized governance have been long debated and are largely dependent on the purpose and the need for governance and the media to be governed. The following section provides a discussion of the merits of these end-member scales of governance as it pertains to addressing challenges unique to groundwater as a common-pool resource and the efficacy of its management.

2.2.1 Decentralization

Whereas the debate over the appropriate scale of governance can often degenerate into arguments that are products of politics rather than a discussion on the merits, theoretical-based discussions of natural resource management and governance have increasingly stressed the principles of user participation enabled though decentralization.[136] This emphasis in theory is largely based on the idea that top-down governance, such as centralized state-level control, is unlikely to achieve resource management objectives without support from the main water users.[137] This is consistent with one of the key tenants of governance, that is, authority to govern must be derived from the consent of the governed.[138] Ostrom for example, who has written extensively

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[136] L. Cook and J. Sachs, *Public Regional Goods in International Assistance*, *in* GLOBAL PUBLIC GOODS: INTERNATIONAL COOPERATION IN THE 21ST CENTURY, at 436–39 (I. Kaul, I. Grunberg & M. Stern eds. 1999).

[137] Ross, *supra* note 95, at 307.

[138] U.S. DECLARATION OF INDEPENDENCE. (1776), www.loc.gov/rr/program/bib/ourdocs/Declarind.html. (Retrieved March 25, 2012 from the Library of Congress website). ("We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable

about the management of common-pool resources, uses case studies of long enduring resource management institutions[139] to suggest that small-scale community-governance institutions may be more effective than centralized institutions for common-pool resource management. From these studies, Ostrom established principles for self-governing resource management systems. One of these key principles requires institutions to have "collective choice arrangements," meaning that many of the individuals affected by extraction limits are included in the group who can modify these rules.[140] Another suggests the need for minimal recognition of the rights of the user to devise their own institutions that are not challenged by external government authorities.[141] These are best accomplished at a smaller scale.

Ostrom also warns that when designing resource management institutions, "one size does not fit all." In other words, management regimes will have to be tailored to the particular circumstances of individual cases.[142] Proponents of local control in Texas concur with this point arguing that local "home-grown" institutions allow for more focused, evolutionary kind of change that is more nimble, adaptable,[143] and best suited to address the large diversity of climatic conditions, water use patterns, growth projections

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Rights, that among these are Life, Liberty and the pursuit of Happiness. That to secure these rights, Governments are instituted among Men, deriving their just Powers from the Consent of the Governed...").

[139] Young, *supra* note 86, at 31. (Young defines institutions as "sets of rules, decision-making procedures, and programs that give rise to recognized practices, assign roles to participants in these practices, and govern interactions among occupants of specific roles.").

[140] Ostrom, *supra* note 92. *See also* E. Ostrom, UNDERSTANDING INSTITUTIONAL DIVERSITY (2005).

[141] *Id.*

[142] E. Lopez-Gunn, *Governing Shared Groundwater: the Controversy Over Private Regulation.* 175(1) THE GEOGRAPHICAL J., at 42 (March, 2009).

[143] Somma, *supra* note 57, at 55.

and aquifer characteristics across the State.[144] Such diversity, which certainly exists in Texas, would make it difficult to formulate and administer uniform laws and regulations to govern the development and use of groundwater statewide.

Challenges Associated with Decentralized GCDs in Texas

While there are theoretical and logical benefits to decentralized groundwater governance, the Texas experience since implementation via the GCD Act in 1949 has drawn criticism pointing to significant challenges associated with local control. These challenges primarily involve the compromised groundwater management efforts associated with local politics and the tendency to preserve self-interests that can be inherent to small-scale governance.

In most social settings, issues related to natural resource management are matters of public policy and therefore subject to manipulation on the part of actors seeking to promote their own interests through political processes.[145] This generalization also applies to the decentralized GCD system where smaller jurisdictions can be more easily influenced without the dilution that may come from actors representing a larger area. The notion suggests that local GCDs will generally tend to give disproportionate weight to the local constituency which may oftentimes lead to resource management decisions that are counter to larger statewide management objectives.[146] Opportunity for undiluted influence was almost certainly a motivating factor in the political compromise that

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[144] Fipps, *supra* note 25, at 6.
[145] Young, *supra* note 86, at 74.
[146] *See* Snyder, *supra* note 76, at 303.

resulted in the GCD Act in 1949 allowing local interests to dictate water policy. As an alternative to state control, local interests recognized that the next best thing to no regulation is self-regulation.[147] This has resulted in a form of governance where entities that are tasked with regulating themselves can be compromised by self-interests and a general reluctance to tell themselves "no."

The tendency for management (or lack thereof) to be motivated by self-interests has been characterized by some as the most serious barrier to effective resource management in Texas.[148] This is an intuitive conclusion, particularly where groundwater production limits affect economic returns (e.g. crop yields, land development, natural gas extraction, etc.). In these situations, GCDs run by boards that are often dominated by those with economic interest affected by local water availability will tend to not aggressively push for production limits.[149] This thinking was most prevalent with the creation of the first GCDs in Texas and continued while there was relatively limited GCD formation in the first 50 years after the GCD Act.[150] Since that time, these types of

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[147] Somma, *supra* note 57, at 59. ("... one can organize one's own water rules or have the state or government do it for you.")

[148] *See* Snyder, *supra* note 76, at 298. ("Despite the gaping holes in UWCD's [underground water conservation districts] management powers, however, the most serious barrier to effective action is its dependence on local politics."); ("The district cannot be effective unless local residents, acting through popularly elected directors, are willing to impose management controls on their pumping activities."); ("While the people in power hesitate to regulate themselves, the state's water problems are growing."); ("elected officials are acutely aware of the attitude of their electorate. They publically denounce any conservation proposal that even suggests the possibility of production regulation."). *See* Johnson, supra note 112, at 1282. ("…the legislature has passed the buck to local communities by authorizing them to do something about groundwater if they wish to do so. The response of local communities has been uneven and generally inadequate.").

[149] *See* Snyder, *supra* note 76, at 302.

[150] *See Sipriano*, *supra* note 4, at 81. ("Yet in the fifty years since the Legislature first authorized the creation of groundwater conservation districts, (citation omitted) the record in this case shows that only

criticisms of GCDs and local control have subsided somewhat in response to the slow evolution and maturation of GCDs and groundwater management in Texas.[151] Nonetheless, the tendency for self-interest and conflicts of interest associated with local politics are still relevant and cannot be dismissed. Some strongly believe that this will always be a flaw in the decentralized system and that resource management decisions should not be left up to entities with primarily narrow and local interests, particularly when there are clashes between the fate of a resource and communities that profit from exploitation of that resource.[152]

In addition to obstacles resulting from economically driven conflicts of interest, small GCDs can also be compromised by local politics driven by ideology. For example, the action of the Fox Crossing Water District in response to the *Day* case opinion, referenced above,[153] is evidence of a GCD going to extremes (i.e., formally resolving to dissolve itself) in response to the strong anti-government ideology of individual board members.[154] Similarly, just on the heels of the opinion issued in *Day*, the Burnet County GOP party voted unanimously at their local convention in 2012 to challenge a GCD's regulatory authority as part of its platform.[155] This type of reaction may be representative

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some forty-two such districts have been created, covering a small fraction of the state".). Some 54 GCDs have been created and confirmed in the short time from *Sipriano* to present.

[151] Much of this maturation can be attributed to judicial scolding and finger pointing directed at the legislature with directives to fulfill constitutional obligations mandated by the Conservation Amendment. *See also Sipriano, supra* note 4, at 79 ("Like the voters that passed the 1917 constitutional amendment, this Court has consistently recognized "the need for legislative regulation of water" (citation omitted.")

[152] *See* S. L. Shadwick, *Obsolescence, Environmental Endangerment, and Possible Federal Intervention Compel Reformation of Texas Groundwater Law.* 32 SOUTH TEXAS L. REV., 641, 677 (1990-1991).

[153] *See Day, supra* note 94.

[154] *Supra* note 134.

[155] *Supra* note 135.

of the local politics and ideology of the political party of the county and the GCD in place for Burnet County[156] but it may not be representative of the larger population of aquifer dependents not represented. A democratically elected governing body should, by design, reflect the ideology of its constituents. However, in a decentralized system dominated by small single-county GCDs, actions based on extreme ideologies can affect stakeholders who also rely on the resource but that may be outside of the jurisdictional area.

2.2.2 Centralization

As documented by Green and discussed in Chapter 1, the question of whether groundwater governance in Texas should be centralized, that is managed from the top down by a state agency like the TCEQ, has been the subject of ongoing debate since the build up to the GCD Act in 1949. Prior to the GCD Act, there was a real push by state agencies and other governmental groups to centralize groundwater governance. This idea was also strongly endorsed by the Great Plains Committee, a national committee of Great Plains states set up by President Roosevelt in response to the Dust Bowl. The committee supported findings by the National Advisory and Legislative Committee on Land Use which urged states in its report to "declare all inappropriate [sic] waters to be public waters of the state, subject to appropriation for beneficial use" in the same way that surface water was managed.[157] Those supporting centralization saw a need to unify

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[156] The Central Texas Groundwater Conservation District is a single-county GCD with boundaries coterminous with the Burnet County boundaries.

[157] Green, *supra* note 12, at 172. *See also* J. W. Nachbaur, *Drivers of Formal, Local Groundwater Governance*, at 11 (2008). http://ssrn.com/abstract=1128327 or http://dx.doi.org/10.2139/ssrn.1128327

groundwater and surface water governance. The debate over centralized control of groundwater was also generally divided along rural vs. urban interests. Advocates for state control lobbied to revoke the absolute private ownership of water and for state allocation of water resources, with preference given to municipalities and manufacturers over irrigated agriculture.[158] This division is present today with urban interests favoring centralization as a way to reallocate water supplies from rural agricultural uses to growing urban populations,[159] while the rural interests are vigilantly lobbying to maintain local control and to fend off an urban invasion of their water supplies.

Centralization as an Alternative to Decentralized GCDs in Texas

Passing the GCD Act in 1949 served to quiet the debate over centralization but only temporarily. Since then, much of the call for centralized groundwater governance tends to be in the form of an indictment against the existing system of local GCDs. Such criticism often leads to a *de facto* endorsement of centralization as the extreme alternative. Throughout the literature, the idea of centralization of groundwater management in Texas has been invoked as the antidote to what some have referred to as "decentralized dysfunction."[160] For example, Shadwick, in her criticisms of local control, describes centralized regulation and administration of Texas groundwater as "the

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[158] Green, *supra* note 12, at 175-176. (In 1948, The Texas Water Conservation drafted a bill that would have placed groundwater under the correlative rights doctrine to be allocated by the state engineer. The bill also established priority of water rights with municipal rights designated as the top priority and irrigation at the bottom.).

[159] M. Jones & A. Little, *The Ownership of Groundwater in Texas: A Contrived Battle for State Control of Groundwater*. 61(2) BAYLOR L. REV., 578, at 608 (2009). ("Pressures from cities eager for predictable and long-term supplies of water… drives the controversy").

[160] Shadwick, *supra* note 152, at 682.

Hannibal's sword that can cut through the Gordian knot of conflicting local interests," suggesting that centralization is needed to overcome the challenges of bureaucratic inertia, funding problems, and the self-limiting nature that characterize the Texas system of local control.[161] She further posits that centralization is needed to unify the regulatory scheme and provide for equitable administration while conforming to hydrological reality.[162] Other advocates suggest that only a single entity, rather than many smaller ones, with adequate statewide powers could effectively manage the state's groundwater resources. The Texas Railroad Commission, the state agency with regulatory authority over oil and gas in Texas, is often cited as an example of a centralized agency with statewide authority that could and should be implemented to manage groundwater.[163]

The persistent threat of moving towards centralized state control in response to the alleged dysfunction of local governance has also been effectively used to galvanize the rural community in efforts to maintain local control. For example, some of the arguments in the recent debate over the ownership of groundwater that played out in the *Day* case have invoked the threat of state control as political pressure to affirm groundwater as a private property right in place and preserve local control.[164] The control of groundwater by a centralized state agency has been equated to a threat to

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[161] *Id*. at 683.
[162] *Id.* at 682.
[163] *Id*. at 683.
[164] Jones & Little, *supra* note 159, at 608. ("It is doubtful that many legislators in Texas will be willing to stand before their constituents to say that this precious resource [groundwater], long the property of landowners, will now be deemed property of the state.").

livelihoods of those that depend on the irrigated agriculture economy.[165] The arguments used in the *Day* case to affirm groundwater as private property relied heavily on the logic of treating groundwater the same as oil and gas. Proponents of this argument point out that oil and gas has a well-established set of case law that has addressed and put to rest all of the same questions over ownership.[166] The Supreme Court agreed.[167] As mentioned, the Texas Railroad Commission is a centralized state agency with the statewide authority to regulate the allocation of oil and gas reserves in Texas. It is somewhat ironic that those in favor of affirming groundwater as private property did so in part to preserve local control by arguing that groundwater should be regulated the same as oil and gas, which is regulated by a centralized state agency.

While decentralization receives high marks in facilitating local involvement in management decisions and adaptability, those that favor centralization largely do so because of some of the inherent challenges, such as compromised objectives resulting from self-interests and local politics, which tend to be associated with small-scale local governance. If the objective is the sustainable stewardship of a common-pool resource like groundwater, the challenges associated with these challenges are compounded where groundwater institutions are also susceptible to problems of fit, that is, hydrological disconnects and insufficient areal extent to provide adequate funding and institutional

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[165] *Id.* at 609. ("[T]he debate should be recognized for what is… and the proponents of change are advocating for state ownership of the means of production for most agricultural producers of the State.").
[166] Jones and Little, *supra* note 159, at 597.
[167] *See Day, supra* note 94, at 825. ("Whether groundwater can be owned in place is an issue we have never decided. But we held long ago that oil and gas are owned in place, and we find no reason to treat groundwater differently.").

resilience. It is fair to say that neither end-member of the scale-of-governance spectrum, state control or small single-county GCDs, is without flaws. The sounder approach, as with most problems, is likely to be somewhere in between.

Chapter 3: Regionalization of Groundwater Management in Texas

The previous chapter provided a summary of the criticisms of the current decentralized system of groundwater management in Texas and the often-invoked alternative of centralized or state control. The following chapter will focus on regionalization as a policy proposal providing an alternate management approach that should be considered as middle ground between these two extreme scales of groundwater governance.

3.1 REGIONALIZATION – A POLICY PROPOSAL

The 2012 State Water Plan projects that demand for water is expected to increase by 22% by the year 2060 while the projected water supplies are expected to decrease by about 10%.[168] The State Water Plan goes further to predict that the existing groundwater supplies and future groundwater availability are projected to decrease by 30% and 24% respectively between the years 2010 and 2060.[169] Since most of the state's surface water is fully allocated and constructing reservoirs involves significant expense on less optimal sites that tend to be met with substantial opposition by landowners and environmental groups, there will be increased pressure to make up these supply shortfalls by further exploitation and depletion of the state's aquifers.[170] Faced with an uncertain water supply future and in recognition of the need for more effective groundwater management, the State has been laboring to find a workable path towards reconciliation of the strong

[168] TEX. WATER DEV. BD., WATER FOR TEXAS – 2012 STATE WATER PLAN, at 3 (2012).
[169] *Id.* at 3 & 176. (Decreases in groundwater availability are attributed primarily to aquifer depletion.).
[170] Foster, s*upra* note 27, at 380.

preference for local control and the disjointed and hydrologically disconnected nature of the existing GCD system.

One of the core objectives of this thesis is to offer a policy proposal for Texas groundwater management that is responsive to these challenges. What is needed is an institutional arrangement that represents a compromise between centralization and decentralization - one that is appropriately scaled to offer the institutional resilience, objectivity, uniformity, and the means of centralized governance while taking advantage of the familiarity, responsiveness, and adaptability of decentralized governance. To accomplish this requires a shift to a somewhat higher scale than the predominant model of single-county GCDs.[171] Regionalization is being offered here as a policy proposal that can provide for this balance at the appropriate scale. For the purposes of this chapter, the term "regionalization" shall be used to describe a scale of groundwater governance with multi-county institutions configured with jurisdictional boundaries that are generally congruent with the boundaries of the natural system to be managed, namely, the designated major aquifer systems in Texas. Regional institutions in this context describe institutions that are designed to avoid the challenges associated with the problem of "fit" and insufficient areal extent. That is, they are of the appropriate jurisdictional area and size to minimize hydrological disconnects and provide sufficient funds, authority, and

[171] Young, *supra* note 86, at 106. ("Moving to high levels of social organization can open up opportunities for increased efficiency in the use of resources and for more comprehensive approaches to equity…"). *See also Id.* at 70. ("It is possible … to address such problems by shifting management authority to a higher level of social organization [i.e. state government].). ("In many cases, unrelated obstacles … effectively rule out these kinds of solutions (citation omitted).").

resources to effectively manage the resource and equitably accommodate all affected actors to the maximum extent practicable.

3.2 SHIFT TOWARDS REGIONALIZATION

Regionalization is not a new or revolutionary concept but is in fact something that Texas has been slowly evolving towards for some time. The slow incremental shift appears to be evidence and recognition of the challenges of the current GCD system and the proliferation of singe-county GCDs that are in place. This issue coupled with the growing competition for the state's water supplies would finally nudge the Legislature towards attempts at developing a workable way to expand management areas through regionalization.

3.2.1 "Groundwater Management Areas"

The logic of designing groundwater management institutions to "fit" within the boundaries of major aquifer systems was established from the outset in the GCD Act of 1949. Mace et al. (2008) chronicles the history and evolution of the concept of delineating areas "best suited for groundwater management" and the terms used to describe them.[172] In short, the GCD Act of 1949 as described in Chapter 1 required that a local petition be first filed to initiate a study to delineate "underground water reservoirs"

[172] Mace, *supra* note 81, Appendix A.

which was the precursor to GCD creation within that reservoir.[173] The term was changed to "management areas" by HB 2 in 1985, then to "underground management areas" by SB 1212 in 1989, then to "groundwater management areas" by HB 2294 in 1995. HB 2 built on the GCD Act by establishing economic incentives for GCD creation within designated "critical groundwater areas" and set up a process for designation of these areas by the Texas Water Commission, predecessor to the Texas Commission on Environmental Quality (TCEQ).[174] Further, HB 2 incorporated the petition process requirement that the boundaries of a GCD had to be coterminous with a designated management area, although political boundaries could be considered.[175] This provision, however, was later repealed by SB 1212 for legislatively created GCDs.[176] SB 1212 did serve to strengthen HB 2 by providing the method for establishing critical areas and for determining the need for creation of a GCD in those areas. The creation of a GCD in accordance with this provision remained optional, however, failure to do so prohibited the use of TWDB funds in the designated areas. HB 2294, which finally settled on the term "groundwater management areas" (GMAs), would prove to provide the foundation for future progress in the shift towards regionalization by 1) establishing Chapter 35 of

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[173] *Id.* Appendix A. (GCD Act of 1949 was amended in 1955 to authorize the Texas Board of Water Engineers to designate underground water reservoirs by its own initiative without having to be initiated by a petition.)

[174] *Id.* at 1. FN 9. (The "critical areas program" was the predecessor to the Priority Groundwater Management Area (PGMA) program that established area with existing or projected groundwater management problems for the purpose of initiating the creation of a GCD). *See also* Ch. 1, §1.1.4.

[175] *Id.* at 1.

[176] R. Johnson, *Groundwater Law and Regulation*, ESSENTIALS OF TEXAS WATER RESOURCES, at 114 (M. K. Sahs, ed., 2009). ("The vast majority of groundwater conservation districts have been established through the action of the legislature.").

the Texas Water Code for the purpose of creating GMAs for reasons similar to those cited for creation of GCDs,[177] and 2) by providing the discretionary authority to the TCEQ to designate GMAs with the objective of providing the area most suitable for the management of the groundwater resources using boundaries that coincide with aquifer boundaries where feasible.[178]

3.2.2 Regional Water Planning

In addition to the significant provisions of SB 1 passed in 1997 affecting groundwater management as described in Chapter 1, SB 1 was also notable for shifting water planning to a more regional approach through the much lauded regional water planning process. Prior to SB 1, early efforts were typically more centrally oriented with the plans internally developed and prepared by the engineers, hydrologists, and planners of the Texas Water Development Board (TWDB). These plans were developed with little interest or participation from the public since the plans were used for little more than a reference document.[179] The extreme drought experienced in Texas in 1996 and 1997

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[177] TEX. WATER CODE §35.001. ("Purpose. In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution, groundwater management areas may be created as provided by this chapter.").

[178] TEX. WATER CODE §35.004(a). ("On its own motion from time to time, or on receiving a petition, the commission may designate groundwater management areas. Each management area shall be designated with the objective of providing the most suitable area for the management of the groundwater resources. To the extent feasible, the management area shall coincide with the boundaries of a groundwater reservoir or a subdivision of a groundwater reservoir. The commission also may consider other factors, including the boundaries of political subdivisions.").

[179] R. Kaiser, B.J. Lesikar, C.S. Shafer, & J.R. Gertson. *Water Management Strategies: Ranking and Options,* at 3 (2000), www.tamu.edu/rakwater/research/WATER-strategi.pdf

helped to convince State leaders to take future water planning more seriously.[180] SB 1 implemented what has been described as a "bottom-up" approach to State water planning, meaning that the plan is developed first on a regional basis and passed up to the State level to be incorporated into the larger State water plan. It established 16 regional water planning areas that were largely delineated by the major river basins in the state and Regional Water Planning Groups (RWPGs) for each (Figure 8). Each group consists of representatives from 11 different interest groups that include: public, county, municipalities, industry, agriculture, small business, electric-generating utilities, river authorities, local government, water districts, and environmental representatives.[181]

RWPGs were tasked with developing regional water plans that identified existing and future available water supplies and projected future population growth and water demands over the next 50 years. A range of water supply strategies is then identified to address any shortages.[182] The significance of this new, unprecedented water planning approach was that 1) it first introduced regionalization as an ideal scale for water planning, and 2) it recognized the importance of designating stakeholder positions from the affected sectors over the entire planning area to ensure equitable representation in water planning decisions.

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[180] *Id.* at 3.
[181] TEX. WATER CODE §16.053(c).
[182] TEX. WATER DEV. BD., *Regional Water Planning*. (2011, November 10). www.twdb.state.tx.us/wrpi/rwp/rwp.asp. (last visited November 3, 2011).

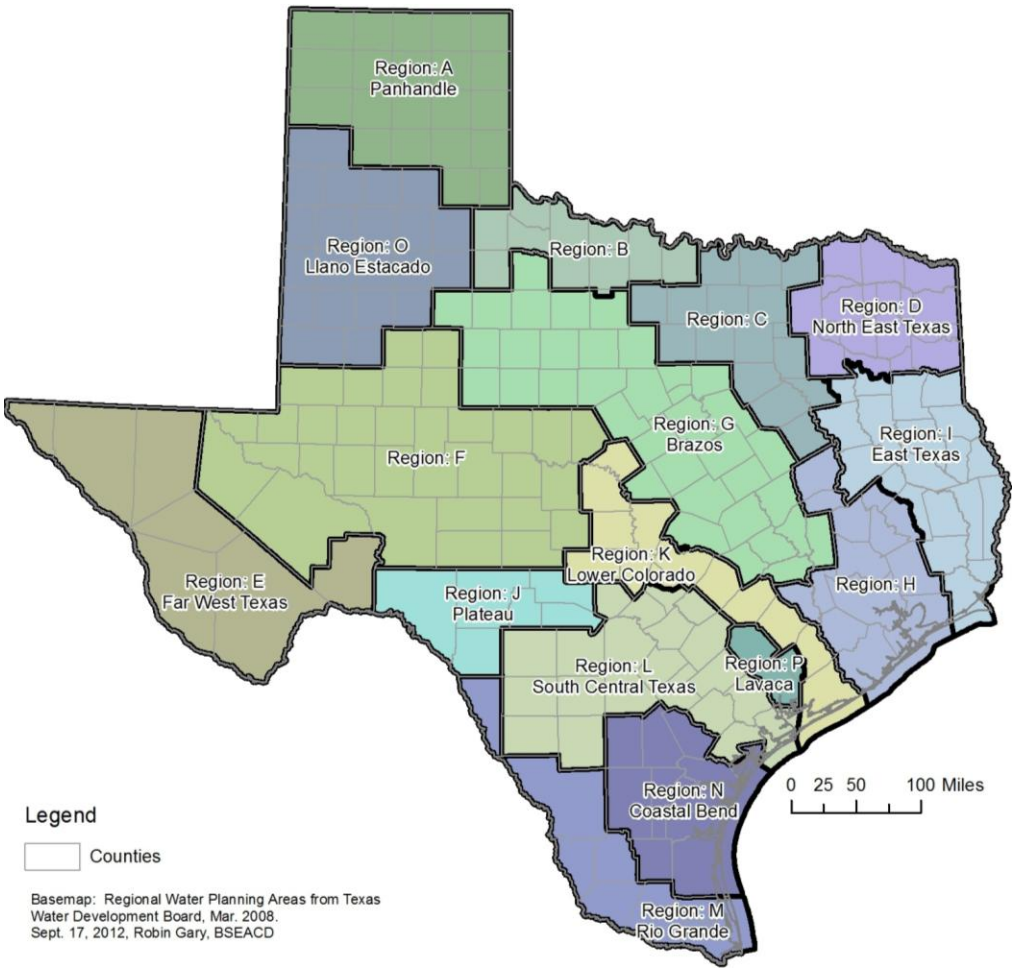

Figure 8: Map of Regional Water Planning Groups

3.2.3 Recognition of the Problems of Fit

The period building up to the 76th Legislative Session in 1999 involved several significant events affecting groundwater management in Texas. In the decision in *Sipriano*, the court highlighted the need for groundwater management and pointed to the legislative duty and responsibility to do so under the Conservation Amendment. This decision combined with the landmark long-term water planning process and the

designation of GCDs as the preferred method of groundwater management that came out of SB 1, and the prospects of large-scale rural to urban groundwater exports would prove to be the impetus for a substantial increase in proposed new GCDs in the 76th session. That session the Legislature considered creating at least 30 new GCDs.[183] The abundance of proposed GCDs caused concern considering that only 44 GCDs had been created in the previous 50 years and more importantly, because many of the proposed GCDs were based on political (county) lines rather than aquifer boundaries. Senator J.E. "Buster" Brown, the then-current chairman of the Senate Committee on Natural Resources and author of SB 1, expressed concerns over the developing single-county GCD precedent. Senator Brown worried that the proposed GCDs might interfere with regional water planning efforts under SB 1 and recommended that the Senate not consider the creation of those Districts.[184] The Legislature compromised by passing SB 1911 creating 13 new temporary GCDs with limited regulatory authority, 8 of which were to be single-county GCDs[185] and 3 were to be configured along county boundaries (Figure 3).[186] Although the bill was a compromise, it nevertheless served to firmly establish the single-county

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[183] HOUSE COMM. ON NATURAL RESOURCES, *supra* note 69, at 17.
[184] *Id.*
[185] The Lost Pines GCD was temporarily created to include both Bastrop and Lee Counties but could be confirmed to be coextensive with a single county based on the results of the confirmation election.
[186] HOUSE COMM. ON NATURAL RESOURCES, *supra* note 69, at 17.
("These new districts will dissolve if not ratified by the 77th Legislature in 2001. If ratified, the districts presumably will receive broader power, including the authority to prepare management plans.").

GCD precedent and set the path for subsequent GCDs to follow – a point that was included in the bill analysis of SB 1911.[187]

Prior to the 77th Legislative Session in 2000, the House Committee on Natural Resources (Committee) was assigned interim charges aimed directly at addressing the developing water management problems. The first charge directed the Committee to:

> Study all issues related to groundwater availability, including the role and needs of groundwater conservation districts to ensure effective management of the resource. Consider the effectiveness and feasibility of aquifer-based management, and the adequacy of data and modeling for regional water planning efforts. Assess the implementation of SB 1911, enacted by the 76th Legislature.[188]

The resulting report included a thorough analysis of the developing issues related to this charge and concluded by acknowledging the single-county GCD precedent and finding that county based-GCDs that overlay only portions of regional aquifers may be ineffective, especially when adjoining GCDs have conflicting rules and varying degrees of pumping.[189] The committee recommended that the GCD creation process needed to be streamlined and that new GCDs, where feasible, should be encouraged to be created *along designated management boundaries as opposed to political boundaries* (emphasis

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[187] SB 1911 Bill Analysis, *supra* note 89. ("During the 76th Legislative session, bills have been filed seeking to create more than 20 new groundwater conservation districts, many of them single-county districts."). ("Concerns have been raised that the myriad of groundwater districts proposed legislatively this session are based on political instead of hydrologic boundaries and, therefore, may not be able to manage the underlying aquifers consistent with the powers and duties of Chapter 36, Water Code (Groundwater Conservation Districts) or with the long-range water management planning envisioned by Senate Bill 1.").

[188] HOUSE COMM. ON NATURAL RESOURCES, *supra* note 69, at 2.

[189] *Id.* at 25-26. (Finding #3).

added).[190] The Committee further recommended that the legislature should strengthen statues that encourage joint management by GCDs that share the same aquifer.[191]

The debate that preceded the passing of SB 1911 in 1999, the Committee's interim charges that were assigned in 2000, and the resulting findings and recommendations were significant in that it was a clear acknowledgement of the then-developing single-county GCD precedent, the associated problems of fit, and the potential to interfere with the recently established preference for regional-scale water management in the state under SB 1. Subsequent unsuccessful attempts were made to compel larger-scale multi-county GCDs,[192] however, policy makers seemed compelled to accept that given the formidable resistance, another approach would be necessary.

3.2.4 Voluntary Joint Regional Groundwater Planning

Momentum to address the single-county GCD precedent and the associated problems of fit was building coming into the 77th Legislative Session in 2001. The product of this momentum was realized in components of SB 2. As discussed in Chapter 1, the provisions of SB 2 substantially increased the authority of GCDs, however, perhaps the most notable provisions pertaining to regionalization were those that laid the foundation for more comprehensive joint groundwater planning and GCD coordination. SB 2 moved the responsibility for creating GMAs from the TCEQ to the TWDB and

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[190] *Id.* (Recommendation #3).
[191] *Id.*
[192] 81st Leg., R.S., HB 3335 authored by Representative Callegari and sponsored by Senator Averitt was filed to require that GCDs created in response to a PGMA designation were composed of territory within two or more contiguous counties. HB 3335 did not pass.
HB 3335 in 2009 to require new GCDs in PGMA to be two or more contiguous counties.

directed the TWDB to create GMAs for all the State's major and minor aquifers by September 1, 2003.[193] TWDB created 16 GMAs covering the entire state using aquifers and other hydrological boundaries that primarily honored the designated major aquifers in Texas (Figure 9).[194] SB 2 also required that GCDs within their respective GMAs share management plans with each other and participate in joint planning on a voluntary basis if an individual GCD called for it.[195] These GCDs could also undertake joint studies, research, or projects.[196]

Provisions of the introduced SB 2 that did not make it into the final bill would also prove to be important building blocks for the future form of the joint regional groundwater planning process that would emerge out of HB 1763 in 2005. The introduced version of SB 2 included requirements for the regional water planning groups to develop "groundwater management standards"[197] and "groundwater withdrawal

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[193] Act of June 15, 2001, 77th Leg. R.S., §2.22 of SB 2 [hereinafter cited as SB 2] (codified as amendments to TEX. WATER CODE §35.004(a)).

[194] Mace, *supra* note 81, at 2. ("TWDB staff used aquifers and other hydrologic boundaries to guide the delineation of groundwater management areas. The boundaries primarily honored the boundaries of the *major aquifers* of Texas as identified in various TWDB publications. In areas with multiple major aquifers, TWDB generally placed a preference on the shallowest aquifer. The TWDB divided several of the major aquifers into multiple groundwater management areas. These divisions were based on hydrogeology and current water-use patterns and coincided with natural features where possible. Where possible, the TWDB aligned boundaries with county and existing groundwater conservation district boundaries."(emphasis added)).

[195] §2.48 of SB 2 (codified as amendments to TEX. WATER CODE §36.108(a)).

[196] §2.48 of SB 2 (codified as amendments to TEX. WATER CODE §36.108(j)).

[197] §2.19 of SB 2 (Introduced version), (proposed amendments to TEX. WATER CODE §16.0531) (Provisions associated with the proposed Groundwater Management Standard: "…Requires the groundwater management standards to describe the desired condition of the groundwater source as indicated by indices of quantity of water in the source, quality of water produced from the source, or subsidence of the land surface. Requires the groundwater management standard to describe this condition for various time periods throughout the planning period.").

rates"[198] which would later become "desired future conditions" and "managed (now, modeled) available groundwater" respectively under HB 1763. These introduced terms appear to be the nascent form of the concept of using policy driven management goals and the best available science to determine groundwater availability.

[198] §2.19 of SB 2 (Introduced version), (proposed amendments to TEX. WATER CODE §16.0532.). (Provisions associated with the proposed Groundwater Withdrawal Rate: "…Requires the regional water planning groups to use groundwater availability modeling information provided by the executive administrator to determine these rates. Requires the groundwater withdrawal rate to be the maximum rate of production that will allow the groundwater management standard to be realized. Requires a groundwater withdrawal rate to be set for various time periods throughout the planning period.").

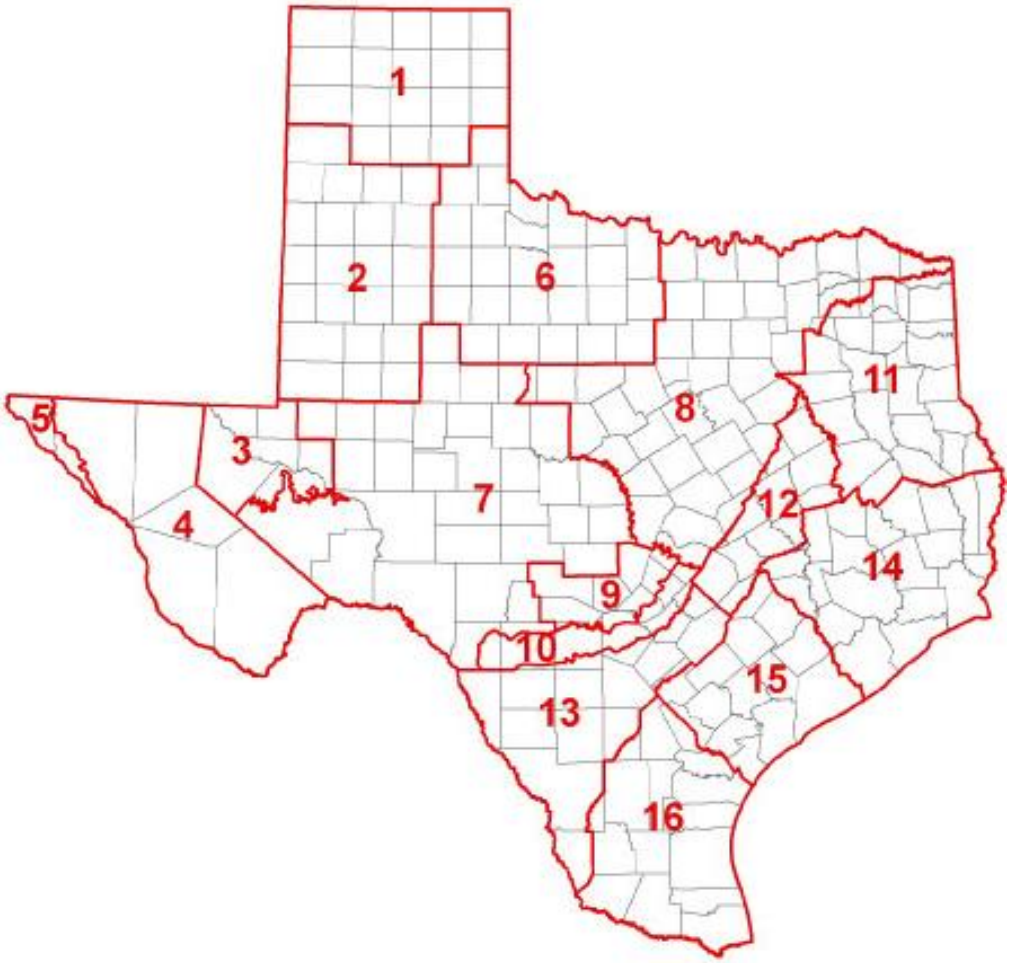

Figure 9: Map of Groundwater Management Areas (GMAs). GMAs were configured to conform primarily to major aquifer boundaries. (Source: TWDB)

3.2.5 The Joint-Regional Groundwater Planning Process

The Failed Senate Bill 3 (2005)

In the 79th Legislative Session in 2005, Senator Kenneth Armbrister filed SB 3 in an attempt to further develop the voluntary groundwater planning process. SB 3 was intended to be the next omnibus water bill, building on the progress of SB 1 and SB 2 - the previous omnibus water bills passed in 1997 and 2001, respectively. SB 3 was made

up of several acts addressing a number of important water issues such as environmental flows, conjunctive use, and water conservation, but most notably, it included provisions that would formalize and mandate joint groundwater planning. The introduced version of SB 3 proposed bold new steps towards regionalization of groundwater management in response to the persistent criticism of the single-county GCD precedent and the associated problems of fit and scale. In 2004 during the interim period before the 79th Texas Legislative Session, the governor convened a Senate Select Committee on Water Policy with charges aimed directly at this issue. The relevant charges included the study of:[199]

- the role of federal, state, regional, and local governments, and their coordination in setting consistent, nondiscriminatory water policies;
- the role of GCDs;
- the regional water planning process; and
- the conjunctive use of both groundwater and surface water resources.

The Committee identified certain specific concerns that might benefit from legislative attention. Importantly, these concerns included:[200]

- single-county GCDs, often with conflicting management goals, attempting to manage regional groundwater resources; and

[199] SENATE SELECT COMMITTEE ON WATER POLICY, INTERIM REPORT TO THE 79TH LEGISLATURE (2004).
[200] *Id.* at 3.

- the ability of large-quantity groundwater pumping just outside the boundaries of a GCD to undermine the district's efforts to manage the groundwater resources.

These recommendations again represented recognition of the ever-growing groundwater management issues that had been alluded to but largely ignored up to this point. The product of the recommendations would be the proposed groundwater planning provisions of Senator Armbrister's bill - SB 3. The relevant provisions of the bill included:[201]

- stating a policy goal to "ensure consistent management of groundwater in a shared management area by the GCDs located in that area;"
- establishing Groundwater Management Area Councils (GMACs) to ensure the coordination of management in each GMA;
    - specifying the makeup of each GMAC to include: 1) the presiding officer from each GCD in the GMA, 2) a resident of the GMA representing a water utility, 3) a resident of the GMA representing each RWPG located wholly or partly in the GMA, 4) a resident of the GMA representing agricultural interests, and 5) a transport permit holder;
- specifying duties of the GMAC including: 1) adopting desired future conditions, 2) adopting groundwater availability estimates generated by the TWDB, 3) approving member groundwater management plans, and 4) verifying consistency with the established DFCs;

[201] 79th Leg. R.S., §2.32 of SB 3 (Introduced version).

- specifying the authorities of a GMAC including: performing area hydrogeologic studies, establishing groundwater monitoring networks, and designating certain duties to member GCDs;
- providing technical assistance to GMACs by providing TWDB employee(s) dedicated to assisting each GMAC; and
- providing funding to GMACs to fund groundwater management coordination.

The proposed groundwater planning provisions of SB 3 appeared to address a long overdue need in Texas by establishing regional scale institutions (GMACs) enabled with authority to set policy and approve GCD management plans, as well as funding and technical assistance to provide for regional groundwater management. It also appeared to be largely inspired by the State water planning process adopted under SB 1 in 1997 that has been widely touted as being a successful planning model and by the GMAs established with the voluntary joint planning initiated under SB 2. SB 3 passed through the Senate but was unable to make it out of the House even with a committee substitute that diluted the bill by deleting all of the groundwater planning provisions. A modified version of the groundwater planning provisions was salvaged via an eleventh-hour floor amendment authored by Representative Robbie Cook and Senator Robert Duncan that attached them to HB 1763. The result was a bill that was originally intended to be an

administrative procedures bill[202] that included a substantially weakened version of the original joint groundwater-planning concept.

House Bill 1763 (2005)

Although weakened, HB 1763 represented a substantial shift in Texas groundwater policy by presenting profound changes in how groundwater was managed and how availability was determined.[203] The substantial provisions saved from the failed SB 3 of the 79th Legislative Session, in essence, served to provide the first step towards regionalized management of groundwater in Texas. The product of what was salvaged in HB 1763 was a joint-regional groundwater planning process that required the collaboration of GCDs with overlapping area in the TWDB-designated GMAs.[204] The GCDs were charged with collectively determining what aquifer conditions should be achieved or maintained in a 50-year planning window while providing for future demands – also known as Desired Future Conditions (DFCs).[205] The TWDB would then make a best-science estimate of what groundwater was available under those conditions – also known as the Managed Available Groundwater (MAG).[206] The MAG estimates,

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[202] Act of May 30, 2005, 79th Leg., R.S., HB 1763 [hereinafter cited as HB 1763]. (The introduced version of HB 1763 was captioned as: "relating to the notice, hearing, rulemaking, and permitting procedures for groundwater conservation districts.").

[203] Mace, *supra* note 81, at 1.

[204] TEX. WATER CODE §36.108 (prior to amendments codified with Act of May 29, 2011, 82nd Leg. R.S., SB 660 [hereinafter cited as SB 660]).

[205] 31 TEX. ADMIN. CODE §356.2(8). (Definition was also codified by SB 660 in 2011 adding TEX. WATER CODE §36.001(30). Term defines "desired future conditions" in statute 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.).

[206] 31 Tex. Amin. Code §365.2(13). (Definition was also codified and revised by SB 660 and Act of April 14, 2011, 82nd Leg. R.S., SB 737 [hereinafter cited as SB 737] adding TEX. WATER CODE §36.001(25). SB

after accommodating estimates of exempt use, were in essence a pumpage cap, which arguably could not previously have been set or enforced by a GCD.[207] These GCD-derived availability estimates are then provided to the planning groups to be incorporated into the regional water plans.[208] The process also provided a mechanism that allowed certain parties by petition to appeal the reasonableness of a DFC[209] and to petition the implementation of a DFC by a GCD.[210]

HB 1763 represented a significant step towards regionalization by establishing a framework that allowed for a "widening of the net" to encompass larger aquifer-based planning areas and more coordinated groundwater management in Texas. However, like much of the historical groundwater policy decisions in Texas, this weakened version of the groundwater planning process that was initially envisioned in the failed SB 3 was the product of political compromise with certain parties holding fast to local control and the existing GCD structure.

Senate Bill 660 (2011)

With the passage of HB 1763, GCDs and state agencies found themselves faced with unique challenges associated with implementing this unprecedented and arguably compromised groundwater-planning process. These challenges began to emerge owing to a number of converging factors building up to the 82nd Legislative Session in 2011

660 and SB 737 revised term from "Managed Available Groundwater" to "Modeled Available Groundwater".).

[207] Mace, *supra* note 81, at 3.

[208] TEX. WATER CODE §36.1071(b).

[209] TEX. WATER CODE §36.108(l) (prior to amendments codified by SB 660).

[210] TEX. WATER CODE §36.108(f) (prior to amendments codified by SB 660).

including the adoption of the first round of DFCs under the relatively immature joint-regional groundwater planning process,[211] the debate over ownership of groundwater,[212] and the TWDB sunset review.[213] Leading into the 82nd legislative session, the Sunset Advisory Commission coincidently scheduled review of the TWDB providing an opportune vehicle for identifying several specific issues related to regional water planning including coordination between GCDs and RWPGs and the DFC adoption process. The product of the Sunset Advisory Commission's report and recommendations was SB 660, the TWDB's sunset bill, which implemented several new provisions that substantially affected the joint-regional groundwater planning process. The relevant provisions of the bill included:

- adding a representative of each GMA that overlaps with each RWPG as a voting member of that RWPG;[214]
- requiring that regional water plans be consistent with the DFCs for relevant aquifers in place at the time of adoption of State water plan in the subsequent water planning cycle; [215]

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[211] TEX. WATER CODE §36.108(d). (The deadline for submittal of the first round of DFCs was September 1, 2010.).

[212] Leading up to the 82nd Legislative Session, a group referring to themselves as "Texans for Groundwater Rights" consisting primarily of the Farm Bureau, the Texas Wildlife Association, and the Texas and Southwestern Cattle Raisers Association, hosted seven forums across the state on groundwater ownership in an effort to build support for legislation that would reinforce the concept of groundwater as a real vested property right.

[213] B. Howe, *Texas Farm Bureau: 82nd State Legislature Summary*, 2(3) TEXAS WATER JOURNAL, 23-38 (2011).

[214] §9 of SB 660. (codified as amendments to TEX. WATER CODE §16.053(c)).

[215] §9 of SB 660. (codified as amendments to TEX. WATER CODE §16.053(e)).

- substantially modifying the requirements for providing public notice of GMA meetings, public hearings, and opportunities for public comment on proposed DFCs;
- allowing GMAs to appoint and convene nonvoting advisory committees to assist in development of DFCs;
- allowing GMAs to request assistance from TWDB technical staff to serve as advisors in the development of DFCs. Changing term "MAG" from "Managed" to "Modeled" Available Groundwater;[216]
- requiring that DFCs are proposed considering certain factors and the "balance test";[217]
- specifying procedure for consideration of proposed DFCs and DFC adoption;
- requiring that each GCD update its management plan and rules to include goals and objectives consistent with achieving DFCs within certain deadlines; and
- requiring that adopted DFCs be submitted with an explanatory documenting how certain factors[218] were considered.

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[216] This amendment also incorporated changes codified by SB 737. The provisions of SB 737 relegated the MAG to being one of several factors that GCDs must consider when issuing permits rather than a permitting cap as it was defined under HB 1763. This effectively shifts the emphasis from permitting within the MAG volumes to monitoring actual pumpage and the effects of pumpage on the DFC – a goal that can be much more nebulous and difficult to measure. While the MAG remains relevant as the source of water availability estimates for regional water planning purposes, the shift in groundwater-planning emphasis places the role of the DFC into a more prominent position, becoming the focus of the planning process both in terms of determining planning goals and in driving development of regulatory policies and rules that preserve the DFC.

[217] §17 of SB 660. (codified as amendments to TEX. WATER CODE §36.108(d-2)) (Each DFC adopted must "provide a balance between the highest practicable level of groundwater production and the conservation, protection, recharging, and prevention of waste of groundwater and control of subsidence.").

While most believed that the 82nd Texas Legislative Session would be quiet relative to water matters, the build-up of emerging groundwater issues resulting from an immature, hastily-passed, and arguably compromised version of the failed SB 3 that passed via HB 1763 in 2005 coupled with the TWDB sunset review provided the motivation and means for substantial change. SB 660 was successful in making sweeping revisions to the DFC adoption process that is now much more involved with a greater level of participation at the GCD level. These most current changes make up the current process as it stands today. And while some consider the modifications of SB 660 to be an improvement, the greater involvement at the GCD level marks a step away from the previous trend towards regionalization by reinforcing GCD autonomy and relegating GMAs to lines on a map. Moreover, the current product represents the many incremental and arduous attempts to evolve toward a regional groundwater management approach – an evolution that has been striving to simultaneously incorporate the logic of regional management while holding fast to the powerful and politically-motivated precedent of local control. Although the efforts are commendable, the many half-attempts and compromised solutions aiming to achieve both may be proving to be unworkable.

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[218] §17 of SB 660. (codified as amendments to TEX. WATER CODE §36.108) (The specific factors to be considered in the DFC decision include: aquifer uses and conditions, water supply needs, hydrological conditions (e.g. total estimated recoverable storage), other environmental impacts (e.g. springflow), the impact on subsidence, socioeconomic impacts, private property rights, the feasibility of achieving the DFCs, and other relevant information.).

3.3 Remaining Problems with the Current Process

The incremental steps towards up-scaling from local management via GCDs have produced a compromised system where GCD representatives within common GMAs have been designated as the regional planners. This system that has evolved towards a larger scale while holding fast to local control, although improved, falls short of regionalized groundwater management as defined in the policy proposal above. That is, groundwater governance via institutions of sufficient areal extent to minimize hydrological disconnects and provide sufficient funds, authority, and resources to effectively manage the resource and equitably accommodate all affected actors to the maximum extent practicable. As mentioned, the GMAs are merely lines on the map to determine which local GCDs are to collaborate. Although a reasonably close proxy, it is not regionalization *per se*. As a result, challenges remain. The following section focuses on the new challenges of the current process as well as some of the challenges described in Chapter 2 that remain unresolved.

3.3.1 Unfunded Mandates

Chapter 2 describes the limited funding and resources available to GCDs as a result of the nature of the funding mechanisms and the economies of scale that are precluded by institutions with insufficient areal extent. As Texas began to recognize and develop a system of regional-scale groundwater planning, policy makers failed to make any strides towards providing adequate resources and funding. To the contrary, the role of already stretched GCDs only grew as the statutorily mandated groundwater planning

process increased in complexity and new GCD responsibilities were added, requiring a much greater level of effort.

For example, the process modifications, notice requirements, and new procedures for considering non-GCD input in adopting DFCs became much more involved with the provisions codified by SB 660.[219] The changes, by opening up the process to be more inclusive, transparent, and accountable, are improvements in concept, however, there is an associated cost to GCDs in terms of both time and money that is now much more substantial. Notifications, hearings, supporting materials, and the required reports require time and effort to prepare and distribute which are incurred solely by the GCD representatives and GCD staffs. The additional responsibilities required by statute without funding describe the classic unfunded mandate. The new time and effort commitments required will be felt as opportunity costs by diverting the limited resources away from groundwater management responsibilities and towards fulfilling these new unfunded mandates. SB 660 did include provisions to make technical staff from TWDB available to assist in development of DFCs, however, the Legislature in the same session slashed the TWDB technical budgets and staff,[220] rendering the assistance offered under this provision to be highly improbable.[221] As is, the groundwater planning process has become a much more complex and resource-intensive unfunded mandate that has been

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[219] R. Mace, *How the 82nd Legislature Changed (and Didn't Change) the Desired Future Conditions Process,* INTERNATIONAL TEXAS WATER LAW CONFERENCE, at M2-3 (September 15-16, 2011).
[220] *Id.* at M2-8. ("The Groundwater Technical Assistance Section suffered a 50 percent reduction in staffing, a 100 percent reduction in groundwater grants, and a 75% reduction in operating budget".).
[221] *Id.* at M2-8. ("Unless [GCDs] have in-house expertise, [GCDs] will most likely have to use existing information or hire consultants to run the models when developing desired future conditions.").

placed squarely on the backs of the GCD representatives but with no additional authority or means to fulfill it.

The mandates may also have the effect of further eroding the already weakened institutional resilience of GCDs. As mentioned in Chapter 2, the resources of underfunded GCDs are predicted to be further stressed as they work out the nuances of balancing private property rights and satisfying the statutory responsibilities of preserving and conserving groundwater resources. The additional responsibilities of SB 660 may create increased risk by requiring such exhaustive reporting and documentation of DFC decisions – documentation that may also serve as litigious ammunition to those that may be looking to challenge GCD authority. The sum total of the additional responsibilities and uncertainty has led some reviewers to question the ability of many GCDs to continue to exist, even suggesting that GCDs are being set up to fail to make room for statewide management of groundwater.[222]

3.3.2 Inadequate Representation/Stakeholder Involvement

As mentioned in Chapter 2, a key principle for common-pool resource management institutions is to have "collective choice arrangements" meaning that those affected by management decisions need to be included in the decision making. This principle was recognized in 2000 in the Senate Natural Resources Committee's Interim

[222] T. L. Brown, *Groundwater Issues and the 82nd Legislative Session*. INTERNATIONAL TEXAS WATER LAW CONFERENCE, at 15 (September 15-16, 2011). ("Groundwater Districts have been seriously underfunded from the beginning. It is ironic for a legislative body like the Texas Legislature, which bitterly resents mandates from the federal government, *to heap new cost mandates on districts, to the extent, I wonder how many will be able to survive.* Perhaps that is the Legislature's ultimate objective, the setting up of a statewide management of groundwater." (emphasis added)).

Charges Report to the 77th Legislature, wherein the committee identified the need to advance stakeholder participation in water management policy as "the fundamental tenet of SB 1."[223] In the current regional planning process, this involves both the stakeholders of the GMA and the RWPGs that are responsible for incorporating the results. In their review of the TWDB, the Sunset Advisory Commission identified several issues related to inadequate RWPG representation[224] and stakeholder involvement.

As mentioned, the voting members of GMAs are solely made up of representatives from the GCDs located wholly or partially within the GMA.[225] RWPGs, on the other hand, include representation from a broader range of specified interests.[226] This arrangement was described in the Sunset Commission's staff report as a disconnect that allows GCDs with representation on RWPGs to have input into the RWPG decisions but provides no opportunity for RWPGs to provide input into GMA decisions on DFCs. To address the issues, the Legislature implemented provisions via SB 660 to add a representative of each GMA that overlaps with each RWPG as a voting member of that RWPG. This was the reverse of the arrangement recommended in the Commission staff report where RWPG members would have been appointed to GMAs to offer input into DFC decisions. While SB 660 was an attempt to improve planning coordination, the new provisions may have missed the mark. The end result is that the voting members of

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[223] SENATE INTERIM COMM. ON NATURAL RESOURCES, *supra* note 74, at 33.

[224] SUNSET ADVISORY COMMISSION, TEX. WATER DEV. BD. - SUNSET COMMISSION FINAL REPORT, at 3 (July 2011). (The staff report noted the lack of coordination between the Regional Water Planning process and the Joint-Regional Groundwater Planning process and specifically called out problems related to the composition of the voting members of GMAs relative to RWPGs.).

[225] TEX. WATER CODE §36.108(c).

[226] TEX. WATER CODE §16.053(c), *supra* note 181.

GMAs continue to be made up solely of GCDs while the number of GCD representatives on RWPGs will likely increase. The potential unintended consequences may be a disproportionate level of GCD representation in RWPG decision-making and the continued perception of planning process disconnects owing to the lack of RWPG representation in GMAs.

With GCDs remaining as the sole voting members in GMA planning decisions, there is little opportunity for affected stakeholders to have their say. The Sunset Advisory Commission addressed this in their report commenting that notification of GMA meetings was too limited to invite meaningful input and concluded "stakeholders may be unaware of the DFC process and the potential effects of DFCs on their groundwater resources."[227] The Legislature responded via SB 660 by providing opportunities for public comment, by requiring more notification of meetings and hearings, and by allowing GMAs to appoint nonvoting advisory committees at their discretion. While this increases the opportunity for public input, it falls short of providing for adequate stakeholder involvement in DFC decisions. It is interesting to note that recommendations of the staff report, which would have included a RWPG representative on GMAs, would have moved the GMAs incrementally closer to what was contemplated in 2005 in the failed SB 3 with its proposal for creation of GMA Councils (GMACs). As mentioned, the GMACs not only included RWGP representation but also had voting membership dedicated to certain stakeholders.

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[227] SUNSET ADVISORY COMMISSION, *supra* note 224, at 26.

And perhaps the most egregious example of insufficient representation occurs in those areas of the state that are not within the jurisdiction of any GCD (Figure 7). These so-called "unprotected areas" are without GCD coverage and therefore are without representation and a vote in the groundwater planning process. Further, pumping in these areas is unregulated and, similarly, groundwater conditions are generally not monitored. Both of these factors impact the ability of a GMA to achieve a DFC with any level of confidence.[228]

3.3.3 Hydrological Disconnects and Local Politics

On its face, joint-regional planning via aquifer-based GMAs is a commendable attempt at reconciling any hydrological disconnects that may occur among the disparate GCDs and management approaches. However, as additional evidence of compromise, the joint-regional groundwater planning process created under HB 1763 allowed the voting members of GMAs to establish DFCs for subdivisions of a GMA that may be based on different "geographic areas" overlying an aquifer provided that use or aquifer conditions differ substantially from one area to another.[229] This concession had the potential to allow local politics to seep back into the decision-making. In anticipation of how this may be interpreted, the TWDB has warned that dividing a GMA into smaller and smaller subdivisions using county or GCD boundaries may further complicate the

[228] SENATE COMMITTEE ON NATURAL RESOURCES, *Implementation of House Bill 1763 and Groundwater Management in Texas,* INTERIM REPORT TO THE 81ST LEGISLATURE, at 5 (2009).
[229] TEX. WATER CODE §36.116(d).

process.[230] Such subdivisions, unless established on a natural basis such as aquifer subdivisions/sub-basins or hydrologically connected areas, could have the effect of increasing the likelihood that DFCs in adjacent subdivisions may be incompatible, which is the situation this process was attempting to resolve.[231]

The engrained tendency to regress back into county-based planning has proved to be realized in the first round of the process that concluded on September 10, 2010, with certain GCDs (counties) submitting DFCs based on objectives in conflict with objectives of adjacent GCDs and those DFCs adopted by the GMA. GMA 1 adopted three DFCs for the three "geographic areas" that encompassed the 18 counties overlying the Ogallala Aquifer in the Texas Panhandle (Figure 10). The DFCs were: 40% of groundwater volume remaining in storage in 50 years ("40/50") for Dallam, Sherman, Hartley, and Moore County and 50% volume of groundwater remaining in storage in 50 years ("50/50") in all the remaining counties except for Hemphill County. A third DFC was adopted for Hemphill County to have 80% volume of groundwater remaining in storage in 50 years.[232] This Hemphill County DFC, which allows greater pumping from geographic areas on three sides of the county, was challenged as being unreasonable

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[230] Petrossian, *supra* note 109, at 1.

[231] 31 TEX. ADMIN. CODE §356.2(8). (The only limitation of DFCs established by TWDB rules for different geographic areas is that the conditions are physically possible, both individually and collectively.).

[232] Panhandle Regional Planning Commission, *Water Planning*, www.theprpc.org/programs/RegionalH2OPlanning/gma1.html (last visited October 25, 2011).

because of the use of political boundaries but was ultimately upheld and accepted as a reasonable DFC.[233]

Prior to the TWDB decision to accept county-based GCDs, there was much debate over the interpretation of "geographic area" allowing the use of political boundaries for establishing DFCs.[234] SB 660 later included provisions that further reinforced this interpretation and the tendency to resort to county-based planning by amending the statute to allow proposed DFCs based on a number of considerations other than hydrogeological conditions.[235] HB 1755 was filed in the same session to clarify that

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[233] M. O. Knisely, *Litigation Update*, INTERNATIONAL TEXAS WATER LAW CONFERENCE, at A-9-10 (September 15-16, 2011). ("Mesa Water, L.P. and G&J Ranch, who had invested considerably in groundwater rights in the affected area, filed a petition in accordance with the relatively untested petition process codified by HB 1763 (citation omitted) contending that the Hemphill County DFC was unreasonable. The petitioners alleged that the DFCs were unreasonable because they were based on the boundaries of a political subdivision. They also alleged that the DFC preserving 80% of groundwater in storage would constitute a taking of the groundwater of the overlying landowners by allowing drainage by surrounding areas governed by more liberal DFCs.").

[234] *See* Jones, *supra* note 3, at 7. ("The term "political subdivision" is defined in both Section 35.001 and Section 36.001, but is omitted from Section 36.108(d). In terms of statutory construction, then, a political subdivision is not a proper basis for differential desired future conditions. Given the serious lack of direction about "geographic areas" in Section 36.108, what has been the experience to date in designating desired future conditions? Not surprisingly, groundwater conservation districts have construed the term "geographic area" to mean that political subdivisions, whether districts as a whole or counties within districts, can be the basis for different DFCs. By seizing upon the "geographic area" language, the districts continue the pattern of attempting to regulate something less than the entire aquifer over which they lie."). *See also* Mace, *supra* note 81, at 4. ("The meaning of "geographic area" is not clear and could include a number of surficial factors."); A. E. Soukhanov, *The American Heritage Dictionary of the English Language,* (third edition ed.) (1992). (Mace goes further to cite Soukhanov who defines "geographic" as (1) of or relating to geography or (2) concerning the topography of a Region. The relevant definition for "geography" is: the physical characteristics, especially the surface features, of an area.) (Author's note: Importantly, none of these definitions include political considerations.).

[235] §17 of SB 660 (codified as amendments to TEX. WATER CODE §36.108(d)). (This section of SB 660 included nine factors for DFC consideration, only one of which was hydrological conditions. The other factors are: aquifer uses, water supply needs, other environmental impacts (e.g. springflow), the impact on subsidence, socioeconomic impacts, private property rights, the feasibility of achieving the DFCs, and other relevant information.).

DFCs were to be based on hydrogeologic conditions, however, it was unsuccessful.[236] The contrasting direction of the successful SB 660, that allows for politically-defined "geographic areas" and the failed HB 1755 that attempted to reinforce the original intent of reconciling the hydrological disconnects is again evidence of the retreat away from the logic and importance of fit. This again reinforced the pattern of holding fast to local control despite the recognized logic and attempt to move towards regionalization.

[236] 82nd Leg., R.S., HB 1755 (hereinafter cited as HB 1755). (HB 1755 filed by Representative Callegari attempted to reinforce the use of aquifers and aquifer subdivisions as the basis for DFCs by deleting the option of using "geographic areas" and by defining aquifer subdivisions as: "a definable part of a groundwater reservoir in which the groundwater supply will not be appreciably affected by withdrawing water from any other part of the reservoir, as indicated by known geological and hydrological conditions and relationships and on foreseeable economic development at the time the subdivision is designated or altered."

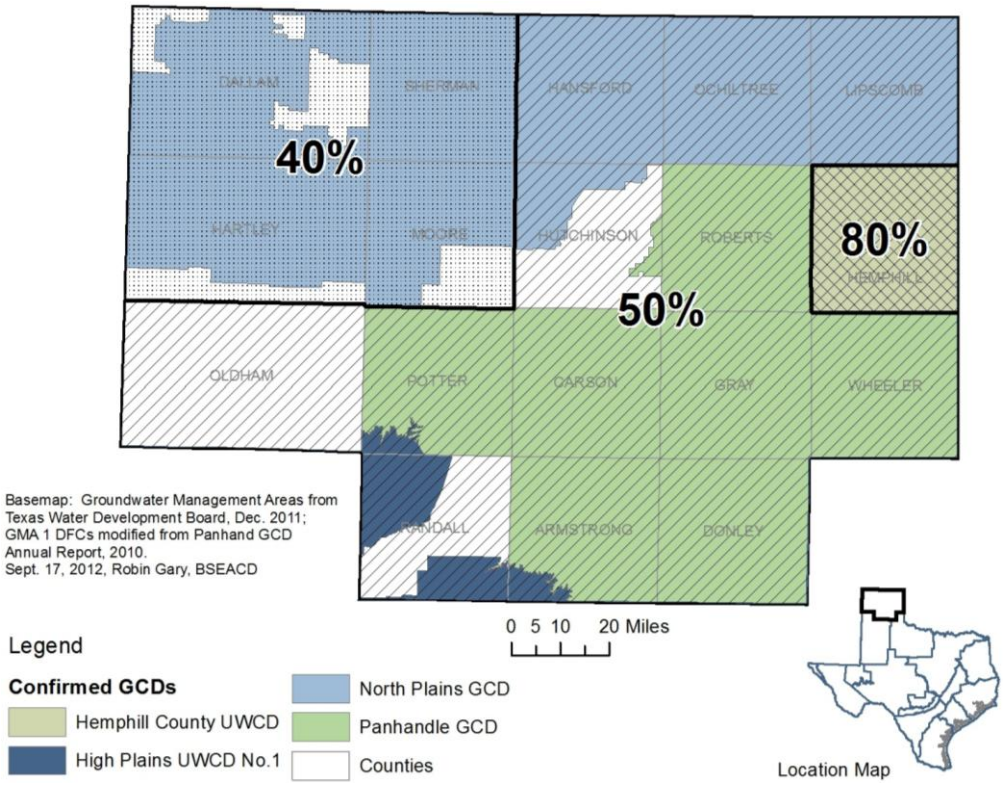

Figure 10: GMA 1 with adopted DFCs. Percentages indicate the volume of groundwater to remain in storage in 50 years.

3.4 AND THE BEAT GOES ON…

Since the GCD Act in 1949, the need to reconcile the groundwater management issues in Texas has become a perennial issue in the Legislature. These efforts only intensified in 1997 when the single-county GCD issue was recognized and was brought to front and center. Despite the exhaustive efforts to find a balance between local pressure to maintain county-based control and the recognized importance of fit and advantages of regionalization, the issue remains unresolved. And true to form, it is once again front and center as evidenced by the Senate Natural Resource Committee's Interim Charges for the 82nd Legislative Session. The pertinent charges include:

Study and make recommendations on the management of groundwater resources. Specifically, consider the following:

- Consolidation of groundwater conservation districts along major aquifer lines in an effort to increase efficiency and enhance responsible groundwater management;
- Effectiveness of single-county and non-contiguous groundwater conservation districts;

The recurrent theme is apparent and begs consideration of a wholesale embrace of regionalization. The directives of the Legislature since the problem was simultaneously recognized and allowed to proliferate in 1999 have consistently brought attention to the matter, but never before has the need for regionalization been so boldly called out as it was in the interim charges. If the pattern holds, however, the likelihood of such bold reform will be slim. Advancement, if any, will likely be in the form of continued incremental but slow progress towards regionalization.

Chapter 4: Models for Regional Groundwater Management

If Texas is to seriously consider "increasing efficiency and enhancing responsible groundwater management" as directed by the Lieutenant Governor in the Senate Natural Resource Committee's interim charges for the 82nd Legislative Session described in the previous chapter, it will have to recognize the advantages of regionalization. As elaborated elsewhere in this thesis, regionalization is intended to serve as a policy proposal that directly addresses this acknowledged necessity by respecting the importance of fit and taking advantage of the efficiency that accompanies a larger regional-scale management approach. The concept is not unprecedented. In fact, there are several examples of resource management via regional-scale institutions that have been applied by other states and even in Texas that may serve as models for regionalization. This chapter describes several successful examples, followed by a discussion of institutional design and management principles that may be gleaned and applied for the purpose of improving groundwater management in Texas.

4.1 State Models for Regionalization

The states of Nebraska and Arizona are examples of other states that have incorporated region-scale groundwater institutions into their water management regimes. They are largely considered successful approaches that may offer valuable insights to incorporating regionalization in Texas. The following section provides a brief summary of pertinent details related to groundwater management in these states.

4.1.1 Groundwater Management in Nebraska

The State of Nebraska is blessed with an abundance of groundwater supplied from the High Plains Aquifer – the nation's largest underground reservoir.[237] The aquifer consists primarily of consolidated and unconsolidated sand and gravel and in most of the state the water table is near and in some areas hydraulically connected to the land surface.[238] Water wells withdrawing groundwater from this prolific aquifer are used to support an extensive irrigated agriculture economy.[239] Even with this abundant groundwater supply, the high demands on the groundwater associated with irrigated agriculture have resulted in issues such as overdrafting in the western parts of the state and effects on intrastate surface water rights from the Republican River, both issues of which are exacerbated by periodic severe droughts.[240]

Prior to 1975, groundwater was managed by piecemeal judicial actions, limited legislative action, and a somewhat unique variation of the reasonable-use doctrine.[241] In

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[237] M. E. Kelly, *Nebraska's Evolving Water Law, Challenges and Opportunities - Part I*, THE WATER REPORT, at 9 (D. Moon, & D. Light, eds., November 15, 2010). (The High Plains Aquifer is currently estimated to store about three billion acre-feet of water of which Nebraska contains 37% of the land area and 65% of the total volume.

[238] R.B. Flay & T. Narasimhan, *Centralized versus Decentralized Approaches to Groundwater Management in the Western United States: How Hydrologic and Political Forces Shaped Management,* at 3. (2005), ("Where the stream-valley aquifers overlie the High Plains aquifer, they are connected hydraulically to the aquifer and are considered to be part of it.").

[239] Kelly, *supra* note 237, at 11. (Nebraska contains the most land of any state in the country under irrigation accounting for over 80% of the state water withdrawals (excluding hydropower and power plant cooling) from 106,000 irrigation wells.)

[240] *Id.* at 11.

[241] Kaiser & Skillern, *supra* note 46, at 287. *See also* Ashley & Smith, *supra* note 49, at 9. (The conventional reasonable use doctrine is considered a modified rule of capture that limits water captured to a "reasonable" use that is appurtenant or limited to use on the overlying tract.). *See also Olson v. City of Wahoo*, 1933 (This variation can be best described as the reasonable use doctrine that is replaced by

1967, the Nebraska Legislature authorized the creation of rural water districts for the purpose of limited regulation of storage, transport, and use of water supplies. By 1969, more than 150 of these small, locally oriented and rather disparate districts had formed.[242] In 1969, the Legislature took the bold step of reorganizing the many small districts into 23 regional-scale Natural Resources Districts (NRDs) that were oriented generally along basin boundaries (Figure 11) and assigned a variety of responsibilities including soil and water conservation, erosion control, drainage, rural water supply, recreation, forestry, range management, and wildlife habitat.[243]

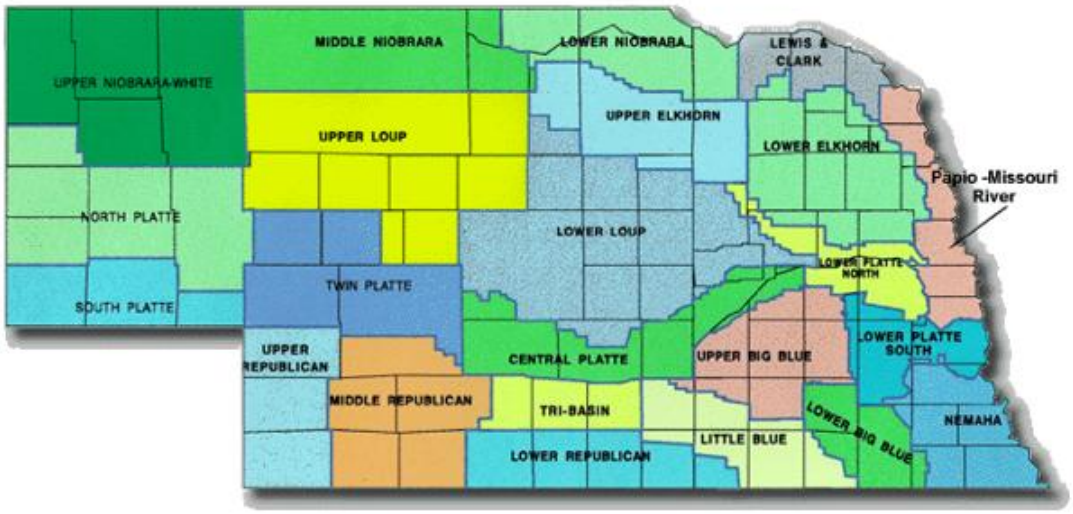

Figure 11: Map of the Nebraska Natural Resources Districts. (Source: Nebraska Department of Natural Resources)

correlative rights or an entitlement to a "reasonable portion of the whole" when the "natural underground supply is insufficient to all owners.").

[242] Ashley & Smith, *supra* note 49, at 160.

[243] Kaiser & Skillern, *supra* note 46, at 288.

In 1975, NRDs were empowered by the Nebraska Groundwater Management Act (NGMA) with a range of authorities to manage groundwater.[244] Most of the groundwater management within the NRDs occurs within the designated groundwater management areas[245] (not to be confused with Texas GMAs) that are established to address declining water levels and/or conjunctive management issues.[246] Within these groundwater management areas, NRDs must develop management plans defining "groundwater reservoir life goals"[247] and may implement certain controls including establishing total permissible withdrawals, mandatory rotation systems, well-spacing requirements, well metering requirements, and moratoria on new well drilling if needed. Although Nebraska has vested NRDs with a strong voice in determining groundwater policy, critics of NRDs have suggested that there had been a general reluctance or political will to implement this authority.[248] State legislation passed in 2004 to facilitate compliance with the multi-state

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[244] Ashley & Smith, *supra* note 49, at 160. (In 1975, the Nebraska Ground Water Management Act (NGMA) was passed in response to the escalating problems of overdrafting and surface diversions resulting from pumping. The authority of NRD's is derived primarily from the Act and subsequent amendments.).

[245] NEB. REV. STATUTES §46-673. (NRDs may designate "groundwater management areas" as control areas within NRDs if it was determined "that there is an inadequate groundwater supply to meet present or reasonably foreseeable needs of a beneficial use of such water supply." These areas may also be established for the purpose of integrating management of groundwater and surface water.)

[246] Kaiser & Skillern, *supra* note 46, at 288. ("About fifty percent of the state is included within a special groundwater management area.").

[247] NEB. REV. STATUTES §46-709. (Requires the development of management plans that specify "groundwater reservoir life goals" defining "the finite or infinite period of time which a district establishes as its goal for maintenance of the supply and quality of water in a groundwater reservoir at the time a groundwater management plan is adopted". NRDs must identify these goals for the purpose of determining long-term groundwater availability and for directing the management efforts of the NRD.) Author's note: Similarly, Texas GMAs are tasked with establishing "desired future conditions" which are the basis of groundwater availability through the MAG determination.

[248] Kelly, *supra* note 237, at 14. (Kelly states: "…before 2004, most NRDs had not exercised the powers provided under the NGMA and subsequent amendments." Kelly reinforces this statement by quoting Professor David Aiken who states that as of 2005, only three of the 23 NRDs (Upper Republican, Middle and Lower Republican NRDs) had begun to regulate pumping."). *See also* Ashley & Smith, *supra* note 49,

Republican River Compact, however, has forced NRDs to be more active by creating more responsibility and by compelling NRDs to integrate surface and groundwater management through the regulation of groundwater withdrawals that affect surface water flows, particularly in the Republican River.[249]

Principles and Findings Applicable to Texas Groundwater Management

Consolidate existing GCDs into GMAs: GMAs are similar to NRDs in that both are regional-scale entities formed along lines dictated by the resource (i.e. river basins for NRDs and major aquifers for GMAs).[250] If the Texas Legislature were so inclined, it could act as the Nebraska Legislature did in 1969 when it reorganized the many small scale and disparate rural water districts into the more logically organized and larger scale NRD jurisdictions that are in place today. Texas has incrementally evolved towards a system where regional GMAs are in place to coordinate planning efforts. A similar effort by the Texas Legislature could reorganize all GCDs and recast the GMA areas as the 16 regional groundwater management authorities to provide coordinated, active management over the major aquifers in the State (Figure 12). This would address problems of fit that typically occur with politically drawn districts over shared aquifers.

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at 163-164. ("This appears to be largely related to the influence of rural agriculture interests that is so strong that some have referred to NRDs as "irrigators clubs.").

[249] Kelly, *supra* note 237, at 14-19. (The passing of LB 962 in 2004 LB 962 is considered by many as a very progressive and long overdue recognition of the interconnectivity of surface and groundwater resources in Nebraska. It has also been suggested that active management by NRDs would not have progressed without the legislative mandate as a driver.).

[250] In terms of groundwater management, it is worth noting that NRDs are based on surface water basins and not aquifers. This does not appear to hinder groundwater management because all NRDs are tasked with managing the one large shared High Plains Aquifer system.

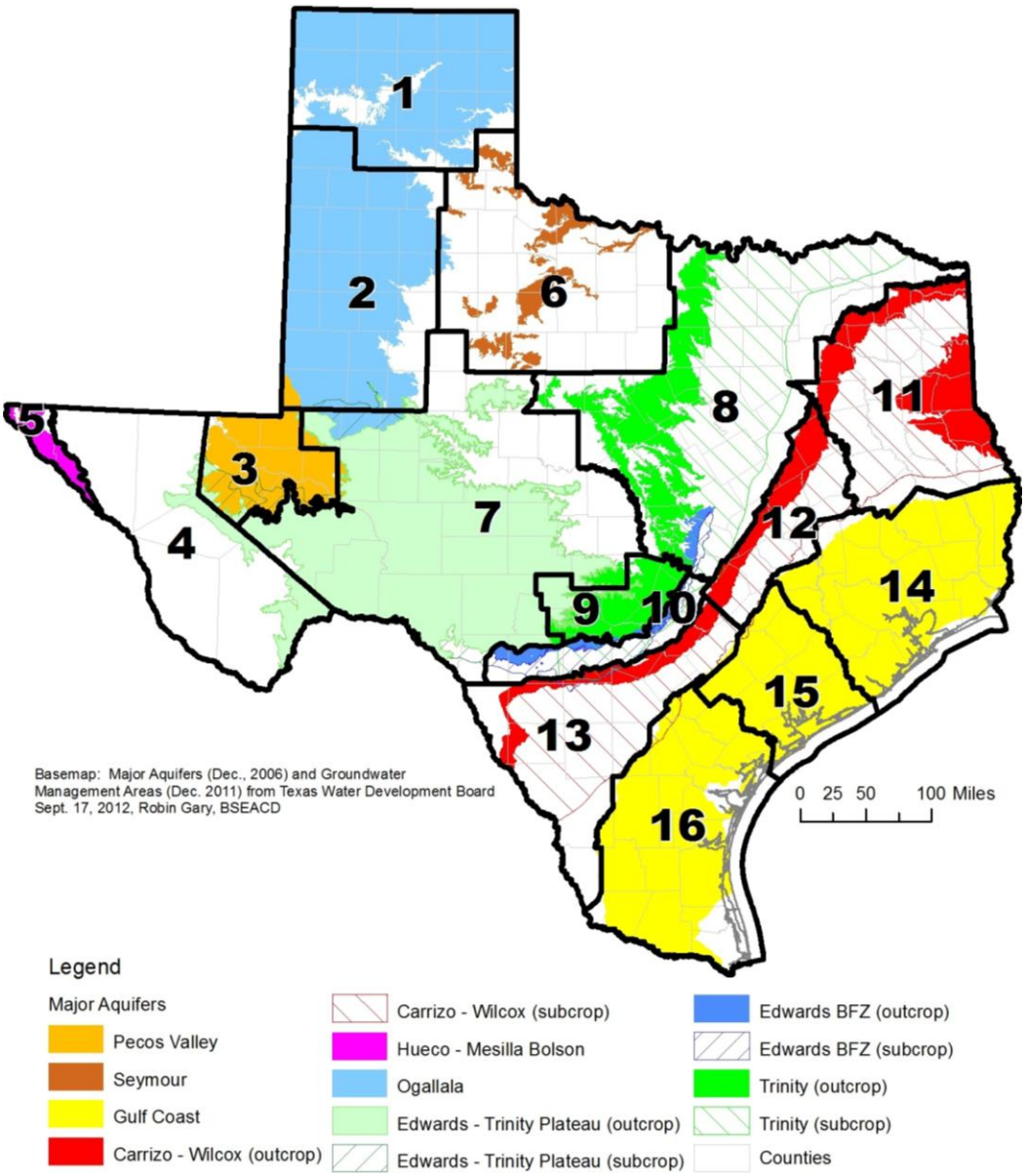

Figure 12: The proposed delineation of regional groundwater management authorities based on GMAs and major aquifer boundaries.

Provide GCD authority to GMAs: A Texas GMA is not an entity on the order of a NRD but more of a delineation of major aquifer systems for the purpose of identifying which GCDs have to jointly plan. A GMA has no authority, no representation (outside of member GCDs), or funding. Conversely, NRDs are relatively autonomous multipurpose districts that have equivalent powers and purpose of GCDs with the resources commensurate with the larger scale area within their jurisdiction. If current GCDs are consolidated into their respective GMAs, these regional institutions could be empowered, as are NRDs, to subdivide their respective areas to manage specific areas of decline, sub-basins within aquifers, or vertically (i.e. hydrostratigraphically) separate aquifers. The larger scale will also minimize the presence of transboundary situations over the minor aquifer systems while creating the economies of scale needed to provide sufficient funding to facilitate aquifer studies and effective management programs.

Facilitate Conjunctive Surface and Groundwater Management: Texas would be well served to acknowledge conjunctive management of surface and groundwater in a more explicit manner, as has Nebraska. As it stands currently, the surface and groundwater connection is only marginally acknowledged in Texas.[251] There is, however, an opportunity for Texas to further unify the management of surface water and groundwater through the joint regional groundwater planning process by including conjunctive

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[251] R. Kaiser, *Conjunctive Management and Use of Surface Water and Groundwater Resources,* at 3 (2011).
(TEX. WATER CODE §11.021, makes reference to "underflow" by designating underflow as part of the surface water resources that are property of the state). Ostensibly, this provision would apply to the stored water in the river system alluvia and would require diversion of underflow in the accounting of river-basin allocations. In practice, however, the underflow provisions are not commonly utilized.).

management objectives in the determination of desired future conditions (DFCs). DFC decisions could consider surface water conditions such as preservation of springflow or baseflow in river systems, particularly where hydrologically connected aquifers and surface waters are present within a GMA. Facilitating conjunctive management in this way would mean that Texas does not have to completely reinvent the current bifurcated system by choosing either GMAs or RWPGs as the singular management entity comparable to NRDs. The two can coexist within the existing arrangement where GMAs determine available groundwater supplies via the joint groundwater planning process and where RWPGs continue as the primary water planning entity responsible for aggregating all data on water supplies, demands, and developing future water supply strategies.

As a practical matter, Nebraska had the foresight to reorganize the many small districts back in 1969 when supplies were abundant and problems associated with intense groundwater use had not yet emerged. Moreover, this abundance of supply and rather recent implementation of pumping management and restrictions has not been subject to the same sort of litigious history, as have GCDs in Texas. That is, the common law related to groundwater management is relatively immature in Nebraska. Conversely, there is a substantial body of common and statutory law in Texas that would render non-incremental change to its groundwater management approach difficult from both a political and a logistical perspective.

4.1.2 Groundwater Management in Arizona

The State of Arizona relies on a mix of surface and groundwater supplies.[252] The major surface water supplies available[253] are dependent upon annual precipitation (both rain and snow) which is highly variable and unreliable in a largely desert environment.[254] This variability coupled with the full appropriation of surface water rights have created a heavy reliance on the groundwater resources to make up for shortfalls in years when surface water is exhausted.[255] The dominant water demand in Arizona has long been irrigated agriculture, however, the amount of irrigated acreage has been on the decline as urbanization encroaches into rural areas.[256] The trend is likely to continue with continued urbanization and in response to overdrafting of the aquifers and the resulting groundwater management measures that have been implemented and new water sources that have been developed (further discussion below).

Similar to Texas and Nebraska, Arizona's surface water and groundwater resources are allocated and regulated according to separate doctrines. Surface water was

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[252] R. P. Maguire, *Patching the Holes in the Bucket: Safe Yield and the Future of Water Management in Arizona,* 49 ARIZ. L. REV., 361, at 363, (2007). ("Today [2007], groundwater makes up approximately 40% of the state's water budget, surface water makes up about 58%, and effluent the remaining 2%."(citation omitted)).

[253] Ashley & Smith, *supra* note 49, at 188. ("Major sources of surface water in Arizona include the Colorado, Gila, Salt, Aqua Fria, and Verde Rivers.").

[254] Maguire, *supra* note 252, at 363. ("Climate models and dendrohydrology (tree ring) studies suggest the possibility of the recurrence of mega-droughts that may be exacerbated by climate change making these surface sources even more unreliable.").

[255] Ashley & Smith, *supra* note 49, at 188.

[256] Ashley & Smith, *supra* note 49, at 190. (The percentage of groundwater use for irrigated agriculture has declined from 95% in 1955 to 77% in 2005.).

allocated from the outset on the basis of prior appropriation[257] while groundwater allocation evolved through case law into the doctrine of Absolute Ownership tempered by the Reasonable Use doctrine.[258] Little progress was made to address the overdrafting problem that had developed as a result of the limited groundwater management afforded under this doctrine until the Arizona Legislature passed the Arizona Groundwater Management Act (AGMA) in 1980. The AGMA was intended to "…provide a framework for the comprehensive management and regulation of the withdrawal, transportation, use, conservation, and conveyance of rights to use groundwater in this state."[259] The AGMA, which received much acclaim for its innovative approach to groundwater management, [260] addressed three primary goals: 1) control severe overdraft in many parts of the state, 2) provide a means to allocate the state's limited groundwater

[257] J. L. Sax, B.H. Thompson, J. D. Leshy, & R. H. Abrams, *Legal Control of Water Resources - Case Materials* (Fourth Edition ed.), at 417 (2006). (The Prior Appropriation Doctrine is characterized as "first in time, first in right" meaning that water rights that were put to use (perfected) earlier in time have priority over later rights.).

[258] Ashley & Smith, *supra* note 49, at 191. (Absolute ownership (similar to the Rule of Capture) was adopted as common law for groundwater in 1904 by the Arizona Territorial Supreme Court in their ruling in *Howard v. Perrin*. This was not considered imprudent given the few competing demands for groundwater at the time. The issue was again revisited in 1952 when, for a brief time, the Arizona Supreme Court overturned absolute ownership, established groundwater as property of the state, and adopted prior appropriation as common law doctrine in their ruling in *Bristor v. Cheatham* (*Bristor I*). That decision was reheard and overturned the following year in *Bristor II* in response to "big pumpers" concerns over the effect of limiting groundwater on their investment. The product of this decision was the adoption of absolute ownership tempered by reasonable use as the common law doctrine.).

[259] ARIZONA REV. STAT. ANN. §45-401(B).

[260] Maguire, *supra* note 252, at 361. ("in 1986, the Ford Foundation even recognized the [A]GMA as one of the ten most innovative programs in state and local government."). *See also* S. Olson, *Arizona Water Management Issues,* THE WATER REPORT, at 11 (D. Moon, & D. Light, eds., October 15, 2009). ("Olsen quotes Bruce Babbit as stating: "The progress Arizona has made toward effective management of its water future carries important lessons for the hard decisions which must be made in the next decade.").

resources, and 3) augment Arizona's groundwater through water supply development.[261] This would be accomplished by establishing the Arizona Department of Water Resources (DWR) as well as regional groundwater management institutions to freeze the growth of irrigation in "Irrigation Non-Expansion Areas" and to address severe overdraft in "Active Management Areas" (AMAs).

The AMAs were established with the most comprehensive management provisions because of the magnitude of regional overdrafting in the areas. Importantly, these AMAs were created using boundaries based on the hydrogeography of the groundwater basins (Figure 13) giving proper consideration to the importance of fit.[262] Each of the AMAs is further divided into sub-basins to reflect the unique hydrological conditions of each AMA (Figure 14).[263] Four of the five AMAs that have been created under the AGMA (the Phoenix, Prescott, Tucson, and the Santa Cruz AMAs) have been established with management goals on the basis of safe-yield[264] in an effort to ensure sustainable water supplies in the urban and urbanizing areas.[265]

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[261] Arizona Department of Water Resources (hereinafter cited as ADWR), *Overview of the Arizona Groundwater Management Code,* at 1, www.azwater.gov/asdwr/watermanagement (last visited June 15, 2012).

[262] Maguire, *supra* note 252, at 367.

[263] ARIZONA REV. STAT. ANN. §45-411. (Statute created initial AMAs with sub-basins within each AMA).

[264] ARIZONA REV. STAT. ANN. §45-561. (Code defined "safe yield" as "a goal that attempts to achieve and thereafter maintain a long-term balance between the annual amount of natural and artificial recharge in the AMA.").

[265] S. Olson, *Arizona Water Management Issues,* THE WATER REPORT, at 11 (D. Moon, & D. Light, eds., October 15, 2009). (The Pinal AMA has established a management goal commonly described as "planned depletion.").

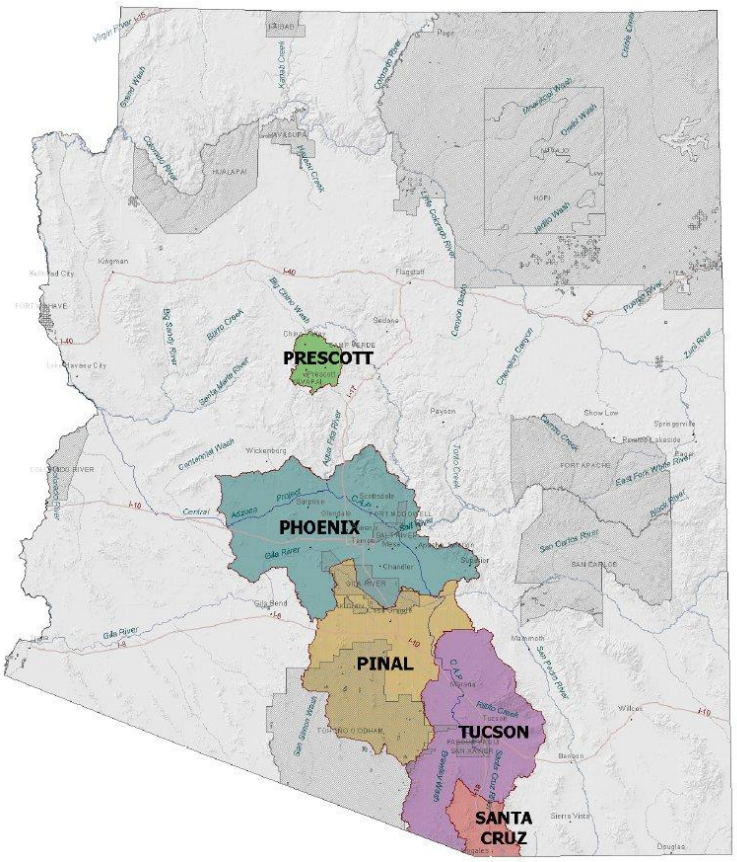

Figure 13: Arizona's Active Management Areas (AMAs). (Source: Arizona Department of Water Resources)

The key provisions applicable to AMA management as summarized by the Arizona DWR include:

- Establishment of a program of groundwater rights and permits including permitting exemptions for certain grandfathered rights and exempt wells.[266]
- Prohibition of irrigation of new agricultural lands within an AMA.[267]

[266] ADWR, *supra* note 261, at 2. (grandfathered and exempt wells are primarily wells in use before the AGMA and wells incapable of producing more than 35 gallons per minute).
[267] *Id.* at 2.

- A requirement of AMAs to establish management plans to meet the conservation goals of each of the five designated management periods.[268]
- A requirement of AMAs to require each new development within an AMA to demonstrate a 100-year assured water supply (AWS) for new growth.[269]
- A requirement to meter water pumped from all large wells and report annual withdrawals.

These provisions governing AMAs coupled with the safe-yield goals have been successful in shifting existing demand away from irrigation and future demand towards renewable and more innovative water supplies and management strategies. Some of these strategies include effluent reuse, long distance surface water diversions (i.e. the Central Arizona and Salt River Projects), groundwater replenishment and storage, demand management measures, and water rights retirement incentives.[270] AMAs are funded by fees assessed by the Arizona DWR and are managed by an area director[271]

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[268] *Id.* at 4. (The AGMA requires the Arizona DWR to set mandatory conservation goals for municipal, industrial, and agricultural users that are increasingly more stringent over time. The scheduled increase in conservation and the concomitant reduction in groundwater dependence are implemented via measures outlined in management plans adopted by each AMA for five generally decade-long management periods beginning in 1980 and ending in 2025.).

[269] Olson, *supra* note 265, at 13-14. (An AWS must demonstrate sufficient water of adequate quality that will be physically, legally, and continuously available to satisfy the needs of the proposed use for at least 100 years.).

[270] Olson, *supra* note 265, at 13-14. (The AWS rule has spawned the creation of institutions such as the Central Arizona Groundwater Replenishment District and the Arizona Water Banking Authority that provide mechanisms that allow members and participants to contribute to funding water supply and replenishment projects as a way of demonstrating AWS.).

[271] ARIZONA REV. STAT. ANN. §45-419. (Duties of area director include: 1) assist the Arizona DWR director in the development and implementation of the management plan for the active management area and 2) furnish technical and clerical services and such other assistance to the groundwater users advisory council.).

with direction from Groundwater Users Advisory Councils appointed by the Governor to give area groundwater users a voice in the AMA's management and policy decisions.[272]

[272] ARIZONA REV. STAT. ANN. §45-420. (Code establishes a Groundwater Users Advisory Council (GUAC) in each active management area consisting of five members. Members of the council are appointed by the governor to represent the users of groundwater in the active management area and on the basis of their knowledge of, interest in and experience with problems relating to the development, use and conservation of water. Duties of the GUAC include: 1) make recommendations on groundwater management plans, programs, and policies; 2) provide comment on the groundwater withdrawal fees and the expenditure of funds; and 3) manifest and record its official actions by motion, resolution or other appropriate means.).

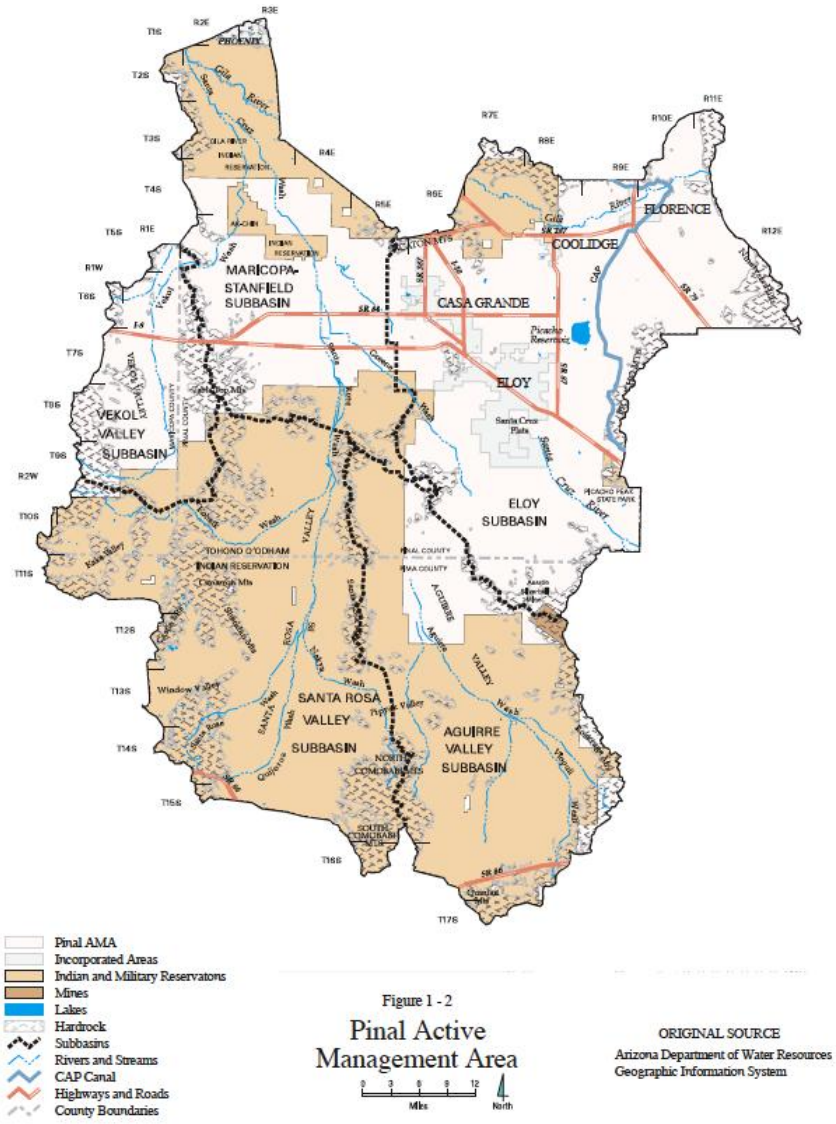

Figure 14: Map of Pinal County AMA. The AMA provides an example of the subdivision of AMAs into the sub-basins based on the unique hydrological conditions of each AMA. (Source: Arizona Department of Water Resources)

Principles and Findings Applicable to Texas Groundwater Management

Consolidate Existing GCDs in Designated PGMAs: Although there are some similarities between Arizona AMAs and Texas GCDs, Arizona's use of AMAs may better resemble the Priority Groundwater Management Areas (PGMAs) of Texas with one important exception noted below. Like Arizona, Texas is tasked under the PGMA program to identify areas that are experiencing or expected to experience groundwater problems. These areas are designated as PGMAs for the purpose of initiating the creation of GCDs. Like AMAs, PGMAs are also regional in scale and generally delineated based on the hydrogeography of the aquifer that it overlies (Figure 1). However, instead of creating smaller GCDs to infill the PGMA (Figure 6), Texas could follow the Arizona example by using these areas as the basis for creating similar regional-scale management entities and consolidating the existing GCDs within the PGMA into a single management entity.

If applied in Texas, a reevaluation of all of the major aquifers, including areas in existing GCDs, would be needed to assess areas in need of "active management." As mentioned, current PGMAs were designated to initiate GCD creation. As such, areas within GCD jurisdictions are not considered for PGMA designation. A reevaluation could take into account current and projected aquifer conditions and the efficacy of the existing GCDs and recommend consolidation where the limitations of small-scale GCDs restrict effective management. To provide maximum management logic and flexibility, the regionalized management areas could also be further subdivided into sub-basins based on unique hydrological conditions, similar to the Arizona AMAs. Limiting these

subdivisions to areas based on hydrogeography would avoid a reversion back to politically oriented alliances and the hydrological disconnects currently allowed by the DFC process in "geographic areas."

These new regional-scale entities would be a logical step based on 1) a confirmed critical groundwater management need within a common aquifer, 2) the conformity with the hydrogeography of the aquifer in need of management, and 3) the economies of scale afforded and funding generated by larger scale entities.

Mandated Safe-Yield Planning Goals: In terms of planning, Arizona's AMAs are like both Nebraska NRDs and Texas GMAs in that they are tasked with setting long-term planning goals that are to dictate the outcomes as to how groundwater is to be managed. In comparison, the "desired future conditions" and "groundwater reservoir life goals" of Texas and Nebraska, respectively, are similar in that they are policies that may be variable and based on the priorities and value judgments of the policy makers. Conversely, the majority of AMAs specify very prescriptive "safe-yield" goals that are established by statute. Without a statutory driver, there can be a tendency for planning goals established at the local level (e.g. DFCs set by GCDs in a GMA) to be set to accommodate the status quo and continue to benefit those that stand to gain from overdrafting. For certain aquifers in Texas (e.g., the Ogallala/High Plains Aquifer) conditions may realistically preclude a safe-yield planning goal.[273] For other aquifers, the

[273] PANHANDLE WATER PLANNING AREA (REGION A), REGIONAL WATER PLAN FOR THE PANHANDLE WATER PLANNING AREA, at 1-20 (2010). (Greater amounts of water have been pumped from the Ogallala (High Plains) Aquifer in the Texas Panhandle for irrigated agriculture than has been recharged resulting in water level declines of greater than 100 feet in some areas. The area dependence on irrigated agriculture

Arizona model of mandating phased-in measures to achieve a long term safe-yield goal over time may be necessary to compel very difficult decisions that are necessary to preserve water availability for not just the current but future generations.

In Arizona, the safe-yield goals and requirements for 100-year "assured water supplies" have also created the impetus for innovated water management strategies that might not have developed otherwise. The groundwater basin-delineated AMAs allow for accounting of the new withdrawals and replenishment projects within the same AMA while also providing administrative convenience and efficiency. Such sophisticated management strategies would only be further complicated with multiple entities and incongruent jurisdictions.

Local Autonomy with State Funding Assistance: AMAs are administered and funded at the state level by the Arizona DWR. Conversely, GCDs are a more autonomous form of local control with locally elected or appointed boards of directors and GCD-dedicated general managers, staff, and operating budgets. The GCD autonomy can be limiting because of the often-inadequate funding mechanisms available whereas the AMAs are equipped with the authority and resources of the state. Although a shift towards state administration of GCDs is unlikely, Texas could assist with funding for certain GCDs with inadequate operating budgets. The additional funding would facilitate more effective management while allowing GCDs to preserve their autonomy.

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therefore dictates a realistic goal of managed aquifer depletion rather than safe-yield.) *See also* Pierce, *supra* note 110. (generally describing concept of sustainable/safe yield).

Opportunity For Meaningful Stakeholder Input: AMAs are administered by the Arizona DWR with input provided by an advisory group comprised of governor-appointed members representing the groundwater users. Most GCDs are made up of elected or locally-appointed directors which, ostensibly, provide a voice and opportunity for representation of their constituents in decision making. GCD representatives are then responsible for representing their GCDs in GMA deliberations and decisions. The joint-groundwater planning process could stand to benefit from adopting the Arizona model by also allowing input by an appointed stakeholders group to ensure that all groundwater-user interests are considered in DFC decisions. With SB 660, advisory groups may be created but creation and use of such groups is discretionary. If Texas were to upscale to aquifer-scale management entities, such an entity could improve the opportunity for stakeholder input by requiring the appointment of similar advisory groups with the influence of a governor appointee to guide policy and operations. Alternatively, an appointed member could be allocated to each county to be appointed by the county commissioners courts as a way to maintain county-level involvement and facilitate political buy-in.

4.2 TEXAS MODELS FOR REGIONALIZATION

The previous section looked to other states that were similarly situated and offered principles that could be used as models to regionalize and improve the effectiveness of groundwater management in Texas. When looking for such models, one must look no further than to some of the Texas' own water resource management

institutions. The following section provides a brief summary of Texas River Authorities and the Edwards Aquifer Authority as multi-county resource-fitted models of regionalization.

4.2.1 River Authorities

The Conservation Amendment to the Texas Constitution (Article 16, Chapter 59), passed in 1917, enabled the creation of a plethora of water-related political subdivisions tasked with charges ranging from resource protection to supporting land development.[274] River Authorities (RAs), which started being created soon after the Conservation Amendment was passed, [275] are well-established surface water management institutions that are the largest in scale and perhaps the most prominent of these abundant special law districts. Although RAs are well established, the term has no special meaning or general-purpose definition in statute.[276] Likewise, there are no general law provisions unique to RAs.[277] RAs function with differing authority established by enabling legislation unique to each district. Generally speaking, RAs are authorized to sell water and allocate water

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[274] L. Dougal, K. L. Petersen, Jr., & C. Quinn, *Drinking Water Supply Issues: Water Utilities - CCNs and Rates*, ESSENTIALS OF TEXAS WATER RESOURCES, at 675 (M. K. Sahs, ed., 2009). ("Texas has many types of districts. The most common ones that provide retail water service to residential customers include municipal utility districts (MUDs), water control and improvement districts (WCIDs), fresh water supply districts (FWSDs), special utility districts (SUDs), and river authorities...").

[275] M. C. Rochelle, B. B. Castleberry, & M. M. Smith, *Meeting Water Supply Needs: Planning, Permitting, and Implementation*, ESSENTIALS OF TEXAS WATER RESOURCES, at 37 (M. K. Sahs, ed., 2009). *See also* G. Jarvis, *Historical Development of Texas Surface Water Law: Background of the Appropriation and Permitting System and Management of Surface Water Resources*, ESSENTIALS OF TEXAS WATER RESOURCES, at 102 (M. K. Sahs, ed., 2009). (creation dates for the first RAs: Brazos River Authority (1929); Guadalupe-Blanco River Authority (1933); the Lower Colorado River Authority (1934); Sabine River Authority (1949); Trinity River Authority (1955).).

[276] A. Stepherson, *Water Districts*, ESSENTIALS OF TEXAS WATER RESOURCES, at 150 (M. K. Sahs, ed., 2009). (Stepherson quoting David B. Brooks, County and Special District Law, §46.26 (West Texas Practice Series, Vol. 35), [hereinafter Brooks] - "Although the Texas Water Code defines river authorities for specific statutory purposes not relevant to this discussion, it contains no general-purpose definition.").

[277] *Id.* at 151.

resources, and are responsible for flood control, soil conservation, and water quality.[278] They may also develop navigation, generate hydroelectric power, and recreational facilities.[279] RAs generally lack taxing authority but may issue bonds backed by utility service revenue and receive loans and grants from the federal and county governments for funding.[280] A governor-appointed Board of Directors, which directs RA operations and policy, is made up of a number director positions generally commensurate with the area served.[281] Similar to GCDs, the missions of RAs are resource management oriented with an emphasis on "conserving, storing, controlling, preserving, utilizing and distributing the waters of their respective areas for the benefit of its residents."[282] And importantly, RAs are generally multi-county in size[283] configured with sufficient areal extent to encompass the entire river basins for which they were established to manage (Figure 15).[284]

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[278] Texas Natural Resource Conservation Commission [hereinafter cited as TNRCC]. A HANDBOOK FOR BOARD MEMBERS OF WATER DISTRICTS IN TEXAS (RG 238), at 60 (1996).
[279] *Id.* at 60.
[280] *Id.* at 60.
[281] SENATE COMMITTEE ON NATURAL RESOURCES, INTERIM REPORT TO THE 81ST LEGISLATURE - TEXAS RIVER AUTHORITIES, at Appendix B (2009). (The number of directors ranges from 9 to as many as 29 directors at the Angelina & Neches River Authorities.).
[282] The Lower Neches River Valley Authority, *Introduction*, http://www.lnva.dst.tx.us/about/intro.htm (last visited August 21, 2012).
[283] Stepherson, *supra* note 276, at 150. ("These entities [RA's] usually encompass a larger geographic area and have powers tailored to the particular purposes they are intended to serve.").
[284] TNRCC, *supra* note 278 at 60. ("The RA encompasses entire river basins and reaches into many counties. The geography of a specific river basin usually determines the shape of each authority.").

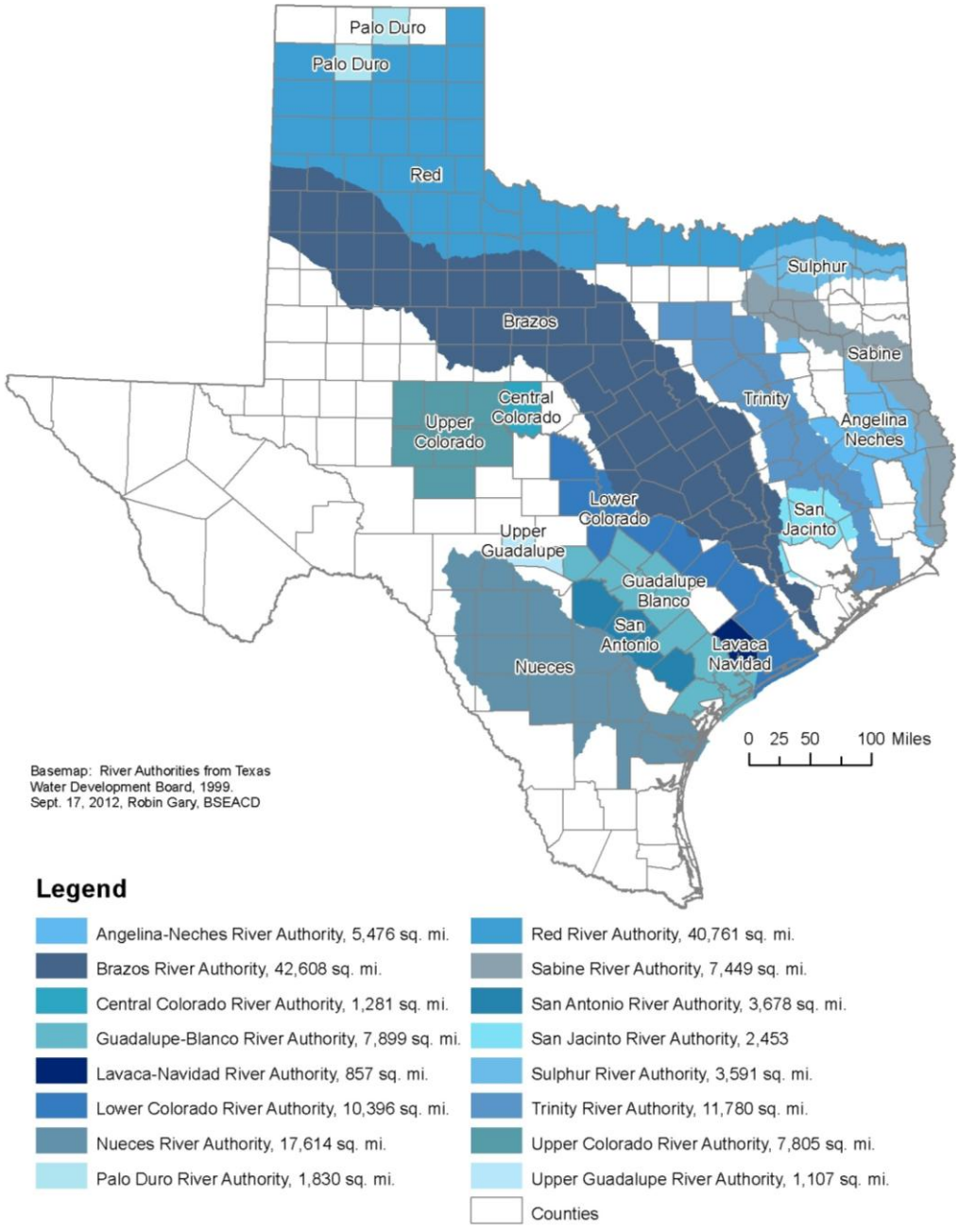

Figure 15: Map of Texas River Authorities (RAs). Shape and scale of RAs illustrates precedent for Texas water resource management entities configured congruent with watershed boundaries.

The first RA, the Brazos River Authority (BRA), was established in 1929 as a public agency of the state of Texas and was configured to encompass the entire Brazos River basin[285] including some 42,000 square miles (one sixth of the area of the state) and all or parts of 65 counties (Figure 16).[286] The Act establishing the BRA was considered a pioneering step in the history of water resource management in the United States marking the first time that management of the water resources of an entire river basin were entrusted to a single public agency for that purpose.[287] The BRA is governed by 21 governor-appointed directors and is entirely self-funded by revenues generated and not by taxes. The BRA and RAs in general, as one of the state's most mature type of resource management institution, represent a well-established model of a compromise between centralized and local governance with sufficient areal extent to be self-funding, well resourced, and effective in achieving resource management goals. With the creation of the BRA, Texas was at the forefront of resource governance by establishing such a relevant institutional model. However, this logic was since lost or dismissed when GCDs began to downsize in favor of hydrologically disconnected single-county entities.[288]

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[285] SPECIAL DISTRICTS LOCAL LAWS CODE §8502.003. ("Territory. The territory of the authority comprises the watershed of the Brazos River, as determined by rule of the Texas Water Development Board, except the portions lying within Freestone, Leon, and Madison counties.").

[286] K.E. Hendrickson, THE WATERS OF THE BRAZOS: A HISTORY OF THE BRAZOS RIVER BASIN AUTHORITY, 1929-1979, (1981).

[287] *Id.*

[288] Although the majority of all RAs are configured along or approximate to basin boundaries, some are configured along county lines. These include: the Upper Colorado River Authority, the Central Colorado River Authority, the Upper Guadalupe River Authority, the Lavaca-Navidad River Authority, and the Palo Duro River Authority (See Figure 15).

Principles and Findings Applicable to Texas Groundwater Management

Texas would be well served to take steps towards applying the design principles of RAs towards groundwater management institutions. The pertinent findings and principles applicable to this goal are almost self-evident and include:

- RAs are water resource management institutions as are GCDs with very similar mission statements; therefore, RA design principles are germane to GCD design.
- Although surface water and groundwater are governed by different doctrines, management institutions are in place for both (GCDs and RAs) and there is no compelling reason why regionalization would not be equally applicable.
- Texas clearly recognized the importance of fit with the initial configuration of the RAs along basins' boundaries (e.g. Brazos River Authority). The same logic should also be recognized with GCDs. With the delineation of the GMAs, Texas has a framework in place to move towards aquifer-based institutions.
- The longevity and maturity of RAs are a testament to the effectiveness of regional scale resource management entities with sufficient areal extent to encompass the resource.
- The scale and areal extent of RAs are a ready made model within the same state for how the economies of scale can provide for self supporting agencies that need not rely on tax dollars while providing for effective resource management.
- RAs are an example of regionalization in practice that serves as an effective balance between centralization and local resource management.

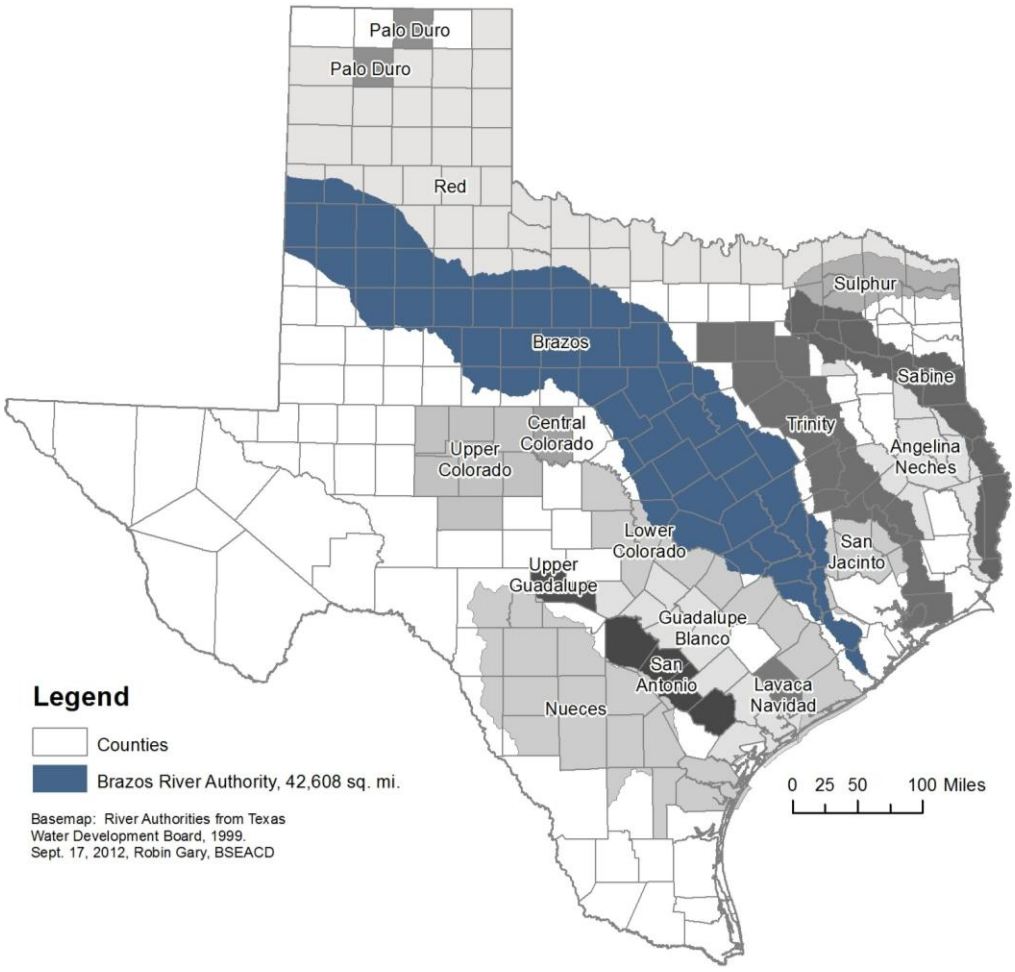

Figure 16: Map of the Brazos River Authority (BRA). BRA was created to manage the Brazos River and was scaled and configured to encompass the entire Brazos River basin.

4.2.2 The Edwards Aquifer Authority

As introduced in Chapter I, invocation of the authority under the Endangered Species Act has had a recent history of compelling unprecedented action relevant to groundwater management in Texas. The most far-reaching, but not the only example of this responsive action, involved the conflict concerning the management of the San

Antonio segment of the Edwards Aquifer and the ensuing events leading up to the creation of the most comprehensive and effective groundwater management entity in the state – the Edwards Aquifer Authority (EAA). Although the product of some nudging from the federal government, the EAA serves as the best and most applicable example of regionalization of groundwater management in Texas.

The San Antonio segment of the Edwards Aquifer[289] in South Central Texas is the primary regional water supply satisfying water demands that are generally dominated by agricultural irrigation in the western portions and by municipal supply in the eastern portions including the region around the City of San Antonio - an urban area with a population of approximately 1.7 million people (Figure 17).[290] It provides the source water for the Comal and San Marcos Rivers and supports habitat for several endangered species at Comal and San Marcos Springs – respectively the first and second largest spring complexes in Texas.[291] These springs provide firm-yield base flows for several rivers on which downstream users depend for municipal, industrial, and agricultural supplies. Given this diversity, the people who live in the region have extremely divergent interests in the way the aquifer is managed. Prior to the creation of the EAA, population growth, industrial development and agricultural expansion had increased the demand for

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[289] Edwards Aquifer Authority, *Hydrogeology of the Edwards Aquifer* (2012), http://www.edwardsaquifer.org/display_science_research_m.php?pg=geology (last visited October 7, 2012). (The San Antonio segment of the Balcones Fault Zone Edwards Aquifer ("SA Edwards") is a Cretaceous age karst aquifer system located in south central Texas that spans approximately 180 miles from Kinney County in the west to Hays County to the northeast and provides the primary water supply for all or parts of eight counties.).

[290] D. A. Frownfelter & D. C. Trejo, *The Rule of Capture and Edwards Aquifer Adjudication,* THE WATER REPORT, at 1 (D. Light, & D. Moon, eds., March 15, 2004.).

[291] *Id.* at 2.

water and exacerbated the political tensions between the urban and rural sectors which complicated management of the aquifer.[292] The increasing demands on the aquifer coupled with recurrent extreme droughts worked to diminish flows from the springs to critical levels that threatened the endangered species that relied on springflow for habitat.

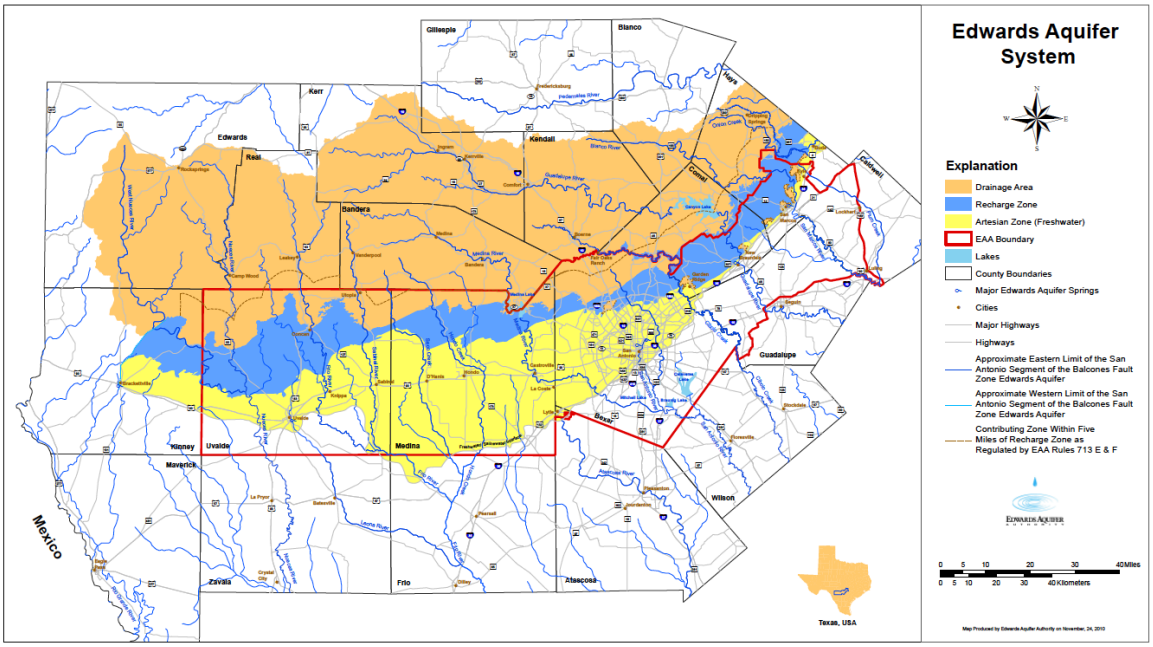

Figure 17: Map of the San Antonio Segment of the Edwards Aquifer and the boundaries of the Edwards Aquifer Authority (EAA). (Source: EAA)

The Edwards Underground Water District (EUWD) was created in 1959 in response to droughts and growing demand to manage the aquifer in the region; however, the unique situation presented by the many competing demands quickly outgrew the

[292] R. Kaiser & L. M. Phillips, *Dividing the Waters: Water Marketing as a Conflict Resolution Strategy in the Edwards Aquifer Region*. 38 Nat. Resources J., 413 at 414 (1998).

capacity of the then conventional GCD and its limited authority.[293] The building stress on the aquifer and the endangered species that were dependent on springflow led to the filing of a lawsuit by the Sierra Club alleging that the U.S. Secretary of the Interior and the United States Fish and Wildlife Service had allowed takings of endangered species by not preserving the minimum water level in the Edwards Aquifer that was necessary to sustain flow at Comal Springs and San Marcos Springs and therefore sustain sufficient habitat to protect the species.[294] In January 1993, the presiding judge, Lucius D. Bunton III, ruled in favor of the Sierra Club and gave the Texas Legislature until the end of the then-current legislative session, May 31, 1993, to adopt a management plant to limit pumpage or face federal regulation of the Edwards Aquifer.[295] In the face of federal intervention, the Texas Legislature passed SB 1477, creating the EAA, one day before the judge's deadline.[296] As further evidence that the Legislature took the judges direction seriously, SB 1477 formally replaced the rule of capture with a historic use permit system and empowered this regional "super-district" with powers, funding, and aquifer-wide

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[293] Johnson, *supra* note 112, at 1282. ("The EUWD… is broadly authorized to conserve, protect, and increase recharge of and prevent the waste and pollution of the underground water but regulatory powers needed to implement these goals have not been conferred upon it….").

[294] *Sierra Club v. Lujan*, No. MO-91-CA-069, 1993 WL 151353, (W.D. Tex. Feb.1, 1993). (When springflows decreased to a point that harms the endangered and threatened species, this constituted "take" under Ch. 9 of the ESA.).

[295] Kaiser, *supra* note 46, at 413. *See also* T.H. Votteler, *Raiders of the Lost Aquifer? Or, the Beginning of the End to Fifty Years of Conflict over the Texas Edwards Aquifer.* 15 TUL. ENVTL. L. J., 257, at 276 (Summer 2002). (Votteler citing Finding 196, *Amended Findings of Fact and Conclusions of Law, Sierra Club v. Lujan* (May 26, 1993): "The next session of the Texas Legislature offers the last chance for adoption of an adequate state plan before the 'blunt axes' of Federal intervention have to be dropped.").

[296] *See Id.* at 413.

jurisdiction sufficient to not only fend off federal intervention but to also effectively manage the resource.[297]

The EAA was created by the Edwards Aquifer Authority Act (EAA Act)[298] in 1993 to replace and expand the EUWD jurisdictional area to include all or parts of eight counties – an area that encompasses 8,800 square miles[299] including portions of the contributing zone and the majority of the recharge zone and the confined freshwater zones of the San Antonio segment of the Edwards Aquifer (Figure 17).[300] The EAA is governed by a board of directors composed of 15 elected directors representing single-

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[297] *Id.* at 423. ("The Legislature created a planning and regulatory institution with sweeping powers to mange, conserve and protect the aquifer"). *See also* Frownfelter, *supra* note 290, at 5. ("The [Edwards Aquifer Authority] Act granted groundwater management powers far exceeding the authority of conventional Chapter 36 GCDs."). *See Also* F. O. Boadu, B. M. McCarl, & D. Gillig, *An Empirical Investigation of Institutional Change in Groundwater Management in Texas: The Edwards Aquifer Case.* 47(1) NATURAL RESOURCES JOURNAL, 117, at 126-127 (2007). ("First, the [EAA] Act set up the [EAA], a new institution to manage water withdrawals from the aquifer. Second, while the Act did not extinguish the rights of existing landowners, it subjected water withdrawals from the aquifer to a permitting scheme similar to the rules governing surface water. Third, to protect against the adverse effects of droughts and to remedy the adverse environmental impacts of excessive withdrawals from the aquifer, the Act placed pumping limits on water withdrawals, mandated minimum springflows to protect endangered species, and laid the foundation for water marketing. Reading these provisions together leads to the conclusion that SB 1477 effectively ended the institutional arrangement - the rule of capture as applied to the aquifer - and replaced it with a permit system that promoted water marketing (citations omitted).").

[298] Act of May 30, 1993, 73d Leg., R.S., ch. 626, 1993 Tex. Gen. Laws 2350, amended by Act of May 16, 1995, 74th Leg., R.S., ch. 524, 1995 Tex. Gen. Laws 3280; Act of May 29, 1995, 74th Leg., R.S., ch. 261, 1995 Tex. Gen. Laws 2505; Act of May 6, 1999, 76th Leg., R.S., ch. 163, 1999 Tex. Gen. Laws 634; Act of May 25, 2001, 77th Leg., R.S., ch. 1192, 2001 Tex. Gen. Laws 2696; Act of May 28, 2001, 77th Leg., R.S., ch. 966, §§ 2.60-.62 and 6.01-.05, 2001 Tex. Gen. Laws 1991, 2021-2022, 2075-2076; Act of May 25, 2001, 77th Leg., R.S., ch. 1192, 2001 Tex. Gen. Laws 2696; Act of June 1, 2003, 78th Leg., R.S., ch. 1112, § 6.01(4), 2003 Tex. Gen. Laws 3188, 3193; Act of May 23, 2007, 80th Leg., R.S., ch. 510, 2007 Tex. Gen. Laws 900; Act of May 28, 2007, 80th Leg., R.S., ch. 1351, §§ 2.01-2.12, 2007 Tex. Gen Laws 4612, 4627-4634; Act of May 28, 2007, 80th Leg. R.S., ch. 1430, §§ 12.01-12.12, 2007 Tex. Gen. Laws 5848, 5901-5909; Act of May 21, 2009, 81st Leg., R.S., ch. 1080, 2009 Tex. Gen. Laws 2818 [hereinafter cited as "EAA Act"].

[299] The Edwards Aquifer Authority, *The Authority: Mission,* www.edwardsaquifer.org/display_authority_m.php?pg=mission (last visited July 15, 2012).

[300] EAA Act §1.02(a). ("A conservation and reclamation district, to be known as the Edwards Aquifer Authority, is created in all or part of Atascosa, Bexar, Caldwell, Comal, Guadalupe, Hays, Medina, and Uvalde counties.").

member precincts and two nonvoting directors appointed to represent Medina and Uvalde County and an advisory committee.[301] Funds to support EAA operations are generated not by taxes[302] but by the assessment of aquifer management fees, administrative fees, and bonds plus additional funding from grants and loans if needed.[303] The EAA Act also provided for creation of the South Central Texas Water Advisory Committee (SCTWAC) as a 20-member nonvoting advisory body made up of appointed members representing downstream water rights and issues with a statutory duty to assist the EAA with development and implementation of the demand management plan.[304] The SCTWAC is funded with aquifer management fees and is empowered with certain authority to provide some oversight over EAA operations.[305] The EAA represented a bold response by the Texas Legislature to create a district that was empowered with statutory authorities that

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[301] EAA Act §§1.09 and 1.091. (The original Act established a Board of Directors with directors that were all to be appointed largely by the Commissioners Courts of Bexar, Comal, Hays, Medina, and Uvalde counties. The Act was amended in 1995 by the Legislature (*See* Act of May 29, 1995, 74th Leg., R.S., § 2, ch. 261, 1995 Tex. Gen. Law 2505, 2516) to replace the appointed directors with elected directors in response to allegations of violations of the Voting Rights Act). *See Also* D.A. Frownfelter, *Edwards Aquifer Authority*, ESSENTIALS OF TEXAS WATER RESOURCES, at 325 (M. K. Sahs, ed., 2009). ("…the U.S. Department of Justice (DOJ) refused to give pre-clearance to the EAA Act under section 5 of the Voting Rights Act because the board of directors of the Edwards Underground Water District (the predecessor agency to the Authority) was an elected board, and the board of directors (board) of the Authority was to be an appointed board. The DOJ was concerned about the regressive impact on the voting rights of minorities in the region of going from an elected board to an appointed board.").

[302] EAA Act 1.28(a). (The EAA is prohibited from assessing *ad valorem* property taxes to fund operations.).

[303] See EAA Act §§1.29(b), 1.29(e), 1.11(d)(4), 1.24(b).

[304] *See* EAA Act §1.10(a), § 1.10(i)(1)&(2).

[305] See EAA Act § 1.10(h). (The SCTWAC is required by statute to file a report every even-numbered year assessing the "effect on downstream water rights of the management of the aquifer."). See EAA Act §1.10(f). (The SCTWAC may request reconsideration of any EAA Board action that may be "prejudicial to downstream to water interests". If the action is left to stand, the SWTWAC may appeal to the TCEQ to make a recommendation on the contested matter). *See Also* EAA Act §3.01. (Oversight of the EAA is also provided by a Legislative oversight committee tasked with regularly reviewing and holding the EAA accountable for achieving statutory management objectives).

were beyond other more conventional GCDs[306] – powers that were initially received as an affront to area landowners and property rights advocates but have since been embraced[307] and validated by the courts.[308] Provisions of the EAA Act and rules unique to the EAA and not generally available to conventional GCDs include:

- Recognition of the hydrological interrelationship between surface and groundwater and the benefit to the welfare of the state offered by conjunctive management measures that reflect this relationship.[309]
- Authority to regulate activities affecting recharge water quality in a "water quality buffer" that extends 5 miles beyond EAA boundaries.[310]

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[306] D.A. Frownfelter, *Edwards Aquifer Authority*, ESSENTIALS OF TEXAS WATER RESOURCES, at 339 (M. K. Sahs, ed., 2009). (EAA authority stems from TEX. WATER CODE Ch. 36 and the EAA Act. Ch. 36, which is the basic law applicable to all GCDs, is used to "fill in the gaps" where the Act is silent. However, in the event of a conflict, the EAA Act prevails.) *See Also* EAA Act, § 1.08(a).

[307] F. O. Boadu, B. M. McCarl, & D. Gillig, *An Empirical Investigation of Institutional Change in Groundwater Management in Texas: The Edwards Aquifer Case.* 47(1) NATURAL RESOURCES JOURNAL, 117, at 133 (2007). ("This is a fundamental shift in position from 1993 when the Authority legislation was being discussed: "farmers would support a drought plan to limit pumping, but they opposed a permanent cap on pumping and marketing provisions for buying and selling water rights." As stated by the president of the Uvalde County Water Conservation Association, "You start buying water rights up and you are going to kill the economy." Today landowners are fully in support of water marketing and are even threatening legal action to remove a requirement in SB 1477 that is intended to prevent stripping land of all water rights.).

[308] Frownfelter, *supra* not 306, at 326. ("…litigation ensued to preclude the EAA Act from taking effect. On November 27, 1995, the district court declared the EAA Act to be unconstitutional and enjoined the State from administering and enforcing the Act. *Medina County Underground Water Conservation District v. Barshop*, No. 95-08-13471-CV (38th Dist. Ct., Medina County, Tex. 1995). It was not until June 28, 1996, that the Texas Supreme Court in *Barshop* reversed the trial court's decision, dissolved its injunction, and found the EAA Act to be facially constitutional.").

[309] EAA Act, §1.06(a). ("The legislature finds that the water in the unique underground system of water-bearing formations known as the Edwards-Balcones Fault Zone Aquifer has a hydrologic interrelationship to the Guadalupe, San Antonio, San Marcos, Comal, Frio, and Nueces river basins, is the primary source of water for the residents of the region, and is vital to the general economy and welfare of this state. The legislature finds that it is necessary, appropriate, and a benefit to the welfare of this state to provide for the management of the aquifer through the application of management mechanisms consistent with our legal system and appropriate to the aquifer system."). *See Also* EAA Act, §§ 1.14(a).

- Authority to issue transferable permits that allow market-drivers to facilitate voluntary reallocation of permitted pumping rights.[311]
- Establishment of a firm cap on annual permitted pumpage.[312]
- Specified duty and authority to interrupt or temporarily curtail aggregate permitted pumpage to accomplish the aquifer management goals (i.e. protection of endangered species and downstream uses).[313]
- Establishment of sub-basins or "pools"[314] (Uvalde and San Antonio pools) that may be managed differently to reflect unique hydrogeologic conditions.[315]

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[310] *See Also* EAA Act § 1.08(c) (This provision provides authority to apply pollution control regulations into an area that extends 5 miles beyond the EAA boundaries.). *See* EAA Rules Ch. 713 (Water Quality), Subchapters E, F, and G. (Rules specify provisions regulating activities that may affect aquifer water quality including spill reporting, hazardous substances, and storage tanks.).

[311] EAA Act §§ 1.14, 1.22, 1.34. (These sections do not explicitly establish or endorse a water market but allows for one by establishing exclusive rights to pumping via permits, by fixing the total amount to be authorized by permits, and by allowing those permit to be transferable. Section 1.34(c) of the Act includes limitations on transfers of 50% of irrigation rights but with an option to sell a portion of the reserved amount that was conserved.). *See Also* Boadu, supra note 307, at 127. (concluding that the provisions of the EAA Act effectively created and promoted water marketing through permit transfers.). *See Also* Votteler, *supra* note 295 at 316. (Votteler concludes that the EAA Act's permitting requirements and fixed cap on permits created a quantifiable property right with exclusivity – characteristics that are fundamental to the existence of a free-market on water rights).

[312] EAA Act, §§ 1.14(b)-(c). (Prior to amendment, these provisions required annual pumping to be limited to 450,000 acre-feet by December 31, 2007. The cap was to be further reduced to 400,000 acre-feet/year thereafter unless drought conditions required more sever restrictions.). *See* Act of May 28, 2007, 80th Leg., R.S., ch. 1351, §§ 2.02, 2.09, 2007 Tex. Gen. Laws 4596, 4612, 4619. (The cap was later increased by the legislature to 572,000 acre-feet/year, which was the sum of confirmed regular permits during the historic use period.).

[313] EAA Act, §§1.14 (a)(f)&(h). (These provisions work together to ensure adequate spring flows for the benefit of the threatened and endangered species dependent on the Edwards Aquifer).

[314] Frownfelter, *supra* not 306, 328-329. ("A pool is a region within the Aquifer where a unique set of hydrogeologic conditions exist relative to other areas of the Aquifer. These unique conditions include isolated water levels, spring flow responses to changes in storage, and unique water quality conditions dependent on (Edwards] Aquifer stresses.").

[315] EAA Act §§ 1.14(a)&1.19. (These sections recognize the San Antonio and Uvalde "pools" as hydrologically unique segments of the aquifer. This subdivision allows for customized management approaches based on conditions unique to each pool. Examples of the rules specific to the pools include: the critical period demand management requirements (*See* Rule 715, Subchapter E, Appendix, Table 1) that

- Authority to discriminate between discretionary and nondiscretionary types of beneficial use and to assign preference to water-use types for the purpose of determining critical period curtailments.[316]
- A more restrictive definition of exempt wells that limits the volume of unmanaged pumpage from wells exempt from permitting.[317]
- Prohibition on any exportation of Aquifer groundwater out of EAA area.[318]
- Authority to assess administrative penalties for enforcement of EAA rules.[319]

The discrepancy between the powers of the EAA and conventional GCDs illustrates the will of the Legislature to create an entity that was empowered with authorities and responsibilities that are tailor fit to address the specific management challenges of a region. The discrepancies are also telling and could be interpreted as an implicit admission, by the Legislature, of the limited authority of all other GCDs and the challenges posed by those limits in providing effective groundwater management.

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require drought-triggered pumping curtailments specific to each pool and the Cibolo Creek transfer rules (*See* Rule 711.329) which limit inter-pool transfer of pumping rights.)

[316] EAA Act §§ 1.26(a)(1)&(4). Personal communication with Rick Illgner, Government Affairs Officer, EAA, (July 20, 2012). (The EAA has chosen not to exercise this authority in favor of deeper across-the-board curtailments specified for a Class V Stage Drought declaration in the Edwards Aquifer Recovery Implementation Plan) (Conversely, TEX. WATER CODE §36 .001(9) stipulates that all other GCDs subject to TEX. WATER CODE, CH. 36 must manage all uses designated as "use for a beneficial purpose" equally.).

[317] EAA Act §§ 1.33(c). (This provision further limits the eligibility for exempt well status by requiring permits for wells within or serving subdivisions requiring platting that might otherwise be considered exempt in accordance with criteria specified for most other GCDs (*See* TEX. WATER CODE §36.117(b)).). This provides for more effective and equitable groundwater management by reducing the total volume of pumpage that is not subject to measurement or drought management.)

[318] EAA Act, §1.34(a). (This provision explicitly limits the use of water withdrawn from the Aquifer to be being used within the boundaries of the authority. Conversely, SB 2 (codified as amendments to TEX. WATER CODE §36.122(c)-(e)) modified the statute to prevent a GCD from adopting rules that would limit groundwater exportation.). *See* Ch. 1, §1.2. at 25.

[319] EAA Act § 1.37(a). (This provision authorizes the assessment of administrative penalties, which is similar to enforcement authority available to other state agencies. Conversely, GCDs must file suit in civil court for the assessment of civil penalties to enforce rule violations (*See* TEX. WATER CODE §36.102(b)).).

Principles and Findings Applicable to Texas Groundwater Management

As the sole regional-scale groundwater management entity in Texas, the EAA is the most obvious and applicable institutional model with principles that could be applied in other regions of Texas with increasingly challenging water management issues. The most pertinent findings and principles include:

- The Legislature has the capacity and political will to create a regional aquifer-scale groundwater management entity that is empowered with authority and responsibilities unique to the management objectives.
- An existing entity with limited authority and effectiveness can be dissolved and replaced with a more functional entity when resource management objectives warrant, as illustrated by the dissolution of the former EUWD and the creation and expansion of the EAA.
- In recognition of the importance of fit, the new EAA jurisdiction was expanded to be configured using both aquifer boundaries and administrative boundaries (where available for convenience) to encompass the majority of the San Antonio segment of the Edwards Aquifer (See figure 17).
- The area of the expanded EAA jurisdiction is of sufficient scale and areal extent to provide the benefits of the economies of scale including sufficient funding to be effective and self-supportive from sources other than taxes.
- A regional groundwater management authority such as the EAA can be governed by a governing body (e.g. board of directors) with guidance from an advisory

group (e.g. the SCTWAC) with a prescribed and meaningful role. If applied to other regional entities in Texas, the two bodies could offer a combination of representation with elected directors representing areas (e.g. precincts or counties) and appointed advisory group members representing specified water interests (e.g. irrigated agriculture, municipal water utilities, power generation, etc.).

- A regional groundwater management authority can be empowered to recognize the relationship between groundwater and surface water in a region (where applicable) and manage accordingly to holistically integrate water management objectives.
- Consistent with the local control mantra of "one size does not fit all," a regional aquifer-scale groundwater management authority can be empowered with authorities and responsibilities that reflect the area-specific management challenges which may include subdivision into sub-basins (e.g. Uvalde and San Antonio pools) and zones (e.g. recharge and artesian zones) with customized groundwater management strategies reflecting unique hydrogeologic conditions.
- The circumstances of the EAA area provide the requisite factors needed for water marketing via a cap and trade system as a management strategy.[320] These factors include: 1) a firm cap on total available permits (572,000 acre-feet/year) which establishes exclusivity, 2) quantified water rights for each permit holder and 3)

[320] Market-based water management strategies can be an effective tool for voluntary reallocation of water rights when the appropriate conditions are in place (i.e. sufficient market size, limiting trade to within basin, diversity of water use types) and when such a strategy is appropriate to the management objectives.

permits transferable via a free-market system within the confines of the EAA's boundaries.

The EAA example proves that with the proper motivation (i.e., federal or state intervention), the local populace in an area who hold on so tightly to local control will generally learn to accept multi-county regional control such as the EAA as a preferred alternative. As the population and the demand for water for all beneficial uses continue to grow in Texas and the available water supplies become more scarce, the state's groundwater water management issues will continue to become increasingly more complex. This competition and complexity may provide the impetus equivalent to the threatened federal intervention in the EAA that would warrant the creation of regional groundwater management institutions that could be modeled after the prototype regional GCD - the EAA. The EAA along with the other models of regionalized water management described above may also offer a glimpse that reveals the future needed direction for groundwater management in Texas. That is, regional-scale aquifer-wide groundwater management institutions with sufficient authority and funding to efficiently manage groundwater resources in the state.

Chapter 5: Findings, Policy Options, and Recommendations

This chapter is the concluding one that builds on the context developed in the preceding chapters by providing findings that represent the key points supporting this thesis (findings are referenced to the thesis chapters, sections, and page numbers providing further detail). These findings form the foundation for criteria that are proposed as key factors to be satisfied in the implementation of regionalization as policy for the improvement of groundwater management in Texas. The chapter will conclude with a set of policy options that represent iterations of regionalization and an analysis of those options with consideration given to the stated policy criteria.

5.1 FINDINGS

1) Groundwater is generally considered a common-pool resource meaning that it is subtractible and has low excludability (Ch. 2 at 35).
2) Management of groundwater, as a common-pool resource, involves unique technical challenges associated with characterizing complex hydrological and hydrogeological systems and institutional challenges associated with influential legal, political, and cultural factors (Ch. 2 at 35).
3) To effectively address the technical and institutional challenges, groundwater management entities must be designed congruent with hydrogeographical boundaries in recognition of the importance of fit and must be appropriately scaled to minimize hydrological disconnects and provide sufficient funds, authority, and resources to effectively manage the resource and equitably

accommodate all affected actors to the maximum extent practicable (Ch. 2, §2.1 at 37, §2.2 at 50).

4) Groundwater management in Texas has evolved from limited management under the Rule of Capture towards a stated preference for a decentralized institutional system of local management through GCDs (Ch. 1, §1.1 at 2).

5) The preference for local control in Texas was initially the product of compromise that responded to the need for groundwater management, particularly in the Texas Panhandle, and was sensitive to private property rights issues and the local aversion to outsider interference – strong sentiments that remain in place today (Ch. 1, §1.2 at 18).

6) The strong preference for local autonomy coupled with path dependency has resulted in a precedent of creating GCDs that are configured along county boundaries and are generally single-county in scale. Of the 98 GCDs established in Texas to date, 57 (58%) encompass the area of a single county or less and the large majority are configured along county lines (Ch. 1, §1.2.2 at 27).

7) The 2012 State Water Plan projects increasing water demands, decreasing water supplies, and increasing pressure on the groundwater resources of Texas (Ch. 2 at 36, Ch. 3, §3.1 at 60).

8) The increased pressure on Texas groundwater resources coupled with the dominance of small-scale county-based GCDs has created challenges associated

with decentralization including hydrological disconnects, insufficient funding, lack of resilience, and myopic local politics (Ch., §2.1.1 at 37, §2.2.1 at 52).

9) Centralized groundwater management via a state agency such as the TCEQ, which has been offered as a response to the challenges of decentralization, would also involve challenges, including lack of management flexibility responsive to local conditions and, more importantly, local stakeholder opposition (Ch. 2, §2.2.1 at 50, §2.2.1 at 56).

10) Regionalization is offered in this thesis as a policy proposal for an institutional arrangement and scale of groundwater governance that provides a compromise between centralization and decentralization and that provides a balance that benefits from the advantages of both scales of governance satisfying the institutional design requirements described in Finding No. 3 (Ch. 3, §3.1 at 60).

11) Recognizing the inherent challenges of decentralization, there has been a persistent effort by Texas policy makers to shift towards regionalized groundwater management, however, strong opposition in favor of the deeply embedded system of local control has produced a compromised solution in the form of the joint-regional groundwater planning via aquifer-defined Groundwater Management Areas (Figure 12) (Ch. 3, §3.2 at 62).

12) The 16 Groundwater Management Areas, which are configured to provide for areas most suitable for groundwater management and generally encompass the major aquifer systems in Texas, provide a ready-made framework for

regionalization of groundwater management with areas that are appropriately scaled to satisfy the institutional design criteria described in Finding No. 3 (Ch. 3, §3.2.1 at 64, §3.2.4 at 70).

13) The current joint-regional groundwater planning process falls short of achieving regional groundwater management by not providing sufficient stakeholder involvement in planning decisions and most notably, by allowing individual GCDs to regress back into county-based planning rather than aquifer-based planning (Ch. 3, §3.3 at 81). Further, the most recent legislative amendments to the groundwater planning process have produced a set of unfunded planning mandates that are overly complicated, overly burdensome to GCDs with limited resources, and most likely unworkable (Ch. 3, §3.2.5 at 77).

14) The states of Nebraska and Arizona utilized successful regional water management institutions that offer principles that could be applied in Texas (Ch. 4, §4.1 at 92).

15) Texas currently has resource-delineated regional-scale water management institutions that manage surface water basins via River Authorities and, even more aptly, that manage an aquifer, the San Antonio segment of the Edwards Aquifer, via the Edwards Aquifer Authority (Ch. 4, §4.2 at 110).

16) Texas River Authorities, as one of the State's most mature type of management institutions, and the Edwards Aquifer Authority, as the lone existing example of a regional groundwater management entity in Texas, represent models of a

compromise between centralized and local governance that provide sufficient areal extent to be self-funding, well resourced, and effective in achieving resource management goals (Ch. 4, §4.2.1 at 111, §4.2.2 at 116).

17) Principles and characteristics common in the other state models and the Texas models of regionalization that could be implemented to improve Texas groundwater management include: small-district consolidation, conjunctive surface and groundwater management, provision of necessary authority and funding, opportunity for meaningful stakeholder representation, and management flexibility responsive to local conditions (Ch. 4, §4.1.1 at 96, §4.1.2 at 107, §4.2.1 at 115, §4.2.2 at 125).

18) The creation of the Edwards Aquifer Authority provides evidence of the necessary political will, when properly motivated, to implement regionalization to improve groundwater management in Texas (Ch. 4, §4.2.2 at 125).

19) While the EAA was motivated by extraordinary circumstances at the time, the projected pressures on groundwater, developing legal issues, and planning process complexity and unfunded mandates, could provide the equivalent motivation for the creation of similar regional groundwater management institutions to be implemented for the major aquifers systems in the remainder of the state (Ch. 4, §4.2.2 at 125).

5.2 POLICY CRITERIA

On the basis of the above findings, Texas should consider a new paradigm for water management utilizing regional groundwater management institutions as the optimal scale of governance that provides for a balance between centralized and decentralized groundwater management. In order to be efficient, equitable, resilient, and effective, these institutions should be designed in accordance with the following criteria:

1. Congruence with hydrogeographical boundaries.

Institutions should be configured to encompass entire hydrologically connected aquifer systems to the maximum extent practicable, to facilitate effective groundwater management, allocation, and planning by minimizing hydrological disconnects and transboundary aquifers. This criterion may be satisfied by drawing institution boundaries that are congruent with the hydrogeographical boundaries of major freshwater aquifer systems. Political and administrative boundaries (counties, precincts, roads, parcels) may also be used for administrative convenience when those boundaries generally closely approximate the hydro-geographical boundaries provided that the resulting area encompasses the entire major aquifer system. Similarly, sub-basins within major-aquifer systems created in response to management needs specific to the sub-basin should also be delineated congruent with hydrogeographical boundaries.

2. Sufficient areal extent.

Institutions should be configured to contain sufficient area to:

- encompass hydrologically connected aquifer systems (Criterion No. 1),

- provide operational efficiency through the economies of scale that allow for the elimination of duplicative overhead functions of multiple small entities,
- generate sufficient revenues through conventional funding mechanisms (Criterion No. 3), and
- discourage myopic management decisions influenced by the self-interests of hegemonic minorities.

Satisfaction of this criterion may be determined by establishing a jurisdictional area that satisfies Criterion No. 1 and that provides sufficient area for tax generation or that contain enough permitted wells for sufficient revenue from water use fees. The area needed to generate revenue through the conventional funding mechanisms (i.e. *ad valorem* taxes and water use fees) may be waived as a consideration provided that Criterion No. 1 is satisfied and other funding mechanisms not dependent on taxing area and permitted wells provides sufficient funding (See Criterion No. 3). Sufficient area that encompasses the larger major aquifer systems will likely not be congruent with boundaries of minor vertically stacked aquifers at depth; however, the larger regional-scale areas will serve to reduce the occurrence of transboundary situations over minor aquifers. Any occurrence of transboundary conflicts over minor aquifer systems will require coordination between the adjacent entities. Finally, discouraging myopic management decisions can generally be achieved by the dilution of any hegemonic dominance that will occur with an increase in area and scale that includes other affected parties and stakeholders.

3. Sufficient funding and resources.

Institutions need to be enabled with funding mechanisms to provide sufficient revenue to effectively and efficiently perform the statutory duties of preserving, conserving, and protecting the groundwater resources of the state. The standard for the appropriate amount of funding should be based on the resources available to the sole example of regional groundwater management in Texas – the Edwards Aquifer Authority (EAA). Using its 2012 annual operating budget, the EAA was funded at a per area rate of approximately $4.19/acre of jurisdictional area (*see* Appendix 2). This standard is contingent on the entity having the sufficient areal extent described in Criterion No. 2, which assumes the efficiency of operations associated with economies of scale. This criterion may be satisfied by authorizing institutions to generate revenues using an appropriate combination of both *ad valorem* taxes and water use fees that are sufficient to elevate annual operating budgets to the minimum standard. Both mechanisms can be justified as fees sufficient to cover the cost of service with permitted users directly benefiting from the management of the resource they rely upon and other taxpayers benefiting indirectly from the economy that is supported and the surface water sources that are positively affected.

4. Political feasibility.

If a shift from county-based local control to aquifer-based regionalization is to be politically feasible, institutions need to be designed to consider both the local government leadership (county commissioners) and the value of social, cultural, political factors at the

local level. Consideration of these factors is necessary to maintain and continue a local role in decision-making and policy setting in order to obtain political buy-in. This criterion may be satisfied by allowing county commissioners to make appointments to the governing body (board of directors) to represent county interests. The board of directors could be configured to be made up of county appointed-directors with the number of representatives allocated on the basis of county area or groundwater dependency. Alternatively, if directors are to be elected rather than appointed, the director precincts could be configured to reflect county boundaries. Additionally, such arrangement should be coupled with an effective education and outreach campaign to communicate the needs and benefits of regionalized groundwater management to facilitate political buy-in of the affected constituents.

5. Equitable representation for all aquifer dependents.

Institutions should provide mechanisms for those that are affected by groundwater management and policy decisions to provide meaningful input into those decisions in order to 1) benefit from local knowledge, 2) provide for "collective choice arrangements" and 3) obtain the "consent of the governed." This criterion may be satisfied by creating advisory bodies with positions designated to defined interests and expertise and could be custom configured on the basis of the local economy, dominant water use types, environmental interests, and other pertinent factors. This body may also be empowered with positions on the governing body (perhaps as nonvoting members) or with some

other defined mechanism for oversight or appeal of a decision in order to ensure that input is meaningful and influential in guiding operations and policy.

6. Sufficient authority.

Institutions should be empowered with the necessary authority to establish and enforce rules necessary to effectively perform the statutory duties of preserving, conserving, and protecting the groundwater resources of the state. This criterion may be satisfied by empowering institutions with authority on par with other state agencies or, more specifically, the EAA. As described in Chapter 4, the EAA has substantial authority beyond conventional GCDs including the ability to enforce rule violations through the assessment of administrative penalties and to prioritize water use types for extreme drought management. Satisfaction of other criteria including Criterion Nos. 3, 4, & 5 will also serve to provide the resources and political will to develop the necessary regulations, enforce those regulations, and provide opportunity for hearing and due process in response to enforcement actions.

7. Conjunctive use management goals.

Institutions should be designed to facilitate holistic water management by reconciling the disconnect that has resulted from the bifurcation of surface and groundwater law in Texas. Using principles from the Nebraska and the EAA models, this criterion may be satisfied by requiring that institutions establish and develop policies and rules to achieve management goals that recognize and address the effects of groundwater management and planning decisions on downstream and interconnected surface water

resources where applicable. In accordance with Criterion No. 9 related to regulatory flexibility, these goals should be developed to address the very specific surface/groundwater relationships in a given area. Such goals are currently required in GCD management plans; however, there is no real oversight of the effectiveness of the goals or the implementation of action to achieve those goals.

8. Long-term sustainability management goals.

Institutions should be designed to manage groundwater resources to achieved long-term sustainability goals that stretch the resource availability to beyond the lifespan of the current generation. This criteria may be satisfied by requiring management goals and water management strategies similar to those of the Arizona Active Management Areas which require the assurance of 100 years of water supply – a planning goal that extends planning beyond current generations and compels consideration of the water needs of future generations. Where aquifer recharge conditions practically preclude such safe-yield goals (such as in the Ogallala Aquifer in the Texas Panhandle), developing and implementing policies and strategies that work in concert to also satisfy Criterion No. 7 could serve to facilitate satisfaction of this goal. That is, the implementation of integrated water supply plans utilizing all available water sources, shifting to less intensive water demands, demand reduction achieved through drought management and conservation, and other innovative water management strategies such as water banking, aquifer storage and recovery, brackish water desalination, and use of reclaimed water.

9. Regulatory autonomy and flexibility.

Consistent with the mantra of "one size does not fit all," institutions should be empowered to be autonomous enough to have the regulatory flexibility to establish policies, management objectives, rules, and groundwater management strategies that are responsive to the hydrogeologic conditions, dominant water use types, area economy, environmental interests, and other pertinent factors unique to the management area. The satisfaction of this criterion is enabled by satisfaction of all of the above criteria, particularly Criteria Nos. 1, 2, 3, & 6. That is, major aquifer-oriented institutions with sufficient area, funding, and authority can be flexible and nimble enough to be subdivided and designed with customized management schemes that work in concert and that are responsive to variable hydrologic conditions and water demands within the management area. Such institutions can be effective in prioritizing issues, identifying critical features of most prominent problems and developing specific management strategies to address those problems.

5.3 POLICY RECOMMENDATIONS

The pros and cons of the two extreme groundwater management approaches of decentralized local control (status quo) and centralized state control were discussed in sufficient detail in Chapter 2. In short, the analysis established the challenges and shortcomings of the current decentralized system that have been observed in practice. State control, as the often-invoked alternative to local control, was established to be equally problematic from a practical perspective. With the state's emphasis on local

control and the disparate geo-political factors and hydrologic conditions in Texas, it would seem a reasonable assumption that any type of centrally controlled regulatory policy would not be politically feasible nor flexible enough to be effective. For these reasons, centralization is not discussed further to narrow the focus on the policy proposal of aquifer-scale regionalization that was offered in Chapter 3 as the optimal scale of governance for groundwater management in Texas.

The following policy recommendations proposed for consideration represent different degrees of regionalization ranging from continuing the recent progress through a small step that would incrementally modify the existing groundwater planning process to a larger stride that would replace the many existing small-scale GCDs with Groundwater Management Authorities configured in accordance with the existing framework of Groundwater Management Areas.

5.3.1 Incremental Modifications to the Existing GCD System

This policy option would represent the next incremental step in the shift towards regionalization by maintaining the current process of GCD representation within the existing GMA framework but with modifications to address the challenges associated with decentralization described in Chapter 2 and the shortcomings of the current joint regional planning process described in Chapter 3. To reiterate, the current decentralized system of small-scale GCDs suffers from challenges associated with limited funding, myopic local politics and self-interests, and hydrological disconnects (Finding No. 8). And while the joint-regional planning process has endeavored to address these issues, the

relatively immature process is challenged by limited stakeholder representation, GCD dominance and myopic policy decisions, growing process complexity, decreasing state technical support, and unfunded mandates on the backs of resource-poor GCDs (Finding No. 13). The following are offered as suggested modifications that work towards addressing these challenges and towards governance that satisfies the policy criteria that require the most attention.

GCD Funding

Limited funding for existing GCDs is a problem that can largely be attributed to the lack of sufficient areal extent. Retaining the existing small-scale GCD structure will obviously not resolve the sufficient area criteria, however, funding challenges could be addressed by empowering existing GCDs with the appropriate funding mechanisms needed to generate sufficient revenue required for effective resource management (Criterion No. 3).[321] Where funding in existing GCDs is insufficient, the current funding authority of each GCD, which is either tax based or fee based but rarely both, should be expanded to include both funding mechanisms at the rate necessary to make up for any deficit below the standards. Where these conventional funding mechanisms may fall short due to resistance to taxing or insufficient water use fees, the funding gap may need to be filled by raising the statutory cap on water use fees or with state financial assistance

[321] As mentioned in Criteria Nos. 2 and 3, lack of sufficient areal extent affects the minimum budget standards established by the EAA model. Small-scale GCDs lack economies-of-scale and therefore may require a higher per acre funding minimum to provide equivalent resource management services.

or through arrangements with local municipalities and other political subdivisions to subsidize individual GCD operating budgets.

GCD Authority

GCDs should be empowered with authority on par with the EAA (Criterion No. 6). This will require legislation to amend Texas Water Code Chapter 36 to lift all GCDs and specific amendments to the enabling legislation of individual GCDs to provide certain authority to address management challenges unique to each region.

Groundwater Management Area Councils (GMACs)

GMACs should be established for each GMA as designed in Senator Armbrister's introduced version of SB 3 filed in 2005.[322] GMACs, as envisioned in SB 3, should be established and empowered as governing bodies with specified authorities, duties, funding, and resources to achieve the stated policy goal of ensuring consistent management of shared major aquifer systems by the GCDs located in each GMA (Criterion No. 1). GMACs would be empowered with the authority to adopt DFCs, approve member GCD management plans, and verify consistency in management objectives (Criteria Nos. 6 & 8). The TWDB would continue to be responsible for processing the GMAC's DFC decisions, deriving MAG estimates, and allocating MAG estimates to the GCDs to serve as a tool in permitting decisions. The GMAC would be made up of the presiding officer of each member GCD, members representing each

[322] Ch. 3, §3.2.5 at p. 72.

RWPG in the GMA, plus additional members to be appointed by the TWDB representing the affected stakeholders with stakeholder positions designed to represent the water needs specific to each GMA including surface water interests (Criteria Nos. 5 & 7). Planning duties would be facilitated with technical assistance and funding provided by the TWDB (Criterion No. 3).

Clearly Define Role of GMACs and GCDs

The relationship, authorities, and duties of GMACs should be clearly defined such that GMACs ensure regional consistency of groundwater management while GCDs remain autonomous to create and enforce rules and manage individual jurisdictions within the context of the bigger regional management goals (Criterion 2 & 9). GMACs will ensure consistency by exercising authority to review and approve GCD management plans on the basis of consistency of management objectives and shall perform an annual review of the measures implemented and progress made by member GCDs towards achievement of those objectives. Instead of being burdened with the increasingly complicated and unfunded planning mandates of the current groundwater planning process as recently modified by SB 660,[323] GCDs would be responsible for providing a representative to the GMAC, development of management plans, development of rules and policies that implement those plans once approved by the GMAC, and enforcement of those rules and policies within their own jurisdictional areas.

[323] Ch. 3, §3.2.5 at 77.

Hydrologically-based GMA Sub-basins

Using the sub-basins of Arizona's AMAs[324] as a model program and the failed HB 1755[325] filed by Representative Callegari in 2011 as model legislation, GMACs should be allowed to delineate sub-basins within the GMAs where specific conditions warrant unique management goals (Criterion 9). When considering DFCs within the GMA, the GMACs may adopt unique DFCs for subdivisions of the GMA, provided that those sub-basins are delineated on the basis of known hydrological and geological conditions rather than political boundaries (i.e., county or GCD boundaries). The term "geographic areas" currently used to define areas within GMAs[326] that may have different DFCs should be replaced with the term "sub-basins" which shall be defined as proposed in HB 1755 as:

> "a definable part of a groundwater reservoir in which the groundwater supply will not be appreciably affected by withdrawing water from any other part of the reservoir, as indicated by known geological and hydrological conditions and relationships and on foreseeable economic development at the time the subdivision is designated or altered."[327]

Overall Feasibility

In terms of overall feasibility, this policy option represents the smallest incremental step towards regionalization, which is consistent, historically, with the pace of the gradual evolution of groundwater management in Texas. Moreover, it will at least partially satisfy most of the policy criteria (Table 3) and therefore will address some of

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[324] Ch. 4, §4.1.2 at p. 102.
[325] Ch. 3, §3.3.3 at p. 88.
[326] TEX. WATER CODE §36.108(d)
[327] §1 of HB 1755. (proposing amendments to TEX. WATER CODE §36.001(6)&(7)).

the most critical challenges associated with the current decentralized system provided that all of the recommended reforms are implemented and adopted. This option does, however, fall short of satisfying the key criterion of providing sufficient area extent. The lack of sufficient areal extent, which is a challenge inherent to small-scale GCDs, will continue to limit operational efficiency and foster tendencies for myopic management.

Criteria	**Satisfied**	**Partially Satisfied**	**Unsatisfied**
1. Hydrogeographical Boundaries		X	
2. Sufficient Areal Extent			X
3. Funding	X		
4. Politically Feasible		X	
5. Representation		X	
6. Authority	X		
7. Conjunctive Use		X	
8. Sustainability Goals		X	
9. Regulatory Flexibility	X		

Table 2. Policy Criteria Scorecard: Incremental Modifications to Existing GCD System

The most notable shortcoming of this policy option involves the assumption that the recommended reforms will be adopted and/or effectively implemented. Implementation of the recommended reforms will rely largely on new legislation that would: 1) empower a new level of government (GMACs), 2) increase GCD authority,

and 3) authorize new or increased taxes and/or financial and technical assistance from state and local agencies - all of which must occur in a political climate where there is a push to downsize government, agency budgets are being cut, and the notion of new or higher taxes is a political nonstarter. While these challenges are substantial, they are not insurmountable and may be plausible if policy makers can rise above local politics by considering the state's water management needs from a state and regional perspective.

5.3.2 Groundwater Management Authorities

This policy option would represent a wholesale implementation of regionalization by using the existing framework of Groundwater Management Areas (GM Areas) as the basis for 16 new regional scale Groundwater Management Authorities (GM Authorities) (Figure 18). This policy would involve dissolution of existing GCDs and the promotion of the former GM Areas, which were originally areas delineated to provide "the area most suitable for the management of groundwater resources," into regional groundwater management institutions (Criteria Nos. 1 & 2). The GM Authorities would be autonomous political subdivisions charged with the responsibility of providing for "the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions." To satisfy the established policy criteria and provide for effective groundwater management, the following are offered as key provisions that are recommended for the proposed GM Authorities.

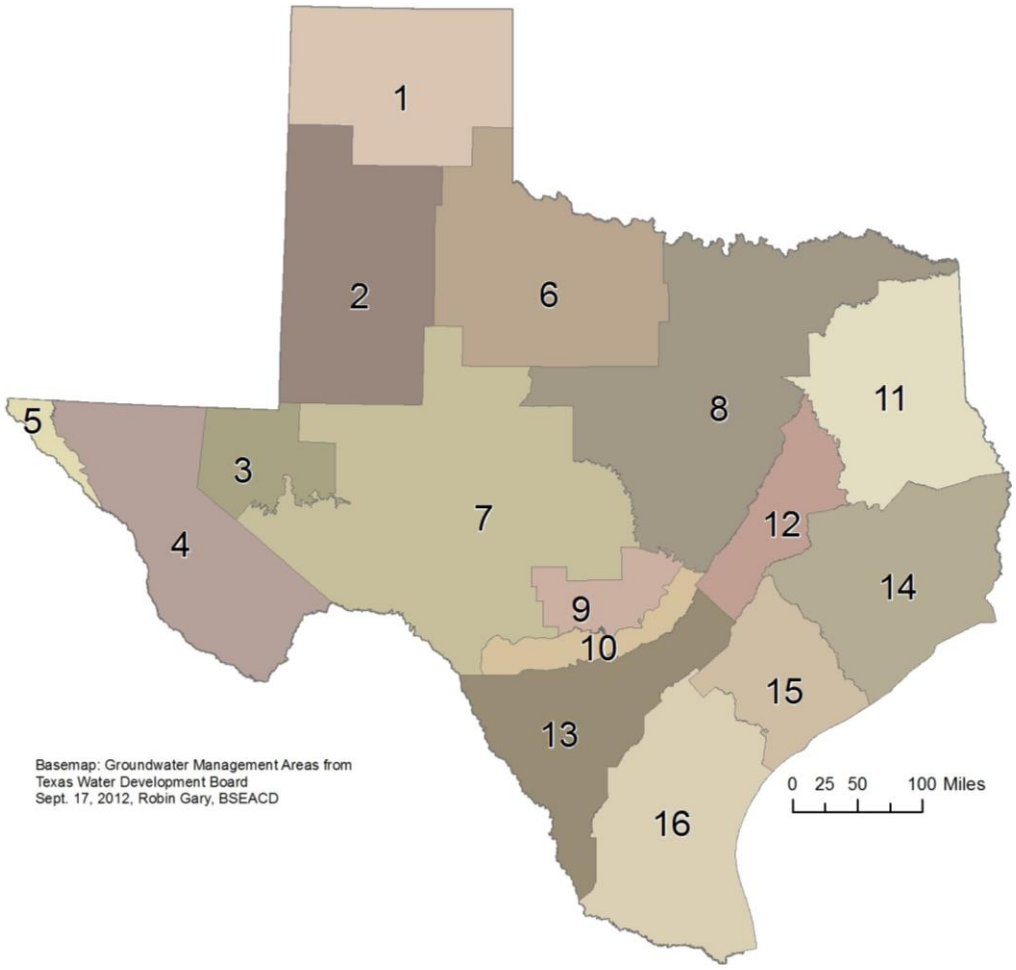

Figure 18: The proposed delineation of regional GM Authorities using GM Area and major aquifer boundaries.

Funding

Using the EAA and the Texas River Authorities as models, GM Authorities would be funded initially using solely water use fees to avoid having to assess taxes provided that water use fees alone would be sufficient to raise revenue to the minimum standards (Criteria Nos. 3 and 4). The water use fees should be considered the primary revenue source and potentially the sole revenue source, provided that sufficient revenue

can be generated within the existing statutory cap. Any tendency to "over permit" for the purpose of generating revenue through fees would be mitigated by the stakeholder-driven process to determine the DFCs and the resulting MAG estimates that would be required to be considered in permitting decisions (further discussion in planning section below). If water use fee revenue at the statutory rate is insufficient, the cap could either be raised to the necessary level or tax-based funding could be authorized at a lower rate that would be minimally felt but sufficient to elevate the total funding to the minimum standards. Where these conventional funding mechanisms may fall short due to resistance to taxing or insufficient water use fee rates, the funding gap may need to be filled with state financial assistance or through arrangements with local municipalities and other political subdivisions to subsidize individual GCD operating budgets.

Authority

Using the EAA as a model, GM Authorities would be empowered by the legislature through enabling legislation specific to each GM Authority with sufficient authority to establish and enforce rules that addresses the very specific management issues of the region (Criterion Nos. 6). This would include the autonomy and flexibility to customize the management approach including the subdivision of the area into management zones that are responsive to variable hydrologic conditions and water demands within the management area (Criterion Nos. 9). These management zones would allow management of specific areas of decline, sub-basins within aquifers, other vertically separate relevant aquifers, or other management needs specific to the GM

Authority. Similar to the Brazos River Authority, the GM Authorities would be empowered to:

> "…exercise all the rights and powers of an independent governmental agency, a municipality, and a body politic and corporate to formulate plans deemed essential to its operation and for its administration ..."[328]

Although relatively autonomous, GM Authority operations would ultimately be subject to oversight by the legislature and could also be subject to the state's sunset review process, similar to other state agencies, to ensure that operations are consistent with the stated missions. GM Authorities with sufficient authority and autonomy and minimal legislative oversight could be flexible enough to incorporate any combination of management and allocation instruments (e.g. historic use, correlative rights, prior appropriation), to best suit the aquifer conditions, uses, and politics of the region.

Governing and Advisory Bodies

GM Authorities would be governed by a board of directors (Board) made up of directors that could either be appointed or elected. The preferred option would be a Board made up of a combination of directors appointed by county governments or municipalities and directors appointed by the TWDB to represent the pertinent stakeholder interests in each area. This use of directors appointed by local governments is based on the original EAA enabling legislation (SB 1477) and would serve to maintain the link to county-level governance and the local knowledge base and smooth the transition from county-scale GCDs to regional GM Authorities (Criterion No. 4). Director positions representing local governments would be allocated to each

[328] SPECIAL DISTRICTS LOCAL LAWS CODE, 8502.001(d).

county/municipality on the basis of groundwater supplies and demands projected in state water plan for the water user groups in those areas. When combined with directors representing specified stakeholder interests, the governing body makeup serves to ensure that all aquifer dependents are provided with equitable representation in groundwater management and policy decisions (Criterion No. 5).

The next option in terms of preference would be elected directors representing single-member precincts and is based on the current make up of directors at the EAA. This would be the fallback position in the event that there are any legal issues related to replacing the elected Boards of dissolved GCDs with appointed officials. Using the Texas RWPGs membership as a model,[329] this option would need to be coupled with an advisory body made up of members representing: 1) pertinent stakeholder interests in the area (including surface water interests (Criterion No. 7), appointees of local governments, and each RWPG with area in the GM Authority. Similar to the EAA, the advisory group's role could be made to be meaningful by allowing nonvoting membership on the Board and by also providing an outlet for the advisory group to appeal any Board decisions (Criterion No. 5).

Planning

With this policy option, the GM Authorities would serve as the de facto planners for their respective major and minor aquifers systems in accordance with the existing groundwater planning process. As the research and management authority for each region, the GM Authorities would be tasked with determining groundwater availability by setting the DFCs for all of the relevant aquifers in their area. The current process involves coordination between the GM Area planning groups, GCDs, the TWDB, and

[329] See Ch. 3, §3.2.2 at 65 related to the makeup of RWPGs.

finally the RWPGs. Use of GM Authorities as regional groundwater planners streamlines the process by removing a level of government (GCDs) and the overly burdensome complexity that has developed in order to compel collaboration among GCDs within the GM Areas. Further, planning at this larger scale rather than GCD scale would considerably reduce the occurrence of transboundary aquifer situations within the major, minor, and vertically stacked aquifer systems (Criteria Nos. 1 & 2). Continued coordination among adjacent GM Authorities over shared minor aquifers would be less cumbersome as there would be fewer entities to coordinate with. This option would also serve to include the so-called "white areas" in Texas where groundwater use is currently unmanaged and where there is no representation in the planning process (Criterion No. 5). With most future outlooks projecting an increased reliance, either directly or indirectly, on groundwater across the state for public water supply, agriculture, power generation, industry, and environmental services, it will become imperative that groundwater is managed and groundwater interests are represented in all parts of Texas.

The TWDB would continue to provide state level objectivity and technical guidance by being responsible for processing the DFC decisions, deriving MAG estimates, and allocating MAG volumes to the aquifer sub-basins determined by the GM Authorities. The TWDB would, however, be significantly unburdened by allowing the GM Authorities to utilize their own funding, resources, and technical expertise to develop the DFCs before being submitted to the TWDB for a MAG determination. And by utilizing governing and advisory bodies in deliberating and setting DFCs as recommended above, surface water and other stakeholder interests would be sufficiently considered in DFC decisions which would further unburden the TWDB by reducing the occurrence of contested DFCs and the onerous petition process (Criterion No. 5).

In terms of management goals, conjunctive management can be facilitated by consideration of the effects of proposed DFCs on downstream interests and interconnected surface waters where applicable (Criterion No. 7). As mentioned, this is accomplished by providing a voice to those representing those interests through Board membership and advisory groups. The DFC planning period would continue to mirror the RWPG planning period of 50 years. While not extending as far out as the 100-year planning goals of the Arizona model, the 50-year planning window will generally extend beyond the lifespan of most policymakers, which partially satisfies the recommended timeframes of Criterion 8.

Overall Feasibility

As soon as the TWDB was assigned the task of delineating GM Areas that provided "the area most suitable for the management of the groundwater resources using boundaries that coincide with aquifer boundaries where feasible,"[330] the logic of the scale and fit, at first glance, became quite obvious. This policy option advances that logic by empowering the areas as regional groundwater management authorities and completes, rather than makes progress towards, the ongoing transition to regionalization. This option satisfies the majority of the policy criteria with one notable exception (Table 4). As stated in the discussion on the modifications of the current GCD system, there is currently an undeniable resistance, politically, to the notion of more layers of government and new and higher taxes. In terms of political feasibility, this criterion was graded as partially satisfied in a positive sense on the basis of the factors associated with this option

[330] TEX. WATER CODE §35.004(a), *supra* note 178.

that are responsive to this resistance. More specifically, these factors are related to the ability of the proposed GM Authorities to:

- be self-funded and more efficient without a reliance on tax-based funding,
- streamline groundwater management by eliminating duplicate functions,
- unify the many disparate and sometimes inconsistent rules and management approaches that evolved among individual GCDs, and
- eliminate the need for the extraordinary planning process complexity that has evolved to accommodate GCD-scale groundwater governance.

Criteria	**Satisfied**	**Partially Satisfied**	**Unsatisfied**
1. Hydrogeographical Boundaries	X		
2. Sufficient Areal Extent	X		
3. Funding	X		
4. Politically Feasible		X	
5. Representation	X		
6. Authority	X		
7. Conjunctive Use	X		
8. Sustainability Goals		X	
9. Regulatory Flexibility	X		

Table 3. Policy Criteria Scorecard: Groundwater Management Authorities

Conversely, the factors preventing a grade of full satisfaction for political feasibility are formidable. Similar to the modifications to the status quo option, dissolution of GCDs and replacement with GM Authorities would be entirely dependent on action by the Legislature. The prospect of such reforms by a Legislature that has established and time and again reaffirmed its preference and commitment to a decentralized system of local control would involve extraordinary complexity and political controversy. Local control has become a mantra that is deeply embedded and some would argue sacrosanct. And while such a process would be difficult, the notion is not unprecedented. As mentioned in Chapter 4, the Nebraska and EAA models for regionalization demonstrate similar situations where resource management challenges provided sufficient motivation to galvanize enough political will to make non-incremental changes to the resource management approach. Both the Nebraska Legislature and, in the case of the EAA, the Texas Legislature, implemented sweeping groundwater governance reform by dissolving and replacing many small-scale districts with larger scale Authorities. Given the increased pressures on groundwater and the mounting water resource management challenges in Texas, such bold reform may be warranted.

5.3.3 Other Policy Options

The detailed discussion above focused on the two policy options that reflect the extreme ranges of regionalization. That is, the incremental step of maintaining but modifying the current GCD system and wholesale implementation of regionalization by dissolving GCDs and replacing with regional GM Authorities using the existing GM Area framework. While not discussed in equivalent detail, iterations representing variations or regionalization within this range should also be considered. Other policy options to be considered may include:

Use of Existing GCD and County Boundaries to Delineate GM Authorities

This option is a slightly different version of the creation of GM Authorities by GCD dissolution using GM Area boundaries. It would involve consolidation of existing GCDs into the GM Areas in which the majority of the GCD jurisdictional area is located. The same logic would apply to inclusion of counties that have a majority of area in a given GM Area where there is no GCD. The consolidated GCDs would become a single GMA with all of the authority, funding, and governing/advisory bodies described for the GM Authority options discussed above. The new GM Authorities would have boundaries reflecting the boundaries of the consolidated GCDs and counties as an administrative convenience to facilitate GM Authority creation.

Consolidation of GCDs in PGMAs

As described in Chapter 4 in the discussion of the Arizona model, this option would involve using PGMAs as the basis for creating similar regional-scale management entities and consolidating the existing GCDs within the PGMA into a single management entity. This option would involve a reevaluation of all of the major aquifers, including areas in existing GCDs, to assess areas in need of "active management." The reevaluation would take into account current and projected aquifer conditions and the efficacy of the existing GCDs and recommend consolidation where the limitations of small-scale GCDs limit effective management.

The purpose of this thesis was to offer regionalization as a viable policy approach that could and should be considered to improve groundwater management in Texas. The version that provides the "right fit" in terms of satisfying the suggested policy criteria may actually be some combination of the different concepts represented by these various iterations of regionalized groundwater management.

5.4 CONCLUSIONS

Groundwater management in Texas is considered by many to be a lawless system of passive non-management under the common law doctrine of the rule of capture. Although Texas has consistently upheld the rule of capture, the doctrine has slowly been modified in areas where local control has been established via GCDs. This established preference for local control through GCDs, however, was the product of political compromise that was largely motivated by a general aversion to outsider interference – a

strong sentiment that remains in place today. The formation of GCDs that initially emerged slowly and then more prolifically in response to judicial provocation and desultory legislative action, merged on to a path where small single-county-scale GCDs became the precedent. The small-scale county-based GCD system that is now predominant and firmly entrenched is accompanied by a series of significant challenges including issues associated with hydrological disconnects, insufficient funding, lack of resilience, and myopic local politics.

With the occurrence of persistent and recurrent periods of extreme drought, a burgeoning population, and projected shortfalls in water supplies, there has been a heightened awareness of the limits of the groundwater resources in Texas and the limited ability of underfunded small-scale GCDs to manage effectively. The persistent response has been a slow evolution towards some form of larger scale management. Although a full conversion away from local control towards centralization via state control is not likely to be politically feasible, it would also be limited in recognizing the wide diversity of climate conditions, water use patterns, growth projections, and aquifer characteristics that exist across the state. Regionalization is offered as a policy proposal for an institutional arrangement and scale of groundwater governance that provides a compromise between centralization and decentralization using institutions that are: 1) designed congruent with hydrogeographical boundaries in recognition of the importance of fit, and 2) appropriately scaled to minimize hydrological disconnects and provide

sufficient funds, authority, and resources to effectively manage the resource and equitably accommodate all affected actors to the maximum extent practicable.

The merits and logic of regionalized groundwater management have been recognized as demonstrated by the actions of the Legislature establishing the joint-regional planning process within aquifer-based GMAs using GCD representatives as the *de facto* regional groundwater planners. However, the new unfunded mandates for which the already underfunded GCDs are now responsible and the extraordinary planning process complexity that has developed in order to accommodate those holding fast to local control may prove to be unworkable. This realization compels consideration of management through regional authorities designed using the ready-made framework of GMAs and principles gleaned from successful models of regionalization from other states and within Texas. Such regional Authorities, if provided with sufficient resources and authority would respect the logic of fit and scale and be equipped to address the current and future groundwater management challenges in Texas.

In order to address the issues with the current institutional design, policy makers will be faced with a choice of either: 1) providing more authority and resources, likely through new or higher taxes and fees, to confront the challenges and complexity of small-scale GCD-oriented local control, or 2) make the politically charged decision to take advantage of the logic and efficiencies of regionalization by replacing existing small-scale GCDs with larger-scale regional Groundwater Management Authorities. Inaction

or delay in implementing significant reform along these lines will only prolong and exacerbate the looming water management challenges in Texas.

Appendices

Appendix 1: Frequently Used Acronyms (FUA).

AGMA	Arizona Groundwater Management Act
AMA	Active Management Areas
AWS	100-year Assured Water Supply
BRA	Brazos River Authority
DWR	Arizona Department of Water Resources
EAA	Edwards Aquifer Authority
EUWD	Edwards Underground Water District
ESA	Endangered Species Act
GCD	Groundwater Conservation Districts
GCD Act	The Groundwater Conservation District Act of 1949
GMA	Groundwater Management Area
GM Area	Groundwater Management Area
GM Authority	Groundwater Management Authority
GMAC	Groundwater Management Area Council
DFC	Desired Future Condition
HB	House Bill
MAG	Managed (Modeled) Available Groundwater
NGMA	Nebraska Groundwater Management Act
NRD	Natural Resource Districts
PGMA	Priority Groundwater Management Area
RA	River Authority
RWPG	Regional Water Planning Group
SB	Senate Bill
SCTWAC	South Central Texas Water Advisory Committee
TWC	Texas Water Code
TWDB	Texas Water Development Board
TCEQ	Texas Commission on Environmental Quality

Appendix 2. GCD Creation and Funding Data. (Source: TAGD 2012 GCD survey, TAGD 2009 Summary of GCD Programs, & TCEQ GCD data)

Groundwater Conservation District	Creation Date	No. of Counties	Area (acres)	Funding Source	Fee Rate (per/1,000 gallons)	Tax Rate (per/$100 valuation)	Full-Time Emp.	Part-Time Emp.	Annual Budget	$/Area
Anderson County UWCD	1987	1	30,408	ND	ND	ND	ND	ND	ND	ND
Bandera County RA & GWD	1989	1	508,578	Tax	N/A	0.018	ND	ND	ND	ND
Barton Springs/Edwards Aquifer CD	1987	3	157,811	Fee	$0.17, $0.46, $1/a-f (ag), $0.31(t)	N/A	9	2	$1,700,000	$10.77
Bee GCD	2001	1	557,743	Tax	N/A	ND	0	1	$92,430	$0.17
Blanco-Pedernales GCD	2001	1	455,568	Tax	N/A	0.030	3		$256,000	$0.56
Bluebonnet GCD	2002	3	1,770,085	Fee	$0.035(t), $0.135	N/A	2	1	$237,800	$0.13
Brazoria County GCD	2005	1	948,055	Fee	No Data	NA	ND	ND	ND	ND
Brazos Valley GCD	2002	2	927,909	Fee	$0.425, $0.25/a-f (ag)	NA	ND	ND	ND	ND
Brewster County GCD	2001	1	3,949,372	Fee, CC	N/A	NA	ND	ND	ND	ND
Brush Country GCD	2009	2	1,724,287	Tax	ND	ND	1	1	$301,000	$0.17
Central Texas GCD	2005	1	649,762	ND	ND	ND	ND	ND	ND	ND
Clear Fork GCD	2002	1	575,198	ND	ND	ND	ND	ND	ND	ND
Clearwater UWCD	1999	1	692,656	Tax	N/A	0.004	2	1	$862,866	$1.25
Coastal Bend GCD	2001	2	698,908	Tax	N/A	$0.02	2	1	$230,000	$0.33
Coastal Plains GCD	2001	1	885,537	Tax	N/A	$0.02	2	1	$220,000	$0.25
Coke County UWCD	1986	1	592,340	Tax	N/A	$0.01254	ND	ND	ND	ND
Colorado County GCD	2007	1	620,936	Tax	N/A	$0.03	2	0	$275,000	$0.44
Corpus Christi ASRCD	2005	2	331,356	ND	ND	ND	ND	ND	ND	ND
Cow Creek GCD	2002	1	420,112	Both	$10/a-f, $1/a-f (ag)	$0.005	3	0	$347,635	$0.83
Crockett County GCD	1991	1	1,788,346	Tax	N/A	$0.0176	1	1	$214,500	$0.12
Culberson County GCD	1998	1	1,103,135	Tax	N/A	$0.0688	ND	ND	ND	ND
Duval County GCD	2009	1	1,148,669	Tax	N/A	ND	1	0	$375,249	$0.33
Edwards Aquifer Authority	1996	7	3,297,158	Fee	$47/a-f, $2/a-f (ag)	N/A	79	1	$13,800,000	$4.19
Evergreen UWCD	1965	4	2,495,010	Tax	N/A	$0.017	4	1	$700,000	$0.28
Fayette County GCD	2001	1	612,061	Tax	N/A	$0.01	2	0	$245,000	$0.40
Fox Crossing Water District	1986	1	477,754	None	None	None	0	0	ND	ND

Groundwater Conservation District	Creation Date	No. of Counties	Area (acres)	Funding Source	Fee Rate (per/1,000 gallons)	Tax Rate (per/$100 valuation)	Full-Time Emp.	Part-Time Emp.	Annual Budget	$/Area
Garza County UWCD	1996	1	572,632	ND	ND	ND	ND	ND	ND	ND
Gateway GCD	2003	5	2,540,661	ND	ND	ND	ND	ND	ND	ND
Glasscock GCD	1981	2	635,703	Tax	N/A	$0.034806	1	1	$70,000	$0.11
Goliad County GCD	2001	1	548,961	Tax	N/A	Up to $0.02	1	1	$72,000	$0.13
Gonzales County UWCD	1994	2	653,879	Tax	N/A	$0.0139	3	0	$220,000	$0.34
Guadalupe County GCD	1999	1	277,424	Fee	ND	ND	0	1	$55,000	$0.20
Hays Trinity GCD	2003	1	238,006	Fees, grants	None	N/A	2	0	$125,000	$0.53
Headwaters UWCD	1991	1	705,853	Tax	N/A	$0.01	3		$439,000	$0.62
Hemphill County UWCD	1997	1	585,672	Tax	N/A	$0.015	3	0	$452,762	$0.77
Hickory UWCD No. 1	1982	6	1,668,924	Tax	N/A	$0.037	ND	ND	ND	ND
High Plains UWCD No.1	1951	15	6,931,616	Tax	N/A	$0.00754	23	0	$2,015,000	$0.29
Hill Country UWCD	1987	1	676,497	Tax	N/A	$0.0089	2	0	$245,671	$0.36
Hudspeth County UWCD No. 1	1957	1	572,268	ND	ND	ND	ND	ND	ND	ND
Irion County WCD	1985	2	703,013	Tax	N/A	$0.0444	1	1	$129,345	$0.18
Jeff Davis County UWCD	1993	2	1,453,733	CC	N/A	N/A	1	0	$49,721	$0.03
Kenedy County GCD	2004	7	1,886,156	Tax	N/A	$0.05	ND	ND	ND	ND
Kimble County GCD	2002	1	776,402	Tax	N/A	$0.002	1	1	$54,085	$0.07
Kinney County GCD	2002	1	869,574	Both	ND	ND	2	1 vol.	$204,794	$0.24
Lavaca County GCD	2009	1	619,821	ND	ND	ND	ND	ND	ND	ND
Lipan-Kickapoo WCD	1987	3	1,918,471	ND	ND	ND	ND	ND	ND	ND
Live Oak UWCD	1989	1	689,630	Tax	N/A	$0.00847	0	1	$45,750	$0.07
Llano Estacado UWCD	1998	1	958,452	Tax	N/A	$0.00952	ND	ND	ND	ND
Lone Star GCD	2001	1	686,687	Fee	$0.06	N/A	8	0-1	$2,070,000	$3.01
Lone Wolf GCD	2002	1	584,309	Tax	N/A	Up to $0.03	1	2	$217,000	$0.37
Lost Pines GCD	2002	2	974,480	Fee	$0.135	N/A	2	1	$657,000	$0.67
Lower Trinity GCD	2006	2	1,108,587	Fee	$0.5	N/A	1	1	$93,000	$0.08
McMullen GCD	2001	1	741,594	Tax	ND	ND	0	1	$29,825	$0.04
Medina County GCD	1991	1	854,852	Tax	N/A	$0.004	2	0	$200,000	$0.23
Menard County UWCD	1999	1	497,475	Tax	N/A	$0.0775	0	3	$80,000	$0.16
Mesa UWCD	1990	1	575,352	Tax	N/A	$0.0189	2	1 (Contr.)	$204,000	$0.35
Mesquite GCD	1986	3	1,192,561	Tax	N/A	$0.06449	1	1	$135,000	$0.11

Groundwater Conservation District	Creation Date	No. of Counties	Area (acres)	Funding Source	Fee Rate (per/1,000 gallons)	Tax Rate (per/$100 valuation)	Full-Time Emp.	Part-Time Emp.	Annual Budget	$/Area
Mid-East Texas GCD	2002	1	1,558,680	Fee	ND	ND	1	0	$153,570	$0.10
Middle Pecos GCD	2002	1	3,035,506	Tax	ND	ND	2	1	$330,000	$0.11
Middle Trinity GCD	2002	2	2,612,486	Tax	ND	ND	4	0	$940,000	$0.36
Neches & Trinity Valleys GCD	2001	3	1,938,503	Fee	$0.025, $.0375(t)	N/A	2	1	$180,000	$0.09
North Plains GCD	1955	8	4,516,237	Tax	N/A	$0.019209	14	3	$1,900,000	$0.42
North Texas GCD	2009	3	1,751,060	Fee	$0.1, $1/a-f (ag)	ND	1	2	$478,597	$0.27
Northern Trinity GCD	2007	1	573,188	ND	ND	ND	ND	ND	ND	ND
Panhandle GCD	1956	7	4,083,435	Both	ND	$1.44	10	2	$1,300,000	$0.32
Panola County GCD	2007	1	523,342	Tax	N/A	ND	3	0	$300,000	$0.57
Pecan Valley GCD	2001	1	580,922	Tax	N/A	$0.015	2	0	$235,000	$0.40
Permian Basin UWCD	1985	2	1,130,135	Tax	N/A	$0.02	3	0	$505,488	$0.45
Pineywoods GCD	2001	2	1,176,958	Fee	$.01, $.05(t)	N/A	2	0	$158,000	$0.13
Plateau UWC and Supply District	1974	1	833,750	Tax	N/A	$0.0548	1	0	$125,000	$0.15
Plum Creek CD	1993	3	219,766	Tax	N/A	$.020, $.0175(fc)	4	0	$2,214,040	$10.07
Post Oak Savannah GCD	2002	2	1,083,351	Fee	$0.02, $.06(t)	N/A	3	0	$1,500,000	$1.38
Prairielands GCD	2009	4	1,823,958	Fee	ND	ND	3	1	$1,200,000	$0.66
Presidio County UWCD	1999	1	2,458,788	CC	N/A	N/A	ND	ND	ND	ND
Real-Edwards C and R District	1959	2	1,800,731	Tax	N/A	$0.02	2	1	$193,000	$0.11
Red River GCD	2009	3	1,199,952	Fee	ND	ND	0	2	$250,000	$0.21
Red Sands GCD	2002	1	19,961	ND	ND	ND	ND	ND	ND	ND
Refugio GCD	2001	1	515,095	Tax	ND	ND	1	2	$542,592	$1.05
Rolling Plains GCD	1999	3	1,702,363	Tax	N/A	$0.0287	1.4	0	$145,000	$0.09
Rusk County GCD	2004	1	598,512	ND	ND	ND	ND	ND	ND	ND
San Patricio County GCD	2007	1	452,523	ND	ND	ND	ND	ND	ND	ND
Sandy Land UWCD	1989	1	509,830	Tax	N/A	$0.01336	7	2	$858,000	$1.68
Santa Rita UWCD	1989	1	687,990	Tax	N/A	$0.03007	ND	ND	ND	ND
Saratoga UWCD	1989	1	454,849	ND	ND	ND	ND	ND	ND	ND
South Plains UWCD	1992	2	578,491	Tax	N/A	$.025	2	1	$290,000	$0.50
Southeast Texas GCD	2004	4	2,384,949	Fee	$0.007, $0.0035(t)	N/A	1	1	$150,000	$0.06

Groundwater Conservation District	Creation Date	No. of Counties	Area (acres)	Funding Source	Fee Rate (per/1,000 gallons)	Tax Rate (per/$100 valuation)	Full-Time Emp.	Part-Time Emp.	Annual Budget	$/Area
Southern Trinity GCD	2009	1	676,803	ND	ND	ND	ND	ND	ND	ND
Starr County GCD	2007	1	788,660	ND	ND	ND	ND	ND	ND	ND
Sterling County UWCD	1987	2	596,566	Tax	N/A	$0.03717	1	1	$140,190	$0.23
Sutton County UWCD	1986	1	926,790	Tax	N/A	$0.0362	3	0	$270,000	$0.29
Texana GCD	2001	1	546,990	Both	ND	ND	0	1	$130,000	$0.24
Trinity Glen Rose GCD	2002	3	198,915	Fee	ND	ND	0	3	$220,000	$1.11
Upper Trinity GCD	2007	4	2,049,590	Fee	ND	ND	6	0	$1,700,000	$0.83
Uvalde County UWCD	1993	1	997,180	Tax	N/A	$0.02	ND	ND	ND	ND
Victoria County GCD	2005	1	567,293	Tax	N/A	$0.01	2	0	$499,000	$0.88
Wes-Tex GCD	2002	1	582,327	ND	ND	ND	ND	ND	ND	ND
Wintergarden GCD	1998	3	2,632,924	Tax	N/A	$0.04	ND	ND	ND	ND

Key: (ag) - agricultural use, (t) - transport, (fc) - flood control, ND - No data, N/A- Not applicable, CC - funding from County Commissioner's Court.

Appendix 3: Significant Events Affecting Texas Groundwater Management.

Year	Legislation/Litigation/Event	Significance
1843	*Acton v. Blundell*	• Established English common law cited as basis for Rule of Capture finding in *East*
1861	*Frazier v. Brown (Ohio)*	• Ohio Supreme Court case cited as basis for Rule of Capture finding in *East*
1904	*Houston and Texas Central Railroad Co. v. East*	• Established the Rule of Capture as groundwater management doctrine
1913	House Bill 37	• Surface water and "underflow" declared waters of the state • Created Board of Water Engineers • First regulations applied to artesian wells
1917	Article 16, Ch. 59 Conservation Amendment	• Authorized legislature to pass laws to preserve and conserve the state's natural resources
1929	Brazos River Authority created	• First River Authority created under the Conservation Amendment • Set precedent for regional basin-oriented water management agencies
1934	Tx Board of Water Engineers Report	• Called for declaring groundwater as water of state to be regulated similar to surface water
1937, 1941, & 1947	Texas Legislative Sessions	• Bill filed in each session to place groundwater under control of the state
1949	The Groundwater District Act of 1949	• Created process for establishing GCDs by petition • GCDs created within areas designated as "underground reservoirs" • Initial indicator of state preference for local control
1951	High Plains UWCD No. 1 created	• First GCD created under GCD Act process
1959	The Edwards Underground Water District created	• 1st attempt to manage the San Antonio segment of the Edwards Aquifer • District not equipped to manage complex area water management issues
1978	*Friendswood Development Co. v. Smith Southwest Industries*	• Modified Rule of Capture adding subsidence caused by pumping as an additional exception to the rule.
1985	House Bill 2	• "Underground reservoirs" changed to "management areas" • Areas established by Texas Water Commission (TCEQ) • Established incentives for GCD creation • Boundaries of GCDs "coterminous" with management areas • Critical areas program
1989	Senate Bill 1212	• "Management Areas" changed to "Underground Management Areas" • Repealed "coterminous" boundary requirement for legislatively created GCDs • Established process for determining need for GCD within designated areas • GCD creation optional • Failure to create GCD prohibited the use of TWDB funds
1993	*Sierra Club v. Lujan*	• Federal judge directed Texas legislature to implement measures to limit pumpage of Edwards Aquifer to protect endangered species

Year	Legislation/Litigation/Event	Significance
1993	Senate Bill 1477	• Bill passed creating the Edwards Aquifer Authority (EAA) to replace the EUWD • The EAA was first aquifer-scale GCD empowered with sufficient funding and authority to manage the aquifer
1995	*Quixx v. Panhandle Groundwater Conservation District No. 3*,	• Found that rules to prevent water exports were beyond GCD
1995	House Bill 2294	• "Underground Management Areas" changed to "Groundwater Management Areas" (GMAs) • Established Ch. 35 of the TWC to direct the creation of GMAs • Provided discretionary authority to TCEQ to delineate GMA boundaries for areas most suitable for groundwater management
1996	*Medina County Underground Water Conservation District v. Barshop*	• Confirmed that the EAA Act was facially constitutional
1997	Senate Bill 1	• Established regional "bottoms up" state water planning • GCDs designated as "preferred" method of groundwater management • Guidelines for and certification of GCD management plans • Oversight of implementation of GCD management plans by the TCEQ • Established PGMA identification and designation process • Assigned "junior" priority date to interbasin surface water transfers
1999	*Sipriano v. Great Springs Water of America, Inc.*	• Challenged Rule of Capture • Conservation Amendment and SB1 cited as reason to take no action • Emphasized legislative responsibility to manage groundwater under Conservation Amendment
1999	76th Legislative Session	• Legislation filed to create 44 new GCDs • Senator Brown expresses concern over single-county GCDs • SB 1911 passed creating 13 new GCDs and setting county-scale precedent
2000	House Natural Resources Committee Interim Charges	• Committee directed to study effectiveness of GCDs and consider the feasibility of aquifer-based management • Committee report concluded that GCDs should be created along aquifer boundaries rather than political.
2001	Senate Bill 2	• Increased GCD well regulation authority • Addressed transport of groundwater out of GCDs • Directed TWDB to create GMAs • Established foundation for voluntary joint groundwater planning
2004	Senate Select Committee on Water Policy	• Committee issues interim charges to study the ability of single-county GCDs to manage regional groundwater resources • Committee provided recommendations for SB 3
2005	Senate Bill 3	• Set policy goal to ensure consistent management of groundwater in shared GMA • Proposed creation of GMA Councils with authority and funding to coordinate GCD management

Year	Legislation/Litigation/Event	Significance
		• Was foundation for HB 1763 • SB 3 did not pass
2005	House Bill 1763	• Established mandatory joint groundwater planning in GMAs • Regionalized groundwater availability decisions (DFCs and MAGs) • Defined permitting caps
2009	HB 3335	• Bill filed to require that GCDs created in PGMAs include two or more contiguous counties. Bill did not pass.
2011	Senate Bill 332	• Recognized groundwater as real property owned by the landowner • Reaffirmed a GCDs authority to well drilling, pumping, and transport of groundwater • Requires GCDs to consider groundwater ownership and all groundwater uses and needs in rulemaking
2011	SB 660 (TWDB Sunset Bill)	• Added GMA representative to each RWPG • "Modeled Available Groundwater" changed "Managed Available Groundwater" • Shifted emphasis from MAGs to DFCs • Provided more opportunity for public and stakeholder input • Substantially increased process complexity and responsibility of GCD representatives to GMAs
2012	*Edwards Aquifer Authority v. Day*	• Affirmed EAA's decision to limit permit • Found that landownership includes a constitutionally compensable interest in groundwater in place • Remanded case to lower court to determine if decision was a compensable taking
2012	Senate Natural Resources Committee Interim Charges	• Committee charged with considering: 1) the consolidation of GCDs along major aquifer lines and 2) the effectiveness of single county and non-contiguous GCDs

References

Allan, Catherine and Allan Curtis. "Nipped in the Bud: Why Regional Scale Adaptive Management is Not Blooming." *Environmental Management*, vol. 36, no. 3, (August, 8, 2005), pp. 414-425.

Arizona Department of Water Resources. (2012, June 15). *Overview of the Arizona Groundwater Management Code.* Online. Available: www.azwater.gov/asdwr/watermanagement. Accessed: April 15, 2011.

Ashley, Jeffrey and Zachery A. Smith. *Groundwater Management in the West.* Lincoln: University of Nebraska Press, 1999.

Blomquist, William. (1991). "State Differences in Groundwater Policy Adoptions, 1980-1989." *Publius*, vol. 21, no. 2, (Spring 1991), pp. 101-115.

Blomquist, William, and E. Schlager. "Political Pitfalls of Integrated Watershed Management." *Society and Natural Resources*, vol. 18, no. 2 (2005), pp. 101–117.

Boadu, Fred O., Bruce M. McCarl, and Dhazn Gillig. "An Empirical Investigation of Institutional Change in Groundwater Management in Texas: The Edwards Aquifer Case." *Natural Resources Journal*, vol. 47, no., (2007), pp. 117-169.

Booth, Michael J. and Ross Richard-Crow. "Regulatory Dance: Rule of Capture and Chapter 36 District Perspective." In *100 Years of the Rule of Capture: From East to Groundwater Management*, eds. William F. Mullican and Suzanne Schwartz, Austin: Texas Water Development Board, (2004), pp. 19-40.

Brown, Timothy L. "Groundwater Issues and the 82nd Legislative Session." Paper presented at Texas Water Law conference, Austin, Tex., November 30, 2011.

Civins, Jeff. "Breaking Decision – A Bad Day for Groundwater Management in Texas." *Environmental Law Articles* (2012, February 29). Online. Available: www.martindale.com/environmental-law/article_Haynes-Boone-LLP1458438.htm. Accessed May 5, 2012.

Cook L. and J. Sachs. "Public Regional Goods in International Assistance." In *Global Public Goods: International Cooperation in the 21st Century.* Oxford: Oxford University Press, 1999.

Darling, Bruce K. "Texas Groundwater - Rule of Capture and Groundwater Management in Texas: Part 1." *The Water Report,* no. 38 (April 15, 2007), pp. 9-17.

Dougal, Leonard, Kenneth L. Petersen, Jr., and Cassandra Quinn. "Drinking Water Supply Issues: Water Utilities—CCNs and Rates." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Edwards Aquifer Authority. *The Authority: Mission*. (2012, July 15) Online. Available: www.edwardsaquifer.org/display_authority_m.php?pg=mission. Accessed: July 15, 2012.

Edwards Aquifer Authority, *Hydrogeology of the Edwards Aquifer*. Online. Available: http://www.edwardsaquifer.org/display_science_research_m.php?pg=geology/. Accessed: October 7, 2012.

Fipps, Guy. "Managing Texas Groundwater Resources Through Groundwater Conservation Districts." College Station: Texas Water Resources Institute, 2002.

Flay, Randolph B., and T.N. Narasimhan, (2005). "Centralized versus Decentralized Approaches to Groundwater Management in the Western United States: How Hydrologic and Political Forces Shaped Management." University of California at Berkeley, 2005. (Unpublished paper.)

Foster, J. "Do Texas Groundwater Conservation Districts Matter?" *Water Policy,* vol. 11 (2009), pp. 379-399.

Fox Crossing Water District Board of Directors. "A Resolution." Goldthwaite, Tex., March 13, 2012.

Frownfelter, Darcy A. "Edwards Aquifer Authority." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Frownfelter, Darcy A., and Deborah C. Trejo. "The Rule of Capture and Edwards Aquifer Adjudication." *The Water Report*, no. 1 (March 15, 2004), pp. 1-10.

Galaz, Victor, Per Olsson, Thomas Hahn, Carl Folke, and Uno Svedin. "The Problem of Fit between Ecosystems and Governance Systems - Insights and Emerging Challenges.*"* In conference preceding: *Institutions and Environmental Change: Principle Findings, Applications and Research Frontiers.* eds. O. R. Young, L. A. King, & H. Schroeder, 2008.

Gershon, Michael. A. "The Recent Evolution of Texas Water Policy and Law." *Southwest Hydrology*, (July/August, 2003), pp. 24-25.

Green, Donald E. *Land of the Underground Rain: Irrigation on the Texas High Plains 1910-1970.* Austin: University of Texas Press, 1973.

Hart, Henry C. "Toward a Political Science of Water Resources Decisions." Man and Water, ed. L. Douglas James, Lexington: Press of Kentucky, 1974.

Hendrickson, K. E. *The Waters of the Brazos: A History of the Brazos River Basin Authority, 1929-1979.* Waco: Texian Press, 1981.

Howe, Billy. "Texas Farm Bureau: 82nd State Legislature Summary." *Texas Water Journal*, vol. 2, no. 1, (2011), pp. 23-38.

Illgner, Rick. Government Affairs Officer, Edwards Aquifer Authority. Personal Communication, July 20, 2012.

Jarvis, Todd, Mark Giordano, Shammy Puri, Kyoko Matsumoto, and Aaron Wolf. "International Borders, Groundwater Flow, and Hydroschizophrenia." *Ground Water*, vol. 43, no. 5, (September-October 2005), pp. 764-770.

Jarvis, Glenn. "Historical Development of Texas Surface Water Law: Background of the Appropriation and Permitting System and Management of Surface Water Resources." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Johnson, Corwin W. "The Continuing Void in Texas Groundwater Law: Are Concepts and Terminology to Blame?" *St. Mary's Law Journal*, vol. 17 (1985-1986), pp. 1281-1294.

Johnson, Russell. "Groundwater Law and Regulation, Essentials of Texas Water Resources." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Jones, Marvin W. "Why the DFC Process is Failing - What Can Be Done to Fix it." Paper presented at the Texas Water Law Institute, Austin, Tex., December 9-11, 2009.

Jones, Marvin W. and Andrew Little. "The Ownership of Groundwater in Texas: A Contrived Battle for State Control of Groundwater." *Baylor Law Review*, vol. 61, no. 2, (2009), pp. 578-609.

Kaiser, Ronald. "Conjunctive Management and Use of Surface Water and Groundwater Resources." Texas A&M University, Texas Water Resources Institute, 2011. (Unpublished paper.)

Kaiser, Ronald, Bruce J. Lesikar, C. Scott Shafer, and Jan R. Gerston. "Water Management Strategies: Ranking and Options." Texas A&M University System, (January 2000). Online. Available: www.tamu.edu/rakwater/research/WATER-strategi.pdf. Accessed: August 31, 2010.

Kaiser, Ronald and Laura M. Phillips, "Dividing the Waters: Water Marketing as a Conflict Resolution Strategy in the Edwards Aquifer Region." *Natural Resources Journal*, vol. 38, (1998), pp. 411-444.

Kaiser, Ronald, and Frank F. Skillern. "Deep Trouble: Options for Managing the Hidden Threat of Aquifer Depletion in Texas." *Texas Tech Law Review*, vol. 32 (2001), pp. 249-305.

Kelly, Mary E. "Nebraska's Evolving Water Law, Challenges and Opportunities - Part I." *The Water Report,* no. 81 (November 15, 2010), pp. 9-21.

Knisely, Marc O. "Litigation Update." Paper presented at Texas Water Law conference, Austin, Tex., September 15-16, 2011.

Lathrop, Coalter G. "Finding the Right Fit: One Design Element in the International Groundwater Resource Regime." *Duke Journal of Comparative & International Law,* vol. 19 (2009), pp. 413-431.

Lesikar, Bruce, Ronald Kaiser, and Valeen Silvy. *Questions about Groundwater Conservation Districts in Texas.* College Station: Texas Water Resources Institute, (2002).

Lopez-Gunn, Elena. "Governing Shared Groundwater: the Controversy Over Private Regulation." *The Geographical Journal*, vol. 175, no. 1 (2009), pp. 39-51.

Lower Colorado River Authority. *LCRA Firm Water Supply Contracts.* (February 18, 2009). Online. Available: from www.lcra.org/water/supply/contracts/index.html. Accessed: September 29, 2012.

Lower Neches River Valley Authority. *Introduction*. Online. Available: http://www.lnva.dst.tx.us/about/intro.htm. Accessed: August 21, 2012.

Mace, Robert E. "How the 82nd Legislature Changed (and Didn't Change) the Desired Future Conditions Process." Paper presented at Texas Water Law conference, Austin, Tex., November 30, 2011.

Mace, Robert E., Rima Petrossian, Robert Bradley, and William F. Mullican. "A Streetcar Named Desired Future Conditions: The New Groundwater Availability for Texas (REVISED)." Paper presented at conference on "The Changing Face of Water Rights in Texas," Bastrop, Tex., May 8-9, 2008.

Mace, Robert. E., Cynthia Ridgeway, and John M. Sharp. "Groundwater is No Longer Secret and Occult - A Historical and Hydrogeologic Analysis of the East Case." In *100 Years of the Rule of Capture: From East to Groundwater Management*, eds. William F. Mullican and Suzanne Schwartz, Austin: Texas Water Development Board, (2004), pp. 63-88.

Maguire, Rita Pearson. "Patching the Holes in the Bucket: Safe Yield and the Future of Water Management in Arizona." *Arizona Law Review*, vol. 49, (2007), pp. 361-384.

Marbury, Laura B. and Mary E. Kelly. *Down to the Last Drop, 2009 Update: Spotlight on Groundwater Management in Texas.* Environmental Defense Fund Report, March 2009.

Nachbaur, James W. "Drivers of Formal, Local Groundwater Governance." University of California, Santa Barbara, Department of Economics, 2008. (Unpublished report.)

Olson, Steve. "Arizona Water Management Issues." *The Water Report,* no. 68, (October 15, 2009), pp. 11-16.

Ostrom, Elinor. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press, 1990.

Ostrom, Elinor. *Understanding Institutional Diversity*. Princeton: Princeton University Press, 2005.

Panhandle Regional Planning Commission. *Water Planning*. Online. Available: www.theprpc.org/programs/RegionalH2OPlanning/gma1.html. Accessed: October 25, 2011.

Panhandle Water Planning Area (Region A). *Regional Water Plan for the Panhandle Water Planning Area.* 2010.

Petrossian, Rima, Cynthia Ridgeway, and Andy Donnelly. *Balancing the Checkbook Account Through House Bill 1763*. Austin: Texas Water Development Board. April 3, 2007.

Pierce, Suzanne A., Robert E. Mace, and John M. Sharp, "Using an Aquifer Yield Continuum as a Guide for Groundwater Management." (2004). (Unpublished paper.)

Potter, Harry Grant III. "History and Evolution of the Rule of Capture." In *100 Years of the Rule of Capture: From East to Groundwater Management*, eds. William F. Mullican and Suzanne Schwartz, Austin: Texas Water Development Board, (2004), pp.1-10.

Rochelle, Martin C., Brad B. Castleberry, and Michelle M. Smith. "Meeting Water Supply Needs: Planning, Permitting, and Implementation." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Ross, Andrew & Pedro Martinez-Santos. "The Challenge of Groundwater Governance: Case Studies form Spain and Australia." *Regional Environmental Change*, vol. 10, no. 4 (December, 2010), pp. 299-310.

Sax, Joseph L., Barton H. Thompson, John D. Leshy, and Robert H. Abrams. *Legal Control of Water Resources - Case Materials (Fourth Edition ed.).* West Publishing Company, 2006.

Shadwick, Lana S. "Obsolescence, Environmental Endangerment, and Possible Federal Intervention Compel Reformation of Texas Groundwater Law." *South Texas Law Review*, vol. 32, (1990-1991), pp. 641-705.

Snyder, Stephan E. "Ground Water Management: A Proposal for Texas." *Texas Law Review*, vol. 51, (1972-1973), pp. 289-317.

Somma, Mark. "Local Autonomy and Groundwater District Formation in High-Plains West Texas." *Publius,* vol. 24, no. 2 (Spring 1994), pp. 53-62.

Soukhanov, A.H, ed. *The American Heritage Dictionary of the English Language (third edition ed.).* Boston: Houghton Mifflin Company, 1992.

Stepherson, Angela. "Water Districts, Essentials of Texas Water Resources." In *Essentials of Texas Water Resources*, ed. Mary K. Sahs. Austin: State Bar of Texas, 2009.

Texas Commission on Environment Quality. *Executive Director's Report and Recommendations to Designate a Priority Groundwater Management Area for the North-Central Texas--Trinity and Woodbine Aquifers Area.* SOAH Hearing - Docket No. 582-07-3917. Austin, Tex, September 2, 2008.

Theesfeld, Insa. "Institutional Challenges for National Groundwater Governance: Policies and Issues." *Ground Water,* vol. 48, no. 1, (January-February 2010), pp. 131-142.

Theis, Charles V. "The Source of Water Derived from Wells: Essential Factors Controlling the Response of an Aquifer to Development." *Civil Engineering,* vol. 10, no. 5 (1940), pp. 277–280.

Texas Alliance of Groundwater Districts. *District Programs*. Online. Available: www.texasgroundwater.org/district program.htm. Accessed: April 10, 2009.

Texas Alliance of Groundwater Districts. *2012 GCD Survey*, 2012.

Texas Commission on Environmental Quality and Texas Water Development Board. *Priority Groundwater Management Areas and Groundwater Conservation Districts, Report to the 82nd Texas Legislature,* January 2011.

Texas Groundwater Protection Committee. *What is a Groundwater Conservation District?* (August 2011). Online. Available: http://www.tgpc.state.tx.us/FAQs.htm. Accessed: February 7, 2012.

Texas House of Representatives. House Committee on Natural Resources. *A Report to the House of Representatives, 77th Legislature.* December 2000.

Texas Natural Resource Conservation Commission. *A Handbook for Board Members of Water Districts in Texas,* no. RG 238, (June, 1996). Online. Available: www.scfpud.org/d/TNRCCWaterDistrictHandbook.pdf. Accessed: October 17, 2012.

Texas Senate. Senate Interim Committee on Natural Resources. *Interim Report to the 77th Legislature - Texas Groundwater Resources.* November 2000.

Texas Senate. Senate Committee on Natural Resources. *Implementation of House Bill 1763 and Groundwater Management in Texas. Interim Report to the 81st Legislature.* February 2009.

Texas Senate. *Senate Committee on Natural Resources, Interim Report to the 81st Legislature - Texas River Authorities*. March 2009.

Texas Sunset Advisory Commission. *Texas Water Development Board: Sunset Final Report*. July 2011.

Texas Water Development Board. *Water For Texas - 2007 State Water Plan*. vol. II, doc. no. GP-8-1, January 2007.

Texas Water Development Board. *Water for Texas- 2012 State Water Plan*, January 2012.

Texas Water Development Board. *Regional Water Planning.* Online. Available: www.twdb.state.tx.us/wrpi/rwp/rwp.asp. Accessed: November 3, 2011.

Todd, David. "Common Resources, Private Rights and Liabilities: A Case Study of Texas Groundwater Law." *Natural Resources Journal*, vol. 32 (1992), pp. 233-258.

U.S. Declaration of Independence. (1776). Online. Available: www.loc.gov/rr/program/bib/ourdocs/Declarind.html. Accessed: March 25, 2012.

Votteler, Todd H. "Raiders of the Lost Aquifer? Or, the Beginning of the End to Fifty Years of Conflict over the Texas Edwards Aquifer (revised)." *Tulane Environmental Law Journal*, vol. 15 (Summer 2002), pp. 257-334.

Walker, James. "GOP Opposes Groundwater District's Rulemaking Power." *Burnet Bulletin* (April 24, 2012, 9:00 AM). Online. Available: http://burnetbulletin.com/news_article.php?category_id=2&article_id=2497.

Weilbacher, E. J. "County Mulls Groundwater District Plan." *My San Antonio* (December 7, 2011). Online. Available: www.mysanantonio.com/community/bulverde/article/County-mulls-groundwater-district. Accessed December 12, 2011.

Woodruff, Edward P., and James P. Williams. "Texas Groundwater District Act of 1949: Analysis and Criticism." *Texas Law Review*, vol. 30, no. 7 (October, 1952), pp. 863-875.

Young, Oran R. *The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale*. Cambridge: The MIT Press, 2002.