Groundwater Management in Texas: Evolution or Intelligent Design?

by

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GROUNDWATER MANAGEMENT IN TEXAS: EVOLUTION OR INTELLIGENT DESIGN?

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I. INTRODUCTION

Groundwater management in Texas is a work in progress. It is evolving from a patchwork of judicial decisions dealing with landowner conflicts over well interference to incremental regulatory changes by legislatively established local groundwater management districts. Except for the Edwards Aquifer Authority, which arguably has elements of intelligent statutory design, the remaining groundwater districts have evolved from planning and education activities to varying degrees of aquifer regulation. The state's burgeoning population growth, recurrent droughts, groundwater mining, restrictions on surface water transfers, increased water demand by cities, rural fears associated with groundwater transfers, and endangered species are the driving factors in this regulatory transformation.[1]

Although it is especially important for irrigated agriculture, groundwater also provides drinking water for a number of Texas cities.[2] The Texas Water

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1. TX. WATER DEV. BD., WATER FOR TEXAS: 2002, 25-39 (2002) (discussing the state's population growth by 15 percent between 1990 and 2000, and its predicted growth to over 40 million by 2050 and documenting water supply conditions, demands and limitations); J. E. Buster Brown, *Senate Bill 1: Weve never Changed Texas Water Law This Way Before,* 28 ST. B. TEX. ENVTL. L.J. 152 (1998) (discussing the role of droughts in stimulating legislative concerns, stating that the Houston-Galveston Subsidence District was created to manage groundwater extractions to prevent land subsidence and that the Edwards Aquifer Authority was created to manage groundwater in protection of threatened and endangered species in the Edwards Aquifer); *see generally* Eric Albritton, *The Endangered Species Act: The Fountain Darter Teaches What the Snail Darter Failed to Teach,* 21 ECOLOGY L.Q. 1007, 1018 (1994) (illustrating the plight of five endangered species in the Edwards Aquifer); Ronald Kaiser & Laura Phillips, *Dividing the Waters: Water Marketing as a Conflict Resolution Strategy in the Edwards Aquifer Region,* 38 NAT. RESOURCES J. 411, 423 (1998) (describing the creation of the Edwards Aquifer Authority in response to a federal lawsuit filed by the Sierra Club).

2. TX. WATER DEV. BD., WATER FOR TEXAS: 2002, 38-39 (2002). About 20 percent of total groundwater use is for municipal and industrial purposes. For example, Amarillo, El Paso, Lubbock, Houston, San Antonio and a number of smaller cities rely on groundwater for use in homes, businesses and industry. Most of the arid western part of the state and a significant part of

Development Board predicts that over the next 50 years, agricultural use of groundwater will experience a dramatic decline because of aquifer depletion and rising energy costs, while the municipal share of groundwater use will double.[3] This will have a profound impact on some small cities and agricultural enterprises which have relied on groundwater.[4]

Given the importance of groundwater to the state's economy, it is curious that state level management of groundwater is limited when compared to surface water management.[5] The capture rule adopted by the Texas Supreme Court in 1904 minimized political conflicts over governmental control of groundwater within the agricultural community, but it is allowing aquifers to be pumped beyond sustainable levels. In spite of the criticism, the Texas Supreme Court has refused to change the capture rule and has deferred to the legislature to develop a managerial approach to groundwater management.[6] The Texas legislature has taken a decentralized approach to groundwater protection by deferring management to local groundwater conservation districts.[7] The ubiquitous issues associated with groundwater management notwithstanding, the legislative preference is that these issues should be managed locally rather than at the statewide level.[8]

East Texas rely on groundwater for municipal and manufacturing uses.

3. *Id.*

4. TX. WATER DEV. BD., WATER FOR TEXAS: 1997, 3-15 (1997) (explaining that irrigated agriculture uses about eighty percent of all groundwater pumped on an annual basis in Texas).

5. TX. WATER CODE ANN. § 11.021 (Vernon Supp. 2005) (stating that surface waters are owned and managed by the state).

6. *See* Sipriano v. Great Spring Waters of Am. Inc., 1 S.W. 3d 75, 80 (Tex. 1989), for a discussion of the limits on the property power; Lana Shadwick, Note, *Obsolescence, Environmental Endangerment, and Possible Federal Intervention Compel Reformation of Texas Groundwater Law,* 32 S. TEX. L. REV. 641, 665 (1991); Eric Behrens & Matthew Dore, *Rights of Landowners to Percolating Groundwater in Texas,* 32 5. TEX. L. REV. 185, 191 (1991) (commenting on the Texas Supreme Court's and Texas Legislature's refusal to change the rule); Joe Greenhill & Thomas Gee, *Ownership of Ground Water in Texas; The East Case Reconsidered,* 33 TEX. L. REV. 620, 629 (1955) (urging Texas courts and the Texas legislature to adopt rule prohibiting malicious waste of water); Corwin W. Johnson, *The Continuing Void, in Texas Groundwater Law: Are Concepts and Terminology to Blame?,* 17 ST. MARY'S L. J. 1281, 1293 (1986) (addressing the absence of a legislative declaration of state ownership of groundwater); Corwin W. Johnson, *Texas Groundwater Law: A Survey and Some Proposals,* 22 NAT. RESOURCES J. 1017, 1024 (1982) (discussing wastefulness of absolute ownership of percolating groundwater); Jana Kinkade, *Compromise and Groundwater Conservation,* 26 ST. B. TEX. ENVTL L. J.. 230, 233 (1996) ("Not only has the Texas Legislature been slow to act, but the Texas courts have impeded the progress of Texas groundwater law."); David Todd, *Common Resources, Private Rights and Liabilities: A Case Study on Texas Groundwater Law,* 32 NAT. RESOURCES J. 233, 256 (1992) (criticizing the law of Texas groundwater management); Ronald Kaiser and Frank Skillern, *Deep Trouble: Options for Managing the Hidden Threat of Aquifer Depletion in Texas* 32 TEX. TECH L.REV. 249 (2001).

7. TEX. WATER CODE ANN. §§ 36.001-36.328 (Vernon Supp. 2005).

8. *Id.* §36.101 (Vernon Supp. 2005).

A. Texas Water Uses

Although the amount varies from year to year because of rain and drought conditions, Texans use about 16.5 million acre-feet of water annually.[9] The 2002 Texas Water Plan lists six major categories of use but just three — agricultural irrigation, municipal and manufacturing—account for 95 percent of all water used in Texas.[10]

Statewide, irrigated agriculture is the largest single consumer of water. Nearly 10 million acre feet of water is used to irrigate nearly seven million acres of land and twelve different types of crops. However, three crops—cotton, wheat and corn—use about two-thirds of all the irrigation water.[11]

Irrigation water use is on the decline in Texas. From an all-time high of 13 million acre-feet used in 1974, irrigation water use has declined to about 9.6 million acre-feet in 2000—a decline of about twenty percent. Most of the decline in agricultural use can be attributed to the declining aquifer availability from excessive pumping by irrigators, increased pumping costs, improved irrigation efficiencies, shifts in market demand for agricultural commodities, voluntary transfers of water from irrigation to municipal use, and the decline in cheap water for agriculture.[12] According to the Texas Water Development Board, irrigation water demand will continue to decline at rates between ten and fifteen percent over the next fifty years.[13] Others suggest that this is a conservative estimate and that the rate of decline may be even greater.[14]

After irrigation, municipalities and industries are the next largest users of water, comprising about thirty-five percent of total annual consumption. According to the 2002 Texas Water Plan, municipal and manufacturing uses will increase water demand to about 7.6 million acre-feet annually, an increase of sixty-seven percent over the current use.[15] By 2030, municipal water use is expected to exceed agricultural water use.

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9. An acre-foot is a common measure used to explain water volume and usage. One acre-foot is enough water to cover one acre of land to a depth of one foot; it is equivalent to 325,851 gallons of water. A family of five uses about one acre-foot of water per year.

10. TX. WATER DEV. BD., *supra* note 2 (stating that uses include irrigation; municipal; manufacturing; steam-electric power generation; livestock; and mining).

11. Mary Sanger & Cyrus Reed, TEXAS ENVIRONMENTAL ALMANAC (2d ed. 1997).

12. *See* TX. WATER DEV. BD., *supra* note 4, at 36.

13. *See* TX. WATER DEV. BD., *supra* note 2, at 35.

14. See generally Lauren Ball, IRRIGATION DEMAND IN TEXAS, AN ANALYSIS OF METHODOLOGIES TO PREDICT IRRIGATION TRENDS, May 2003 (available at_www. texaswatermatters.org).

15. *See* TX. WATER DEV. BD., *supra* note 2 at 34.

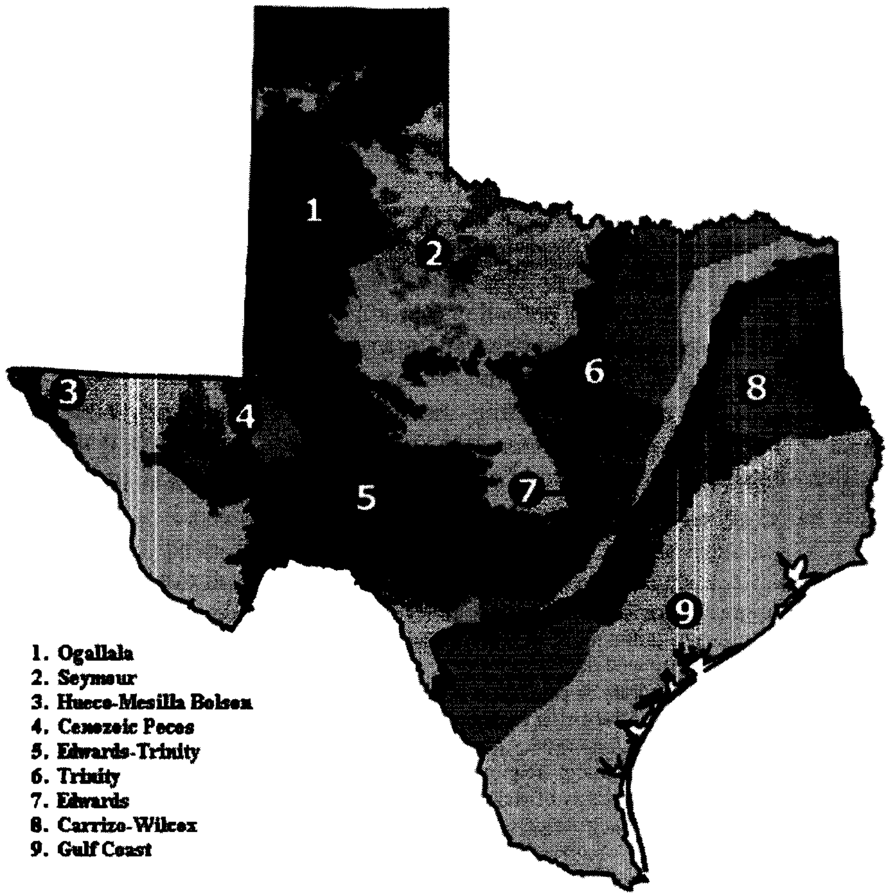
B. Texas Aquifers

Texas aquifers are like droughts; no two are exactly alike. Nine major aquifers supply about ninety-seven percent of the groundwater used in Texas.[16] The other three percent is drawn from twenty minor aquifers.[17] Some aquifers are very rechargeable and can store large volumes of water, while others have little recharge and have limited storage. Still others have little recharge but store a large volume of water. The Ogallala, for example, is a limited recharge, large storage aquifer that supplies two thirds of all the groundwater and more than one third of all the water used in Texas. In contrast, the Edwards Aquifer, located in an around San Antonio, is a highly rechargeable aquifer subject to rapid draw downs but it can be quickly replenished by rainfall. The point is that each aquifer is unique and that management plans should be structured to provide sustainable yields, or managed depletion.

16. Groundwater provides about 60 percent of the estimated 16.5 million acre-feet of water used in Texas, with rivers and reservoirs providing the rest.

17. *See* TX. WATER DEV. BD., *supra* note 2, at 34.

Figure 1: The Aquifers of Texas



Shaded Areas: Outcrop (That Part of a water bearing rock layer which appears at the land surface)
Ruled Areas: Downdip (That Part of a water bearing rock layer which dips below other rock layers)

Source: Texas Water Development Board

Annual pumping and recharge rates for the nine major aquifers are varied in amounts and uses. Some aquifers are being mined—more water is being pumped from the aquifer than will be replaced by the natural recharge process. The mining of aquifers has long-term economic, environmental, and social implications for the regions served by the aquifers. This paper will focus on the management practices in the Ogallala and Edwards aquifers.

Table 1. Extraction and Recharge Rates from Nine Texas Aquifers*

1996 Estimated Pumping	(Million Acre-Feet)	1996 Estimated Recharge (Million Acre-Feet)
Ogallala	6.22	0.30
Edwards (Balcones)	0.47	0.44
Edwards-Trinity	0.25	0.78
Carrizo-Wilcox	0.49	0.64
Trinity	0.19	0.10
Gulf coast	1.15	1.23
Bolsons	0.39	0.43
TOTAL	9.16	3.92

* Source: Mary Sanger and Cyrus Reed. 2000. Texas Environmental Almanac 2d Edition (Texas Center for Policy Studies, Austin: University of Texas Press and Texas Water Development Board. 1995 Estimated Groundwater Pumpage Summary by Major Aquifers Units (1997).

II. GROUNDWATER ISSUES IN TEXAS

While not an exhaustive listing, there are five predominant groundwater issues in Texas: (1) well interference;[18] (2) aquifer overdrafting;[19] (3) defining aquifer sustainability standards;[20] (4) aquifer mining;[21] and (5) transfers of

18. Well interference is a highly volatile policy issue in the allocation of groundwater in the West. Well interference is the result of the lowering of water levels in shallow or low-capacity wells near a high-capacity well during and shortly after the period when the high-capacity well is pumped. It may be a temporary or permanent hydraulic phenomenon and may result from any of three circumstances. First, if the well interference is caused by a cone of depression created by the intermittent operation of the high-capacity well, the condition may be temporary. Second, if the high-capacity well is operated more frequently, the cone of depression may be longer lasting. A third, and perhaps permanent, cause of well interference is the overall lowering of the water level in an aquifer caused by pumping which exceeds recharge. Most well interference problems arise when high-capacity commercial, irrigation, and municipal wells are located near lower-capacity domestic wells. *See generally* William M. Alley, SUSTAINABILITY OF GROUND-WATER RESOURCES: U.S GEOLOGICAL SURVEY CIRCULAR 1186 (1999).

19. This condition results from withdrawing water from an aquifer at a rate faster than its natural, or artificial, recharge rate. The consequences of over-drafting are progressively higher water costs, and possible subsidence, or water quality degradation. In Texas, over-drafting occurs in portions of a number of aquifers. *See* Table 1, *supra*.

20. Two interrelated concepts—aquifer overdraft and safe yield—are at the core of regulatory schemes for managing water use when aquifer pumping levels exceed natural or artificial recharge. "Overdrafting" is generally defined as a temporary condition in an aquifer, or segment of an aquifer, where the amount of water withdrawn by pumping exceeds the rate of natural and/or artificial recharge overtime. "Sustainability" refers to the optimal quantity of water that can be continuously withdrawn from the aquifer without adverse economic, environmental, and aquifer impacts. These two concepts connote a public policy choice between treating an aquifer as a renewable or a nonrenewable resource.

21. In aquifers with little or no recharge, sustained withdrawals will eventually exhaust the supply or lower water tables below economic pump limits. In effect, the aquifer is being mined. Groundwater mining results in numerous adverse consequences, including reduced flexibility to respond to dry spells and droughts in the future. Additionally, future economic development opportunities may be minimized because of a lack of water. Groundwater mining can also lead to land subsidence. In Texas, groundwater mining occurs in the Ogallala Aquifer and in some of the Bolson Aquifers in and near El Paso, Texas. *See* Table 1.

water from rural to urban areas.[22] When examined in this context, the issues shift from protecting private property rights in groundwater to effectively managing aquifers and groundwater in order to sustain an agricultural economy that is transitioning to an urban service economy.

A. The Judicial Response

Texas is the only major state that follows the judicially crafted rule of capture regarding groundwater. This rule has its genesis in the doctrine of absolute ownership enunciated the 1843 English case of *Acton v. Blundell,* establishing landowner rights to percolating groundwater.[23] From a legal perspective, the rule of capture is simple and straightforward. Landowners have an unqualified right to withdraw unlimited quantities of water beneath their land, without liability to surrounding landowners. In a practical sense, the surface owner does not own the water but only has a right to pump and capture whatever water is available, regardless of the effect on neighboring wells. Conversely, neighboring landowners have this same right.

A landowner has a "bundle of rights" under the capture rule. These include: (1) an access right to capture groundwater; (2) a right to drill a well anywhere on the property to any depth and to any size capacity; (3) an ownership right to the water captured and brought to the surface; (4) a right of use; (5) a right of sale or lease of the water; and (6) a right to export water beyond boundaries of land or of the aquifer.[24]

Landowners may exercise the right of capture, or sell, lease, or assign this right to another. Once assigned, any water captured under the right may be sold and transported off the land, or transferred outside the boundaries of the aquifer.

Two widely cited Texas Supreme Court cases—*East* and *Sipriano*— have affirmed and outlined the general parameters of this law, and other Texas courts have consistently followed the principles of the capture rule.[25] The rule

22. Based on the transfers proposals reported in the 2002 State Water Plan up to 2.4 million acre-feet of surface and groundwater will be voluntarily reallocated from primarily irrigation and agricultural water uses to municipal and industrial uses. To put this in perspective, this is about one-third of the current total surface water and one quarter of the current groundwater use. These proposals clearly suggest that water marketing will be a big part of Texas's water future. *See* TX. WATER DEV. BD., *supra* note 2, at 77.

23. 152 Eng. Rep. 1223 (1843).

24. *Infra* note 25.

25. *See* Barshop v. Medina Co. Underground Water Conserv'n Dist., 925 S.W. 2d 618 (Tex. 1996); Denis v. Kickapoo Land Co., 771 S.W.2d 235 (Tex. Civ. App. 1989); City of Sherman v. Pub. Util. Comm'n of Tx. 643 S.W.2d 681 (1983); Beckendorf v. Harris-Galveston Coastal Subsidence Dist., 558 S.W.2d 75 (Tex. Civ. App. 1977); Friendswood Dev. Co. v. Smith-Southwest Indus., Inc., 576 S.W.2d 21 (Tex. 1978); City of Corpus Christi v. Pleasanton, 276 S.W.2d 798 (Tex. 1955); Pecos County W.C.I.D. No. 1 v. Williams, 271 S.W.2d 503 (Tex. Civ. App.1954); Lower Nueces Water Supply Dist. v. City of Pleasanton, 251 S.W.2d 777 (Tex. App. 1952).

was first enunciated in 1904 in *Houston & T.C. Ry Co. v. East*[26] where the court found the movement of groundwater "so secret, occult and concealed that an attempt to administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would, therefore be practically impossible."[27] Following this line of reasoning, the court adopted the English rule of absolute ownership, granting landowners the right to withdraw groundwater from beneath their land.

The rule was reaffirmed in 1999 in *Sipriano v. Great Spring Waters of America, Inc.*[28] (a.k.a. Ozarka). As with *East*, this dispute involved harm to domestic well owners from a neighboring high capacity commercial well. The Texas Supreme Court refused protection for the domestic well by unanimously affirming the capture rule. However, it did encourage the legislature to address well interference and groundwater mining problems.

B. Judicial Limitations to the Capture Rule

At common law, the capture rule is limited by the following restrictions: (1) malicious pumping,[29] (2) negligent pumping-subsidence nexus,[30] and (3) waste. In theory, these three exceptions seem to be major constraints to landowner abuse, yet as applied by Texas courts they are minimal limitations on exploitation. For example, in *City of Corpus Christi v. Pleasanton,*[31] the Texas Supreme Court adopted the malicious pumping rule but refused to find waste in the transportation of groundwater some 100 miles through a surface watercourse even though three-fourths of the original supply was lost in transit due to evaporation and seepage. Correspondingly, in the *Friendswood Development Corp v. Smith-Southwest Industries, Inc,*[32] the court also held that landowners could recover for subsidence losses caused by negligent pumping of groundwater, but could not recover if their well went dry. Essentially sinking land is actionable but a dry well is not.

C. The Legislative Response

The Texas legislature has not been totally unmindful of the consequences of the capture rule on well interference, over-drafting, mining, and water exportation conflicts. It has said that groundwater may be regulated when it is drawn from the underflow of a river,[33] or by the rules of a local groundwater

26. 81 S.W. 279 (Tex. 1904).

27. *Id.* at 280 (quoting Frazier v. Brown, 12 Ohio St. 294, 314 (1861)).

28. 1 S.W.3d 75 (Tex. 1999).

29. *Id.* at 77.

30. Friendswood Dev. Corp. v. Smith-Southwest Indus., Inc, 576 S.W.2d 21, 26-27 (Tex. 1978).

31. 276 S.W.2d 798 (Tex. 1955).

32. *Friendswood*, 576 S.W.2d at 75.

33. *See* TX. WATER CODE ANN, § 11.021 (Vernon 2005). Underfow of a river is considered state property, however it is not defined by statute. One court has held that it is that portion of the flow of a surface watercourse occurring in the sand and gravel deposits beneath the

conservation district.[34] The Texas Supreme Court, in upholding the constitutionality of the Edwards Aquifer Authority, found that groundwater rights can be regulated, but that individual landowners could sustain a taking claim under certain circumstances.[35]

III. THE EVOLUTION OF GROUNDWATER CONSERVATION DISTRICTS IN TEXAS

Except for Edwards Aquifer Authority, which has an exlicit statutory design related to aquifer sustainability, the powers and duties of Texas groundwater conservation districts (GCD's) have evolved over time. The legislature has empowered groundwater conservation districts to deal with the litany of groundwater issues; the response to date has been mixed. Supporters contend that districts are locally controlled and are best suited to consider local needs in developing their management plans.[36] Critics counter that problems of self-interest, limited funding, local politics, conflict, confusing enabling authority, and the self-limiting nature of these districts prevent the meaningful management and protection of groundwater.[37] Concerns have been raised regarding the number of districts, the motivations for creating districts, the lack of conformity between district and aquifer boundaries, and the lack of integration and coordination between districts and regional water planning groups. In spite of the criticism of groundwater districts, the legislative sentiment remains strong that groundwater should be managed locally.[38]

A. An Overview of Groundwater Conservation Districts

Groundwater conservation districts were first authorized in 1949, and in 1951 the High Plains Underground Water Conservation District became the first Texas district.[39] The number of groundwater districts grew slowly over time, numbering twenty-two by 1985.[40] However, over the last twenty years, the number of groundwater districts has expanded dramatically. By 2000, Texas had fifty confirmed groundwater management districts, and by 2006 the number had grown to eighty-nine.[41]

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surface of the stream bed that is hydrologically connected to the surface flow of the stream. Texas Co. v. Burkett, 296 S.W 273, 277 (Tex. 1927).

34. *See* TX. WATER CODE ANN. § 36.001 (Vernon 2005).

35. *See* Barshop v. Medina County Underground Water Conser'n Dist. 925 S.W.2d 618 (Tex. 1996).

36. *See* Texas Alliance of Groundwater Dists. *available at* http://www.texasgroundwater.org/ (last accessed April 26, 2006).

37. *See supra* note 6.

38. *See* TEX. WATER CODE ANN. § 36.0015 (Vernon 2005).

39. *See id.*, Chapter 36 (Vernon 2005); RONALD KAISER, HANDBOOK OF TEXAS WATER LAW (1986).

40. *See id.*

41. *See* GCD Facts, *available at* http://www.twdb.state.tx.us/gwrd/gcd/factoids.htm (last accessed April 22, 2006).

The smallest district covers an area of about 31 square miles (the Red Sands Groundwater Conservation District in Hidalgo County) and the largest district (the High Plains District) an area of more than 10,000 square miles. Of the eighty-nine districts, fifty-nine are single-county districts. The total reported groundwater usage in Texas for 2000 was approximately 10 million acre-feet. In the same year, the total reported groundwater usage in all the districts in the state was approximately 9 million acre-feet. Districts over the Ogallala aquifer accounted for approximately 6.5 million acre-feet of this usage.[42]

B. Regulatory Authority

Legislative directions given to GCD's reflect a conflicting and confusing mix of public policy directives casting doubt on the regulatory potency of districts.[43] A careful reading of the required regulatory powers reveals that GCD's must only develop a management plan, register certain wells, and adopt governance rules.[44] Surprisingly the Texas Water Code allows GCD's to exempt all wells from regulation.[45] Although they are not required to regulate groundwater, most districts have implemented some type of groundwater regulation related to well spacing.

Most districts work to prevent waste, collect data, educate the public about groundwater and conservation, and prevent irreparable harm to the aquifer. They are governed by a local board of directors which normally hires a manager to oversee the management of the district, including hiring employees, keeping records, implementing the management plan, and administering the regulations.

C. The Mandated and Exempted Duties of the GCD's; Exemptions.

Groundwater Conservation Districts are mandated to do seven things: (1) to develop and adopt a management plan, and coordinate planning with regional planning groups, state agencies and other GCD's;[46] (2) to adopt rules to implement the plan;[47] (3) to set goals to achieve conservation, preservation, protection, and recharge of the groundwater reservoir; to control subsidence; to prevent degradation of water quality; and/or to prevent the waste of

42. *Id.*

43. *See generally* TEX. WATER CODE ANN. §§ 36.101 – 36.1071 (Vernon 2005). The Code contains a litany of powers including the authority to: preserve, conserve and protect the aquifer; regulate well spacing and production;minimize the reduction of artesian pressure;permit and register wells; keep drilling and well records; buy, sell, transport and distribute water; conduct surveys and research on aquifers and pumping; engage in aquifer recharge and recovery; require a permit for water transfers; and levy taxes and/or pumping fees.

44. *Id.* §§ 36.1071, 36.111, 36.113. 36.117 (2005) (Vernon 2005).

45. *Id.*

46. *Id* § 36.1071 (Vernon 2005).

47. *Id.*

groundwater;[48] (4) to register wells and require permits for wells;[49] (5) to keep records on wells and the production and use of groundwater;[50] (6) to adopt governance rules and establish administrative and financial procedures; [51] and (7) to hold regular meetings.[52]

GCD's also have the following nine optional duties. (1) They may regulate the spacing and production of wells.[53] (2) They may set rules to control land subsidence, prevent degradation of water quality, and prevent waste of groundwater.[54] (3) They may buy, sell, transport, and distribute surface and groundwater.[55] (4) They may acquire land by purchase or eminent domain.[56] (5) They may provide public educational materials and programs.[57] (6) They may require wells to be capped or plugged. (7) They may require export permits for water transported outside the boundaries of the district. [58] (8) They may establish export fees. [59] Finally, (9) they may enforce their rules by injunction and also set reasonable civil penalties, not to exceed $10,000 per day per violation, to ensure compliance with the district rules.[60]

There are two principal regulations which are exempted from the control of the GCD's. First, a GCD can exempt any and all wells from permit requirements if the exemptions are documented in the management plan.[61] Second, the following are statutorily exempt from GCD regulation: (a) wells on tracts of land smaller than ten acres in size and used solely for domestic, livestock and poultry production and capable of producing less than 9.1 million gallons per year (less than 25,000 gallons per day); [62] and (b) wells used solely for oil and gas exploration and development.[63]

As outlined, groundwater conservation districts have the choice of a continuum of management styles. Districts can opt for *laissez faire* management, or districts can take a very proactive regulatory approach.

48. *Id.* § 36.101 (Vernon, 2005).
49. *Id.* § 36.113 (Vernon, 2005).
50. *Id.* § 36.111 (Vernon, 2005).
51. *Id.* § 36.154 (Vernon, 2005).
52. *Id.* § 36.064 (Vernon, 2005).
53. *Id.* § 36.116 (Vernon, 2005). A district may regulate total production limits based on: (1) acreage or tract size; (2) a defined number of acres assigned to an authorized well site; (3) acre feet of water per acre of land; (4) gallons per minute per well site, or managed depletion.
54. *Id.* § 36.101(a) (Vernon, 2005).
55. *Id.* § 36.104 (Vernon, 2005).
56. *Id.* § 36.105 (Vernon, 2005).
57. *Id.* § 36.110 (Vernon, 2005).
58. *Id.* § 36.122 (Vernon, 2005).
59. *Id.*
60. *Id.* § 36.102(b) (Vernon, 2005).
61. *Id.* § 36.117(a) (Vernon, 2005).
62. *Id.* § 36.117(b)(1) (Vernon, 2005).
63. *Id.* § 36.117(b)(2)(3) (Vernon, 2005)..

IV. GCD REGULATIONS ON THE OGALLALA AQUIFER

A. *Aquifer Overview*

The Ogallala Aquifer is one of the largest aquifer systems in the world, stretching across parts of South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. The aquifer stretches across approximately 174,000 square miles, and encompasses 111 million acres of land in the Great Plains region of the United States.[64] Approximately twenty percent of the Ogallala Aquifer is in Texas.[65]

The Texas section of the Ogallala is an unconfined and limited recharge aquifer. As a result, groundwater levels fluctuate with changes in atmospheric pressure and with changes in the amount of water stored in the aquifer. Water in a well drilled into an unconfined aquifer will reach the top of the zone of saturation, also known as the water table. The water table in an unconfined aquifer will rise and fall in response to recharge and pumping.

In Texas, infiltration is minimal due both to the presence of an impermeable layer of caliche found just under the soil surface in many areas, and due to the absence of much rainfall. Only about one inch of precipitation actually reaches the water table annually, because rainfall is minimal, the evaporation rate is high, and the infiltration rate is slow. The highest recharge infiltration rates occur in areas overlaid by sandy soils and in playa lake basins.

The Canadian river cuts through the aquifer dividing it into two parts, the North and South Plains. Water depth in the aquifer ranges between 100 and 200 feet throughout much of the South Plains with depths commonly exceeding 300 feet in the northeast portion of the North Plains. In general large irrigation areas north and west of Lubbock, the saturated interval generally ranges between 100 and 300 feet. South of Lubbock, the saturated zones are generally between 50 and 150 feet thick.[66]

Water level monitoring showed a rapid decline in the water table from the early 1950's through the 1970's. Water levels in the Ogallala Aquifer in the northern part of the Texas Panhandle declined an average of about 5.5 feet per year during 1960–80.[67]

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64. "The Ogallala Aquifer," *at* http://www.hpwd.com/the_ogallala.asp (last visited April 26, 2006).

65. "Characteristics of the High Plains Aquifer," http://www-ne.cr.usgs.gov/highplains/hpchar.html (last visited April 29, 2006).

66. *See* Tex. Water Development Board, *supra* note 4.

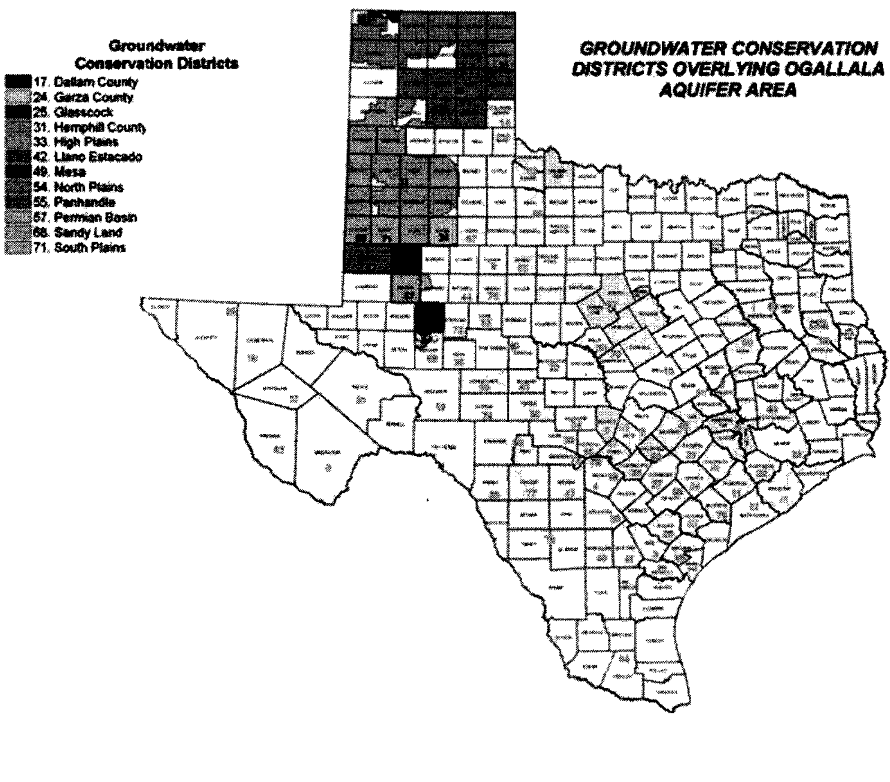
67. Dutton, Alan, Robert Reedy and Robert Mace, Saturated Thickness in the Ogallala Aquifer in the Panhandle Water Planning Area—Simulation of 2000 through 2050 Withdrawal Projections, December 2000, at 7

Groundwater in the Texas portion of the Ogallala is predominantly used for irrigation. An estimated ninety-five percent of the groundwater pumped on an annual basis is used for irrigation agriculture.[68] The remaining five percent is used for municipal and industrial purposes.

B. Groundwater Conservation Districts in the Ogallala Aquifer Region

There are twelve groundwater conservation districts overlying the Ogallala in Texas.[69] The High Plains District was the first GCD created in the state and it has been in operation since 1951. One of the criticisms of GCD's is that they conform to geopolitical boundaries, and not to aquifer boundaries. As outlined in Figure 2 and Table 2, that is certainly the case in the Ogallala. Eight of the twelve districts comprise only one county in size and jurisdiction.

Figure 2: Texas Groundwater Conservation Districts



68. Tex. Water Development Board, *supra* note 2.

69. Each district was contacted for a copy of their management plans and regulatory rules. All districts responded with their plans and rules.

Table 2: Groundwater District Size, by County

Single County	Two Counties	Multiple Counties
Dallam	Permian Basin	High Plains
Garza	Glasscock	North Plains
Hemphill		Panhandle
Llano Estacado		
Mesa		
Sandy Land		
South Plains		

C. District Regulations

With the exception of the Permian Basin, all districts have adopted well registration or well spacing requirements. The degree of regulatory compliance and enforcement is unknown. However, the assumption is that the districts are enforcing their rules.

1. Well Permitting

All districts have well permitting requirements with exemptions for certain types of wells. Except for the Dallam and High Plains districts, which only require permits for wells pumping more than 100,000 gallons per day, the remaining districts exempt wells producing less than 25,000 gallons per day. Districts require permits for changes to existing wells that increase production rates above these minimums.

2. Well Spacing

All districts except the Permian Basin have adopted some type of well spacing requirement. Spacing requirements based on well size or on well production capacity are used as the primary regulation to prevent or limit well interference conflicts. This regulation has modified the capture rule.

Table 3: Well Spacing Requirements

District	Well Spacing t from Nearest Property Line
Glasscock	660 feet
Permian Basin	None
Mesa	300 feet
Llano Estacado	300 feet
Sandy Land	300 feet
South Plains	300 feet
Garza County	300 feet
High Plains	600 feet
Panhandle	300 feet
Hemphill	300 feet
North Plains	450 feet
Dallam	600 feet

3. Pumping Limitations

Districts have the authority to limit water pumping, provided that the regulations relate to aquifer protection and conflict minimization.[70] Production limitations can be based on a volume of water applied to a given acreage of land, on a defined number of acres assigned to an authorized well site, or on production fees.[71]

Three districts have established volumetric pumping limitations.[72] The total annual production limit for a well in the Mesa and South Plains is four-acre feet per acre. The total amount of production of a well or well system in Llano Estacado cannot annually exceed 16.13 acre feet of water per contiguous acre.

4. Production Fees

The economic concept behind production fees assumes that a landowner will conserve water and regulate production if the landowner has to pay an increasing price for the water. No districts in the Ogallala Aquifer use production fees to control pumping. Districts have not adopted the economic logic of using water pricing to control pumping.

5. Export Fees

Districts may impose an export fee on water transported outside the district to cover some of the cost of program administration, but they cannot fund all of their costs exclusively with export fees.[73] Only the Glasscock, Mesa, Hemphill, and Panhandle districts require transportation and export permits. None of the districts levy export fees for water transported beyond district boundaries.

6. Depletion Rates

The decision to manage groundwater as a renewable or nonrenewable resource is a widely debated topic. Sustainability is the practice of limiting use of an aquifer to a rate at which it can be replenished on a continual basis. While some districts may approach aquifer management with sustainability, or

70. TEX. WATER CODE ANN. § 36 (Vernon 2005). In order to minimize the draw down of the water table, to protect artesian pressure, to control subsidence, to prevent well interference, to prevent degradation of water quality, or to prevent waste, a district by rule may regulate the production of groundwater.

71. *Id.* at § 36.116 (Vernon 2005).

72. Some districts set rate pumping limits rather than volume limits. These regulations seek not to limit the total amount pumped but rather to prevent short-term well interference conflicts. Permitted wells in the southern districts of South Plains and Mesa can only pump five gallons per minute per contiguous acre owned. A permitted well in Sandy Land may only produce a cumulative total of five gallons per minute per acre owned. However, permitted wells in neighboring Llano Estacado are allowed to pump a cumulative total of 10 gallons per minute per contiguous acre owned. Only one northern district, North Plains, has a maximum pumping capacity for a tract of land. Wells in this district cannot exceed five gallons per minute per acre on a tract of land.

73. TEX. WATER CODE ANN. § 36.112(e) (Vernon 2005).

depletion allowance as a goal, they are not statutorily compelled to do so.

Only the Panhandle District has established depletion restrictions. Hemphill County and North Plains allow the Board of Directors to establish depletion restrictions, but to date they have not done so. The Panhandle rules specify that the amount of allowable decline will be based on the district's management goal that the district insures that at least fifty percent of the current groundwater supply remains after fifty years.

V. THE EDWARDS AQUIFER AUTHORITY: INTELLIGENT DESIGN?

In order to avoid federal regulation of the Edwards Aquifer under the Endangered Species Act,[74] the Texas legislature established the Edwards Aquifer Authority, and granted it the power to impose pumping restrictions in order to protect spring flows.[75] The Aquifer provides the economic lifeblood for a thirteen county region in south central Texas, extending some 180 miles from Brackettville in Kinney county in the west to Kyle in Hays county in the east (see Figure 3). Including its drainage area, the Aquifer region covers 8,000 square miles and serves as the primary source of water for approximately 1.7 million people.[76]

A. Aquifer Hydrogeology and Water Use

The hydrogeological features of the Edwards Aquifer are well known and have been widely publicized.[77]Due to its limestone composition and its rapid recharge rate, the Aquifer is extremely transmissive, making it susceptible to rapid water level changes from pumping and drought conditions. The aquifer is a single water-bearing system and any recharge, pumping, or spring discharge affects water levels across the entire system.

It is a network of drainage, recharge, and storage areas, consisting of three distinct regions: the Edwards Plateau,[78] the Balcones Fault Zone,[79] and

74. *See* Sierra Club v. Lujan, No. MO-91-CA-069, slip opinion. When springflow decreased to a point that harms the endangered and threatened species, this constituted a "take" under section 9 of the ESA. *Id* at 13.

75. *See* S.B. 1477, codified as Act of June 11, 1993, R.S. ch 626, 1993 Tex. Gen. Laws 2350, available at www. edwardsaquifer.net/1477.html. For a history of the dispute see Eric Albritton, *The Endangered Species Act: The Fountain Darter Teaches What the Snail Darter Failed to Teach*, 21 ECOLOGY LAW QUARTERLY 1007 (1994).

76. For information on hydrology and the geopolitical setting, see http://edwardsaquifer. org/pages/data.htm.

77. *Id.*

78. The Edwards Plateau, encompassing some 4,400 square miles, is the catchment and drainage basin of the Aquifer. Surface water in the form of rainfall, runoff and spring flow from the Plateau is funneled into streams that flow across the recharge area where water penetrates the ground and replenishes the Aquifer. Since most aquifer recharge occurs through streambeds, this funneling effect is an important function of the drainage area.

the Coastal Plain[80] (see Figure 3). Average annual recharge to the Edwards equals 640,00 acre-feet, with an historical range from 43,000 to over 2 million acre feet.[81] So long as the recharge rate equals or exceeds the pumping rate, the Aquifer remains in equilibrium, and wells and springs do not dry up.

Water from the Edwards Aquifer is the critical resource that has supported economic growth and development in south central Texas. Over the last forty years, population growth, industrial development, and agricultural expansion have increased the demand for water, have exacerbated the political tensions between urban and rural interests, and have complicated the management of the Aquifer. The population of the Edwards Aquifer region is expected to increase to approximately 2.3 million by 2020, with the highest concentration of people living in Bexar county.[82]

Water use patterns vary through the region. In the west, Uvalde and Medina counties rely heavily on aquifer water for irrigation. Farmers in these two counties irrigate more than 82,000 acres and irrigation pumping rates have increased 822% from 1958 to 1989.[83] In the center of the region, San Antonio is the largest city in the United States that relies solely on a single aquifer for its water supply. Further to the east, the Comal and San Marcos springs are significant recreational and environmental resources.[84] Comal Springs in New Braunfels and the springs in San Marcos are important recreational resources which have helped the region develop into a popular tourist destination centered around the Guadalupe River. The San Marcos springs are a designated critical habitat for endangered species.[85]

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79. South of the drainage area lies the Balcones Fault Zone, or the recharge zone. It is approximately 1,500 square miles, and includes parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties. In this area many closely spaced, nearly vertical faults occur along the relatively narrow Balcones Fault Zone, exposing fractured Edwards Limestone at the land surface. As the streams originating in the Plateau cross this zone, much of their flow percolates through the streambeds into the aquifer. *See* http://edwardsaquifer.org/pages/data.htm

80. Directly south of the recharge zone lies Edwards Coastal Plain, which is the artesian/reservoir area. It is approximately 2,100 square miles and includes parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties. The groundwater in this area moves generally east and then northeast, toward the spring openings The highest yielding wells are in the artesian zone along a relatively narrow band from near San Antonio northeastward through New Braunfels to San Marcos.

81. See http://edwardsaquifer.org/pages/data.htm

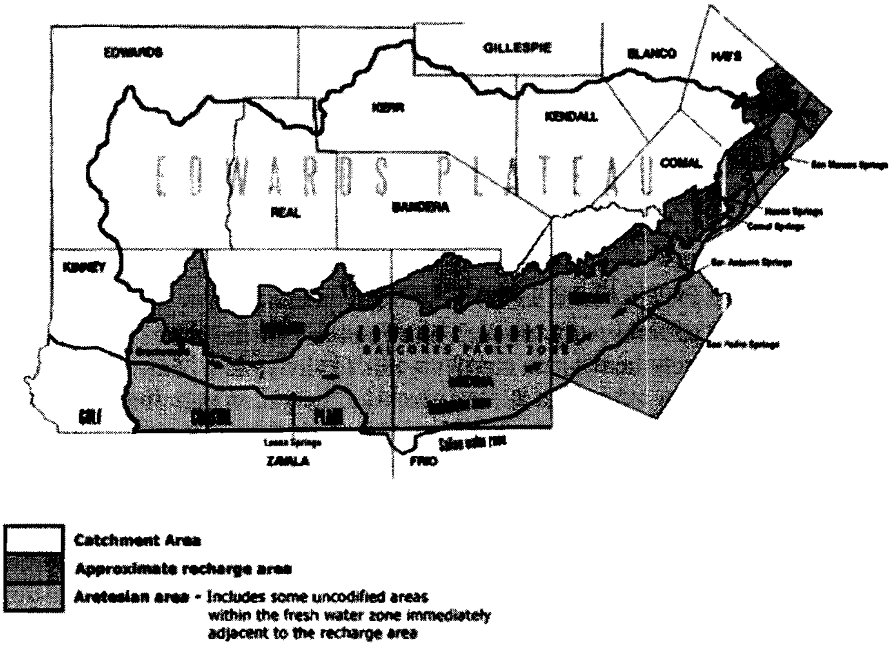
82. See SAN ANTONIO WATER SYSTEM, THE CASE FOR NEW LEGISLATION FOR THE EDWARDS AQUIFER, 11 (1993) [hereinafter SAWS].

83. See Albritton, *The Endangered Species Act*, *supra note* 75, at 1016.

84. The Edwards Aquifer also affects surface water levels in Comal and Hays counties. Approximately thirty percent of the base flow of the Guadalupe River is supplied by the Springs under normal non-drought conditions, and in times of drought the Springs provide up to seventy percent of the base flow. *See* SAWS, *supra note* 82, at 1017.

85. The Springs are vital to maintaining the habitat of the Fountain Darter, the Texas Blind Salamander, the San Marcos Gambusia, the Texas Wild Rice, and the San Marcos Salamander. See SAWS, *supra* note 82, at 86.

Figure 3: The Edwards Aquifer



B. The Edwards Aquifer Authority

Against the backdrop of increasing demand, economic and environmental conflicts, and a threatened federal management of the aquifer, the Texas Legislature established the Edwards Aquifer Authority ("Authority") and imbued it with regulatory potency. The act contains nine principal highlights. First, it established the Authority with the mandated responsibility to prepare a comprehensive water plan for the planning and implementation of a regulatory permit program.[86] Second, it mandated protection for continuous minimum spring flows to protect endangered and threatened species. Third, it limited pumping to 400,000 acre feet annually by 2008.[87] Fourth, it established a mandatory permit system to regulate the use, reuse, and conservation of water.[88] Fifth, it imposed mandatory permit requirements, except for domestic and livestock wells pumping less than 25,000 gallons per day.[89] Sixth, it guaranteed to pre-existing irrigators two acre-feet of water per acre annually.[90] Seventh, it allowed for a water marketing program, but only within the

86. S.B. 1477 §§ 1.02, 1.15 & 1.25.
87. *Id.* § 1.14(c).
88. *Id.* §§ 1.13 & 1.15.
89. *Id.* § 1.33(e).
90. *Id.* § 1.16(e).

confines of the Edwards Aquifer region.[91] Eighth, it established a pumping fee system to provide revenue to the Authority.[92] And finally, it authorized the assessment of administrative penalties as well as injunctive relief to enforce the regulatory powers of the Authority.[93]

Beginning in 1997, the Authority instituted the permit application review process. As of December, 2004, the Authority has issued 865 permits, representing 564,100 acre-feet of withdrawal rights as follows: municipal, 229,000 acre-feet; industrial, 72,100 acre-feet; and irrigation, 263,000 acre-feet.[94]

The act which created the Authority contains conflicting language regarding permissible annual withdrawals. Through 2007, the statutory cap is 450,000 acre-feet annually, but by 2008, the cap is reduced to 400,000 acre-feet. Since the 564,100 acre-feet of permitted annual withdrawals exceeds both mandates, the Authority still has some work remaining to comply with the statutory sustainability standard. Members of the Authority are developing five strategies to comply with the withdrawals caps. Their options include: (1) seeking legislation to increase the cap; (2) purchasing excess rights; (3) reducing water use proportionally; (4) assigning junior rights to the permits over the cap; and (5) ignoring the cap. In spite of awarding permits that exceed the statutory cap, the authority is well positioned to manage the Aquifer in a way that allows for continued growth, while at the same time protecting spring flows and the threatened and endangered species which rely on these resources.

VI. FINAL OBSERVATIONS

Texas has made Faustian choices in allocating, managing, and protecting its groundwater resources. In adopting the laissez-faire capture rule, the Texas Supreme Court sought to minimize political and legal conflicts over groundwater ownership and management, but it left Texas landowners without a remedy for well-interference disputes, and it left Texas aquifers subject to harmful over-pumping and mining. The capture rule provides little protection for rural areas when municipalities seek groundwater to export to their city. In response to these state-wide problems, the Texas legislature has turned to local groundwater conservation districts and asked them to develop and implement solutions to these problems.

Well interference conflicts remain an issue in areas not covered by GCD's. However, groundwater conservation districts and the Authority have the legal power to resolve well interference conflicts within their jurisdiction. All of the districts in the Ogallala, except the Permian Basin district, have

91. *Id.* § 1.34(c).
92. *Id.* § 1.29.
93. *Id.* § 1.37.
94. EAA Annual Report, *available at* http://edwardsaquifer.org/pages/reports. htm.

adopted well spacing requirements to minimize conflicts. Due to the porosity in the Edwards Aquifer, well spacing has not been addressed and is not an issue for the Authority.[95]

Aquifer overdrafting and mining remain pressing issues for the Ogallala and other aquifers in Texas. Districts have the authority to limit production, or to address managed depletion. Only the Llano, Mesa, and South Plains districts have adopted volumetric pumping limits, and only the Panhandle district has adopted a 50/50 managed depletion rule. The remaining districts allow "free market" mining and depletion.

Conflicts over rural to urban transfers of groundwater, and the entanglement of local districts which these disputes create, will remain vexing issues in the rapidly urbanizing regions of Texas. Groundwater transfers and water marketing are viable and cost effective ways to supply water to growing Texas cities and industries. Transfers also promote efficient water use and can supply water for environmental and recreation uses. Marketing is particularly suited for satisfying these new demands, because it encourages voluntary transfers while protecting, promoting, and enhancing private property rights. For example, the Canadian River Municipal Water Authority, located in the northern portion of the Texas Panhandle, recently completed an acquisition plan to transport water from rural areas to urban areas. This project will supply water to the eleven cities in the Panhandle served by the Edwards Aquifer Authority .[96] A water market is also flourishing in the Edwards region.[97] The Authority allows permit holders to transfer groundwater rights to other aquifer uses and uses throughout the region. As of January 2005, the Authority had recorded more than 515 transfers, totaling some 84,000 acre-feet of water, from irrigation to municipal use. This rural to urban transfer pattern will continue to grow. It is a quiet success story that has gone unnoticed..

GCD's may limit the amount of water transferred in order to protect local real local growth demands, but they cannot prohibit these transfers. One problem with limiting the transfers relates to quantifying the amount of water required to meet rural growth needs. Rural areas in Texas are not experiencing rapid population growth, and so have difficulty protecting significant quantities of water from exportation.

Except for the success of the Edwards Aquifer Authority in limiting aquifer over-drafting and in managing the conflicts associated with rural to urban transfers, the record of other GCD's in Texas is spotty. Eventually, they may match the success of the Authority, but this will require an evolutionary process. Over-drafting, mining, sustainability standards, and the economic impacts of local groundwater regulations are state-wide issues that must be addressed accordingly. Delay will only result in further conflict making

95. *See* http://www.texasgroundwater.org/district/Edwards.htm (April 25, 2006).

96. *See* http://www.crmwa.com/ (April 25, 2006).

97. *See* http://www.edwardsaquifer.org/pdfs/2004%20Annual%20Report/BMD/Annual%20 Financial%20Report/pdf_files/EAA_AR_2004-Permitting-Transfer_Process.pdf (April 25, 2006).

solutions harder to achieve.

Overall, groundwater conservation districts have the regulatory tools to address these problems. However, self-interest, limited funding, local politics, and the self-limiting nature of these districts often prevent meaningful management and protection of groundwater. The legislature has not faced up to the problems of the lack of conformity between district and aquifer boundaries, the lack of integration and coordination between districts and regional water planning groups, and the impact of district regulations upon local and regional economies in Texas. The issue is not whether Texas will continue to rely on local districts to solve regional or state problems, for it is a foregone conclusion that it will. Rather the issue is twofold: whether Texas will provide sustainable use standards for its aquifers, and whether it will provide managed depletion schedules for local groundwater conservation districts.